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FOREWORD

It is my pleasure to recommend the following, ninth issue of *Geomatics, Landmanagement and Landscape* scientific journal. The series raises many fundamental issues pertaining to the development of European rural areas, with a particular consideration given to economic and geographical conditions. From this perspective, the Małopolska region, with its mountainous terrain and its finely divided agriculture, is a kind of an experimental "test-bed", where pioneering studies are being conducted in the field of developing the social and economic potential, and the range of that development, in the larger Carpathian region. The questions presented herewith – also from the scientific perspective – reach far above the regional constraints of the Małopolska region, to become European issues. In that respect, experiments and conclusions developed by teams of scientists, who conduct similar analyses in other mountain regions of Europe, are especially significant. Perhaps the most valuable of those are research projects within the MRI (Mountain Research Initiative) and S4C (Science for Carpathians) programmes.

University of Agriculture in Kraków is a leading academic centre in the Southern Poland region, in which we seek solutions that serve to shape the sustainable development of rural areas. Particularly important are those of our activities dedicated to the inhabitants of foothill and mountain areas. For the implementation thereof, we have created the Research Centre for Protection and Development of Mountain Areas (Centrum Badawcze Ochrony i Rozwoju Ziem Górskich), which is in the position to undertake and engage in activities aimed at developing methods and procedures intended to counteract or remove negative geomorphological changes, degradation of water resources, air pollution and soil contamination. University of Agriculture in Kraków is open to cooperation with units and agencies of local self-government authorities in Małopolska and its neighbouring regions. Together we not only assert our potential, but also we enable the creation of appropriate agricultural, economic, organisational, legal, and cultural instruments, which condition sustainable development of mountain areas – consistent with development priorities of the European Community.

The present issue contains a wealth of interesting material, presenting both Polish and European experiences. It starts with an analysis of Bavarian approach to spatial planning – and the region of Bavaria may provide a point of reference for the region of Małopolska, due to its features of terrain, as well as the degree of advancement of

numerous programmes and processes. Yet another article, the fifth in this issue, continues the theme of the Bavarian experience, this time focusing on the legal and financial framework for the years 2014–2020. The author of the latter article proposes solutions, dedicated to the representatives of organisations and agencies acting in favour of the development of rural areas – a range of stakeholders, which includes politicians, elected self-government officials, scientists, and local communities. All actions undertaken by the municipal authorities should be based on a careful analysis of their financial management – and such is the theme of the second article in the issue. In this context, it is necessary to use the municipal pool of land and property resources in a rational way. The third article points out that the conditions, in which the agricultural operations function, are closely linked to the spatial structure of rural areas, including the level of advancement of land consolidation procedures – as land consolidation constitutes one of the key factors conditioning the profitability of agricultural production. The fourth article presents the application of a linear way of land planning and transformation using the simplex method. The authors demonstrate that using the simplex method enables effective construction of an optimal model for the utilisation of land resources, and helps find such a mix, which would allow for the maximum performance of the resources in question, calculated in the monetary equivalent. The sixth article, which is also the last in the present issue, argues that the official databases, which gather spatial data, should include sets of metadata, that serve to describe the information within. The author proposes a method for the evaluation of database quality pertaining to databases of topographic objects (BDOT500) based on four criteria: location accuracy, completeness, validity (in the sense of being up to date) and logical coherence. It is important to note that applying the method does not require involving any additional means, as all the necessary information is already embedded within the database.

As Vice Rector for Research, Implementation and International Cooperation, I evaluate the quality of the presented material very highly. This goes not only for the content of the present issue, but the whole publishing cycle of the *Geomatics, Landmanagement and Landscape*. I perceive the *Geomatics* series as a broad platform for the proliferation of scientific achievements, and therefore I do not hesitate to invite you to read all the issues, and to partake in a fruitful exchange of hypotheses and scientific opinions. I am convinced that this is one of many initiatives that will allow our regional research centre, and particularly the University of Agriculture in Kraków, not only to see a dynamic growth, but also to successfully participate in a global circulation of thought, thus endorsing our unique scientific potential.

Dr hab. inż. Stanisław Małek, prof. UR
Vice Rector for Research, Implementation
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LAND-USE PLANNING AND PUBLIC ADMINISTRATION IN BAVARIA, GERMANY: TOWARDS A PUBLIC ADMINISTRATION APPROACH TO LAND-USE PLANNING

Uchendu Eugene Chigbu, Vache Kalashyan

Summary

Germany has notable land management and planning traditions. As part of their formal responsibilities, local governments have powers to regulate and structure their areas and landscapes through land-use planning. They use it to prepare and guide land-uses for development purposes in municipalities. This study presents the Bavarian experience of land-use planning in relation to public administration. The study emanated from a research conducted at Technische Universität München and funded by the German Academic Exchange Service. It uses data from semi-structured interviews with land management experts, mayors and public administrators at different levels of public administration. The authors used these interviews to discern the scope, nature and role of public administration of land-uses at either the local or regional scale. It led to four findings. The two major ones being that: first, based on good governance principles, there are contradictions in the administration of land-use planning in Germany. Second, there are no harmonised criteria for assessing the efficiency and effectiveness of land-use planning administration. By way of recommendation, it suggests an efficiency assessment criteria and method of land-use planning through public administration, among others suggestions.

Keywords

Bavaria • Germany • land management • land-use planning • public administration

1. Introduction

In Germany, local governments regulate development and structure their municipal areas and space by means of land-use planning as part of their formal responsibility. Local governments use it to guide development in municipalities. This makes land--use planning essential for local development administration and vice versa – leading to a relationship between land-use planning and public administration. Both public administration and land-use planning literature are vast. This study considers public administration to include the processes involved in fulfilling government tasks (at national, regional and local scales) to the public. On the other hand, land-use planning

is a culmination of all activities and decisions concerned with guiding the allocation and use of land in patterns that enable improvements in peoples' way of living.

This study emanated from a research project conducted at Technische Universität München, Germany. The project, entitled Local-Level Governance Diagnostics: Development Of Combined Assessment Framework On Land-Use Planning In Germany was funded by the German Academic Exchange Service (DAAD). Its objective is to present steps for improving land-use planning through public administration in Germany. Hopefully, it will serve as important learning points for other countries. A critical aspect of the project was a cooperation between Technische Universität München (Germany) and Yerevan State University (Armenia). The essential elements of the study are that it emphasised the broad developments and institutional issues that make land-use planning a public administration affair in Germany.

2. Methodology

The methodological approach to the study involved the use of semi-structured interviews to collect data on the scope, nature and role of public administrators of land--use planning at both the local and regional scale in Bavaria, Germany. 16 interviews with local, regional land management experts and administrations were conducted. In general, the study answers the following questions. What is the public administration framework in Germany? What is the general indicator for assessing the effectiveness of public administration of land-use planning? How can any anomalies identified be improved? What are the challenges to land-use planning in the context of public administration? In determining the effectiveness of public administration activities related to land-use planning, decision-making is critical. In this regard, the study adopted the following formula for general applicability within Bavaria and Germany:

$$E \sim \frac{R}{G}$$

where:

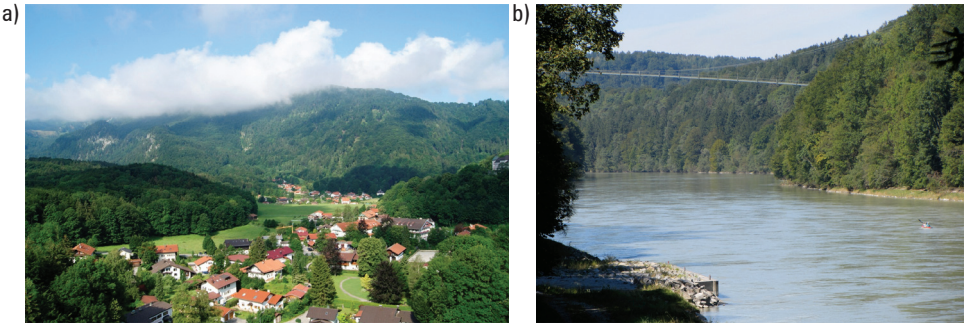
E – the effectiveness,
R – the result,
G – the goal.

The study used the above formula to derive a more generalisable efficiency assessment criterion and method for public administration of land-use planning.

3. General description of Bavaria

The Free State of Bavaria comprises the entire southeast of Germany. Geographically, it is the largest federal state of Germany, with Munich as its capital. It has a land area of 70.548 km^2 and a population of 12.604.244. Land management in Bavaria has technical, social, cultural, environmental and political decision-making aspects. As a key instrument, land-use planning serves as a base for development (Figure 1). The Land-use

Planning Ordinance Bavaria 2006 (*Verordnung über das Landesentwicklungsprogramm Bayern*) guarantees unique development of Bavaria and its parts with focus to the whole municipalities; central places, housing projects and nonphysical development issues. It also guides the development of agriculture and forestry, social and cultural, as well as technical infrastructure. What this study does is to analyse the administration of land-use planning critically.



Source: Chair of Land Management, Technische Universität München

Fig. 1. Visualisation of some important evidences of different land-uses in Bavaria: a) residential, mountains and forests land-uses in Füssen; b) water system as part of land-uses in Upper Franconia

4. Public administration of land-use planning in Germany

Being a federal democracy, legal and institutional frameworks serve as the basis for all forms of planning in Germany – strategic, sectoral, and spatial and land-use planning. The country's Basic Law (*Grundgesetz*) recognises the autonomy of municipalities in determining their vision for development. Usually, a preparatory land-use plan (*Flächennutzungsplan*) provides the basis for determining the types of land uses for municipalities and sets the framework for binding land-use plans. Binding land-use plan (*Bebauungsplan*) serves as "the chief instrument for implementing local government planning, and constitutes the basis for other measures needed to implement the Building Code" [Pahl-Weber and Henckel 2008: 79]. The typical development activities engendered by the binding land-use plan include land consolidation, infrastructural provisions, rural and urban development, etc. Despite the autonomy in decision-making enjoyed by the municipalities, there exist some forms of restrictions on the ability of municipalities to self-planning. They are meant to follow a "highly structured institutional and legal framework characterised by the legally determined distribution of responsibilities and tasks between the Federal government (Bund), the states (*Länder*) and the municipalities (*Gemeinde*)" [Schmidt 2009: 1912]. In between the state and municipalities, are the districts (*Kreise*). The districts comprises of a number of municipalities with the role of coordinating functions that a municipality may not

be able to perform adequately on its own. Districts also play supervisory functions over their municipalities on behalf of *Länder*. At the centre of the operation of these institutions are three important ideological concepts that guide development at all levels. Firstly, the concept of *Raumordunung* (spatial planning or management) that is ensured by the federal and regional governments. Then, the concept of *Bauleitplanung* (local planning), catered for by the municipalities. Decision-making and feedback mechanisms are based on the principle of *Gegenstromprinzip* (reciprocal influence of authority) by all three levels of government. The different spatial units develop and operate within a policy of equal living conditions [Magel 2014]. Public administration contributes in the actualisation of the objectives of land-use planning and related schemes. In this regard, there are two dominant programmes – *Flurbereinigung* (land consolidation) and *Dorferneuerung* (village renewal).

