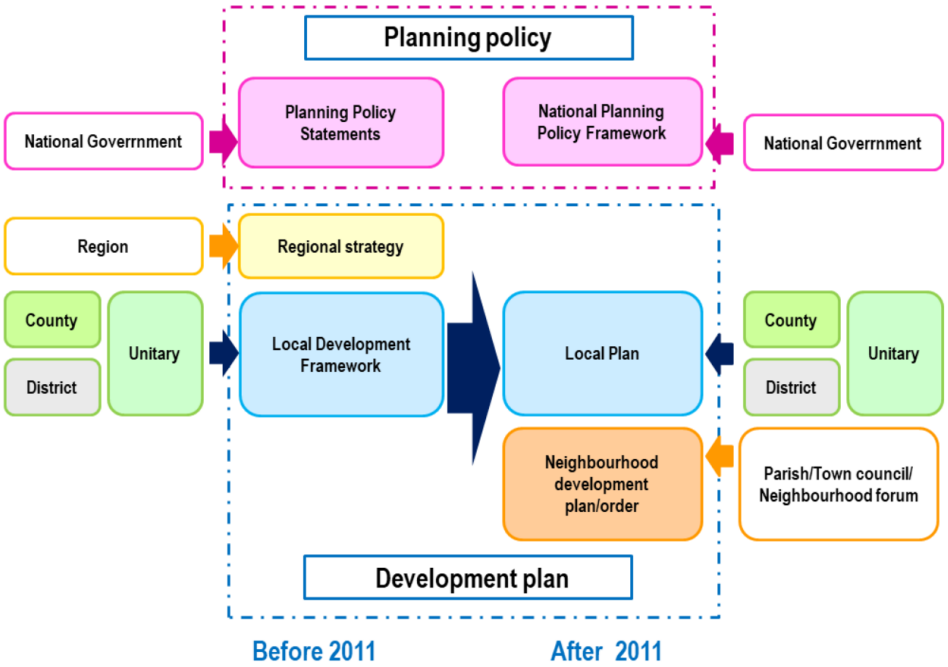


Fig. 2. Spatial development planning in England before and after 2011
Source: Created by authors from the data of the research „An Overview of Spatial Policy in Asian and European Countries."

There are three planning levels in Latvia – national, regional (5 planning regions) and local (119 municipalities) planning levels with development of multiple planning documents in each of them (table 1). There are three planning documents on a national level - *Latvian Sustainable Development Strategy*, *National Development Plan* and *Maritime Spatial Plan*. When developing regional and local level planning documents such as Sustainable Development Strategies or Development Programmes or Plans, the hierarchy of planning levels must be taken into account, which means that need to follow the directions and conditions described in hierarchically higher level planning document (Spatial Development Planning Law, 2011).

Discussions and results
Comparing the developed planning documents in both countries on each planning level, in table 1 it is shown that in Latvia there are at least three planning documents on each planning level while in England it is just *National Planning Policy Framework* on the national level and two plans and *Core Strategy* for 15 years period on local level. Apart from Latvian planning documents of national planning level, *the National Planning Policy Framework* serves only as a guideline in developing *Local Plan, Neighbourhood Plan* and *Core Strategy* (National Planning Policy Framework, 2012). While *Local Plan* and *Neighbourhood Plan* are laid-out plans, *Core Strategy* is a document where the aims of the territory's development for next 15 years are described.

Table 1

Planning documents in Latvia and England

Planning level	Latvia	England
National	• Latvian Sustainable Development Strategy • National Development Plan • Maritime Spatial Plan	• National Planning Policy Framework
Regional	• Regional Sustainable Development Strategy • Regional Development Programme • Thematic Plans	---
Local	• Sustainable Development Strategy • Development Programme • Territorial Plan • Local Plans • Detailed Plans • Thematic Plans	• Core Strategy • Local Plan • Neighbourhood Plan

But not only the number of planning levels and the number of documents on each level are different in both countries, but also the development process of spatial development documents on a local level. For example, comparing the development process of *Local Plan* in England and the development process of *Territorial Plans* and *Local Plans* in Latvia, it was noticed that in England public involvement in the planning process is available in more planning steps than in Latvia (Figure 3, Figure 4).

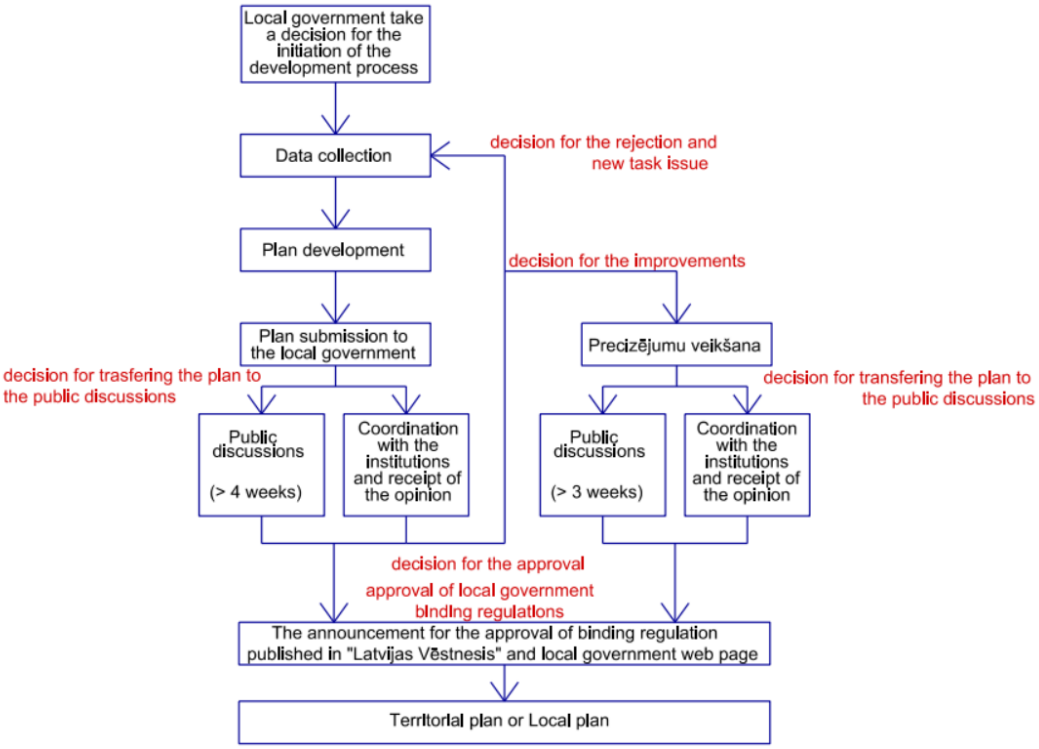


Fig. 3. The development process of Local Plan and Territorial Plan in Latvia
Source: Created by authors from Latvian laws and regulations

Even though the public involvement is possible in both spatial development planning, in Latvia, it is possible for few weeks on steps 5 and 8 (Figure 3), while in England it is possible on steps 1, 2, 4, 6 and 8 (Figure 4).

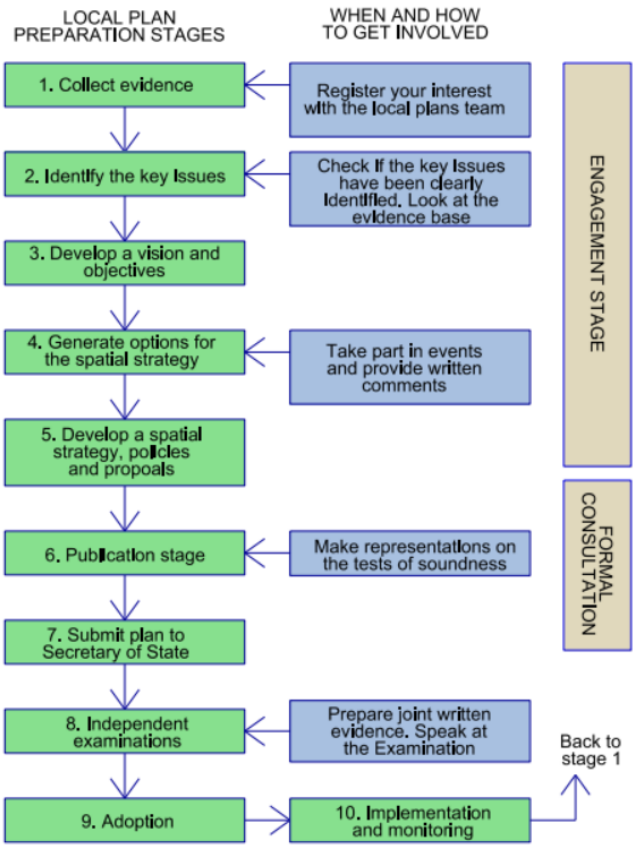


Fig. 4. The development process of Local Plan in England
Source: Created by authors from Guidance: Local plans, 2016

There are also many principles that must be considered in spatial development planning in both countries. The principles described in *the National Planning Policy Framework* and the legislation in Latvia are similar, mostly pointing out that *economic, cultural, social* and *environmental* aspects should be harmonized. They also describe that interests of different industries and spheres should be coordinated, regional development planning priorities of different planning levels should be hierarchically coordinated and the planned solutions' influence on surrounding areas and the environment evaluated (Spatial Development Planning Law, 2011; National Planning Policy Framework, 2012).

The vital importance of the *economic aspect* of the spatial development planning is directed to the questions regarding land as the primary planning object and its the most effective usage economically (Larsson, 2006). In order to ensure the prosperity and needs of people, the promotion of economic development is practically the most critical precondition. It is because to provide the needs of people maximally, firstly, they need to live in an economically secure and stable environment, and the main components of such environment are developed infrastructure and sectors of an economic system (Lektauers, Trusins, Trusina, 2010). In order to promote sustainable development in Latvia and other EU countries, EU funding is attracted and realized in many different development support programs, for example, as for rural territories, tourism, and business development.

Evaluating the *cultural aspect* in Latvia, it was noted that great accent is being put on preservation, renovation, and maintenance of cultural and historical objects. These objects are excellent instruments in tourism development and also for preservation of cultural heritage of the area, which, based on the country's architecture and unique landscapes, promotes the preservation of national identity (Antrop, 2005). However, cultural heritage in rural areas and cities may be different. In rural areas, it is essential to prevent open landscape's deterioration by overgrowing with forests and have a tendency to preserve hedges, masonry walls, natural pastures and other natural objects, which shows the magnificence of the former countryside. In the preservation of city landscapes there are different

values, for example, separate historical buildings, constructions or parks, very often they can be several residential districts (Larsson, 2006).

The environmental aspect is considered as the most crucial spatial planning and development aspect. It is because environment firstly is a union of natural, anthropogenic and social factors (Environmental Protection Law, 2006), which makes it very important in sustainable territorial development because it has a significant influence on people's desire to stay and live in that area. The dominant factors in cities and rural territories are different, but the influence on the landscape and people's living condition very often is easily noticeable.

For a very long time, the aim to preserve and improve environment was suffering from too little attention, especially, if it conflicted with economic interests. However, during the last few decades the situation on a global scale has been changed significantly, and nowadays one of the main problems with particular importance in spatial development are the consequences from the too frivolous attitude towards the environment (Larsson, 2006).

The social aspect is also significant and sometimes even especially accented spatial development planning aspect (Chazdon, Lott, 2010). Social aspects are environment created for human's needs, and it includes healthcare, education, culture, active lifestyle, social work and services, and security, which all together are the most critical issues of social aspect, but it is essential to have people's participation in the development of the territory (Cimdins, 2015).

Population's well-being manifests with improving living standards, different available services, including transport, recreational territory, and public building. All improvements from viewing this and other aspects are closely related to land (Larsson, 2006).

As examples from Latvia there are projects accepted in 2012 and 2015 and many other projects, in order to develop sports and cultural squares, to develop new and upgrade existing tourism routes, and many more, but all of them with full or partial funding from EU. In order to attract more finances for tourism, a unique support programme regarding tourism development for 2014-2020 has been developed. Great importance is being put on investments in researching and development, mostly to increase capacity for innovation and also capability to create new products and services, because then the opportunities of international competition for Latvia would increase. A significant problem in Latvia at the moment is increased numbers of unemployment, but it is considered to reduce the number with developing new industries with an accumulated essential knowledge as financial service, transit, and logistics (National Development Plan, 2012).

As examples from England, there are multiple projects of sustainable development in England's National Parks since 2003. Also, there is a specially founded Sustainable Development Fund which supports with funding many environmental, mostly water, hydrology or water technics related sustainable development local projects.

Conclusions and proposals

1. 2011 was a year of significant changes in the spatial development planning of Latvia and England because new "Spatial development planning law" with several new spatial development planning documents prescribed by the law came to force in Latvia, while England had a reform of spatial development planning system.
2. In comparison, the development of planning documents in Latvia is more complicated than in England, because there are multiple types of planning documents on all planning levels in Latvia, while in England there is only one planning document on national planning level and only two types of planning documents on the local planning level.
3. In comparison, the people in England can get involved in the development process of the local level planning documents more easily than in Latvia because the public participation is allowed from the initiation to the moment of public discussions, while in Latvia all the objections and suggestions are allowed only during the process of public discussions.
4. In both Latvia and England, spatial development planning must follow the principles, which points out that economic, cultural, environmental and social aspect must be harmonized, that interests of different industries must be coordinated and that influence on the environment must be evaluated.

References

1. An Overview of Spatial Policy in Asian and European Countries (2015): Ministry of Land, Infrastructure, Transport and Tourism, Japan. Viewed 2 March 2017, (https://www.mlit.go.jp/kokudokeikaku/international/spw/general/uk/index_e.html).
2. Antrop M. (2005). Why landscapes of the past are important for the future. Landscape and urban planning 70 (1), 21-34.
3. Cave S., Rehfisch A., Smith L., Winter G. (2013) Comparison of the planning systems in the four UK countries. Research paper 13/39, House of Commons Library, UK, pp 18
4. Chazdon S. A., Lott S. (2010). Ready for engagement: Using key informant interviews to measure community social capacity. Community Development, 41 (2), 156.
5. Cimdins R. (2015) Teritoriju socialais potencials: novertesanas iespejas un nozime attistibas planosana. Promocijas darba kopsavilkums. Doktora zinatniska grada iegusanai geografijas nozare Lietiskas geografijas apaksnozare. LU, Riga, 42 (in Latvian).
6. Environmental Protection Law: law of Republic of Latvia (2006). *Latvijas Vēstnesis*, No. 183 (3551), 15 November, 2006.
7. Guiding Principles for Sustainable Spatial Development of the European Continent (2000). European Conference of Ministers responsible for Regional Planning (CEMAT), Hannover, pp 39
8. Ieskats vesture: State Regional Development Agency (Latvia) homepage. Viewed 10 February, 2018, (www.vraa.gov.lv/uploads/Par%20mums/Ieskats%20VRAAvEsture.doc) (in Latvian).
9. Ilgtspejiga attistiba: Ministry of Environmental Protection and Regional Development of the Republic of Latvia homepage. Viewed 10 February, 2018, (http://www.varam.gov.lv/lat/darbibas_veidi/ilgtspejiga_attistiba/) (in Latvian).
10. Larsson G. (2006). Spatial Planning Systems in Western Europe: An Overview. IOS Press, Amsterdam, Netherlands, pp 277
11. Lektauers A., Trusins J., Trusina I. (2010). A Conceptual Framework for Dynamic Modeling of Sustainable Development for Local Government in Latvia. In No: Proceedings of the 28th International Conference of the System Dynamics Society, Republic of Korea, Seoul, Vol. 25, p. 29
12. Local plans: Guidence (2016). Department for Communities and Local Government. Viewed 7 May 2017, (https://www.gov.uk/guidance/local-plans--2#local-plans-key-issues)
13. National Development Plan 2014-2020 (2012). Cross-Sectoral Coordination Centre, Republic of Latvia Viewed 31 January 2018, (http://www.varam.gov.lv/lat/pol/ppd/ilgtsp_att/?doc=13858) (in Latvian).
14. National Planning Policy Framework (2012). Department for Communities and Local Government, London, UK, pp 59
15. Our Common Future (1987): Report of the World Commission on Environment and Development. United Nations, Rio de Janeiro, pp 300
16. Spatial Development Planning Law: a law of Republic of Latvia (2011): *Latvijas Vēstnesis*, No. 173 (4571), 2 November 2011

Information about authors:

Irena Kukule, Mg.sc.ing., lecturer, Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering, Department of Land Management and Geodesy. Akademijas iela 19, Jelgava, Latvia, e-mail: irena.kukule@inbox.lv

Vivita Pukite, Dr.oec., associate professor, Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering, Department of Land Management and Geodesy. Akademijas iela 19, Jelgava, Latvia, e-mail: vivita.pukite@llu.lv Fields of interest: geospatial information systems, land use, real estate valuation.