The village renewal and land consolidation programmes gear towards the improvement of rural living conditions. They provide a multifaceted approach to revitalising rural lives in the aspects livelihood improvements, farmland facilitation, cultural and landscape preservation. Land-use planning plays the role of ensuring lawful, appropriate and none-conflicting uses of land in the whole process. The land consolidation schemes involve the reorganisation of land for economic purposes, for landscape preservation and farmland prioritisation. This does not imply a mere reallocation of parcels to remove effects of fragmentation. Usually, there is a tendency for conflicts to arise between uses and users of land. This depends on the scale of land reorganisation. Where conflicts occur (and they usually do occur), public administration serves the first purpose for mediation and facilitation of resolutions, as well as for remediation and compensation of claims. Public administration is inseparable from land-use planning in Germany because political decisions are crucial to activities' location and management of space.

5. The land-use planning and public administration relationship in Bavaria

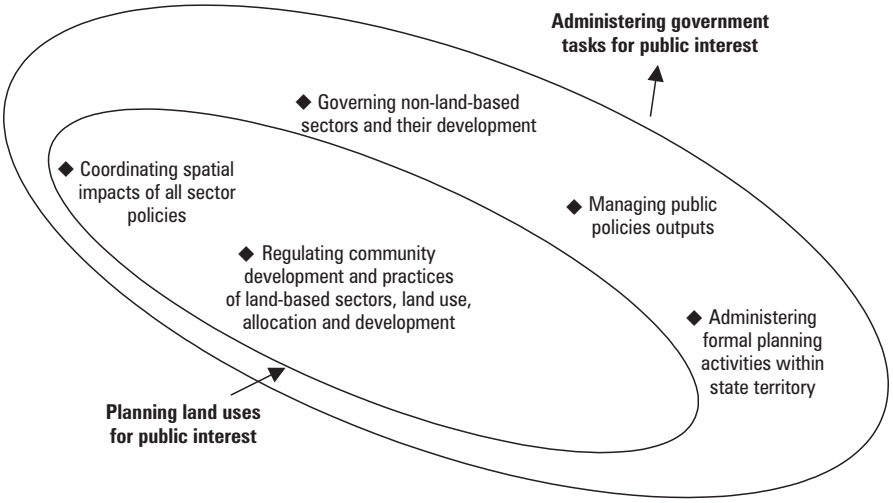
The study found that there is a strong connection between land-use planning and public administration in Bavaria (Figure 2). Public administration is a governance tool through which land-uses (and planning) and the interests of the public are guided. It is the elements of public administration (such as land administration) that drive and deliver land-use planning objectives. Public administration encompasses government activities over land in all sectors.

Land-use planning mainly focuses on the land-based component of planning which depends on public administration for approval. Therefore, it is public administration that makes the land-use planning a formal procedure.

6. Separation of political power from land-use planning decisions is unclear

The study found that there are some regulations of cooperation between staff, mayor and council of the municipality within the administrative structure of municipalities in Germany. This gives mayors and council members the choice to decide on the manner

and mechanisms. Functions of mayors and council officials in some municipalities are poorly defined and clearly interwoven. Mayors in this case are expected to provide disciplinary leadership and control, whereas the administrative staffs are limited to the realisation of the decisions made by mayor and council. All heads of administrative personnel in the municipalities are under the power of mayors and councils. Based on the above scenario it is evident that public administration system at the local level does not meet the principles of separation of political power from the administrative management. There is a structural overlap of political power (political decision making) and public administrative duties, from the context of land administration.



Source: authors' study

Fig. 2. Relationship between land-use planning and public administration

7. No common criteria of assessment of land-use planning decisions

The study found that there are some indicators for the evaluation of effectiveness or efficiency of administrative decisions in land-use planning. It identified indicators such as noise protection, landscape protection, and forest conservation issues, among many others. In most cases, these indicators constitute prerequisites for obtaining financial support from the state. In other cases, they serve as legal demands for administering land-use planning projects. However, these assessments are carried out prior to the inception of projects. They are, therefore, pre-conditions for land-use planning. However, this study could not find any framework for assessing the effectiveness of land-use planning processes (or its administration). This calls for post-completion assessments. In this regard, the only thing that the study found is a framework of

reporting for the projects which did not involve any scientific studies for evaluating the effectiveness of the projects or how they were administered. The lack of result-based assessment is a missing link in land-use planning in many Bavarian municipalities.

8. There is urban bias in the administration of building permits

Within the administration of land-use planning, there exist power imbalance between urban and rural areas, in favour of the urban. This relates to the issuance of building permits. Existing practice indicates that only municipalities with a population of over 250 000 have the legal powers to carry out this exercise. For municipalities with less population, the issuance of building permission is delegated to local in districts (*Landkrüs*). Considering that most rural municipalities are less than 10 000 population in Germany, they are denied the controlling powers for building permit regulation. Nevertheless, urban areas or cities enjoy the right to control building permits because of their population advantage over the countryside. They are usually more than 25 000. This sparks of urban bias and a disenfranchisement of regulatory development powers of the rural municipalities.

9. There is no uniformity in local government administration structure

There is no uniform structure for public administration for municipalities. The implication is that land-use planning processes are not unified in Germany. Even within an individual state (like in Bavaria), legislative processes of land-use planning have tremendous differences from municipality to municipality and from rural and urban areas. For instances, cities are professionally organised in the field of land-use planning. They can handle significant management processes whereas rural municipalities would need external experts in managing their land-use planning concerns. At the state level, public administration in the field of land-use planning is different from state to state. The Bavarian state takes a more conservative approach to land-use planning than in other states, such as Berlin and Hamburg. This lack of uniformity in structure of local government administration in land-use planning leads to difficulty in making comparison between municipalities, adopting general assessment criteria for evaluating results and facilitating cross-municipal cooperation in the administration of land-use planning.

10. Questionable context of good governance at the local government level

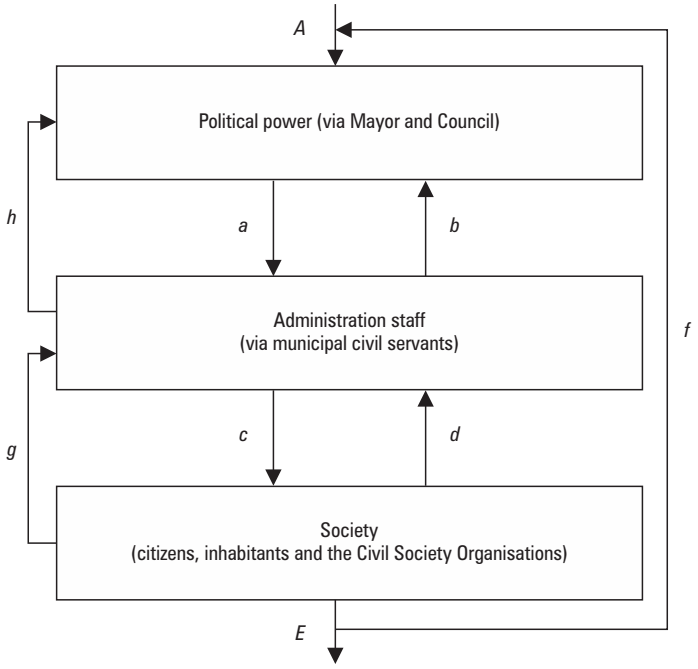
Democracy or democratic government is not the same as good governance. It is a well-known fact that there has to be good governance in a democratic government. The governance structure at the local level in Germany, with respects to political tenures, is questionable. This study is not alone on this. Despite providing a very positive side of rural development through village renewal processes, Chigbu [2012: 223] questioned the "the context of good governance" in Bavaria Germany. In Bavaria, just as in other

parts of Germany, some of the mayors have been in office for 20–35 years. Considering the overwhelming powers they wield on public administrative issues – and their double positions as part-time mayors in addition to being local citizens – long political mayoral tenures has consequences on public administration of land-use planning. Studies have shown that long political tenures are directly linked to increases in government spending [Basham 2011]. The reason being that longevity in office is likely to change mayors' political visions toward other programs that incur higher spending [Steelman 1998]. This can be detrimental to land issues in situations where land management is not a priority supported by the long-standing government.

11. Suggestions for improvement

11.1. Separate political power from public administration of land-use planning

In the contemporary notions of the public administration system, a particular attention is paid to ensuring efficient interactions between its sub-systems. Incompatible links between the politics and the state administration affect efficiency in land-use planning. More so, a lack of the principle of separation of the political power and administrative management of land-use planning, fuses rather than differentiates, between administration and government. System reorganisation is needed.



Source: authors' study

Fig. 3. Reorganising public administration to enable separation of powers

The logic is not that the two institutions, political authorities and the public service of land-use planning should exist independently from each other. The concerns hinges on a direct influence of political power on land-use planning decisions through public administration. As a way forward, this study calls for a structuring or restructuring of the current system. This is necessary in order militate against the impinging of political power on land-use planning administration. The suggested structure is presented in Figure 3. There is need for a system where politicians, administrators and the society have inter-dependent but separate duties. For instance, the links *b* and *a* characterise the spectrum of the alternative decisions proposed to the political authorities by the state/public service system and the decisions already taken by the authorities respectively. The decisions already taken by the authorities are subject to implementation by the state apparatus. In other words, *a* should be the sub-multitude of the *b*. The less the difference between the decisions taken and the proposed alternative versions, the more efficient will be the feedback between the political authorities and the administrative staff. This difference will become even lesser if the level of the involvement of the public servants and their inter-identification with the apparatus become bigger – in the diagram, this is shown by the link *h*. Furthermore, the links *c* and *d* characterise the services provided by the authority (in this case, land-use planning) and the control of the quality of those services by the public (public/participative monitoring) respectively. The effectiveness of this feedback is directly proportional to the level of its influence due to the participation of the public in public decisions, presented by the link *g*. The component *A* represents promises given by the authorities during the pre-election phase, the leading values of the political power having the authority, the vision of the latter on development. The component *E* is the component characterises public needs. Components *A* and *E* should be in a permanent state of inter-influence because they are conditioned by each other, thereby producing the link *f*. This study asserts that the stronger and bilateral the feedbacks are, the more effective the whole system of the public administration will be for land-use planning. Moreover, the level of the reciprocity of the feedback *f* describes the political structure of the public organisation. Therefore, the more dominant the top down direction in the information flow is, as represented *f*, the more the political regime is inclined towards totalitarian and authoritarian manifestations in administrative activities. This situation should be avoided within German administrative systems in land-use planning. Similarly, the case of the dominance of the bottoms up directions can lead to excessive liberal manifestations.

Therefore for the interaction between political power and administrative staff to be balanced, the following four steps are imperative.

1. Develop an approach for separating political functions from managerial ones. This is possible through readdress of the roles of the mayor and council, and the staff of the municipality in land-use planning issues.
2. Establish positions for "municipal servants" at the local level that should be, also, protected by law and in line with promoting the objectives of land-use planning within municipalities.

3. Clearer job descriptions should be made concerning the role of municipal civil servants operating to wade off higher political interferences in their duties. It requires career stability in the position of the head of staff of the municipality (in terms of tenure) and independence from the influence of the mayor or council of the municipality concerning employment of personnel.
4. Improving the capacity and development of municipal staff in administrative duties regarding land-use planning is important. This can be achieved by providing obligatory training courses for municipal servants in land management. However, such trainings can lead to further strengthening of relationships between the academic institutions and local self-government system.

11.2. Device a general efficiency assessment criterion and method for public administration of land-use planning

Concerning the lack of a framework for efficiency assessment of public administration in the context of land-use planning, this study provides a framework as a suggestion. This framework can provide a standard criterion for efficiency assessment and serve as a guideline for characterising the effectiveness of decisions based on the theories (and practices) of good political governance. In this sense, for the characterisation of any activity effectiveness, the study suggests that the following formula should be applicable:

$$E \sim \frac{R}{G} \tag{1}$$

where:

E – the effectiveness,
R – the result,
G – the goal.

A necessary methodological issue is important. "The effectiveness of each concrete decision must be characterised corresponding to the criteria conditioned by the content and results of that decision" [Kalashyan 2013: 53]. It means that a different approach is needed for the selection of each criterion (comprising of objectives of land-use planning) based on the concrete situation during the decision-making and implementation. Where it concerns a decision on the extraction and redistribution of resources by the governing subject, the criterion for the assessment of its effectiveness needs to be precisely defined. This is important because the result of the implementation of a decision in this case is the confirmation of the resource supply. The role of the expenditures is the use of a particular type of capital (political, social and informational factors). In such cases, the effectiveness of the administrative activity should be characterised by the goal (or result, interests and profit) on the basis on which the decision about the resource distribution was made. This enables that the goals and outcomes in the equation (1) are in line with the draft decisions and the decisions carried out on the basis of the latter during the governance quality assessment. In the case of the administration

quality assessment, it will enable them to be in line with the already made decisions and the decisions implemented on the basis of the latter. Deriving from equation (1) and taking into account the methodology of the mathematical elaboration of the pilot data (usual data on land-use planning), the study adapted the equation to arrive at the following:

$$E_p \sim \frac{\sum_{n=1}^{p} D_{\text{conf. n}}}{\sum_{n=1}^{p} D_{\text{draft n}}} \tag{2}$$

$$E_n \sim \frac{\sum_{n=1}^{p} D_{\text{im p. n}}}{\sum_{n=1}^{p} D_{\text{conf. n}}} \tag{3}$$

Where:

- D_{draft} – the number of the draft decisions proposed for the discussion during one session of the council,
- $D_{\text{conf.}}$ – the number of the decisions confirmed and adopted during one session of the council,
- $D_{\text{imp.}}$ – number of the implemented decisions,
- p – the number of the sessions held during a given period,
- E_p – potential effectiveness,
- E_n – nominal or adequate effectiveness.

This means that the closer E_p and E_n (measured during the same period) are to each other, the more the general effectiveness of a given agency. Based on this approach, E_p will be in accordance with the good governance quality, while E_n will be in accordance with the good administration quality. The implication of all these is that the effectiveness of land-use planning decisions (particularly as it affects achievement of its goals or objectives) will become assessable based on known criteria.

12. Conclusion

Although this study focused on Bavaria, the situation in Bavaria is applicable to other parts of Germany. It raises some questions regarding the German planning scenario, from a public administration perspective. Concerns about the role of state need to be addressed. A common assessment framework for determining the effectiveness of public administration decisions in relation to land-use planning need to be addressed. Separation of political power from the administrative management will enable decision-making processes to become professionally adequate for handling the new realities faced by municipalities in Bavaria. When it operates as nonlinear processes,

the administration of land management issues will be carried out in a more participative manner within the administrative office. Participation should not only be about citizens, and should be practiced in the spheres of decision-making on administrative duties concerning land-use planning. This way, public administration will serve as an instrument for fostering rapid responsiveness of governance in land-use planning towards fulfilling the growing needs of local societies.

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MANAGEMENT OF COMMUNAL LAND AND PROPERTY RESOURCES IN THE CONTEXT OF MUNICIPAL DEVELOPMENT – THE EXAMPLE OF BOBOLICE MUNICIPALITY

Julia Gorzelany-Plesińska, Monika Rewkowska

Summary

The article contains the analysis and evaluation of the management of communal land and property resources, or the real estate pool, in the Bobolice municipality, as well as the impact of the said management on the municipality's development. The analysis consisted in the assessment of municipal real estate management from the point of view of the municipal finance and economy. Reports from the municipal budget implementation for the years 2009–2013 have been assessed, with the focus on costs and revenues pertaining to municipal real estate resources. Subsequently, indices have been proposed, which determine whether the management of communal land and property resources has an impact upon municipal development. Values which the indices have reached served to demonstrate that the revenue from municipal real estate is so low as it cannot significantly stimulate the development of the municipality, whereas the costs of preparing the real estate for investment purposes was not covered. However, when municipal investment is taken into account, it should be stated that the management of communal land and property resources does support municipal development of the studied municipality in a long-term perspective. The article shows the management of communal land and property resources through the lens of financial indices, however, there are also non-financial factors, which have a significant impact on the effectiveness of real estate management in the given municipality.

Keywords

development • real estate • management

1. Introduction

Often discussed in literature in the field of economics, the issue of development is a broad and complex one. It is, however, universally agreed that the term "development" should always be associated with desired positive change, occurring in the quantitative, qualitative and structural properties of a given system. If the system in question is a distinct, social and territorial unit with a set of economic, spatial and cultural characteristics, expressed needs, as well as a value system and a hierarchy, then

we are dealing with the development at a local (regional) scale. The many terms we encounter throughout the subject literature, despite the necessary simplifications, seem to clarify its essence in a precise way – as on the one hand, they present the "local" quality of development, and on the other hand, its effects and decisive factors [Sztando 1998, Sobczyk 2010].

Real estate management signifies, among other things, the process pertaining to the development of real estate, the use and protection of land, as well as generating revenues from sales, rental, and taxes, and also, resolving any conflicts pertaining to property rights [Dale and McLaughlin 1999].

The municipality owns a wide range of real estate – beginning with land, council flats, real estate supporting technical infrastructure, and ending with roads, public utility property, and strategic real estate perceived as mainstays supporting the development of town centres (also in a trans-regional context) [Kaganova et al. 2006].

According to article 24 passage 1 of the Real Estate Management Law, municipal property resources include the real estate properties, which are owned by the municipality and/or are used by the municipality pursuant to the perpetual usufruct rights. The foundations for the creation of the municipal property pool of resources lie in the municipal Studies of the Conditions and Directions of Spatial Management, adopted on the basis of the Spatial Planning and Development Act (under the Polish Law). The municipality should strive to obtain ownership of a pool of real estate indispensable for the implementation of its functional objectives. Municipal real estate pool management consists in taking all decisions and performing all operations in a manner complying with principles of good governance. Performing the operations pertaining to the management of real estate is a responsibility of an alderman, a mayor, or a town president, who represents the municipality in that regard [Magiera-Braś and Salata 2010].

Municipal real estate pool may have positive impact on the development of a self-governed regional unit only if the management thereof is effective and efficient. Development potential of a territorial unit is shaped by a variety of factors, however, the basic ones of those factors include attractive land for investment, which facilitates the location of new economic activity units within the municipality, and therefore, the creation of new jobs. In order for the municipality to become an attractive investment partner, it should conduct an active and effective management of its pool of real estate resources. This kind of management should consist in obtaining real estate properties, preparing land properties for new investment projects (equipping it with access to networks of technical infrastructure, enabling access to public roads, etc.), followed by selling or renting out a given property. As far as municipal housing (the council flats) is concerned, the municipality should ensure their adequate numbers and the highest standard possible.

The goal of the present report is to evaluate the municipal real estate pool management in the Bobolice municipality, and its impact on the development of the studied municipality – which is located in the Koszalin poviat (district), in the West Pomeranian region of Poland. Furthermore, we have analysed the impact of managing communal property upon the development of the municipality in question.

2. Research materials and methodology

In the report, we have used the method of a descriptive, logical analysis, based on descriptive statistics. The analysis was conducted based on the collected data, originating in the reports from the Bobolice municipal budget implementation for the years 2009–2013, as well as the data of Główny Urząd Statystyczny (Central Statistical Office of Poland).

Bobolice municipality is a mixed, urban and rural municipality. It is located in the Koszalin poviat (district), in the eastern part of the West Pomeranian region of Poland (Figure 1). It is one of the largest municipalities within the region, with the total area of 367.56 km^2. Bobolice municipality shares borders with seven other municipalities, including: Biały Bór, Świeszyno, Tychowo, Manowo, Szczecinek, Grzmiąca, Polanów [Lokalny Program Rewitalizacji… 2008].

Source: http://www.wios.szczecin.pl/ (accessed: 28.09.2014)

Fig. 1. Administrative location of Bobolice municipality among neighbouring municipalities

When analysing the impact of the management of communal real estate pool upon the development of the municipality, a number of conditions should be taken into account, which occur within its territory. The most important of these conditions include: geographic location, demographic structure, as well as economic and financial conditions. In the present report, it is the economic and financial conditions that have been analysed most broadly, and the conclusions were based on an exhaustive assess-

ment of the municipal budget, in particular the costs and revenues of the municipality pertaining to the management of communal real estate pool.

Any municipality conducts its financial management using the key document, which is the municipal budget. The budget of a municipality is an annual financial plan: of revenues and expenditures of a territorial self-governing unit, of revenues and expenditures of their financial units, state entities, auxiliary divisions, and so forth. It is adopted in the form of a budgetary resolution [http://www.ekonom.info/725-budzet_gminy/, accessed: 27.04.2014].