Vita Cintina, Mg.sc.ing., doctoral student, lecturer, Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering, Department of Land Management and Geodesy. Akademijas iela 19, Jelgava, Latvia, e-mail: vita.cintina@llu.lv Fields of interest: spatial planning, remote sensing, geospatial information systems.

DOI: 10.22616/j.balticsurveying.2018.009

THE CONCEPT OF LAND PLOT AS A COMBINATION OF SMART CONTRACTS: A VISION FOR CREATING BLOCKCHAIN CADASTRE

Andrii Martyn
National University of Life and Environmental Sciences of Ukraine

Abstract
The key features of the blockchain databases, such as decentralization, distribution, security, and record of the history of all transactions, create significant prospects for their application in the field of cadastre and real estate registration activities, including creation of the global real estate cadastre infrastructure, which will be able to go beyond national legal systems and jurisdictions. The conceptual approach to registration of land plots as spatial objects using blockchain technology is proposed. The land plot should be considered as a combination of smart contracts between landowners, surveyors, appraisers, notaries and other persons. The subject of such contracts will be the description and establishment of spatial (plot boundaries, territorial zones, etc.) and other (property rights and encumbrances, monetary valuation, soil bonitet, etc.) characteristics of land plots. The classification of such smart contracts reliability is also presented.
Key words: land cadastre, land plot, blockchain, smart contract, global cadastre.

Introduction

In recent years, it becomes clear that the blockchain technology may have a much wider application than the crypto-currency market. Key features of databases based on blockchain technology, in particular: shared databases, multiple writers, distributed trust, disintermediation, transaction dependency, timestamping, transaction rules, validation, scalability etc., cause significant prospects for their application in the field of cadastral and property registration activities. In particular, today it is possible to model scenarios, in which the state will no longer perform the function of a guarantor of rights to real estate, as well as establish technical and organizational grounds for launching a global cadastral system, which will go beyond national legal systems and jurisdictions. At the same time, many researchers pay attention to the multiple risks related with the transition to blockchain technology implementation in land registration.

Study conducted by the European University Institute (EUI) and European Private Law Forum (2005) indicates that various systems of real estate registration in Europe often are divided between five basic "legal families": Common Law; Civil Law of the countries of the Napoleonic Code; Civil Law of Germany (or of Central Europe); Civil Law of the former Communist countries; Law in the Scandinavian countries. Lodde (2016) conclude, that distinguishing factors between the five families listed above are numerous, but there are five that most readily facilitate the comparison: the organization of the registry; the content of the registration; the substantial effects of registration; the protection (or non-protection) of good faith; the effects toward third parties. In most of the European systems, the structure of the "property sheet" is made up of three parts: (1) description of the property, usually identified with a unique number; (2) ownership of the property; (3) the rights of others on the property, burdens and mortgages.

Real property registration systems of developed countries, as a rule, remain quite traditional and sensitive to changes. At the same time, their "immutability", perhaps, should be regarded as one of the conditions for public trust in their services over the centuries. It should be noted that none of the European countries has fully implemented the registration of real property rights for real estate on the technology of distributed databases.

The concept of a land registry built on the blockchain technology basis is particularly attractive for developing countries or countries conducting land reforms, where cadastral systems are not conservative or at the stage of technological and information development. The state cannot always be considered a reliable guarantor of real estate rights, since officials are often prone to traditional "paper" registration technologies, there is always the possibility of losing the registration data due to negligence, emergency situations, war, etc. Unfair government officials and registrars for whom

registration procedures create a broad field of corruption are becoming a problem for poor countries. Often, at the stage of registering real property rights, the state is trying to interfere in market transactions and limit the economic freedoms of entrepreneurs and citizens.

For example, in Ukraine, where the cadastral system is still in development, the government's decision in 2016 to introduce blockchain technology in the State Land Cadastre has generated considerable enthusiasm in society and the professional environment. In conditions, when paper documents on real estate registration in parts of the country (Crimea, Sevastopol, certain areas of Donetsk and Lugansk regions) are lost or inaccessible due to military occupation, the transfer of the cadastral system to technology, which can guarantee the storage of records of property rights to land and other real estate in a distributed database seems to be a rather tempting idea. Unfortunately, the actual implementation of the blockchain cadastre in Ukraine did not go further than specifying a hash-tag in the cadastre certificates, which could be used only for verifying the validity of the document, while the land cadastre database itself is still kept in traditional form and has not become distributed.

Vos, Lemmen and Beentjes (2017) point out, that compared with a 'classic land registration system', blockchain may even provide some additional certainty. Because of the shared databases there is security of back-ups. Trust is added by cryptographic proof and a decentralized database, especially in the case the current administrator (registrar) is not trusted. It might save costs because of remediation of intermediaries (notaries or licensed conveyancers) or administrators (registrars). Therefore, it can be judged as an alternative for the classical land registers. But without the cooperation of legal and geodetic professionals, who indicate the legal and geodetic meaning and its implications, the use of blockchain might not be applicable in the right way and might even backfire in the absence of knowledgeable (legal and geodetic) council. Implementation of such techniques could result in unforeseen circumstances.

Barbieri et.al. (2017) conclude that in judicial matters blockchain raises serious security concerns, promotes tax fraud and money laundering and itself does not offer any solutions for document and data storage, data transport and data protection, issue of certificates and the transfer of ownership to users, genuine authentication of users, preservation of evidence and encryption, protection against key loss and sustainable management. So, from today's perspective, blockchain technology seems to be useful only in the context of machine-to-machine communication, because of the high affinity of the blockchain for standards: the more participants and transaction types exist, the more complex the adoption of new standards becomes.

Peiró and Martinez García (2017) considering the legal aspects of the use of blockchain in land registers, note that the transfer of land rights is not similar to the transfer of shares, since the rights to land are more complex.

It should be noted that the existing studies are largely focused on the use of blockchain technology, first of all, when registering property rights (titles) for land plots. However, many researchers note that the role of a surveyor, who is responsible for describing the spatial characteristics of real estate, as well as the role of a registrar or a notary, certifying the legality of the transaction, does not find sufficient reflection in the concept of the blockchain land registry.

Thus, the conceptual approaches to blockchain registration of land parcels as spatial objects, in the formation of which not only landowners or land users take part, but also land surveyors, appraisers and other specialists carrying out a description of spatial and other characteristics of land plots, remain practically unexplored.

Methodology of research and materials

The purpose of the study was to define a conceptual approach to describing the characteristics of a land plot when maintaining a land registry using the blockchain technology. Technical aspects of blockchain land registry were not considered, but the article operates with the generally accepted concept of this technology as continuously growing list of records, called blocks, which are linked and secured using cryptography. Each block typically contains a cryptographic hash of the previous block, a timestamp, and transaction data. The concept of a smart contract in this article is taken as a computer protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart contracts allow the performance of credible transactions without third parties. These

transactions are trackable and irreversible. In the course of the research, an attempt was made to introduce the new concept of the “land plot” as a set of smart contracts, at the conclusion of which a fixation of various characteristics of the real property is made.
It should also be noted that the registration system based on blockchain technology can in fact be considered as a further extension of the type of land registration systems based on the registration of deeds (documents), since the system will register transactions (contracts) regarding land plot.

Discussions and results
It is worth noting that the use of blockchain technology for the registration of real estate will require, first of all, an introduction of a new definition of the concept of "land plot" as a set of smart contracts, the subject of which is the establishment of spatial (boundaries of land, restrictions, lands, servitudes, etc.) and others (monetary value, soil yield class, market value, etc.) characteristics of land plots. Smart contract (hereinafter – SC) is a computer protocol that simplifies, verifies, ensures compliance with the negotiation or execution of the contract. Signatories (parties) of such SC should be: (1) owners (users) of land plots; (2) owners (users) of adjacent land plots; (3) competent engineers carrying out a geodetic description of the boundaries (surveyors); (4) competent specialists who establish other characteristics of the land plot (for example, notaries, appraisers, soil scientists, hydrologists, geologists, etc.) (Fig. 1).

Fig. 1. The conceptual model of interaction of participants of the land plot related smart contracts.

In an ideal situation, the boundary of a land plot should be considered as the result of a multilateral SC, which outlines a standardized geodetic description of the boundary between the land plot and neighboring plots signed by the electronic digital signature of the land surveyor and the signatures of the landowner and owners of adjacent land plots. Taking into account that consensus on all spatial characteristics of a land plot may take a long time, spatial characteristics of land plots should be recorded using SC with different levels of reliability – from the most primitive to the most perfect ones.
A separate issue will also be the procedure for the initial recognition of land plot ownership. Obviously, at the initial stage of the functioning of the new registration system, this function can be assigned to a group of special persons – notaries or state registrars who will nominally sign the first ("zero") SC, confirming the existence of rights of owner to the land plot, based on existing title documents at the time of the first registration in the blockchain database.
Five different levels of reliability of the SC related with registration of the land plots and their properties can be offered. Information on land plots registered with SCs with a higher level of reliability, respectively, should have priority in the event of conflicts or disputes.

Level I: Description of the boundaries of the land plot is absent

In fact, contract should be considered "zero" SC, if it is concluded between the owner and the person who certifies with his signature the primary registration of the existing right (notary or registrar). The basis for the primary registration of the right should be the title documents available to the owner, on the basis of which his rights are confirmed. Thus, the "zero" contract serves, first of all, for the confirmation of the title to the land plot. This contract, in addition to ascertaining the existence of the right to a real estate object, may also provide a payment of the services of a person confirming ownership.

Level II: Description of the boundaries of the land plot is absent, but location of the land plot is described as a point object

SC is signed between the owner of the land plot by the land surveyor who described the geographical location of the land plot with the coordinates of its centroid. This type of SC may provide payment for the services of the land surveyor. Such a way of identifying the location of land plots can be considered as one of the most primitive, but for countries with low incomes, even such a simple spatial identification of a land plot can be a mass solution for the initial filling of land registry data.

Geographical identification of the land plot can be specified later by signing new SCs with the land surveyor, on the basis of which a new block with updated information about the coordinates of the centroid of the land plot will be added to the blockchain.

Land plots registered with a second level of reliability on the coordinates of the centroid will in fact correspond to the concept of a "point cadastre" (Antwi et.al., 2012).

Level III: Boundary of land plots is described as a line(s)

In this case, the subject of the SC is the establishment of a boundary between two neighboring land plots. The boundary is described in the form of a polyline(s) with known coordinates of the turning points, as well as an indication of the accuracy with which they were determined. In this case, the subject of the SC is the establishment of a boundary between two neighboring land plots. The boundary is described in the form of a polyline with known coordinates of the turning points, as well as an indication of the accuracy with which they were determined. The contract is signed by the land surveyor, who established the border, as well as the owner of the land plot.

In fact, in this case the border can be established "unilaterally". Of course, the land surveyor, within the limits of his competence, must identify the existing boundaries of the land plot on the terrain, if such boundaries are fixed by landmarks. At the same time, the existence of land plots, boundaries of which are not identified on the ground is quite possible (for example, plots allocated as land shares in the process of land reform within the boundaries of the field).

Level IV: Boundary of the land plot is described as the line agreed by the neighboring landowners

In this case, the boundary between two land plots is established by the land surveyor as a polyline in a manner similar to the third level of reliability. But the main feature of a SC is now multilateralism: it must be signed by the land surveyor, who established the border, and both adjacent landowners, whose land plots share this border.

It can be noted, that in this case the contract will in fact perform the function of coordinating the border between neighbors. Of course, further changes to the boundary established in this way can occur solely by mutual agreement of the owners of adjacent land plots.

A prerequisite for such a delimitation is also the presence of registered property rights for the neighbor's plot. A block with geographic information about an agreed by SC boundary line between parcels should be added to the blockchain on both land plots.

Level V: The boundary of the land plot is described as a polygon

This level of reliability of registration, in fact, is not connected with the signing of additional SCs, but it reflects the state of registration of the land plot, under which contracts corresponding to the fourth level of reliability are concluded with all owners of adjacent land plots. Thus, the set of polylines of individual boundaries conditionally turns into a closed polygon.

The SC may also envisage the entry into force after verification of the spatial (geodetic) parameters of the land plot by another land surveyor or group of land surveyors, which may be considered as an additional way to increase confidence in the information to be recorded.

When transferring rights to a land plot, its spatial characteristics, recognized by the previous owner, will be preserved, and their change will require the conclusion of appropriate new SCs. Fixing other characteristics of a land plot (for example, a monetary valuation of a plot, boundaries of land, soil cover, etc.) should be considered as the subject of landowner's SCs with competent specialists, which provide relevant data.
One of the traditional functions of land registers is the guarantee of property rights and the resolution of disputes, which requires, first of all, retrospective information on all actions that took place with rights to the land plot and its borders. Taking into account the distribution and publicity of the land registry, the management of which is carried out on the basis of the detachment, it can perform such a function quite effectively.
An interesting option arising from the development of a distributed land registry on the basis of a blockchain is the possibility of creating a global cadastre that will no longer depend on national legislation and jurisdictions. Sooner or later, before mankind there will be a need to register real rights to immovable property (or objects equated to immovable property) located beyond the surface of the Earth and state borders, and for this purpose the blockchain property registry will be very convenient. Undoubtedly, this is a very distant prospect, but this is not an excuse for the scientific community to postpone consideration of these possibilities.
It should also be noted that the registration system based on blockchain technology can be viewed as a further continuation of the type of land registration systems based on the registration of deeds (documents), since the system will actually register transactions that are subject to rights to the land plot or its characteristics.
The development of distributed land registers can take place both with the support of the state (when it considers the blockchain-cadastre as a way to reduce government costs) and when it counteracts (when the state does not want to lose monopoly control over the registration of property rights). In the second case, an interesting option may be the creation of special organizations or companies that will perform the function of a nominal owner of real estate in accordance with the national legislation of the country in which it is located. In turn, the actual right to own or use land plots can be provided on the basis of the registration data provided by the "non-state" distributed land registry.

Conclusions and proposals

The creation of distributed land registries (cadasters) based on blockchain technology still raises concerns among many experts in the field of law, land administration and cadastral systems. At the same time, the possibilities of this technology inspire many researchers to find new ways of reliable registration of property rights for real estate.
The key idea of this research is to consider the land plot as a set of "smart contracts" between the landowner and land surveyors, notaries, appraisers and other specialists whose work creates an array of information about the land parcel as a real estate object.
The proposed approach can be considered as one of the first attempts to define a concept on the basis of which it is possible to develop a decentralized blockchain infrastructure not only for registration of transactions with real estate, but also spatial and other characteristics of real estate as objects of property rights. In the long run, this will allow governments to deprive not only the functions of the registrar of real rights to real estate, but also the functions of administering the cadastre of real estate, reducing the taxpayers costs.
Further studies may be devoted to the development of unified formats for describing information on land plots within the framework of a distributed land registry. Also, the technical feasibility of effective operation of such registries should be assessed based on the volume of the database, the number of transactions conducted, and the quality of the cadastral data. Further research is also needed to improve the means of identifying the owner of real estate, prevent fraud, and control the accuracy of geospatial data.

References

1. Real Property Law and procedures in the European Union – General Report, 31/5/2005. Study conducted by the European University Institute (EUI) Florence / European Private Law - www.iue.it - Forum Deutsches Notarinstitut (DNotI) Würzburg.

2. Lodde A. (2016). The European systems of real estate. Territorio Italia. 2016;2016(1/16):23-42 DOI 10.14609/Ti_1_16_2e
3. Vos J., Lemmen C.H.J., Beentjes B. (2017). Blockchain-based Land Administration: Feasible, Illusory or Panacae? In Responsible Land Governance: Towards and Evidence Based Approach, Washington, D.C. March 20-24, 2017 : Proceedings of the Annual World Bank Conference on Land and Poverty Washington, D.C.: The World Bank.
4. Barbieri, M., Gassen, D. (2017). Blockchain – can this new technology really revolutionize the land registry system? Paper prepared for presentation at the "2017 World Bank Conference on Land and Poverty" The World Bank – Washington DC, March 20-24, 2017. Viewed 7 June, 2018, (http://www.notartel.it/export/contenuti_notartel/pdf/Land_Poverty_Conference_Blockchain.pdf).
5. Peiró N., Martinez García E. (2017). Blockchain and Land Registration Systems. European Property Law Journal, 6(3), pp. 296-320.
6. Antwi R., Bennett R., De Vries W., Lemmen C., Meijer C. (2012). Requirements for point cadastres. In: FIG Working Week 2012, Rome, 6-10 May 2012 "Knowing to manage the territory, protect the environment, evaluate the cultural heritage. Rome: FIG. 2012, 11 p.
7. Hackman-Antwi R., Bennett R., De Vries W., Lemmen C., Meijer C. (2013) The point cadastre requirement revisited, Survey Review, 45:331, 239-247, DOI: 10.1179/1752270612Y.0000000015
8. McDougal, K & Bennett, Rohan & van der Molen, Paul. (2013). The global cadastre. 27. 30-34.
9. Loenen, Bastiaan van, Sergio NassarreAznar, Hendrik Ploeger, 2005, EuroTitle: a standard for European Land Registry Paving the road to a common real estate market. GIM International Volume 18, ISSN 1566 9076.

Information about author

Andrii Martyn, Dr.Hab. in Economics, Assoc. Prof., Head of the Land-Use Planning Department, National University of Life and Environmental Sciences of Ukraine. Address: Office 117, 17 Valylkivska str., Kyiv, 03040, Ukraine; phone: +380672745061; e-mail: martyn@nubip.edu.ua . Fields of interest: land administration, spatial planning, land market regulation, cadastre systems.

DOI: 10.22616/j.balticsurveying.2018.010

THE CITTASLOW MOVEMENT IN RURAL AREAS – A CASE STUDY OF A VILLAGE IN THE POLISH REGION OF WARMIA AND MAZURY

Katarzyna Pietrzyk
University of Warmia and Mazury

Abstract
The international Cittaslow movement brings together towns that promote the slow life philosophy. The concept has been developed in response to the increasing pace of life and the adverse effects of globalization. According to the members of Cittaslow, the organization contributes to the sustainable development of their regions and to improvement of the quality of life. In view of the benefits of Cittaslow membership confirmed by research studies, the question arises whether the concept of Cittaslow could also be introduced in rural areas. This paper seeks to answer the above question. The study involved an analysis of the Cittaslow membership criteria (Cittaslow goals) and a survey conducted among the inhabitants of the Warmian village of Żabi Róg. The results of the study were used to test the research hypothesis and to assess the quality of life in the analyzed area.
Keywords: rural areas, quality of life, slow life, Cittaslow

Introduction

The slow life concept has been gaining increasing popularity in the 21st century. A fast-paced life and a multitude of responsibilities have disrupted the harmony of human existence. A need was born for an idea that would remedy these problems while preserving a high standard of living. The slow life philosophy draws upon centuries of tradition in various cultures and religions (Buddhism, Christianity) to promote the idea of modern life that is based on mindfulness, inner reflection, richness of simplicity, modern solutions that respect tradition, culture, the natural environment and sustainable development. Mostly slow life organizations focus their activities in large cities and highly urbanized areas that are most susceptible to negative consequences of globalization. However, the slow life movement has not been sufficiently adapted to the specific needs of rural areas (Botta 2016).

The main aim of the research was to show whether the Cittaslow concept can also be implemented in rural areas. The village was analyzed on the basis of a modified and expanded certification procedure for Cittaslow candidates. At the same time, this study is an attempt to evaluate the quality of life in a village in the Polish Region of Warmia and Mazury based on the criteria for Cittaslow accreditation, which is an intermediate goal. The outcomes were compared with the results of a local community survey to determine whether the fundamental principles of the slow life movement can be adapted to rural areas, and to evaluate the perceived standard of living in the village of Żabi Róg. The analysis of the type has never been conducted in Poland or in other countries, and the present study is the first attempt to transfer the Cittaslow concept to rural areas.

Rural areas

In the second half of the 20th century the rural area was defined as the area of the state with low population density, whither dominate agricultural activity also forestry and fishing. Which was often identified with the use of land, leaving aside the social aspect - this concept was quickly considered wrong. This is strongly emphasized by the present research, which consider the rural area as a complex phenomenon with many features. In the 1990s you could easily see approaches close to nowadays, the rural area was considered to be an area outside the city border, which is distinguished by a number of different or similar statistical indicators, for example: population density, agrarian structure, occupational activity rates, etc. (Bański i Stola 2002). Today, it is emphasized that defining a rural area requires flexibility, and any definition at the time of creation may become obsolete or incomplete. It is accurate to say that there is a "discourse to recognize them as a multifunctional

space, taking into account both the features of the diversification of the functional structure of the local economy and human communities" (Stanny 2014, p. 128).
The aforementioned changes in rural areas in the 21st century will occur in a very dynamic way. It is difficult to determine what direction they will take, because there are many global and local trends in the world. They have a significant impact on the shape of the Polish countryside. The orientation most often presented is focused on counteracting the basic problems of modern times, such as disorders of demographic structure, social problems, monofunctionality, deficiencies in social and technical infrastructure (Bański 2013a). Not only the phenomenon of globalization causing excessive competitiveness, discrimination of rural areas outside the suburban zone, but also the development of agricultural technology, Internet networks, increasing the pool of external subsidies, and scientific and technical solutions is still a major impact on the rural areas. It is related to the need to adapt Polish rural areas to global trends, especially economic ones. Uniformity of the world leads to the necessity of finding unique features of the region, original food products. This is how the next trend is shaped: localization characterized by adapting modern solutions and technologies to the potential and resources of a given place. In recent years more and more often this trend can be found in the Polish countryside, where the local population, its value, culture and history are appreciated. Recent publications emphasize that the best solution is to combine the two trends described above, and both their positive and negative features are a developmental stimulant. Researchers particularly stress the negative transformations and their effects, environmental and climate disasters. The surface of natural spaces is reduced in favor of anthropogenic ones, but the concept of primary landscape has no reference in reality. At the same time, increasing social awareness causes the formation of pro-ecological organizations, repeated use of raw materials, renewable energy sources, renewal of forgotten plants, breeding of endangered animal species and many other activities. Trends and directions of changes are many more, and how the future will look like we will learn only after some time (Banski 2013b).

Methodology of research and materials
The village of Żabi Róg is situated in the Polish Region of Warmia and Mazury, Ostróda county, Morąg municipality (Fig. 1). According to German historical sources, the village was founded in 1340. Its name has changed for multiple times over the centuries, from Złoty Róg to Róg, Górniki and, ultimately, Żabi Róg in 1947 (*Pociąg do przeszłości …2008*).

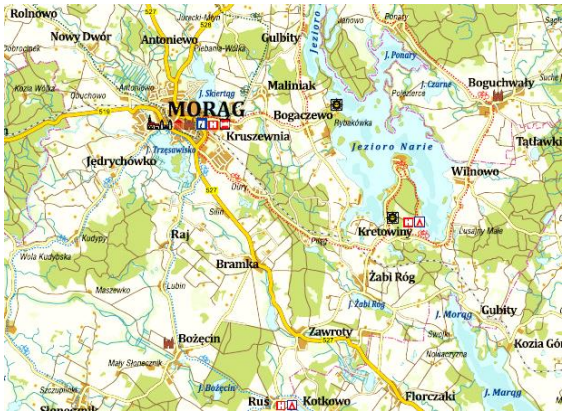


Fig. 1. Location of the village of Żabi Róg
Source: Renewal Plan for Żabi Róg Village for 2014-2020. (2013)

Żabi Rog is the largest village in the Morag municipality with an estimated population of 1,200 people. The village has a railway station, and it is also connected with the regional cities by a network of county and regional roads. Żabi Róg is surrounded by picturesque forests and lakes, Lake Żabie is situated in the Centre of the village. There are several farms in the village, but agricultural production is not the main source of income in the area due to poor geomorphological conditions (*Renewal Plan* for… 2014).

It is worth mentioning how land use planning works in the area of the village of Żabi Róg. The first planning document that allows you to keep harmony in the area of the village is "Study of conditions and directions of spatial development of the commune of Morąg. Area of the City and Rural Areas". It covers the whole area of the village, defines the basic principles of spatial policy of the region, and its findings are binding for the authorities when creating new local zoning plans. The second extremely important document is Resolution No. VI / 44/11 of February 24, 2011, regarding the adoption of a local zoning plan for the commune of Morąg within the geodesic area of Żabi Róg. The plan covers as much as 45.5% of the area of the village of Żabi Róg, the remaining 54.5% (land not covered by the plan) are mainly agricultural, forest and meadow areas. This enables the maintenance of spatial order in the central part of the village, stimulates the proper development of social and technical infrastructure. Analyzing the graphic part (Fig. 2) of the local plan for the village of Żabi Róg, the dominance of agricultural land can be observed (129.22 ha), a significant role is played by farm buildings, farms and horticultural farms (81.11 ha), single-family housing, service areas (61.70 ha) and forests (44.98 ha). The smallest area was allocated for cultural services, areas of technical infrastructure and water supply.

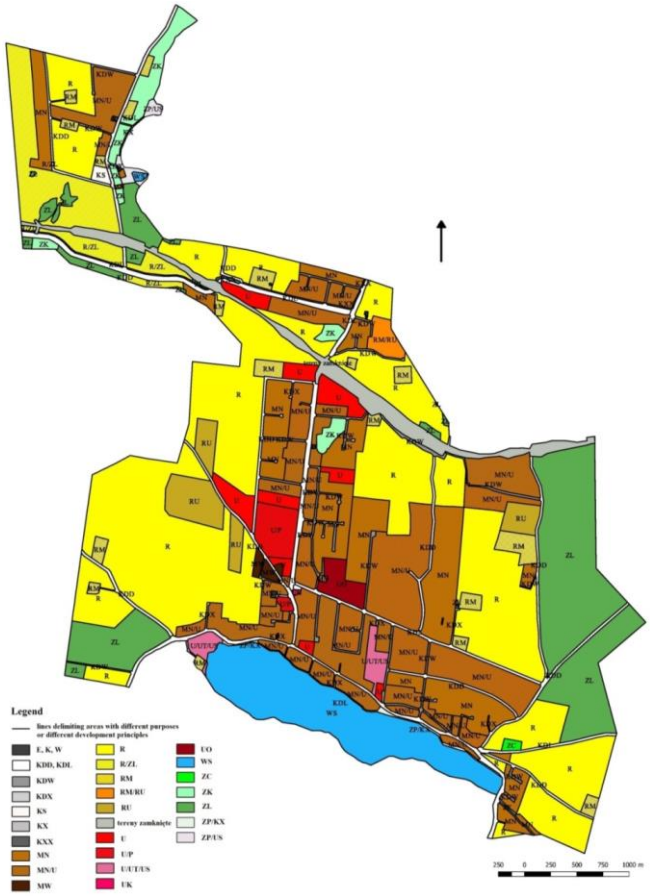


Fig. 2. Local spatial development plan for the village of Żabi Róg

Legend: E-areas of technical infrastructure–electrical power engineering; K-areas of technical infrastructure–sewerage; KDD-areas of public access roads; KDL-areas of public local roads; KDW-areas of internal roads; KDX-areas of pedestrian and footpath; KS-parking; KX-areas of pedestrian routes; KXX-areas of walking and cycling routes; MN- areas of single-family housing; MN/U areas of single-family housing/areas of service development; MW-areas of multi-family housing; R-agricultural areas; R/ZL- agricultural areas with the possibility of afforestation; RM- areas of farm buildings on farms, farms and horticulture; RM/RU- areas of farm buildings on farms, farms and horticulture as well as production areas on farm and fishing farms; RU- areas for production services on farms, farms, horticultural and forest and fishing farms; U- areas of service development; U/P- areas of service development/areas of production facilities, warehouses and warehouses; U/UT/US-areas for service development/tourism areas/areas for sports and recreation services; UK- areas of cultural services; UO-areas of education services; W-areas of technical infrastructure – waterworks; WS- areas of surface water inland;

ZC-cemetery; ZK-natural and landscape greenery; ZL-forests; ZP/KX-greenery areas and walking routes; ZP/US – greenery areas, sports and recreation.

An attempt was made in this study to determine whether rural residents adhere to the slow life philosophy and whether villages should be incorporated into a slow life organization. The local standard of living was evaluated with the use of the self-assessment procedure for Cittaslow candidates applicable to Polish cities. The results of the evaluation were analyzed to determine whether the Cittaslow network should be expanded to include rural areas or whether the slow life concept should be transposed to the rural setting as part of a separate organization such as *Villageslow*. A separate rural organization would have to develop its own charter because the Cittaslow International Charter applies only to urban areas. The results of the assessment were also used to discuss the possible charter of a slow village organization in areas relating to membership fees, support for village administrators in the certification procedure, and candidate admission criteria. The quality of life was evaluated based on the modified self-assessment process for Cittaslow applicants. The potential candidate in this case would be the village of Żabi Róg which should score at least 50% in the evaluation, but unlike in the Cittaslow network, none of the criteria were obligatory. The above provision has been introduced on account of the fact that Polish rural areas differ considerably in their level of development. Separate groups and criteria have been introduced in the self-assessment process for rural areas. According to the Cittaslow charter, cities are evaluated based on 72 criteria in 7 policy areas. The rural accreditation requirements have been adapted to local needs, and the introduced modifications are presented in Table 1. The modified classification process for rural area consists of 40 criteria divided into 6 policy areas.