One of the key elements of the budget consists in the revenues of a municipality. Without doubt, real estate property can be seen as a source of the municipality's income. This is the case with the communal real estate pool, which, firstly, serves for the implementation of the municipality's own tasks and responsibilities, but also, secondly, it is the source of income, that every municipality possesses.

Table 1. Size and structure of real estate revenues in Bobolice municipality between 2009–2013

Item	2009	2010	2011	2012	2013
(amount in zł)					
Revenues from municipal real estate	1 047 738	947 580	1 258 522	1 457 392	965 960
Revenues from municipal real estate management	654 367	604 804	584 542	594 358	627 714
Revenues from municipal real estate trading	393 370	341 012	657 682	854 207	336 285
(percentage)					
Revenues from municipal real estate	100.00	100.00	100.00	100.00	100.00
Revenues from municipal real estate management	62.46	63.83	46.45	40.78	64.98
Revenues from municipal real estate trading	37.54	35.99	52.26	58.61	34.81

Source: authors' study based on the data from the Town and Municipality Council of Bobolice

As follows from Table 1, revenues received from communal real estate pool may be subdivided into:

- revenues from municipal real estate management,
- revenues from municipal real estate trading.

The data presented in table 1 goes to demonstrate that there is no clear tendency within revenues pertaining to municipal real estate. In each of the years, we observed a different situation, resulting above all from the varying numbers of real estate properties sold. In 2009, revenues from municipal real estate slightly exceeded one million Polish złoty, while almost 63% of that came from the revenues from municipal real estate management, and 38%, from the revenues from municipal real estate trading. We observed a similar situation in 2010, where the revenues from municipal real estate decreased by 10.5%, and the revenues from municipal real estate management

still constituted a little more than 63% of all revenues from municipal property, while the revenues from municipal real estate trading – amounted to 35.99%. In 2011, we observed an increase in the revenues from municipal real estate, which amounted to almost 1.3 million Polish złoty, however, the revenues from municipal real estate management decreased down to 46.45%, while the share of the revenues from municipal real estate trading increased up to 52.26%. In 2012, we observed another increase in the revenues from municipal real estate, and – similarly to the previous year – the decrease in the share of the revenues from municipal real estate management, now down to 40.78%. An increase in the revenues from municipal real estate trading was noted – up to 58.61%. In 2013, the situation changed again, and it resembled that of the years 2009–2010. The revenues from municipal real estate decreased by 50.8% and it now amounted to over 960 thousand Polish złoty. At the same time, the share of revenues from municipal real estate management increased (compared to the year 2012) by almost 25% and it constituted 64.98%. The share of the revenues from municipal real estate trading decreased by approx. 24% and it constituted 34.81%.

We should remember that the municipal real estate pool serves for the implementation of the municipality's own tasks and responsibilities, and therefore, it also constitutes a source of expenditures (costs). The scale of expenditures pertaining to the communal property may be best perceived when seen in juxtaposition against general expenses of the given regional administration unit, which we are analysing. These expenditures pertain mostly to the maintenance of the communal property, repairs and current conservation. Investment costs on the communal real estate constitute the lesser part of expenses.

Table 2. Expenditures pertaining to communal real estate in the budget of Bobolice municipality between 2009–2013

Item	2009	2010	2011	2012	2013
(amount in zł)					
Total budget expenditures	32 019 472	35 993 946	34 750 904	35 723 050	36 558 748
Real estate expenditures pertaining to investment	7 896 000	5 602 712	2 923 897	1 881 443	2 989 988
Total current costs	24 123 472	30 391 234	31 827 006	33 841 607	33 569 761
Total expenditures pertaining to communal real estate	535 126	2 126 064	1 303 227	1 447 337	1 367 610
(percentage)					
Share of investment expenditures in total expenditures	24.66	15.57	8.41	5.27	8.18
Share of current costs in total expenditures	75.34	84.43	91.59	94.73	91.82
Share of expenditures pertaining to communal real estate in total expenditures	1.67	5.91	3.75	4.05	3.74

Source: authors' study based on the data from the Town and Municipality Council of Bobolice

When analysing the expenses on the communal real estate, no clear tendency can be determined, as these costs are not subject to any trend – similarly as in the case of total budget expenditures in general. In 2009, expenses pertaining to communal real estate were at the lowest level of all the analysed years, and they amounted to over 535 thousand Polish złoty, which constituted 1.67% of all budget expenditures. In 2010, the highest increase in the communal real estate costs was noted, when these costs increased by as much as 297.3% and amounted to over 2.1 million Polish złoty, which constituted 5.91% of all budget expenditures (the highest share in the analysed period). In 2011, expenses on the communal real estate decreased by 61.3% compared to the previous year, while their share in all budget expenditures decreased down to 3.75%. In 2012, costs pertaining to communal real estate again increased by 11%, in order to decrease in 2013 by 5.5% – in that latter year, their amount reached the level of slightly above 1.3 million Polish złoty. Despite the decrease in the spending on the communal real estate in 2011, its share in all budget costs increased by 0.3%, and it constituted 4.05%, while in 2013, despite the increased communal real estate expenses, their share in the total budget decreased by 0.31%.

3. Non-financial instruments versus the management of municipal land and property resources

Management of municipal real estate pool does not focus solely on the management of municipal finance, but it also encompassed the planning functions, which create the guidelines for the municipality's development [Fernholz 2007]. Municipality possesses also a number of non-financial instruments, which can be used in the process of managing its resources. The first group are the planning and strategic instruments. They chiefly consist in elaborating strategic documents, which set long-term objectives for action and development. The first and foremost of those is a municipal development strategy, which is an optional document, determining economical development goals of the municipality. At the same time, it is, in a way, a scenario for the development, presented in the format of a long-term vision. The second document is the Study of the Conditions and Directions of Spatial Management of the municipality, which defines the economic, geographic and social conditions within its territory, while at the same time, it sets out the desired directions for change and development of the municipality. The second group of the non-financial instruments are those of a planning and operational character, which are more detailed than the planning and strategic ones. These include: the local land use plan, as well as planning permissions (land use decisions). In addition to the above, municipalities may develop also other studies and reports, which can help in managing the municipal resources, for instance the plan for the utilisation of municipal real estate property [Cymermann 2013]. Another group consists of implementation instruments of an economic and financial character. These include all kinds of fees and taxes pertaining to real estate properties, paid to the municipality by the owners or perpetual usufruct holders of these properties. For instance, such payments may include: perpetual usufruct fees, bonuses on sale price, penalties for not devel-

oping the given property within the stated deadline, etcetera. Finally, the last group of instruments, used by the municipalities in managing communal real estate pool, consist of implementation instruments of the legal and administrative character. These include, above other things: division of property, merging of properties, pre-emption rights, investment, expropriation, permanent management, and so forth.

4. Empirical analysis of the impact of municipal land and property resources on the municipal development – the example of Bobolice municipality

The problem of evaluating the efficiency of communal property management is a difficult one, as it depends upon a great number of factors. In case of each analysis or each evaluation, the starting point should be in the examination of the present condition, which can provide a baseline for further studies.

Based on the conducted analysis of the present condition of the municipality, indices should be proposed, which shall depict certain relationships, correlations, and dynamics over a certain period of time, and through that depiction, they will enable the correct conclusions leading to the evaluation of the impact of communal property management upon the development of the municipality in question. Proposed indices adopted for the analysis have been included in Table 3.

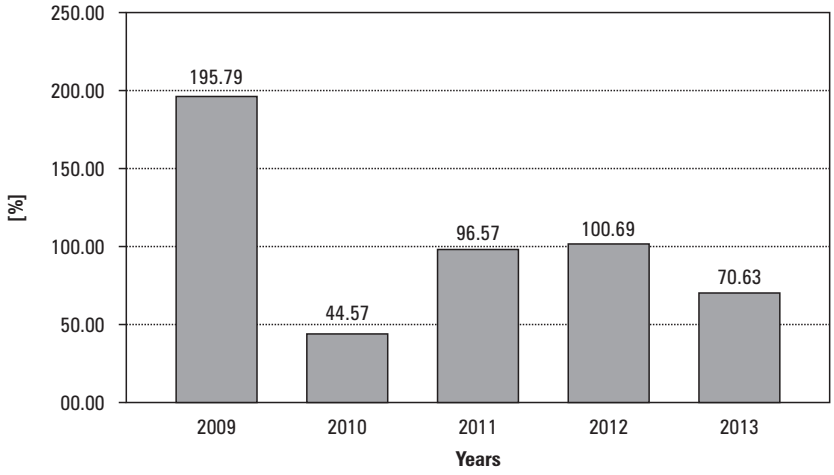
Table 3. Proposed indices for the evaluation of communal real estate pool management in a municipality

Evaluation index	Justification
Revenues from municipal real estate / total revenues of the municipality	Presents the structure of municipal revenues with reference to revenues from the municipal (communal) real estate.
Revenues from municipal real estate / municipality's own revenue	Presents the structure of municipal revenues with reference to revenues from the municipal (communal) real estate.
Expenditures pertaining to municipal real estate / total expenditures of the municipality	Presents the structure of municipal expenditures with reference to expenditures pertaining to the management of municipal (communal) real estate.
Expenditures pertaining to municipal real estate / number of inhabitants in the municipality	Presents the amount of expenditures per inhabitant of the given municipality.
Revenues from municipal real estate / number of inhabitants in the municipality	Presents the amount of revenues generated from the municipal (communal) real estate per inhabitant of the given municipality.
Revenues from municipal real estate / expenditures pertaining to municipal real estate	Presents the level of financing of the expenditures pertaining to the management of municipal (communal) real estate – i.e. the coverage of these costs with the revenues resulting from the municipal real estate management.
Area of municipal land properties / total area of the municipality	Presents the share of the municipal land properties in the total area of the municipality.

Source: authors' study based on Nalepka 2014

5. Research results

The results of the discussed analysis are based chiefly on the proposed indices for the evaluation of communal real estate pool management in the given municipality. In the present article, the most pertinent of those indices have been depicted. The most important of those is the level of financing of the expenditures pertaining to the management of municipal (communal) real estate; or in other words, the coverage of these costs with the revenues resulting from municipal real estate management (Figure 2).



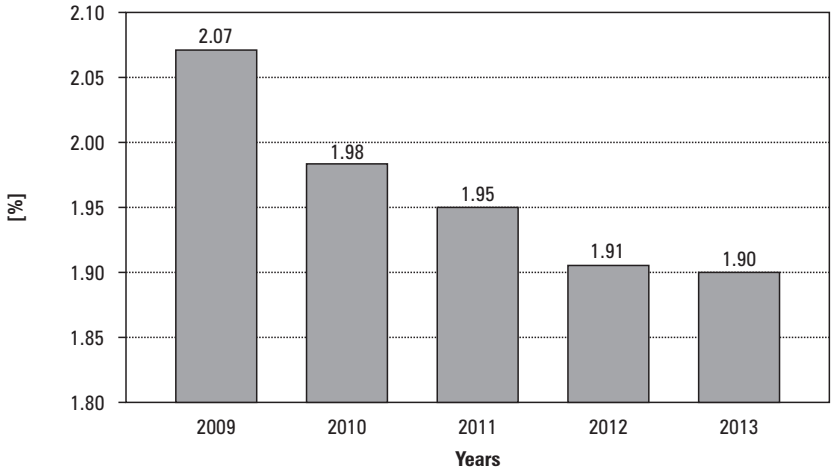
Source: authors' study

Fig. 2. The level of financing of the expenditures pertaining to the management of municipal (communal) real estate, i.e. the coverage of these costs with the revenues resulting from municipal real estate management, in the Bobolice municipality between 2009–2013

When analysing Figure 2, we should note that the average level of coverage of financing the expenditures pertaining to the communal real estate with the revenues resulting from the municipal real estate management, in the period of 2009–2013, remained at the level of approximately 102%. This testifies to very good management of municipal real estate, in other words, to such management, which is effective, for instance in producing financial surplus in the sector of communal land and property. Having said that, the index varied from year to year over the studied period. For instance, in 2009, it reached more than 195%, which means that municipal real estate property did not only cover the cost, but it also generated profit. On the other hand, in 2010 the value of the index decreased by as much as 4.5 times. Between 2011–2012, the coverage of financing the expenditures pertaining to the communal real estate with the revenues resulting from the municipal real estate management, remained at the level of approximately 100%. In 2013, the value of the index decreased again, to only a little more than

70%. In each case, whenever the value of the index falls below 100%, this means that the municipality has to bear additional cost for the maintenance of its real estate pool.

Another interesting index, which explicitly depicts a certain trend observed in the studied municipality, is the share of the municipal land properties in the total area of the municipality (Figure 3).



Source: authors' study

Fig. 3. The share of the municipal land properties in the total area of the municipality, in the Bobolice municipality between 2009–2013

Figure 3 shows a clear tendency, indicating that the share of the municipal land properties in the total area of the municipality decreased annually. In 2009, it was a little above 2%, and it decreased each year, in order to reach the share of 1.90% by the year 2013. This change may seem a slight one, however, in the case of a municipality with an area of approximately 367 km^2, these fractions of per cents are of high significance. Figure 3 also demonstrates that Bobolice municipality gradually sells its land communal property. This consisted mostly in the sale of communal land property to private persons, in order to release it for the construction of single-family developments.

6. Conclusions

As demonstrated by the financial indices pertaining to the management effectiveness of the municipal real estate pool, investment projects cause the situation in which communal properties generate revenues insufficient for financing the necessary expenditures. This, however, should not be perceived as negative – the spending in question is sure to bear fruit in the period of the next dozen or several dozen years, having a positive impact on the image of the municipality, as well as bringing investors and

tourists hereto. Most certainly, testifying to the investment attractiveness of the area is the rich repository of competitive municipal properties, providing ideal location for all kinds of investment projects. On the other hand, tourism attractiveness of a given municipality is mainly decided by its abundant leisure offer, which is created mostly based on its communal resources, including the real estate. These expenditures will also serve the local residents, inhabiting the municipality. Therefore we cannot draw conclusions – based on the financial indices only – that in the Bobolice municipality the management of the municipal real estate pool does not significantly impact the development of the municipality, as this would be a false inference. Following a broader analysis of the issues pertinent to the management of communal property resources by the municipality, which takes into account also the non-financial instruments, we note an impact of the municipal real estate pool management upon the development of the said municipality.

To conclude, we need to remark that the municipal self-government should strive at continuously increasing the effectiveness of the municipal real estate pool management – both as it relates to the social effect, and the economic and financial results. One of the possible ways to increase the effectiveness of the communal real estate pool management in the Bobolice municipality would be to develop a planning document with detailed guidelines for the management of communal land and property in a long-term perspective. This would allow the municipal authorities to plan any larger investment projects, which require large financial outlays. Furthermore, a long-term plan for the utilization of communal land and property would influence the increase in the revenues from the communal real estate, and it would facilitate the control of the implemented tasks and juxtaposing them with the planned tasks, which had not been implemented. The plan for the management of the communal land and property should deal separately with non built-up land properties, municipal buildings and structures, and council housing. Each of these types of properties is different – and each requires specific conditions and guidelines, in order to provide a positive impulse for the development of the given municipality. In addition to the implementation of the plan, municipal authorities should purchase new properties in order to increase their real estate pool of resources. The purchased properties should be prepared as well as possible for the investment process for private investors. Also selling properties at a price higher than the one at which they had been bought would have a positive impact on both the municipal budget and the activation or communal real estate turnover.

Another important issue consists in the local spatial development plans. It would be the best possible option for the Bobolice municipality to implement the plan for the entirety of its area, which would significantly and positively impact the development of spatial order within its range. These goals, however, may be achieved only as a result of rational management of the municipal real estate pool.

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Zarządzenie Nr 26/2013 Burmistrza Bobolic z dnia 29 marca 2013 roku w sprawie przyjęcia sprawozdania z wykonania budżetu za 2012 rok.

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THE IDEA OF RANKING IN SETTING PRIORITIES FOR LAND CONSOLIDATION WORKS

Jarosław Janus, Jarosław Taszakowski

Summary

Functioning conditions of agriculture are closely related to the spatial structure of rural areas, which is one of the most important factors influencing profitability of agricultural production. Essential changes in rural space can be effected in a short period of time only as a result of land management works. The scope of these works is limited because the financial resources are often insufficient. As a result, scarce funds must be distributed in such a way as to ensure their flow to where they are mostly needed or where the return on investment, in the form of improvement of farming conditions, would be the highest [Błaż et al. 2010, Gawroński 2005].
The article presents the idea of creating multicriteria ranking of surveying sections of Małopolskie Voivodeship aimed at identifying areas that should be the subject of land management works in the first place. It is suggested that to achieve this goal databases of rural areas in the Małopolska region, including data from the descriptive and graphic part of the land and building register as well as digital orthophotomap.
Voivodeship authorities, having access to the results of the proposed calculation process, could play an important role in programming the land management works.

Keywords

land consolidation • land spatial structures • land management works

1. Introduction

Małopolska region has a specific spatial structure of rural areas, because large fraction of the rural population is engaged mainly in subsistence farming, and farming is not its primary source of income. There is a large number of adverse factors lowering the profitability of commercial agricultural production in the region, such as relatively small mean size of farms, significant land fragmentation together with unfavourable shape of parcels and domination of poor soils.

In order to improve the conditions of farming and to stimulate the development of rural areas, it is necessary to accurately assess the status quo, and particularly the problems and limits related to agricultural production areas. The assessment will allow

to indentify areas of highly distorted agricultural and non-agricultural production activity and to find measures to limit the scope of these distortions.

This study presents the main assumptions of creating the ranking of the rural areas (surveying sections) in which agricultural and non-agricultural production activity faces major difficulties and where consolidation and exchange of lands is most urgent.

For the purposes of this study a farms' land has been defined as a parcel (land plot) belonging to one land registration unit according to a registration group 7.1. The definition involves certain degree of simplification that results from the specificity of the processed databases such as land and building register data saved in the Register Data Exchange Standard (SWDE, Standard Wymiany Danych Ewidencyjnych). In these databases it is not specified which units could be merged into one farm nor other attributes defining a particular parcel as part of a given farm. This problem however does not affect the essential aspect of the results, namely the opportunity to make a comparison of various phenomena within a given section, and it is related to individual sections with similar (in percentage terms) intensity of traits, and it is only a systematic error, which should be kept in mind during description and interpretation of the results.

2. Characteristic of spatial structure of rural areas in the Małopolska region

The main features of spatial structure that are exceptionally unfavourable for the development of standard agriculture are too small mean size of farms and parcels. Spatial differentiation of these features in communes of Małoposka is shown in Figures 1 and 2.

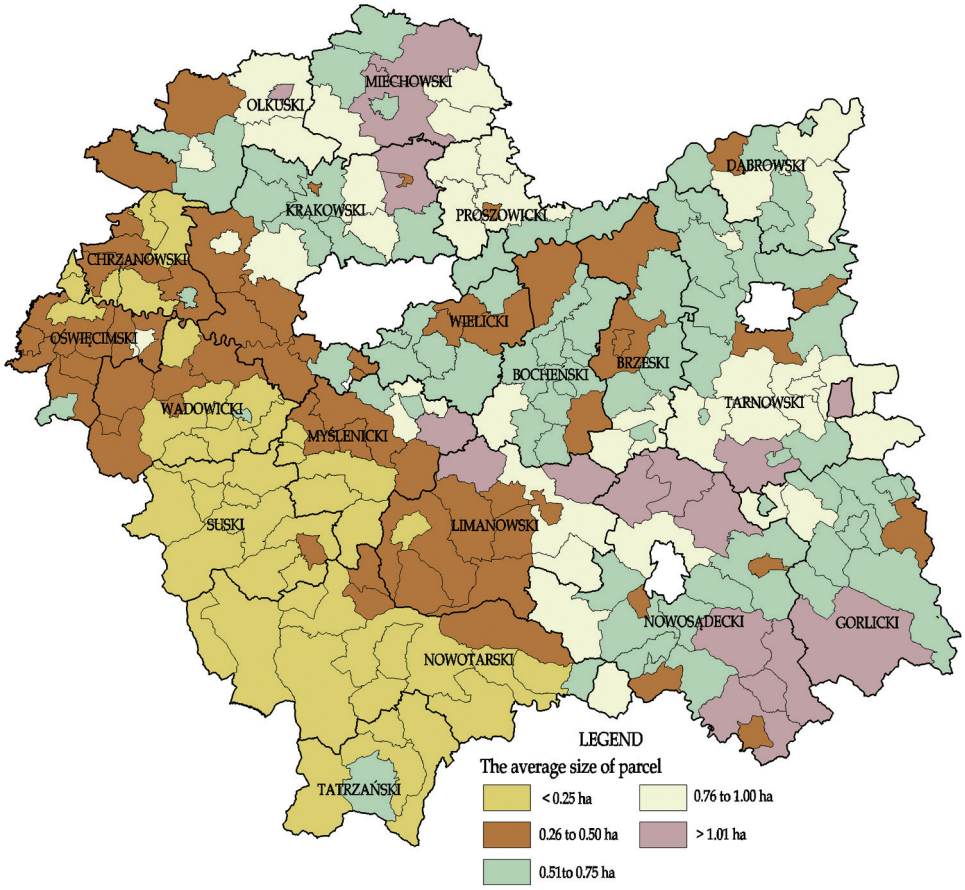
The analysis of chosen parameters of spatial structure, some of which have been presented in Tables 1 and 2, shows what are the main obstacles in development of rural areas in the Małopolska region.