Table 1

Cittaslow accreditation criteria modified for rural areas

Policy area	Criteria	Policy area	Criteria
I. Energy and the environment	Air quality conservation	II. Infrastructure	Efficient cycle paths
	Water quality conservation and water consumption		Length and quality of roads
	Selective waste collection, landfills, composting bins		Quality of public transport
	Wastewater treatment		Elimination of architectural barriers
	Energy conservation		Access to public services
	Reduction of visible pollution, traffic, noise		Access to basic services (shops, schools)
	Preservation of biodiversity		Employment, unemployment, commuting
III. Quality of rural life	Initiatives promoting rural development	IV. Agriculture, tourism and craftsmanship	Development of organic farming
	Support for families and development programs		Promotional of traditional work methods and occupations
	Sustainable land use		Use of local products
	Internet access		Taste education and promotion of local products
	Creation of spaces for the commercialization of local products		Preservation and appreciation of local cultural events
			Additional hotel/restaurant capacity (diversity)
V. Hospitality, awareness and training	Hospitality and warm welcome	VI. Social cohesion	Social problems – low percentage
	Increasing the awareness of operators and traders		Degraded ad devastated areas
	Slow routes (cycling, historical, etc.)		Integration of persons with disabilities
	Health education (combatting obesity)		Youth status
	Local initiatives		Reduction of poverty
	Cooperation with other organizations		Community building
	Support for Cittaslow campaigns		Political participation
	Use of the Cittaslow logo on headed paper (in the future)		Youth activity centers

Source: made by the authors based on the Cittaslow International Charter 2017

The self-assessment procedure for Cittaslow candidates is long and detailed. Therefore, a grading scale was developed for the needs of this study. In the proposed system, candidates that do not meet a given requirement are also evaluated for their growth potential and the efforts undertaken to achieve specific goals. Every criterion was analyzed and validated based on the documents and information obtained from the Morąg Town and Municipality Office or other public institutions. The grading scale was adapted to the needs of the study based on the fulfillment of every criterion: the criterion has been met (+), the criterion can be met (0), the criterion has not been met (-), data not available (nd).
The second research method was a survey, and a dedicated questionnaire was developed to survey the opinions of Żabi Róg residents. The surveyed population consisted of 25 persons who accounted for around 2% of the local population. The questionnaires were hand delivered to members of the local community and were completed anonymously by the respondents. The questionnaire contained 9 open-ended questions written in casual language (Apanowicz 2002).

Discussions and results

The quality of life in the village of Żabi Róg was evaluated based on a modified self-assessment procedure for Cittaslow candidates (Table 1). The evaluation was conducted based on 40 criteria divided into 6 policy areas. The results were presented separately for each of the 6 policy areas as well as cumulatively for the village of Żabi Róg to provide a detailed overview of the criteria where the village did and did not meet the 50% threshold.
Energy and environmental policies were the first analyzed area (Fig. 3) with 7 criteria relating to the availability and quality of the local utility networks (water supply, sewage disposal, power grid, municipal heating, gas supply). Air and water quality, biodiversity, pollution, noise and waste management were evaluated in the environmental dimension.

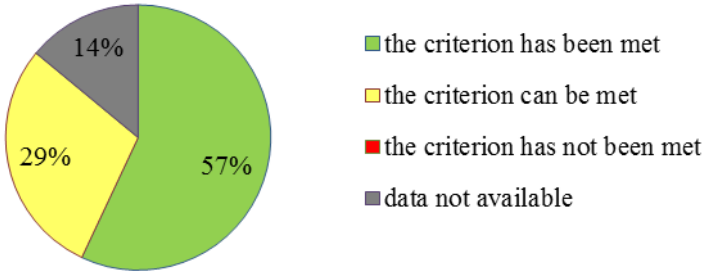


Fig. 3. Score in the energy and environmental policy area

The analyzed village met 57% of the requirements (4 out of 7) in the energy and the environment policy area. Żabi Róg has a sewage network, a water supply network and a biological wastewater treatment plant. Only several households in the outskirts of the village do not have access to public utilities (criteria: Wastewater treatment, Water quality conservation and water consumption). Municipal authorities initiated biodiversity protection measures, they manage Lake Żabie, regularly stock the lake and prohibit boat fishing. The village is surrounded by forests, and the land-use types indicated in the local zoning plan include forests, public greens and agricultural areas (criterion: Preservation of biodiversity). All households have an access to the power grid, and energy conservation campaigns are conducted locally (criterion: Energy conservation). The following two criteria can be met because the village has a high energy and environmental potential. The municipality has the required resources, procedures, structures and facilities for fulfilling the described requirements. Household waste is collected on selected days of the week and is processed by a professional operator in Morąg. Many households have composting bins. There are no selective waste collection schemes, and the local residents are reluctant to sort waste (criterion: Selective waste collection, landfills, composting bins). Traffic is low, the village can be accessed by several roads, and it is situated in the proximity of a regional road that shifts some of traffic away from local roads. Information about traffic noise was not available. There are no polluting businesses in Żabi Róg. The village is not connected to a municipal heating network, and households are equipped with largely

outdated coal-fired furnaces which contribute to local pollution (criterion: Reduction of visible pollution, traffic and noise). Data on air quality and air protection were not available.
Rural areas require efficient infrastructure policies (Fig. 4). In the infrastructure policy area, the village was analyzed based on 7 criteria relating to the labor market, unemployment, roads, pavements, public transport and architectural barriers. Easy access to public and social services contributes to social cohesion in rural areas.

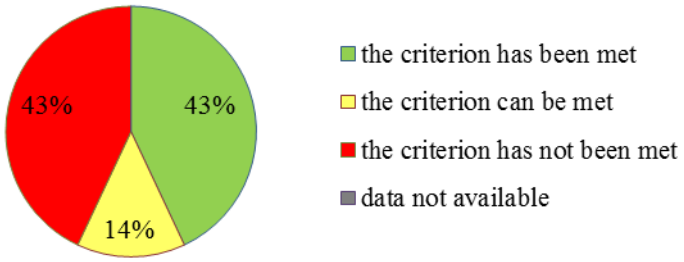


Fig. 4. Score in the infrastructure policy area

The *Renewal Plan for Żabi Róg Village* (2014) indicates that the village has not met the criteria relating to employment, unemployment and commuting. The village has a thriving labor market in comparison with the surrounding areas, but most businesses are construction companies, carpentry companies, gravel mines and food retailers. There are 6 medium-sized farms in Żabi Róg. Not all residents are able to find work locally, and many of them are employed in the nearby cities of Olsztyn and Ostróda. Commuting is difficult because the village is situated around 1 km away from a railway station, and public transport is slow due to the poor condition of local roads. Unemployment is relatively high, and around 160 residents were unemployed at the time of the study. The village has low infrastructure standards, in particular in the area of transport. There are no paved cycle paths, and several foot paths and cycle paths have been trodden in the local fields. Paved sidewalks are in very poor condition, they are overgrown with grass, uneven and very narrow. They are found only in the central part of the village, usually on one side of the street only, with high curbs and no ramps (criterion: Elimination of architectural barriers). The length and quality of roads is a criterion that could be improved and fully met in the future. The village is conveniently located in the proximity of regional road No. 527. Żabi Róg can be accessed by several county roads which are in poor condition and do not have a paved shoulder. The remaining 3 criteria have been met. The local residents have satisfactory access to public transport, the village has a railway station with a regular timetable, and there are privately operated buses to Morąg and Olsztyn. Żabi Róg has a large primary school for both local residents and children from the surrounding villages. The local residents have access to basic services, several shops and a church. Public services are available in the town of Morąg which is situated around 10 km from the analyzed village.
The following 5 criteria (Fig. 5) were evaluated in the quality of rural life policy area which has a positive impact on many aspects of community life. The relevant activities include the promotion of local attractions and products. Promotional measures contribute to an improvement in the quality of life and support local families. Internet access is also an important requirement in the 21st century.

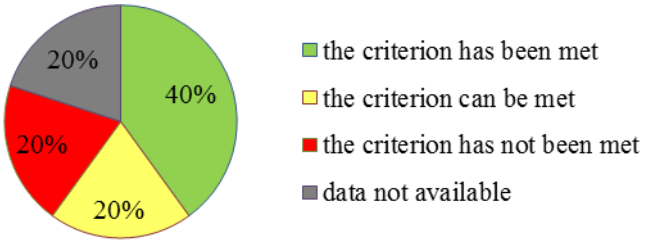


Fig. 5. Score in the quality of rural life policy area

The local authorities undertake various initiatives to promote local attractions and products. Information brochures are published, the village has a music band, its own anthem, songs and ballads commemorating local traditions and heritage. Workshops and festivals are frequently organized, and the inhabitants eagerly promote the region and regional products in local markets, local customs festivals, culture and food fairs. Żabi Róg meets the land-use criterion. The local zoning plan was developed in 2011, and the village has a satisfactory agrarian structure. The criterion relating to the creation of spaces for the commercialization of local products can be met. Commercial facilities could be created in rural community centres, the local school and shops. At present, local products are sold only during municipal fairs. There are no dedicated measures and projects to support families and local development. The residents are entitled only to standard welfare. Żabi Róg has only wireless Internet access.

Agriculture, tourism and craftsmanship play very important roles not only in rural development, but in the entire slow life philosophy. These activities promote local agriculture and local produce. The development of tourism in Żabi Róg was evaluated based on its hotel and restaurant capacity.

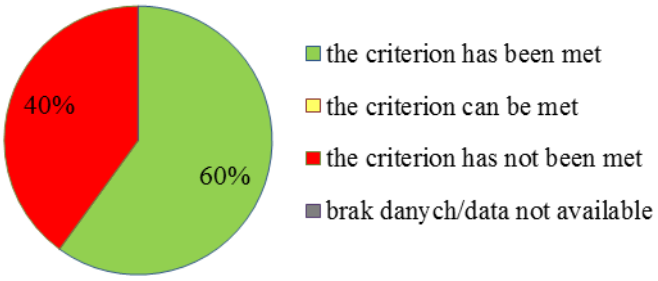


Fig. 6. Score in the **agriculture, tourism and craftsmanship policy area**

The criterion relating to the development of organic farming cannot be presently met for a number of reasons. Żabi Róg has a small number of farms that produce mostly cereal crops, and the local inhabitants are reluctant to work in agriculture. Tourist facilities are very limited. The village has only one guest house (Stara Szkoła) and no restaurants or bars. The remaining criteria have been met (Fig. 6). The local residents regularly organize cultural events, theater trips and concerts. They attend municipal fairs and events, such as the Harvest Festival, and celebrate local holidays. Community members use and promote local products, and craft artists create handmade objects.

Hospitality, awareness and training constituted the fifth evaluated policy area. The surveyed respondents were asked to voice their opinions about local organizations, cooperation with other organizations, health education, and customer service standards in retail and tourism (Fig. 7).

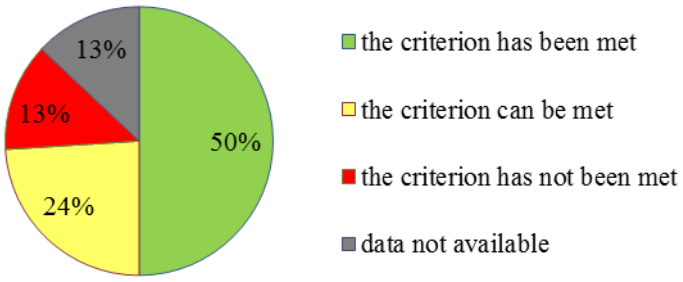


Fig. 7. Score in the **hospitality, awareness and training** policy area

The fifth policy area was difficult to assess due to scant data and the fact that many criteria had to be evaluated subjectively by the author. The local guest house (Stara Szkoła) has high customer service ratings on the Internet. The author (who is not a resident of Żabi Róg) has been served politely and competently in all local shops. Community members organize many local events such as bonfires, New Year's parties, carnival events, family fairs, Saint John's and Saint Andrew's Eve celebrations, Secret Santa gift exchanges, state holiday celebrations and trips to cultural institutions. The village

has two community centres and a library. Żabi Róg collaborates with various organizations, including the Rural Support Foundation, municipal authorities in Morąg and other rural institutions. The local residents would gladly support Cittaslow campaigns; therefore, this criterion is likely to be met in the future. The slow routes criterion has not been met, and the progress made in the area of health education could not be analyzed due to the lack of data.
Social cohesion can be analyzed in various contexts in relation to different age groups, professional groups and social groups.

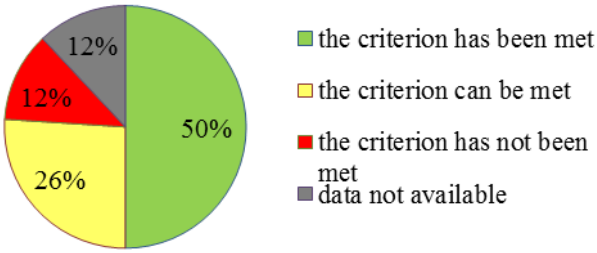


Fig. 8. Score in the social cohesion policy area

A half of the criteria in the social cohesion policy area have been met (Fig. 8). The residents of Żabi Róg frequently stage local initiatives, which significantly contribute to social cohesion. They are eager to join interest groups and bands. The village runs two community centres that are open to both young children (with supervision) and adolescents. The local residents participate in political life, vote in elections, and voter turnout is usually high during village elections. There are no damaged or devastated areas in the village. Several old buildings and the railway station require upgrading. The criteria that can be met in the future include a low percentage of social problems, integration of persons with disabilities, and reduction of poverty. The prevalence of social problems is low in Żabi Róg, and most of them can be remedied through dedicated support programs. Most of the problems are associated with poverty, unemployment, low coping skills and alcohol abuse. The progress in integrating people with disabilities is difficult to assess due to the absence of quantitative data. The only criterion that cannot be met is an improvement in the youth status after graduation.
Żabi Róg should meet at least 50% of the criteria to be eligible for membership in a slow life organization. The analyzed village scored exactly 50% in the evaluation. The following 20% requirements can be met, which is a promising outcome for local development and improvement in the quality of life. Żabi Róg did not meet 20% of criteria, mainly in the areas of infrastructure as well as agriculture, tourism and craftsmanship. Data relating to compliance with 4 criteria (10% of the evaluated elements) were not available.
The survey involved 25 local residents who were asked to express their opinions about the village and potential membership in a slow life organization in an anonymous questionnaire (Table 2).