When analysing Table 1 one can conclude that out of four millions record parcels in Małopolska, slightly more than 2 millions belong to farms, and nearly equally large group (almost 1.5 mln) belong to natural persons, and these lands are not even part of small farms (agricultural property). The mean size of a parcel in rural areas of both rural and rural-urban communes is 0.37 ha. And the mean size of land registration unit in rural areas of both rural and rural-urban communes is 2.56 ha.

In Figure 1 the mean size of parcels in a farm in different communes of Małopolskie Voivodeship is presented. The smallest parcels can be found in the south-west part of the voivodeship, mainly in communes of Nowy Targ, Tatra, Sucha, and partly in Myślenice and Wadowice districts. The largest record parcels occur in some parts of communes of Miechów, Kraków, Nowy Sącz, Gorlice (Uście Gorlickie commune), Tarnów and Limanów districts.

In Table 2 farms of size 1–2 ha are dominant, but when the total surface area of farms is considered, the largest group (almost 37%) are farms of acreage of 2–5 ha.

In Figure 2 the mean size of family farms in communes of Małopolskie Voivodeship is shown. The smallest farms (up to 2 ha) can be found mainly in communes of Chrzanów and Wielczka districts, and the largest (up to 5 ha) in Uście Gorlickie commune in Gorlice district and Piwniczna commune in Nowy Sącz district.



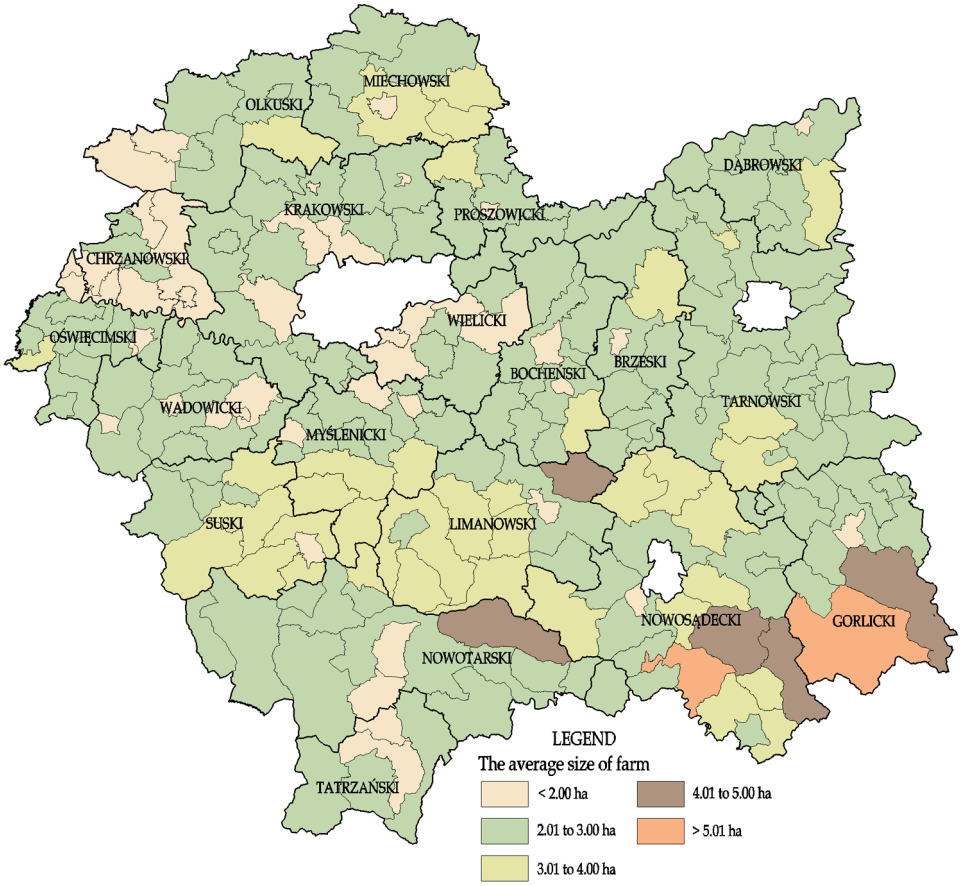
Source: authors' study based on EGIB (Land and Building Register) 2010

Fig. 1. Differences in mean size of parcel in a family farm in the communes of Małopolskie voivodeship

Table 1. Chosen parameters of spatial structure of lands in Małopolskie voivodeship

No.	Feature	Value
1	Total number of record parcels	4 052 284
2	Number of record parcels of farms' lands (land registration unit)	2 071 983
3	Number of record parcels being agricultural land properties	1 489 929
4	Mean size of record parcel [ha]	0.37
5	Mean size of farms (land registration unit) [ha]	2.56

Source: authors' study based on data from EGIB (Land and Building Register), 2010



Source: authors' study based on EGIB (Land and Building Register) 2010

Fig. 2. Differences of mean size of family farms in communes of Małopolska

Table 2. Structure of land fragmentation of farms in Małopolska

No.	Size of farms	Number of farms		Total surface area of farms	
		Number	[%]	[ha]	[%]
1	1–2 ha	150 875	51.19	213 596	22.33
2	2–5 ha	114 809	38.95	353 404	36.92
3	5–10 ha	24 594	8.34	160 386	16.76
4	more than 10 ha	4 481	1.52	229 519	23.99
Total		294 759	100.00	956 905	100.00

Source: authors' study based on EGIB (Land and Building Register) 2010

Development of agricultural production environment in Małopolska is influenced not only by parameters of spatial structure of lands but also by quality of soils (Table 3). As Table 3 shows, in Małopolska soils of middle quality dominate (4th class – 41%) and there is only small share of high quality soils (both 1st and 2nd class soils constitute around 5%). The numbers show that during land management works non-agricultural aspects of development of rural areas should be emphasised.

Table 3. Soil quality in Małopolska

No.	Total surface areas and percentage of arable lands	Surface area	Percentage
		[ha]	[%]
1	1st class	15 726	1.37
2	2nd class	46 576	4.08
3	3rd class	272 773	23.83
4	4th class	469 510	41.02
5	5th class	232 295	20.29
6	6th class	107 716	9.41
Total		1 144 596	100.00

Source: authors' study based on EGIB (Land and Building Register) 2010

In spite of numerous flaws of spatial structure of Małopolska, many areas of the region, where there is no modern, large-scale extensive farming, have exceptional cultural and scenic values. Undoubtedly the process of transformation and revitalization of rural areas in Małopolska should be implemented with the utmost attention paid to maintaining these unique elements, constituting real cultural landscapes [Cymerman et al. 1992, The European Landscape Convention 2002]. Apart from care given to maintenance of these elements, when improving the functioning of these areas (including land consolidation) measures should be taken to emphasize their non-agricultural values.

3. The idea of creating ranking defining demand for land consolidation works

One of the priorities of the voivodeship self-government is a coordination and facilitation of actions aimed at improvement of area structure of farms and proper farming in rural areas. These actions are realized by the authorities in accordance with their legal provisions, capabilities and limits (mostly financial, sometimes procedural). The basic instrument of making comprehensive changes in rural environment is land consolidation, which together with investments made as part of post-consolidation management can improve conditions of farming and provide a developmental stimulus for the whole village and thus result in better standard of living of inhabitants.

The programme for agriculture and rural development in Małopolskie voivodeship [Program 2010] shows that land consolidation should be popularized, but it does not contain practical solutions as to how to make an informed choice of objects of that procedure.

To achieve this goal the study proposes fast and convenient method of analysis of rural areas (communes, districts and voivodeships), and presents ways of its application for identifying group of surveying sections in which there is simultaneously high intensity of negative traits of spatial structure of farms and a good chance that the land consolidation works would bring satisfactory results. For this reason, on the basis of a number of partial indices of features important in planning land consolidation works, a characteristics of individual survey sections has been proposed, and then the use of these indices in the process of creation the final ranking has been shown.

The following partial indices were used. The way they were calculated has been described in detail in other scientific papers:

- index related to the size of farms (W_1), presented in Janus and Taszakowski [2013a],
- index of land fragmentation (W_2), presented in Janus and Taszakowski [2013b],
- index related to soil quality (W_3), presented in Janus and Taszakowski [2014],
- index showing lack of road access to parcels (W_4), presented in Janus and Taszakowski [2013c],
- index related to analysis of aerial photographs (W_5), presented in Janus and Taszakowski [2014].

The data used for calculations of individual indices are graphic data and descriptions from land and building register in the form of SWDE (the Register Data Exchange Standard). As an IT-tool, MkScal was used, a software for comprehensive services of land management works. By means of its modules the software generates sets of data essential in calculation of separate partial indices.

In the process of determining the index related to the size of farms survey sections with large group of big farms and simultaneously with relatively small group of small farms must be identified. Therefore it has been assumed that the occurrence of large number of bigger farms (with highly fragmented lands) in a given area increases the possibility of positive outcomes of land consolidation, and that the large share of small farms results in less significant changes of an area spatial structure during its consolidation. The group of middle size farms, as having a neutral effect, has not been taken into account. The process of calculation of this index had two stages. In the first stage the share of land registration units within the range 1–2 ha has been calculated, while the lowest value of this share received highest points. Accordingly, individual sections are awarded points within the range from 0 to 100. Next the share of large units is calculated, those of 5–10 ha, and large share of such units get maximum number of points. Likewise the sections are valued from 0 to 100. The sum of these two values for a given section is ultimately brought to such a form so that a section is rated between 1 and 100 points.