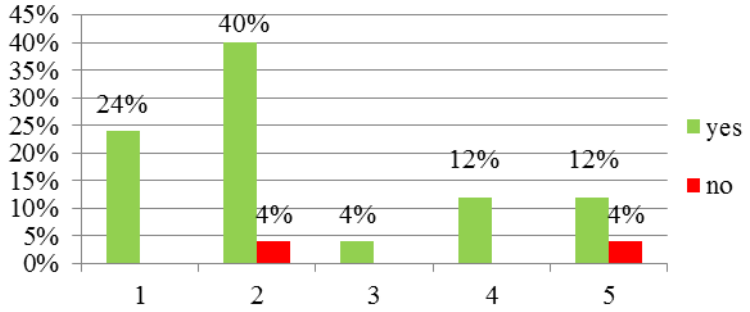
Table 2

Respondents' age and gender

Gender and age	Number of people	Percentage	Number of people	Percentage
Women aged <18 years	0	0%	17	68%
Women aged 18-50 years	6	24%		
Women aged > 50 years	11	44%		
Men aged <18 years	1	4%	8	32%
Men aged 18-50 years	3	12%		
Men aged > 50 years	4	16%		
Total	25	100%	25	100%

At the beginning of the questionnaire, the respondents were asked to state their age and gender. The majority of the surveyed subjects were women (68%) who were more eager to participate in the study than men. Respondents younger than 18 years were least numerous, probably because the questionnaires were handed out during school hours. The above can also be attributed to the fact that

pensioners account for a large proportion of the local population. The questionnaire was developed to elicit opinions about the quality of local life without previous knowledge of the slow life philosophy. In successive parts of the questionnaire, the surveyed subjects were provided with a brief description about the main goals of the slow life movement, and were asked whether Żabi Róg could benefit from membership in such an organization. In the first question (Fig. 9), the respondents were asked whether Żabi Róg was a village with a high quality of life and a culture of good living.



1. Women aged 18-50 years, 2. Women aged >50 years, 3. Men aged < 18 years, 4. Men aged 18-50 years, 5. Men aged >50 years

Fig. 9. Respondents' opinions about the quality of life in Żabi Róg village

Nearly all respondents (92%) were of the opinion that Żabi Róg was a friendly place to live. These answers constitute valuable inputs because the above opinion was expressed by permanent residents of the analyzed village.

The questions addressing the village's compliance with slow life criteria emphasized the importance of local initiatives. The surveyed residents were asked to voice their opinions on community involvement. Only 56% of the surveyed subjects recognized the importance of community involvement. Surprisingly, 24% of the respondents were not aware that their neighbors had been involved in local initiatives. The above could be attributed to the fact that community initiatives in the village attracted regular groups of local activists. However, the respondents were aware that many local initiatives, community integration events, leisure time events and promotional activities were being organized in Żabi Róg. Thirteen respondents were able to identify 1 to 5 initiatives, 11 subjects – 5 to 10 initiatives, and one respondent – more than 10 initiatives.

The question probing the respondents' familiarity with the slow life concept preceded the definition of the slow life philosophy to verify whether the movement was as popular in rural areas as in cities (Table 3).

Table 3

Familiarity with slow life and slow food concepts and the Cittaslow movement

Gender and age	Familiarity with slow life and slow food concepts and the Cittaslow movement	
	Yes	No
Women aged <18 years	0%	0%
Women aged 18 - 50 years	8%	16%
Women aged > 50 years	12%	32%
Men aged <18 years	0%	4%
Men aged 18 - 50 years	4%	8%
Men aged > 50 years	4%	12%
Total	28%	72%

More than 70% of the respondents were not familiar with the slow life philosophy, which indicates that this concept is not popular in rural areas. The majority of the subjects who had heard of the slow life movement were women older than 50 years. Having read the short note describing the main goals of the slow life movement, 84% of the respondents agreed that Żabi Róg could benefit from membership in a slow life organization similar to the Cittaslow Association. Fourteen subjects were of the opinion that Żabi Róg meets the criteria required for membership in a slow life organization.

The remaining 11 respondents were unable to answer this question and concluded that they needed more information about the slow life philosophy.
The respondents' opinions regarding the possible benefits of membership in a slow life organization are presented in Table 4.

Table 4

Benefits of membership in a slow life organization

No.	Benefits of membership in a slow life organization for Żabi Róg	Respondents
1.	Promotional advantages/Enhanced promotion of the member village	21
2.	"Slow" influx of tourists into the village	11
3.	Improved quality of the natural environment	13
4.	Promotion of natural and environmentally-friendly food preparation techniques/Promotion of regional and traditional cuisine	3
5.	Promotion of the village's cultural heritage and local traditions	13
6.	Improving the quality of life in the village	13
7.	Increasing environmental awareness among the inhabitants	8
8.	Promoting the culture of hospitality in the village of Żabi Róg	16
9.	Sustaining a sense of place and local identity	17
10.	There are no benefits of membership	2

The surveyed subjects recognized various benefits of membership in a slow life organization. Twenty-one respondents were in favor of enhanced regional promotion. Surprisingly, 16 respondents were of the opinion that Żabi Róg could benefit from improvements in the culture of hospitality.

Conclusions and Proposals

This study evaluated the quality of life in the village of Żabi Róg based on compliance with the Cittaslow criteria and the opinions expressed by the local residents who participated in a questionnaire survey. The village has both strengths and weaknesses which are presented in Figures 3-9. For the needs of the study, the Cittaslow accreditation procedure has been adapted to the specific features of rural areas, and the results indicate that the Cittaslow movement could be expanded or that a separate slow life organization uniting rural areas could be established. However, the Cittaslow charter would have to be modified to achieve this goal. Villages are weakly populated, and they do not have city rights; therefore, population limits would have to be eliminated from the accreditation process for rural areas. The membership fees for rural areas would have to be considerably lowered or eliminated because the financial aspects of membership could discourage villages from joining the slow life movement. The accreditation procedure could pose a significant burden for village administrators who should be provided with significant support during the process. The village and its administrator should receive professional assistance in the process of filling out application documents. The assistant should reside in the village during the entire classification process. The present study marks the first stage of research which will be continued in other rural areas.

References

1. Apanowicz J. (2002) *Metodologia Ogolna*. Bernardinum. Gdynia. 85p. (in Polish).
2. Baldemir E., Kaya F., Sahin K. T. (2013) *A Management Strategy within Sustainable City Context: Cittaslow*, In: Özşahin M. (eds.) T*he Proceedings of 9th International Strategic Management Conference*, Procedia - Social and Behavioral Sciences 99, ELSEVIER, p. 75 – 84.
3. Bański J. (2013a) *On the future of the Polish countrysid.* Studia Obszarów Wiejskich XXXI, PTG: PAN. IGiPZ Warszawa. p. 9-24.
4. Bański J. (2013b) *Polish countryside in the perspective of 2050.* Studia Obszarów Wiejskich, tom XXXIII, PTG: PAN. IGiPZ Warszawa. p. 9-22.
5. Bański J., Stola W. (2002) *Changes in the spatial and functional structure of rural areas in Poland.* Studia Obszarów Wiejskich, tom III. PTG: PAN. IGiPZ Warszawa. p.13-16.
6. Botta M. (2016) *Evolution of the slow living concept within the models of sustainable communities*, In: Ghisa M., Kapoor R. (eds.) *Transforming Futures – a glimpse from the WFSF Conference 2013*, Futures, vol. 80, ELSEVIER, Gangtok, p. 3-16.

7. *Cittaslow International Charter 2017.* Available at http://cittaslowpolska.pl (accessed on 18/01/2018).
8. Kowalek E. (2008) *Pociag do przeszlosci – stacja Zabi Rog.* ADSUM. Zabi Rog. p.2-6 (in Polish).
9. *Renewal Plan for Żabi Róg Village for 2014-2020.* (2013) Resolution No. L/805/14 of 11 July 2014 approving the Renewal Plan for Żabi Róg Village for 2010- 2020. Morąg Town Office. p.1-20.
10. Stanny M. (2014) *Village, rural area, rural population - about problems with defining them. Multidimensional look.* Wieś i rolnictwo, Kwartalnik Nr 1 (162). IRWIR PAN. Warszawa. p. 123-138.

Information about author

Katarzyna Pietrzyk, University of Warmia and Mazury in Olsztyn, Faculty of Geodesy, Geospatial and Civil Engineering, Department of Real Estate Resources, ul. Prawocheńskiego 15, 10-720 Olsztyn, katarzyna.pietrzyk@uwm.edu.pl

DOI: 10.22616/j.balticsurveying.2018.011

PROBLEM OF DETERMINING A GEOID

Olga Pisetskaya[1], Alexander Yarmolenko[2]
Belarusian State Agricultural Academy[1], Novgorod State University named after Yaroslav the Wise/ Belarusian State Agricultural Academy[2]

Abstract
The issue of the study of the problem of determining the geoid and quasi-geoid models is considered. Development of methods for constructing an exact geoid model using different dimensions.
Analysis of the calculation of normal heights using satellite measurements, construction of geoid and quasi-geoid models by different methods is performed.
Based on the results of the analytical review of existing methods for determining the geoid, it was proposed to use various data (geodetic heights, mixed gravity anomalies, anomalous potential) to construct this model, which allows building a model of a geoid with millimetre accuracy. The possibility of using the collocation method is considered.
The task is to develop a methodology for constructing a geoid model using a network of low density gravity points and using pure and mixed gravity anomalies, which allows us to solve the problem of finding potential by solving the Laplace equation or using wavelets.
Key words: geoid, anomalies of heights, local quasi-geoid, gravimetric network, collocation method.

Introduction

The purpose of this article is to analyze the state of the study of the problem of determining the models of a geoid and quasi-geoid on a local territory and to identify the direction of construction of an adequately accurate model.
Main article objects are as follows:
1. To study the possibilities and features of calculating the normal heights according to the results of satellite measurements.
2. To analyze the construction of geoid and quasi-geoid models using different methods.
3. To set specific tasks to solve the problem of determining a geoid by using available measurements on the earth's surface.

Methodology of research and materials

In practice, various methods of constructing geoid models are encountered: astronomical and geodesic, gravimetric; joint use of GNSS measurements and leveling networks; joint use of gravimetry and satellite altimetry; satellite gradiometry (Gofman-Vellengof, 2007).
The possibility of using one or another method depends on the availability of input data, in which all available accurate geodetic measurements can be taken. Special attention is paid to the results of satellite leveling.

Discussions of results

The heights obtained from the materials of geometric leveling refer to the system of normal heights. The result of satellite measurements are geodetic heights. Using the results of satellite leveling, the normal height is determined as the difference between the geodetic height and the height of the quasi-geoid (Lazarev, Samochkin, 1980).
In (Kravchuk, 2010), a technique for calculating normal altitudes by interpolation method with reference points with known differences of geodetic and normal heights according to the results of satellite measurements without gravimetric surveys is considered.
But when moving from the general earth coordinate system to a national reference coordinate system, the problem of converting them to combined points arises. In geodetic networks there are distortions in their position caused by various causes, in addition to random errors of the points. Therefore, the calculated transformation parameters will also be burdened with such errors. In addition, it is

necessary to take into account the error in the radius of curvature of the first vertical, which will be present in the calculated normal heights (Kravchuk, 2010).

The possibility of determining a quasi-geoid on the territory of Vietnam is being investigated in (Neiman, Fam Hoang Lan, 2010). The results of calculating the orthometric height (H_p) based on the geopotential number (C_p).

$$H_P = \frac{C_P}{\bar{g}}, \tag{1}$$

where $\bar{g}$ denotes the average value of the modulus of gravity, obtained from geometric leveling and gravimetric measurements.

$$\bar{g} = \frac{1}{H_P} \int_L^{(P)} g dH, \tag{2}$$

where L denotes the point of intersection of the curvilinear vector line of the real gravity potential with the geoid surface,

P denotes a point on the earth's surface.

In this article, it is noted that the position of the vector line of a real geopotential and the value of the gravity on it can be indicated approximately, which leads to approximations of the orthometric heights, and precise calculations can be made only in the framework of a certain model of the geopotential (the normal potential U), observing a number of conditions:

1) the modulus of real gravity g is replaced by the modulus of normal gravity γ;

2) the point of intersection of the vector line of the normal potential with the surface of the ellipsoid is taken as the starting point;

3) the end point is selected on the same vector line so that the geopotential number remains unchanged.

Thus, in this work there is also no strict solution to the problem of heights due to the impossibility of the strict determination of $\bar{g}$.

These conditions lead to the conclusion that in order to calculate the height anomaly, it is necessary to know the normal field and the perturbing potential, as well as the potential value on the surface that is assumed to be the geoid. In this case, it is necessary that the initial data for modeling with sufficient density uniformly cover the entire Earth. If we use anomalies of heights computed from gravimetric data, we get a global quasi-geoid corresponding to the general earth ellipsoid and the level surface that best approximates the averaged topographic sea surface.

The normal height H_P^{γ} can be obtained from the following formula:

$$h_P = H_P^{\gamma} + \zeta_P, \tag{3}$$

where h_p denotes the geodetic height determined by GPS/GLONASS,

ζ_P denotes gravimetric anomaly of height.

The set of points obtained by this method determines a single system of heights and is its carrier. At the same time, the leveling networks are a high-precision means of propagation of the system of normal heights relative to the whole set of points. Here, the scale factor of the heights is deformed and the displacement of the resulting local quasi-geoid relative to the corresponding global surface by a certain amount (Neiman, Fam Hoang Lan, 2010). It is noted that it is necessary to amend the geodetic heights determined relative to the reference ellipsoid, which differs from the general earth's when using this method.

The results given in (Neiman , Fam Hoang Lan, 2010) are verified under the condition of a certain correspondence between the anomalies of geometric and gravimetric altitudes, which clarifies the reference altitude surface. This correction (calibration) leads to changes in gravity anomalies, and, as

a consequence, to changes in elevation anomalies. It should be noted that the territory of Vietnam was divided into 30 regions and each covariance model was used for each region. To determine the gravimetric anomalies, the ground values of gravity anomalies in free air were used. It is indicated that the development of gravimetry and leveling is necessary to determine a local quasi-geoid.

Work (Vu Hong Kuong, 2013) reflects the results of calculations and their accuracy characteristics with the conclusion about the expediency of using the gravitational model of EGM2008 to introduce clarity into the quasi-geoid in the study area. It should be noted that for the construction of a model of gravity anomalies in Vietnam, the results of long-term ground-based measurements of gravity on land were used (Vu Hong Kuong, 2013), in addition to the use of satellite altimetry data. The average quadratic deviation of the definition of the height of the geoid of this model was approximately 0.4 m, which indicates the need for further research on the construction of models of the Earth's gravitational field for the territory of Vietnam. The task is to create an algorithm for calculating the pure gravity anomalies (Δg) and altitude anomalies (ζ) for the study area, which will allow us to refine the model using ground and satellite measurements, as well as calculate anomalies of heights and gravity at any point by using method of interpolation (Vu Hong Kuong, 2013).

In (Ha Min Hoa, 2015), the problems of equalizing the state high-rise networks of I and II classes for obtaining a geoid model by converting the measured excesses in the difference of geopotential values (dC_{ij}) in the normal gravitational field of the ellipsoid are considered:

$$dC_{ij} = \left[\bar{\gamma}_{ij} - 0.1543 \cdot 10^{-6} \bar{H}_{ij} + \left(g - \gamma\right)_{ij} \right] h_{ij}, \tag{4}$$

where $\bar{\gamma}_{ij}$ denotes the average value of the acceleration of normal gravity between *i* and *j* marks,

$\bar{H}_{ij}$ denotes the average normal height,

$\left(g - \gamma\right)_{ij}$ denotes the average value of the anomalies of gravity between *i* and *j* marks,

h_{ij} denotes the measured excess between *i* and j marks in the real gravitational field of the Earth (Ha Min Hoa, 2015).