The way of calculation of the above index can be presented as follows:

$$W_1 = (W_{WG} - \text{Min}(W_{WG})) / \text{Max}(W_{WG} - \text{Min}(W_{WG})) \cdot 100$$

where:

$W_{WG} = W_{\text{G1–2(0–100)}} + W_{\text{G5–10(0–100)}}$

Max(), Min() – maximal and minimal value of expression in brackets for individual sections,

where:

$W_{\text{G1–2 (0–100)}} = W_{\text{G1–2}} / \text{Max}(W_{\text{G1–2}}) \cdot 100$

$W_{\text{G5–10 (0–100)}} = W_{\text{G5–10}} / \text{Max}(W_{\text{G5–10}}) \cdot 100$

where:

$W_{\text{G1–2}} = (100 - U_{1–2\%}) - \text{Min}(100 - U_{1–2\%})$

$W_{\text{G5–10}} = (U_{5–10\%}) - \text{Min}(U_{5–10\%})$

where:

$U_{1–2\%}$ – percentage of 1–2 ha farms in the total area of farms' lands,

$U_{5–10\%}$ – percentage of 5–10 ha farms in the total area of farms' lands.

The index of land fragmentation is also the result of adding up two partial indices according to a formula given below. One half of the index value is estimated on the number of parcels in a given area group of farms. The other half of the index is related to the size of parcels in a given area group of farms.

The way the above index has been calculated can be presented as follows:

$$W_2 = W_{\text{Ldz}} + W_{\text{Pdz}}$$

where:

$$W_{\text{Ldz}} = \text{Ldz}_{1–2} \cdot U_{1–2} \cdot w_{1–2} + \text{Ldz}_{2–5} \cdot U_{2–5} \cdot w_{2–5} + \text{Ldz}_{510} \cdot U_{5–10} \cdot w_{5–10}$$

where (by way of example for an area group of farms of 1–2 ha)

$\text{Ldz}_{1–2}$ – mean number of parcels in farms from 1 to 2 ha range,

$U_{1–2}$ – percentage of group of farms from 1 to 2 ha range,

$w_{1–2}$ – weight of the part of formula related to a given area group of farms.

The value of partial index W_{Ldz} is converted to a form in which its lowest value corresponds to 0 points, and its highest value to 50 points, and the variability of the received value is proportional to variability of an output index W_{Ldz}.

If the default weights in the above formula are 1, they can be omitted and thus the formula is much simpler. Leaving the weights in place gives a possibility to change the significance of a share of area group of farms in the final form of index, as it is during calculation of the second part of land fragmentation index.

The second half of the land fragmentation index (0–50 points) is related to the size of parcels in a given area group of farms, calculated according to the formula:

$$W_{\text{Pdz}} = \text{Pdz}_{1–2}^{-1 \cdot U_{1–2}} \cdot w_{1–2} + \text{Pdz}_{2–5}^{-1 \cdot U_{2–5}} \cdot w_{2–5} + \text{Pdz}_{5–10}^{-1 \cdot U_{5–10}} \cdot w_{5–10}$$

where (by way of example for an area group of farms of 1–2 ha):

Pdz_{1-2} – mean size of parcels (in ha) in farms from 1 to 2 ha range,
U_{1-2} – percentage of group of farms from 1 to 2 ha range,
w_{1-2} – weight of the part of formula related to a given area group of farms.

In this case, the default weights can be proposed as 1, for a group of farms from 1 to 2 ha range, 1.5 for group of 1–2 ha farms, 2 for farms larger than 5 ha. Such a differentiation of weights is aimed at singling out sections in which larger farms have large number of small parcels, because it means that the area is especially recommended for land consolidation works. However it should be remembered that the proposed weights can be easily modified, and they can as well be omitted and then it would be assumed that their values would equal 1.

Similarly, as in the case of partial index W_{Ldz}, the value of partial index W_{Pdz} is brought to a form in which its lowest value corresponds to 0 points, and the highest – to 50 points.

The final land fragmentation index W_2 is the result of adding up values W_{Ldz} and W_{pdz}, which again is brought to a form in which it receives values from 0 to 100 (the lowest valued section will receive 0 points, the highest valued section – 100 points).

The soil quality index is first of all based on the calculation of the surface area of classification contour in each surveying section. Finally the index is calculated on the basis of division of the sum of the surface area of individual classification contours (multiplied by the appropriate score for a contour presented in Witek and Górski [1977]) by the total sum of classification contours.

The value of soil quality index can be calculated according to the following formula:

$$W_3 = \sum_{1}^{n} \frac{P_{kk} \cdot W_p}{P_{ckk}}$$

where:

P_{kk} – the surface area of individual classification contours,
W_p – point values of individual classification contours,
P_{ckk} – the total surface area of contours classified within a surveying section.

One half of the value of an index measuring lack of road accessibility to parcels is the result of share of surface area of parcels from the 7th registration group, which have no connection to the road network in a total surface area of parcels from that registration group. The second half of the value takes into consideration the share of number of parcels with no access to the road network (also form the 7th group) in the total number of parcels belonging to that group.

The way this index was calculated can be presented as follows:

$$W_4 = (W_{BD} - \text{Min}(W_{BD}))/\text{Max}(W_{BD} - \text{Min}(W_{BD})) \cdot 100$$

where:

$W_{BD} = W_{BDpowdz(0-100)} + W_{BDldz(0-100)}$

Max(), Min() – maximal and minimal value of expression in brackets for a given sections,

where:

$$W_{BDpowdz(0-100)} = W_{BDpowdz} / Max(W_{BDpowdz}) \cdot 100$$
$$W_{BDldz(0-100)} = W_{BDldz} / Max(W_{BDldz}) \cdot 100$$

where:

$$W_{BDpowdz} = W_{BDpowdz\%} - Min(W_{BDpowdz\%})$$
$$W_{BDLdz} = W_{BDLdz\%} - Min(W_{BDLdz\%})$$

where:

$$W_{BDpowdz\%} = \Sigma(Pow_{DzBd}) / \Sigma(Pow_{Dz}) \cdot 100$$
$$W_{BDldz\%} = \Sigma(L_{DzBd}) / \Sigma(L_{Dz}) \cdot 100$$

where:

$\Sigma(Pow_{DzBd})$ – the sum of surface area of parcels from the 7th registration group, that do not have access to roads,

$\Sigma(Pow_{Dz})$ – the sum of surface area of parcels from the 7th registration group,

$\Sigma(PowL_{Dzbd})$ – the total number of parcels from the 7th registration group that do not have access to roads,

$\Sigma(PowL_{Dz})$ – the total number of parcels from the 7th registration group.

The index related to the analysis of aerial photographs (W_5) consists in categorization of all voivodeship sections through an analysis of the occurrence of factors that hinder the free shaping of new arrangement of parcels and producing satisfactory effects of land consolidation works.

The most important hindrances in the process of creating new parcels arrangement or the factors that put usefulness of land consolidation in question are:

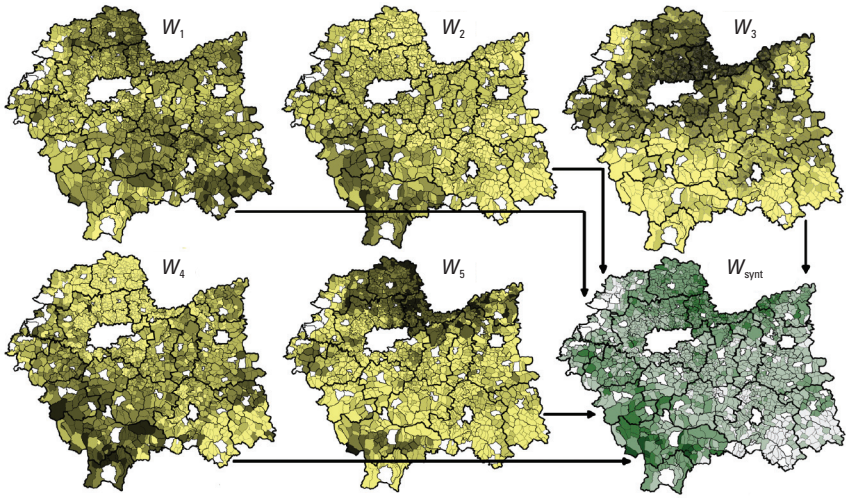
- occurrence of large number of field obstacles that have to be taken into consideration at the stage of measuring invariants and subsequent planning process (high boundary strips, slopes, afforestations, orchards etc.),
- occurrence of succession of forests on large areas of the section,
- large number of irregular afforestations or afforestation along the existing boundaries in the area of a possible consolidation,
- large areas taken up by permanent, multi-annual plantations (orchards),
- large percentage of permanent fallow lands because of low soil quality,
- exceptionally small size of sections.

The significance of the above factors is difficult to assess in an automatic way, as they are not derived from data contained in the land and building register. For this reason the index has been proposed, the value of which is determined by means of an analysis of intensity of their occurrence. The value of this index should be the result of an assessment of individual sections by experienced (with many years of practice) people having sufficient amount of knowledge about shaping the rural landscape by means of consolidation works and having required qualifications to carry out geodesic management of rural and forest areas.

The following method of calculating the index has been proposed. Each of the sections should be assessed independently as to the intensity of the occurrence of the above mentioned factors by at least two persons. Such an assessment consists in putting each section into one of the five categories. These assessment should than be averaged out and in some cases, when significant differences in the results are observed, discussed. Then each section should receive appropriate number of points and as a consequence be put into one of the five categories:

- I (100 points) – lack of significant obstacles in free shaping of new arrangement of parcels,
- II (75 points) – minor obstacles in free shaping of new arrangement of parcels,
- III (50 points) – average possibilities of significant improvement of spatial structure of lands by means of consolidation works,
- IV (25 points) – major obstacles in proper shaping of new arrangement of parcels,
- V (0 points) – section is not fit for consolidation works because its arrangement of parcels cannot be improved and its agricultural character is in decline.

The result of suggested calculation process related to multicriteria analysis of spatial structure is a synthetic index, which allows for the ranking of the survey sections of the studied area by the value of this index. In practice it means creation of a ranking determining the usefulness of land consolidation works in each of the section, according to accepted criteria. A diagram showing how the priority ranking of consolidation works has been created is presented in Figure 3. It shows that the set of accepted partial indices and their values influence the final form and value of the ranking.



Source: authors' study

Fig. 3. Creation of priority ranking of consolidation works

The way a synthetic index has been calculated can be presented as follows:

$$W_{synt} = W_1 \cdot w_1 + W_2 \cdot w_2 + W_3 \cdot w_3 + W_4 \cdot w_4 + W_5 \cdot w_5$$

where:

W_1, W_2, W_3, W_4, W_5 – partial indices,
w_1, w_2, w_3, w_4, w_5 – weights of partial indices.

The method of calculating the final ranking consists in adding up all partial indices with selection of respective values of indices weights.