But the measured excess is in the middle tidal system, but it should correspond to the zero tidal system, which requires the δdC_{ij} amendment to the difference of the geopotential values *of* dC_{ij}:

$$\delta dC_{ij} = -0.28841\left(\sin^2 B_j - \sin^2 B_i\right) - 0.00195\left(\sin^4 B_j - \sin^4 B_i\right), \tag{5}$$

where B_i, B_j denotes geodesic latitudes of *i* and *j* marks.

In this article, it is noted that when using a geoid, it is possible to increase the accuracy of a local quasi-geoid, the gravitational field of the Earth on a local territory, which will improve the state high-altitude system of the local territory (Ha Min Hoa, 2015).

Construction of a geoid model using satellite observations at the points of leveling and gravimetric networks with the known orthometric heights obtained from leveling in the materials of the article for building a geoid model on the territory of the Republic of Benin (Gosmin M. Iessuru, 2015) is considered. It is indicated that in the territory of the Republic of Benin the heights of a geoid were obtained at certain chaotically located points of the leveling network. They were required to restore the surface of the geoid to the entire territory of the country. The accuracy of such a geoid will depend on the degree of coincidence of the field of application of the mathematical dependence used and the location of the control points, the properties of the mathematical dependence, the location of the reference points, and the accuracy of the initial data (Gosmin M. Iessuru, 2015).

The solution of the problem was carried out by the method of spline approximation of a function of two variables using splines with a differential quality functional. The advantage of this method lies in sufficiently accurate results with a low density of reference points, with the exception of sharp peaks

or dips in the restored function. The solution involved the leveling and gravimetric points (Gosmin M. Iessuru, 2015).
On the territory of the Republic of Belarus, the methodology for creating a local model of quasi-geoid heights using a geometric method based on global gravity models of the Earth with the use of satellite observations is investigated. The technique was tested on the territory of Minsk and its environs without using gravimetric data (Larionov, Rudnickaya, 2016).
In this case, the essence of the geometric method consisted in the optimal combination of dissimilar heights in order to perform the detailed elaboration and correction of the global model of quasi-geoid heights by the mean-square collocation method. The main task of collocation is the prediction of a continuous surface using discrete observations. The mathematical model used by the function represented by the equation:

$$l = Ax + t + n\ , \tag{6}$$

where l denotes is the vector of measurements,
Ax denotes parametric model,
t denotes signal vector at measurement points,
n denotes noise vector at the measurement points.
The algorithm of computations is implemented in the materials of the article (Larionov, Rudnickaya, 2016).
The results of the studies indicated that the calculated deviations of normal heights using this model give more accurate results relative to the same data obtained by the results of calculations using the model of EGM2008. It was experimentally established that the creation of elevation models quasi-geoid on the territory of the Republic of Belarus with an accuracy corresponding to modern requirements requires a sufficiently dense network of points with known geodetic and normal heights that is impractical to perform and for the possibility of using this model it is necessary to develop a gravimetric network on the territory of the Republic (Larionov, Rudnickaya, 2016).
But there are other possible solutions of the problem for determining a geoid.
1-st task. For the simplicity of the theory of analysis, it is necessary to represent the potential not only in the form of spherical functions or their analogs (substitutes): spherical functions; basic functions of various kinds (radial, spline functions, etc. (Neiman , Sugaipova, 2016); polynomials, etc., but also in the matrix form. Assuming that the observation of gravity anomalies is performed in a discrete space, that is, if the coefficients of the expansion of the potential or another potential function in terms of spherical (spherical) functions in the form of the vector a and the observation vector g are given, then we can write that

$$a = W \times g\ , \tag{7}$$

where W denotes the matrix of the transformation of the vector g into the vector a.
There must be a reverse transition

$$g = F \times a\ , \tag{8}$$

where F denotes the inverse of W.
For example, if g is the anomaly of gravity, then a are the coefficients of the expansion of T anomalous potential according to the above-mentioned anomalies:

$$T = a_1 \times g_1 + a_2 \times g_2 + \ldots + a_n \times g_n\ . \tag{9}$$

At the same time, it is necessary to perform the estimation of the accuracy of the potential presented in this way.

2-nd task. When studying the gravitational field of the Earth, there are performed the determinations of such quantities as:
- mixed anomalies;
- pure anomalies;
- differences in normal and geodetic heights;
- derivatives of gravity anomalies: components of deviations of plumb lines;
- second derivatives of the potential.

Then, having a common algorithm (7)-(9), one can express any potential function in a convenient form. A special case of such a problem is the presence of a set of points, on the part of which Δg pure gravity anomalies are measured, and on the other part – mixed anomalies (fig. 1).

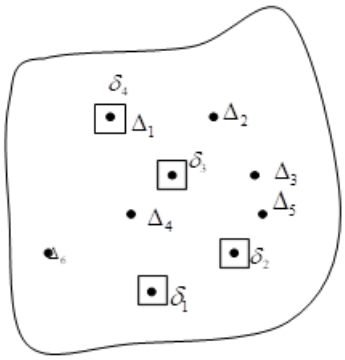


Fig. 1. Points with dimensions

As a result, on the given N_Δ set for points the boundary condition will be correct

$$\frac{\partial T}{\partial h} = \Delta g \,, \tag{10}$$

and for the points N_δ the boundary condition will be

$$\frac{\partial T}{\partial h} + \frac{2T}{R} = \delta g \,, \tag{11}$$

where N_Δ denotes number of points at which pure anomalies are measured,
N_δ denotes number of points at which mixed anomalies are measured.
For the whole set of points

$$N = N_\Delta + N_\delta \tag{12}$$

it is necessary to solve the Laplace equation

$$\nabla T = 0 \,, \tag{13}$$

where

$$\nabla T = \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} = 0 \,. \tag{14}$$

In a particular case, when the corresponding measurements are made at the same point (for example, δ_4 and Δ_1, Fig.1), after substitution (10) in (11) we get

$$\Delta g + \frac{2T}{R} = \delta g \,, \tag{15}$$

or

$$\frac{2T}{R} = \delta g - \Delta g \,. \tag{16}$$

Since the mixed anomaly is

$$\delta g = g_M - \gamma_P \,, \tag{17}$$

and when measuring g_M at the point M, the value of γ_P is calculated at the point of P,

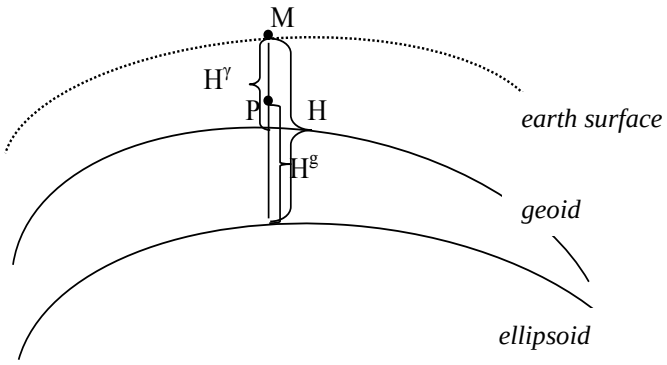


Fig. 2. Surfaces of relevance

and

$$\Delta g = g_M - \gamma_M \,, \tag{18}$$

then, after substituting (17), (18), in (16), we have

$$\frac{\partial T}{\partial h} = \left(g_M - \gamma_P\right) - \left(g_M - \gamma_M\right), \tag{19}$$

and then

$$\frac{\partial T}{\partial h} = -\gamma_P + \gamma_M \,. \tag{20}$$

Then the problem of finding the potential leads to solving the Laplace equation with the boundary condition (20).

3-rd task. The task, partially solved by Russian scientists Neiman Yu. M. and Sugaipova L. S. (Neiman, Sugaipova, 2016).
The essence of the problem lies in the fact that it is possible to represent the potential (or its derivatives) not only in the form of ball (spherical) functions, but also by a combination of functions, for example, up to a certain harmonic, the expansion of the potential is carried out according to spherical functions, and after it to harmonics of an arbitrary degree – the expansion can be performed by radial basis functions, or even wavelets.
In our opinion since the combined representation of the potential is a complication of the theory, it should be constructed on the basis of the matrix approach (7) - (9).
In this case, you need to solve the following subtasks:

1) To develop an algorithm for solving this problem;
2) To estimate the accuracy of the solution; to determine the conditions under which the accuracy of such a solution will be no lower than the standard approach for spherical functions.

The advantages of such a combined approach are proved by scientists Neiman Yu. M. and Sugaipova L. S. by the so-called frequency localization, which is clearly inherent in wavelets. For example, if we consider Table 1, the largest frequency of the wavelet expansion is inherent in the third stage of the W_3 wavelet transformation.

Table 1

The wavelet decomposition

№	measurements	W_0	W_1	W_2	W_3
1	4	4.7	-0.5	-1.2	+1.0
2	2	4.7	-0.5	-1.2	-1.0
3	5	4.7	-0.5	+0.8	-0.5
4	6	4.7	-0.5	+0.8	+0.5
5	7	4.7	+0.5	+0.3	+1.5
6	4	4.7	+0.5	+0.3	-1.5
7	1	4.7	+0.5	-0.2	-4.0
8	9	4.7	+0.5	-0.2	+4.0

But this example shows that the disadvantage of the wavelet expansion is the discrepancy between frequency localization and amplitude. Thus, in the third stage of the wavelet expansion in this example, the highest amplitudes (4 – according to module) of the wavelet expansion correspond to the highest frequencies. And if we remove the component of the expansion with the highest frequencies, then the largest amplitudes are also removed, which leads to a gross distortion of the original signal.

However, in Fourier series, which are actually the basis of spherical (or ball) functions, one can in principle find synchronization of the localization both in frequency and in amplitude. In Fourier series, high frequencies correspond to low amplitudes. Accordingly, the high-frequency components can be removed without a significant change in the original signal (column "Measurements").

In Fourier series, high frequencies coincide with low amplitudes. Therefore, spherical functions are convenient in application, because high degrees of expansion can be discarded, knowing that low amplitudes correspond to them, which cannot be done in wavelets.

Thereby it is necessary to solve the following subtasks:

1. The detailed development of algorithms for combined representation of a potential function based on the approach (7) - (9);
2. The search for the possibility of applying these algorithms in practice with obtaining final results of a given accuracy.

Conclusions and proposals

1. In the dissertation (Piseckaya, 2007) it is proved that at a density of pure anomalies of gravity one point per 10 square kilometers one can determine the height of a global geoid (quasi-geoid) over an ellipsoid with an accuracy of 3 mm. But such density is necessary for the mentioned anomalies throughout the Earth, which is by now unattainable. But subject to the availability of data of geometric leveling, geodetic heights, and other precise geodetic measurements (mixed anomalies of gravity, anomalous potential, etc.) in the local territory, it is possible to determine the heights of the geoid over the ellipsoid with a given millimetric accuracy.
2. It is also necessary to generalize the problem of interpolating geoid heights over an ellipsoid using the model of EGM2008 through applying the collocation method, taking into account that inhomogeneous data are known in a limited area. For example, the anomalies of heights ζ are known in the series of the points, and the deviation of the plumb line ξ, η, the gravity anomalies, the excess between the points (at normal, geodetic heights), and the anomalous potential are known for the remaining part.

3. It should be noted that the construction of a local system of heights using the collocation method is carried out by approximating linear equations, but it is possible to use polynomials (Abakushina, 2016). This operation - adaptation of EGM2008 model to the local area, called calibration, is performed on the difference between the measured and calculated heights, but it is possible to use it based on other data given at the beginning of this paragraph.
4. Due to the lack of initial data (in this case gravimetric), the use of approximating functions (spherical, ball) on a global scale can lead to distortion of results (smoothing). Therefore, according to the suggestion of Professor Yu. M. Neumann, it is necessary to develop such a technique for constructing an accurate geoid, in which gravimetric measurements made with a low density of points would not have a negative effect on the results obtained using measurements made in areas with high density of gravimetric points. In this case, other approximating functions other than spherical and ball functions may be used.

References

1. Abakushina, M., Nepoklonov, V. (2016). Ocenka tochnosti modelei gravimetricheskogo geoida v kontinentalnih raionah, Moskva. Izvestia vuzov. Geodezia I aerofotosiomka, № 6, s. 17-23 (in Russian)
2. B. Gofman-Vellengof, G. Morits (2007) Phizicheskaja geodesia. Moskva, MIIGAiK, – 426 s. (in Russian)
3. G. Lazarev, E. Samochkin (1980) Osnovi vischei geodesii. Moskva, Nedra, – 424 s. (in Russian)
4. Gosmin M. Iessuru (2015). Postroenie modeley geoida na territoriu respubliki Benin, Moskva. Izvestia vuzov. Geodezia I aerofotosiomka, № 6, s. 13-17 (in Russian)
5. Ha Min Hoa (2015). Razvitie gosudarstvennoi visotnoi sistemi Vietnama na osnove ispolzovania lokalnoi modeli geoida, Moskva. *Izvestia vuzov. Geodezia I aerofotosiomka*, № 2, s. 10-13 (in Russian)
6. Kravchuk, I. (2010). Osobennosti vichislenia normalnih visot po resultatam sputnikovih izmereniy, Moskva. *Izvestia vuzov. Geodezia i aerofotosiomka,* № 4, s. 35-40 (in Russian)
7. Larionov, A., Rudnickaya, N. (2016). Sozdanie localnoi modeli visot kvazigeoida geometricheskim metodom, Minsk. Zemlia Belarusi, № 6, s. 36-41 (in Belorussian)
8. Neiman U., Sugaipova L. (2016) Osnovi raznomashtabnoi approksimacii geopotenciala, Moskva.218 s. (in Russian)
9. Neiman, U., Fam Hoang Lan (2010). Localniy kvazigeoid izolirovannoi territorii, Moskva. *Izvestia vuzov. Geodezia i aerofotosiomka,* № 5, s. 31-36 (in Russian)
10. Piseckaya, O. Opredelenie figuri Zemli s ispolzovaniem GPS-izmereniy (2007), Novopolock. 124 s. (in Belorussian)
11. Vu Hong Kuong (2013). Issledovanie modelei gravitacionnogo polia Zemli po nazemnim i sputnikovim izmereniam, Moskva. *Izvestia vuzov. Geodezia i aerofotosiomka*, № 1, s. 20-25 (in Russian)
12. Vu Hong Kuong (2013). Resultati vichislenia anomaliy visot i anomaliy sili tiagesti po sputnikovim izmereniam na territorii Vietnama, Moskva. *Izvestia vuzov. Geodezia i aerofotosiomka*, № 4, s. 8-13 (in Russian)

Information about the authors

Olga Pisetskaya, PhD, Dean of the Faculty of Land Management, Belarusian State Agricultural Academy, Republic of Belarus, Leninsky Boulevard, 4, Gorki, Mogilev region, +375-22-33-79644, e-mail: piseckaja@tut.by. Geodesy

Alexander Yarmolenko, Doctor of Technical Sciences, Professor, Novgorod State University named after Yaroslav the Wise/ Belarusian State Agricultural Academy, Republic of Belarus, Leninsky Boulevard, 4, Gorki, Mogilev region, 8- 911-611-47-62, e-mail: yarmolenko_alex@mail.ru . Geodesy

DOI: 10.22616/j.balticsurveying.2018.012

ENVIRONMENTAL POLICY AND LAND MANAGEMENT IN RURAL AREAS OF UKRAINE

Nataliia Stoiko, Nadiia Kryshenyk, Olha Soltys, Oksana Cherechon
Lviv National Agrarian University

Abstract
The research studies the issue of ecological stability of rural territories that is the most important component of the national environmental policy of Ukraine. A special attention is paid to degradation of arable lands as the main ecological problem of land management. On the example of Lviv region, the authors calculated the index of ecological nonconformity of current use of arable lands, proving a considerable excess of permissible ploughing of lands in the region. The carried analysis confirms that no measures were performed concerning land protection, including conservation that in the recent years. In this context it is necessary to improve land resources management on the basis of sustainable development. Integration is considered to be the main principle of land resources management. The research proves that solution of ecological problems of land management requires achievement of a set of coordinated targets concerning development of rural territories, land resources management and national environmental policy based on the principles of suitable development. The targets include: planning of land use outside settled areas on the landscape and ecological basis; land inventory; formation of the land bank of agricultural lands; development and support of alternative kinds of activity on rural area; development of an efficient mechanism to encourage performance of land protection measures; improvement of environmental responsibility of population and development of ecological education.
The methodological basis of the research is the concept of sustainable development, which expects support for a continuous character of development in order to meet the current needs along with ensuring the needs of future generations. The fulfilment of the task requires examination of scientific works on the issue of sustainable management of land resources and an ecological component of rural territory development.
Key words: degraded and unproductive arable land, rural development, land protection, sustainable land management.

Introduction

Important components of the state regional policy of Ukraine include development of rural territories and establishment of an efficient system of environmental protection. The two targets are substantially connected, because an area of agricultural lands occupies 70.8 % (among the total of agricultural lands, arable lands take 78.4 %) in the structure of land fund of Ukraine. It makes a considerable impact on ecological conditions of the environment within the rural territories, i.e. the territories outside the towns. Rural territories in addition to agricultural lands include water bodies, swamps, forests, shrubs, constituting together 90% of the land fund of the country (Rozvytok silskyh terytorii …, 2011).

National environmental policy of Ukraine is focused on stabilization and improvement of the environment by integration of that policy into social and economic development and introduction of an ecologically balanced system of land management (Pro Osnovni zasady …, 2010). On the way, the important stage is to make space planning of the territory development, which expects the measures focused on formation of stable communities by means of physical organization of space according to the general strategy of the region development with maximum consideration of natural potential of the territories (Parsova V., Stoiko N., Kryshenyk N., 2018).

For this reason it is needed to regulate the relations in the field of nature management through the Integrated neutral resource management (INRM) secured by the state, self-government and public institutions, which perform organizational and managerial, coordinative, advisory, controlling and other functions in the direction of efficient employment and protection of natural resources (Meine van Noordwijk, 2017; Lovell C., Mandondo A., Moriarty P., 2002). Such management is carried out both at the regional level and at the level of separate communities.

On the rural territory of Ukraine, land is the principal natural resource of economic and social value. Since 1992 it has become the object of property right. Consequently, denationalization of agricultural

lands and parcelling of collective farms has caused the situation when agricultural lands are divided into more than 10 million land parcels, transferred to private ownership. The state has introduced economic mechanisms of land relations regulation by payment for land, land assessment and economic responsibility during land use or for violation of land laws. Nowadays one can observe establishment of land market and circulation of agricultural lands (Natsionalna dopovid …, 2015).
However, such social and legal changes in Ukraine have still little influence on development of well-being, firstly, of rural population. Moreover, one sees a permanent tendency of deterioration of ecological conditions of land resources. According to the data of the Food and Agriculture Organization of the United Nations (FAO), degraded and unproductive arable lands take above 20 % of the total area on Ukraine. Depending on the degradation degree, 300-600 million tons of soil are lost annually due to soil erosion. It causes fall of yields of agricultural crops, but losses due to products deficiency account for 20 billion UAH (approximately 759 million USD) annually (FAO kicks off project…, 2018).
For Ukraine, it is important to stop land degradation, improve stability of ecosystems and reduce anthropogenic load on the environment in the regions. Thus, the strategic goals of the national environmental policy include reduction of the area of arable lands, consideration of environmental requirements in land use, introduction of the system of management of agro-landscapes by means of forest-melioration methods on the basis of sustainable development (Pro Osnovni zasady …, 2010).
Minimization of land degradation, reclamation of degraded land, support for sustainable employment of land resources can be secured by implementation of Sustainable Land Management (SLM). Sustainable Land Management is considered as "the use of land resources (including soils, water, animals and plants) for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions" (Sustainable Land Management…, 2017).
Such use of land meets the changing human needs (agriculture, forestry, conservation) and ensures long-term socioeconomic and ecological functions of the land (Dumanski, J., Gameda, S., Pieri C., 1998). It is a system of technologies and/or planning, which aims to integrate ecological principles with socio-economic and political ones in the management of land for agricultural and other purposes in order to achieve intra- and intergenerational equity' (Dumanski J., 1994).
The aim of the article is to demonstrate how the national environmental policy and land resources management can support sustainable development of land management in rural territories of Ukraine. To reach the goal, the following tasks were performed: the analysis of ecological conditions of arable lands and their protection on the example of Lviv region; the description of the main principles of land resources management on the basis of sustainable development. Consequently, a set of strategic targets is proposed for improvement of ecological stability of land management in rural territories.

Methodology of research and materials

The methodological basis of the research is the concept of sustainable development, integrating three components, particularly economic, social, ecological. The work considers one of the principles of the concept of sustainable development, i.e., to ensure a sustainable and long-term character of development to meet the needs of the present generation, while simultaneously securing the possibility of the future generation to satisfy their needs (Jonathan M. Harris, 2000; Sustainable use …, 2005). The stress is put on greening of land management by combination of the tasks of sustainable land resources management, environmental policy and development of rural territories.
The abstract and logical method, theories and hypotheses about sustainable development and greening of land use have been used to solve the issues of improvement of ecological stability of rural territories, to develop conclusions and give recommendations on their basis. The monographic method was applied for the analysis of negative ecological phenomena in agricultural land use. The method helped to analyze current conditions of arable land use and to specify potentially dangerous factors of land degradation, as well as to apply the obtained results while developing recommendations for improvement of ecological stability of land use in rural area. The graphic method was used for visual presentation of the data which constitute the studied statistical aggregate, and for depiction of their linear dependence.

Ecological aspects of land management on rural territories were investigated on the examples of Lviv region located in the west of Ukraine. It occupies 3.6 % of the territory (2183.2 thousand ha). In the structure of its lands the largest share is taken by agricultural lands, i.e., 58 % of the territory, forests – 32 %, built-up lands – 5 %. The index of the territory reservation accounts for 7.2 %. In spite of the fact that anthropogenic load on land resources is less in Lviv region than generally in Ukraine (ploughing of land in the region constitutes 32 %, while in Ukraine the average figure is 54 %), the processes of land degradation still occur in the region. The common kinds of degradation of arable lands include erosion (24.3 % of the total area) and blowout (18.1 % of the total area). In the territory of the region there are also 12,040.61 ha of deteriorated lands, 8,273.68 ha of low-productive lands, 736.5 ha of industrially polluted lands, 2,236.30 ha ravines[1].

Anthropogenic load on landscapes causes a reduction of biodiversity and deterioration of ecological balance (Matson P.A. et al., 1997). Arable lands are the most ecologically sensitive among all agricultural lands. For optimization of land management it is reasonable to determine the index of ecological nonconformity of current use of arable land (I_{in}) and excess of permissible ploughing (E) (Kanash O., 2013). The authors of the article performed calculations on the example of Lviv region (Table 1) according to the following formulas:

$$I_{in} = T_a / A \quad (1)$$

$$E = (I_{in} - 1) \cdot 100 \quad (2)$$

Where T_a – is the total (recorded) area of arable lands, ha; A – is the area of lands, available for arable farming, ha, calculated by the formula:

$$A = T_a - (D + S_d) \quad (3)$$

Where D – is the area of degraded and low-productive arable lands, ha; S_d – is the area of soil, which can be easily subjected to degradation under intensive employment, ha (arable land parcels with medium-washed soils on > 3° slopes).

On an average in Ukraine, the index of ecological nonconformity of current use of arable lands constitutes 1.17 (Dobriak D.., Kuzin N., 2016). Comparison of the indicator with Lviv region proves that excess of permissible ploughing in the region is by 36% more than the average in Ukraine. The higher the index of ecological nonconformity of current use of arable land (I_{in}) is, the more the excess of permissible ploughing (E) is. In Peremyshliany district the indicators are the highest and constitute 3.2 and 221.2, while in Stryi district, they are the lowest, i.e., 1.1 and 9.4 respectively.

Excess of permissible ploughing in Lviv region is described by a linear dependence $y = 1.3219x + 47.124$ (Fig. 1). The study of the dependence of excess of permissible ploughing (E) on the index of ecological nonconformity of current use of arable lands (I_{in}) confirms that the structure of arable lands includes a considerable area of degraded lands, which have lost their model properties due to excessive anthropogenic load (eroded, secondary salted and alkali, waterlogged or dried), or low-productive lands, which have been employed in agricultural production under conditions of extensive arable farming, regardless their poor fertility (too light or heavy soils by their granular content, skeleton, salted and alkali, waterlogged and overwatered).

Thus, in Lviv region, excess of land ploughing constitutes 53.5 %. It grounds the need to introduce the measures concerning protection of arable lands. The authors of the article consider that in that case it is important to perform the measures of land conservation as well as phyto- and forest- melioration. However, the analysis of implementation of the regional program of use and protection of lands in Lviv region argues that since 2012 measures of land conservation have not been performed[2]. It is a

[1] According to data of the Main Department of State Office of Ukraine on the issue of geodesy, cartography and cadastre in Lviv region as of 01/01/2017

[2] According to data of the Main Department of State Office of Ukraine on the issue of geodesy, cartography and cadastre in Lviv region as of 01/01/2012

negative practice because conservation is an important measure of environmental protection (Spencer R. Meyera et al., 2014).

Discussions and results

In 2014 Ukraine initiated the process of power decentralization and establishment of amalgamated territorial communities. Thus, the issue of land protection is of an urgent importance because efficient development of the territories is possible under conditions of comprehensive employment of land resources. The authors of the article consider that interruption of soil degradation and performance of the measures concerning land protection require improvement of the system of land resources management on the basis of sustainable development and integration of the system into social and economic development of the communities. Inter alia, land resources management should be based on the following principles:

- integration (to combine social and economic tasks with ecological problems of the territories at the state, regional and local levels);
- subsidiarity (land resources management should be "bottom-up" organized, i. e., all problems, which can be efficiently solved at the local level, should stay within the competence of municipal authorities);
- inter-sector character (to consider the needs of all sectors of activity, e.g., agriculture, recreation, environmental activity, etc.);
- generation approach (to employ land resources by the present generation, considering the needs of future generations); inter-generation approach (to consider the needs for land resources by different social groups);
- publicity (to secure a free access to the information about land resources conditions).

Table 1

Calculation of the index of ecological nonconformity of current use of arable lands within the boundaries of Lviv region [3]

Administrative district	Total area of arable lands, ha (T_a)	Area of degraded and low-productive arable lands, ha (D)	Area of the soils, which can be easily subjects to degradation under intensive employment, ha (S_d)	Area of lands, available for arable farming, ha (A)	Index of ecological nonconformity of current use of arable lands (Iin)	Excess of permissible ploughing of lands, % (E)
Brody	42,381.2	5,563	10,525	26,293.2	1.61	61.2
Busk	36,008.5	2,381	4,477	29,150.5	1.24	23.5
Horodok	36,871.1	242	11,511	25,118.1	1.47	46.8
Drohobych	3,722.6	291	12,054	24,876,6	1.50	49.6
Zhydachiv	44,187.1	1,281	11,854	31,052.1	1.42	42.3
Zhovkva	56,490.4	1,740	17,531	37,219.4	1.52	51.8
Zolochiv	46,170.4	2,296	10,156	33,718.4	1.37	36.9
Kamianka-Buzka	40,090.1	971	4,864	34,255.1	1.17	17.0
Mykolaiiv	22,518.5	2,187	3,936	16,395.5	1.37	37.3
Mostyska	45,038.6	3,169	19,571	22,298.6	2.02	102.0

[3] According to data of the Main Department of State Office of Ukraine on the issue of geodesy, cartography and cadaster in Lviv region as of 01/01/2012

Administrative district	Total area of arable lands, ha (T_a)	Area of degraded and low-productive arable lands, ha (D)	Area of the soils, which can be easily subjects to degradation under intensive employment, ha (S_d)	Area of lands, available for arable farming, ha (A)	Index of ecological nonconformity of current use of arable lands (Iin)	Excess of permissible ploughing of lands, % (E)
Peremyshliany	37,865.1	1,354	24,723	11,788.1	3.21	221.2
Pustomyty	47,705.7	724	14,813	32,168.7	1.48	48.3
Radekhiv	49,464.8	11,555	8,513	29,396.8	1.68	68.3
Sambir	44,593.5	14	12,619	31,960.5	1.40	39.5
Skole	12,891.8	86	4,341	8,464.8	1.52	52.3
Sokal	63,668.7	6,004	20,916	36,748.7	1.73	73.3
Staryi Sambir	38,338.1	2,445	16,684	19,209.1	2.00	99.6
Stryi	31,761.5		2,717	29,044.5	1.09	9.4
Turka	21,635.8	334	10,346	10,955.8	1.97	97.5
Yavoriv	35,790.8	469	10,172	25,149.8	1.42	42.3
Total in the region	**790,693.3**	**43,106**	**232,323**	**515,264.3**	**1.53**	**53.5**

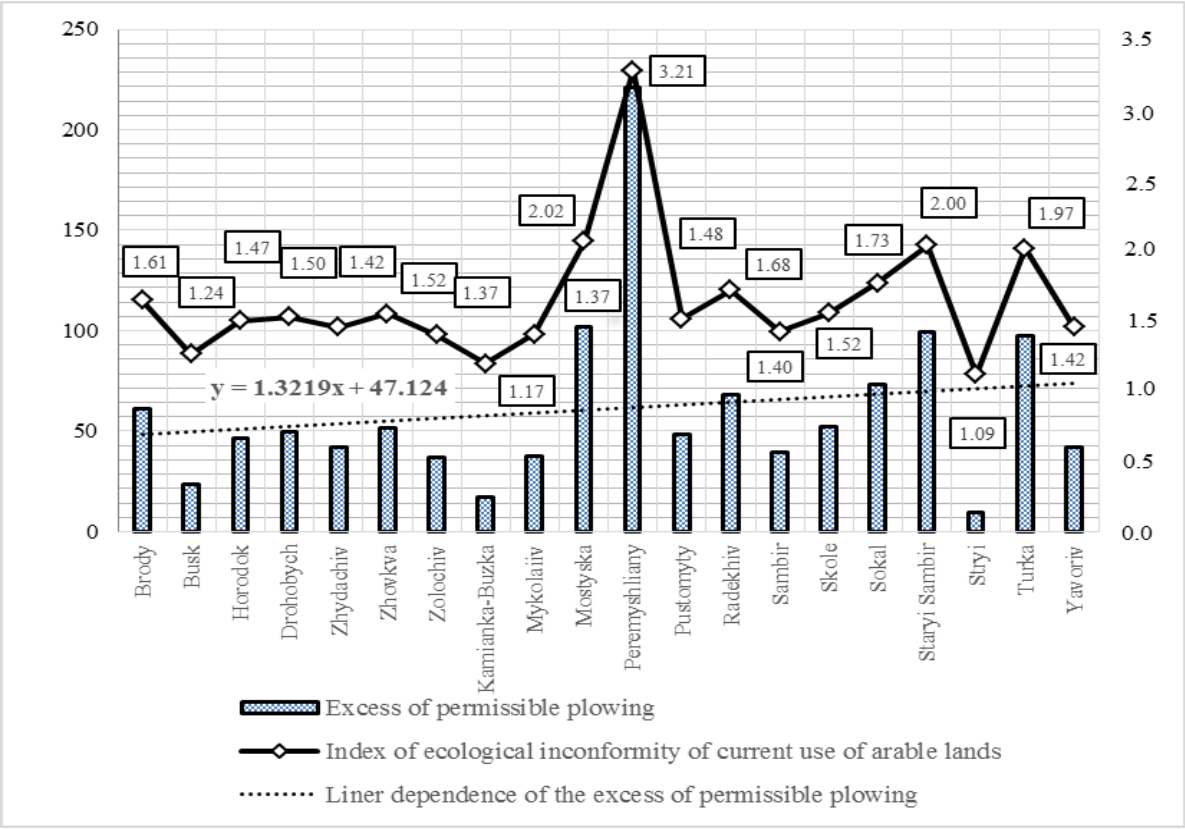


Fig. 1. Liner dependence of the excess of permissible ploughing on the index of ecological nonconformity of current use of arable lands (developed by the authors).

The system of land resources management should secure the decisions which would be beneficial for: land-owners and land-holders (profit from land use); local self-government (a land tax); the state generally (food and ecological safety). In its turn, all subjects of land relations should focus their efforts to support sustainable land management. However, an important position is occupied by a combination of managerial functions in the field of land relations with the tasks of development of territorial communities and national environmental policy (Fig. 2).

It is proposed to make planning of land use outside settled areas on landscape and ecological basis, i.e., landscape and ecological zoning of lands, to improve ecological stability of rural territories in Ukraine. Such zoning will help to define types of land use according to ecological and economic suitability for different kinds of land use. Each type of land use is characterized by territorial restrictions in land use according to the standards and norms in the field of land protection, as well as technological parameters of soil-protective arable farming. Such a step will determine the land areas, which require land protection measures, particularly phyto- and forest-melioration, including withdrawal for permanent conservation.

A considerable share of degraded lands is in private property in the forms of land parcels (shares). It makes the process of extraction of such lands more complicated and requires introduction of an efficient mechanism of performance of land protection measures.

Concerning the fact that in Ukraine a considerable share of land fund is employed in agricultural use, demonstrating incorrect land management that is the principal reason of land degradation, particularly soil erosion, it is important to motivate land-owners and land-holders to make conservation of the agricultural lands using the principles of good will and stimulation. Referring to the foreign experience (Stoiko N., 2014), conservation easement, i.e., agro-protective agreement between landowners and the state or local authorities, is an efficient instrument in the direction. Conservation easement expects restriction of some kinds of land use or suspension of any activity on the land for an indefinite period (mainly a long-term one) or forever only on the basis of a good will. Land can be transferred for protection free of charge, as well as can be sold by a landowner with a determined compensation. Such easements help owners to keep the right of private property, to live on their own land, to carry environmentally safe use of their own land and get tax privileges.

For Ukraine it is important to introduce the methods of indirect economic stimulations for business entities concerning implementation of the measures of land protection as well as their conservation. Such methods can include granting of payment for the land parcels, which are at the stage of revival or intended for phyto- or forest belts, granting of payment for the land parcels, which are under temporary conservation; tax privileges for the land parcels under permanent or long-term conservation, tax privileges by means of accelerated depreciation. Those methods do not need considerable funds from the state or local budgets.

Local authorities should initiate land inventory for obtaining of reliable information about quantity and quality conditions of lands, as well as for control of land use and protection. The land inventory will make a basis for the register of unproductive lands and development of the measures concerning their perspective employment (growing of energy crops, re-naturalization of lands, etc.). It is also necessary to develop an economic mechanism in order to stimulate performance of land protection measures, for example, the tax breaks for farmers, who keep to the requirements concerning land protection, who run organic arable farming or develop animal breeding. A substantial attention should be paid both by local authorities and by the state to development and support for alternative kinds of activity on rural territory (rural tourism, ecological tourism, fishing, hunting and others).

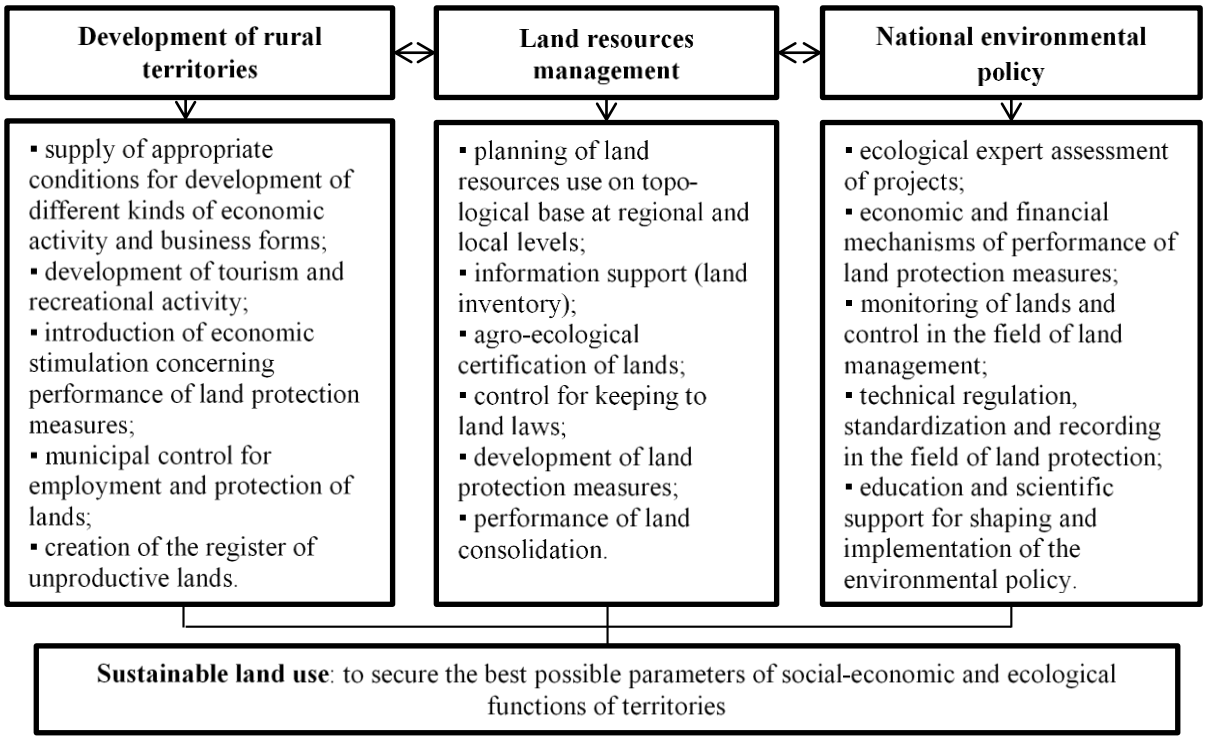


Fig. 2. Strategic goals concerning improvement of ecological stability of land use on rural territories (developed by the authors).

The national environmental policy should be focused on organization, regulation and control of activity of the society and the state for an efficient combination of the functions of land use and protection to secure appropriate living environment for the current and future generations. The main targets of environmental policy in the field of land use should include: control for keeping to the standards and rules of rational use and protection of lands (while a law-breaker pays a fine and compensates the harm committed to land resources and environment); introduction of an efficient mechanism to encourage and support performance of land protection measures by development of state and regional programs of land protection with a rigid control for the intended use of the funds appropriated for such measures; improvement of ecological responsibility of population and ecological respect to nature management by separate landowners, land-users and communities.

It is proposed to develop programs concerning protection and reclamation of land resources by means of land conservation. The programs should be coordinated by the Ministry of Ecology and Natural Resources of Ukraine. They can be various, but the principal goal is to reproduce the valuable vegetation layer in order to prevent soil erosion, to improve the quality of water, to reduce losses of living environment for wild animals and birds, to support appropriate conditions of forests and water-swamp lands.

Conclusions and proposals

1. In Ukraine degradation of agricultural lands, mostly arable ones, is a serious challenge for sustainable development of rural territories. It is caused by a high level of economic use of the territory. On average in Ukraine, the index of ecological inconsistency of the current use of arable land constitutes 1.17. In the studied region, i.e., Lviv region, the indicator is by 36 % higher and constitutes 1.53.
2. Sustainable development of land use in rural territories of Ukraine requires introduction of the tools of sustainable management of land resources, which would integrate the targets of environmental policy into social and economic development of territorial communities. The authors of the article consider that planning of land use outside the settlements on the topographic and ecological basis is an important instrument, which expects specification of ecologically sensitive land parcels and setting of territorial restrictions concerning their employment.

3. It is stressed that land conservation, including degraded and low-productive arable lands, is an essential measure for improvement of ecological stability of rural territories. It is recommended to apply the methods of indirect economic stimulation (tax privileges and granting of payment for land) to motivate business entities to introduce the measures of land protection and conservation.
4. The state environmental policy should plan development and introduction of the target environmental programs of agro-ecological focus, which would be coordinated by the Ministry of Ecology and Natural Resources of Ukraine.

References

1. Rozvytok silskyh terytorii (stan, problemy, perspektyv. Boiko Ye. I. et al. NAN Ukrainy, Instytut rehionalnyh doslidzhen, Lviv, 2011, 61 s. (In Ukraine)
2. Pro Osnovni zasady (stratehiiu) derzhavnoi ekolohichnoi polityky Ukrainy na period do 2020 roku: Zakon Ukrainy (2010) No 2818-VI, 21, December. Viewed 15 May, 2018, (http://zakon0.rada.gov.ua/laws/show/2818-17/conv) (In Ukraine)
3. Parsova V., Stoiko N., Kryshenyk N. (2018) Landscape-ecological requirements for spatial planning of rural territories of Ukraine. *Engineering for Rural Development: Proceedings of the 17th International Scientific Conference.* Jelgava, May 23-25, 2017, Volume 17, p. 446-452.
4. Meine van Noordwijk. (2017) Integrated natural resource management as pathway to poverty reduction: Innovating practices, institutions and policies. *Agricultural Systems,* 12 p. Viewed 25 April, 2018, (https://doi.org/10.1016/j.agsy.2017.10.008)
5. Lovell C., Mandondo A., Moriarty P. (2002) The question of scale in integrated natural resource management. *Conservation Ecology,* Volume 5(2): 25. Viewed 3 May, 2018, (https://www.ecologyandsociety.org/vol5/iss2/art25/)
6. Natsionalna dopovid shchodo zavershennia zemelnoi reform. Za nauk. red. L. Ya. Novakovskoho. K.: Ahrar. nauka, 2015, 48 s. (In Ukraine)
7. FAO kicks off project aimed at tackling land degradation in Ukraine. (2018) Viewed 12 June, 2018, (http://www.fao.org/europe/news/detail-news/en/c/1128337/)
8. Sustainable Land Management (SLM) in practice in the Kagera Basin. (2017) Lessons learned for scaling up at landscape level – Results of the Kagera Transboundary Agro-ecosystem Management Project (Kagera TAMP). Food and Agriculture Organization of the United Nations, Rome, Italy. 440 p.
9. Dumanski, J., Gameda, S., Pieri C. (1998) Indicators of Land Quality and Sustainable Land Management: An Annotated Bibliography, http://documents.worldbank.org/curated/en/487661468739557843/pdf/multi-page.pdf.
10. Dumanski J. (1994) International Workshop on Sustainable Land Management for the 21st Century: Summary. Workshop Proceedings. Agricultural Institute of Canada, Ottawa, 50 pp.
11. Jonathan M. Harris. (2000) Basic Principles of Sustainable Development. Global Development and Environment Institute, Tufts University. Medford MA 02155, USA, 26 pp.
12. *Sustainable use and management of natural resources*, European Environment Agency, Copenhagen, 2005. 68 pp.
13. Matson P.A., Parton W.J., Power A.G., Swift M.J. (1997) Agricultural Intensification and Ecosystem Properties. *Science*, Vol. 277, p. 504-509.
14. Kanash O. P. (2013) Grunty – providna skladova zemelnykh resursiv. *Zemleustrii i kadastr.* No. 2, s. 68-76. (In Ukraine)
15. Dobriak D. S., Kuzin N. V. (2016) Ekoloho-ekonomichne otsiniuvannia protsesiv, shcho sprychyniaiut dehradatsiiu zemelnyh resursiv. Zbalansovane pryrodokorystuvannia, No. 2, s. 105-113. (In Ukraine)
16. Spencer R. Meyera, Christopher S. Cronanb, Robert J. Lilieholmc, Michelle L. Johnsond, David R. Fostere. (2014) Land conservation in northern New England: Historic trends and alternative conservation futures. *Biological Conservation*. Volume 174, p. 152-160.
17. Stoiko N. Ye. (2014) Zarubizhnii dosvid konservatsii zemel. Visnyk Lvivskoho natsionalnoho ahrarnoho universitetu. No. 21 (2), s. 149-156. (In Ukraine)

Information about the authors

Nataliia Stoiko, Ph.D, Associate Professor of Department of Land Organization of Lviv National Agrarian University. Address: Lviv-Dublyany, Ukraine, 80381, phone: +38 067 132 76 16, e-mail: n_stoiko@ukr.net Fields of interest: land management, land use planning, environmental economics, environment protection.

Nadiia Kryshenyk, Ph.D, Lecturer of Department of Land Organization of Lviv National Agrarian University. Address: Lviv-Dublyany, Ukraine, 80381, phone: +38 097 183 93 17, e-mail: nadya_kryshenyk@ukr.net Fields of interest: environmental economics, land management, land protection, land use planning.

Olha Soltys, Ph.D, Associate Professor of Department of Land Organization of Lviv National Agrarian University. Address: Lviv-Dublyany, Ukraine, 80381, phone: +38 096 301 47 77, e-mail: soltysog@gmail.com Fields of interest: environmental economics, economic-mathematical modeling, optimization of land use.
Oksana Cherechon, Ph.D, Associate Professor of Department of Land Organization of Lviv National Agrarian University. Address: Lviv-Dublyany, Ukraine, 80381, phone: +38 097 530 09 33, e-mail: okcherechon@gmail.com Fields of interest: environmental economics, organization of the territory, land protection.