One of the assumption of the analysis is a great deal of freedom in shaping components in calculating values for each section and its weights. Hence there is a possibility of creating many different sets (rankings) of sections, each is related with assuming different premises regarding sets of partial indices and their weights. Using weights with a higher value than one for a given partial index will prove that the analysis is oriented toward the choice of sections in which features measured by a given index are the most important from the point of view of demand for consolidation works.

It is essential to enable the choice of ranking parameters (as to the number of features considered in the calculation process and their weights), so that the identification of problem areas is adjusted to current priority actions of voivodeship authorities and changing rules of law, especially those defining the basic goals of land management works.

4. Usage, role and significance of ranking determining the urgency of land consolidation works

The role of data in the form of objective ranking will be growing especially in the long-term perspective. It is probable that there would be an ever increasing interest in using the EU funds for improvement of living standard in rural areas. One can predict that an informed choice of objects for land management works would be necessary. The role of the correct assessment of problem areas should increase with time, also due to vast possibilities of modification when preparing ranking of criteria.

The ranking can be used in the continuation of process of creating programmes of land management works for the chosen communes of Małopolskie voivodeship. Using the proposed or different set of criteria will allow for singling out the communes in which conditions of the agricultural production environment should be improved in the first place.

The proposed ranking can also improve the accuracy of assumptions of land consolidation project. The project assumptions should still regard the areas where the land consolidation works are planned in the foreseeable future. These surveys should precisely indicate which methods in a given area are best for improving technical and spatial functioning parameters of family farms, and propose changes in the road network and land reclamation structures. The surveys should also include recommendations for investments in the technical and social infrastructure and broadly understood elements related to land reclamation, protection and revival of landscape values,

environment protection and increase of forestation rate. When preparing the consolidation works project an assessment of impact of the planed works on the environment should be taken into account.

It is also suggested that the promotional actions aimed at popularizing knowledge about the advantages (not only of strictly agricultural nature) of consolidation works in rural areas should focus on the areas chosen by means of the proposed ranking that indicates where these works in Małopolskie voivodeship are most urgent.

5. Conclusions

The idea of creating the ranking of survey sections in a voivodeship, showing where the land management works are mostly needed, has many advantages. The most important of them is a great accuracy of an analysis of individual survey sections where land consolidation works could be carried out. The calculation process, based on data from land and building register, is also relatively little time-consuming. The result of implementing the idea would be a precious material helping the institutions, responsible for spatial structures transformations of rural areas in a voivodeship, to focus their activities on places where consolidation works are mostly needed and where they could be most effective.

Implementing the idea can also contribute to the better use of available funds allocated for improvement of functioning of rural areas in Małopolskie voivodeship, because the money can be spent on objects with the highest needs. The proposed idea will also give the chance to verify and increase the social acceptance for the proposed works. Consolidation works in these areas should be carried out faster, they should cause less complaints, and their results could be positively verified as to the usefulness and effectiveness of the money expended and be an example to the neighbouring areas.

Data acquired and processed during the preparation of the ranking, due to their high accuracy, could also be used in many other studies characterizing rural areas of Małopolska.

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TRANSFORMATION OF AGRICULTURAL LANDS

Igor Perovych, Daria Kereush

Summary

One of the methods of land transformation is linear programming method, which is called the simplex method. Its application allows us quickly and efficiently to build a model of optimal use of land resources and helps to find such combination of the lands, that allows us to obtain the maximum yield in money equivalent with given resources. The application of methods of remote sensing (RS) as spatial information to solve the problems of land management, including land transformation, becomes the most optimal in modern conditions.

Keywords

transformation of the land • simplex method • GIS technologies • remote sensing

1. Introduction

At this stage of organization of land relations the new character and the content of the socio-economic problems of land use are determined: formation of new land ownership, its division and augmentation, transferring of rights on the land plots (shares) to the land users, transferring of land to lease, land protection and rational land use. New land-uses are arising or arrangement of existing ones is occurring constantly. Nowadays there is a need to meet the maximum satisfaction of the economic interests of landowners and land users, the most complete and effective utilization of productive capacity of farms and lands which are associated with them, in strict compliance with the special regimes and the conditions of land resources use [Tretyak et al. 2011]. Therefore, for the quick and efficient resolution of the problems of land management, including land transformation, we should use modern space, computer and terrestrial technologies that greatly facilitate this process.

Increasingly new methods of automated execution of land transformation using modern GIS technologies are developing. An urgent task is to solve the problem of development of methodological and algorithmic mechanism for providing by information technologies the field of land management and cadastre as also for solving a number of practical problems that arise during the creating of the projects of territorial land management and land management affairs, land protection and rational use of lands [Enemark 2005].

Every management decision about the transformation of agricultural lands has its own particular result, and the goal of management activity is to find out such forms, methods, means and decision-making tools that could help to achieve the optimal result in specific conditions and circumstances.

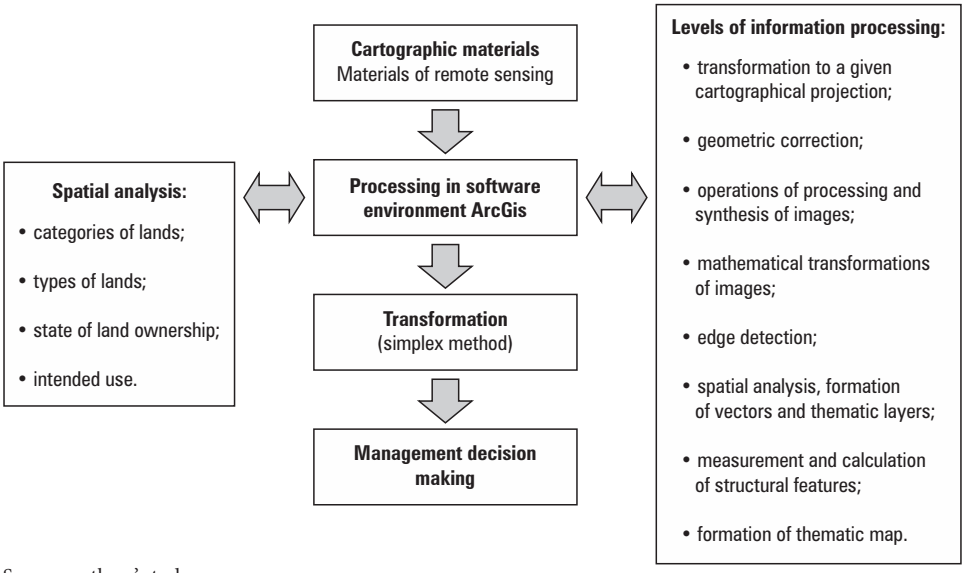
The technology of development, adoption and implementation of decisions and procedures, the implementation of logical, analytical, information retrieval, computing and other operations should provide their clear sequence. Developing managerial procedures we prescribe a procedure of implementation of certain operations which are related to the collection, movement, storage, processing, analysis of information, providing structural departments and individual working places by it, and we determine other actions, arising from the need to solve economic problems.

2. Material and methods

2.1. Block diagram of the implementation of the research

In the world of the new requirements the theoretical and methodological providing of land management production by using computer technologies based on the graphical land use planning is relevant [Becek 2011]. Geoinformation systems (GIS) allow to interpret spatially coordinated information, related to a particular area, for the purpose of creating new units of landholdings.

Due to this the need to improve the theory and methods of land management using new information technologies is increased. Block diagram of the research, carried out by us, is shown in Figure 1.



Source: authors' study

Fig. 1. Block diagram of the research

2.2. The cartographic material

The initial stage of conduction of land transformation is a compilation of cartographic material on which basis the research and scientific study of the transformation from one type of agricultural lands to another are conducted. This cartographic material is obtained as a result of processing of in situ data, data of aerial photography, of satellite methods of earth remote sensing (RS) for obtaining spatial information and solving the problems of land management, including land transformation. Currently, the question of exploring the possibility of using satellite images to create this material remains very relevant.

2.3. Software for data processing

For solution of this problem the technological procedures of processing of data using existing software occupy an important role.

In particular, software for processing of remote sensing data are the packages for obtaining the coordinates of points in the selected coordinate system, processing of space and air photo images provided by various mathematical apparatus that allows to conduct various operations with incoming information [Sverdljuk 2006]. This is a fairly wide range of operations, from all kinds of correction (optical, geometric), through the geographical bridging of the images, down to the processing of stereo pairs with the issuance of the results in the form of actualized topographical drawing.

For the creation and processing of cartographic material for the purpose of conducting land cadastre the full-featured GIS are used most frequently. ArcGis, Erdas, Envi, AutoCad are the most widespread software systems [Kalantari 2003].

Among the many GIS software the ArcGIS, a set of software products developed by the corporation ESRI (USA) [www.esri.com/industries/cadastre], which is the most common GIS in Ukraine, is shown up with its fullness, high functionality and effectiveness. ArcGIS is an integrated collection of GIS software products for the development of a fully functional data processing system that allows users to deploy functionality of GIS in a place where it is needed: in the desktop version (ArcGIS Desktop), server (Server) or in the form of specially created program; for web or for working in the field conditions, mobile versions (Mobile).

An integrated suite of such software modules is included in the content of desktop products of ArcGiS Desktop: ArcCatalog – organization of the structure, spatial data storage and creating the databases for recording, viewing and management of metadata; ArcMap – performing of all works on mapping and editing, cartographic analysis and ortho-transformation of satellite images; ArcToolbox – data management, conversions, layers processing, vector analysis, geocoding and statistical analysis; ArcBuilder – visual graphical modeling during the construction and implementation of geo processing models that can include tools, scripts and data. Models are presented as the diagrams of data processing, they are binding the tool sets and data, which are necessary to perform complex analytical procedures and for the implementation of workflows.

With the help of these software modules and their interfaces we can perform mapping, geographic analysis, data editing and compilation, geo processing and data management.

2.4. Land transformation by simplex method

To ensure effective and efficient use of land resources it is necessary to conduct transformation of land, i.e. there is a need to change their intended use [Pongratz et al. 2008].

Transformation of lands is conducting for the purposes:

1) to increase the area of other lands,
2) to change of land allocation, taking into account soils, terrain, soil conservation,
3) to create large masses of homogeneous use, to improve or to straight land borders,
4) close-together arrangement of the specified mass of required size.

The criterion of feasibility of the planned transformation of the lands is to increase economic efficiency and to obtain the net profit based on the preservation and protection of the soils and the environment [Ludchak 2010].

There are two main methods to transform the land from one type to another – graphical and mathematical. In this case, we propose to perform transformation of the lands by linear programming method, and specifically by the simplex method. This is a widespread method of optimizing the use of limited resources which is rather effective [Fourer 2014].

The method of linear programming using the simplex method for solving the problems of land management, including land transformation, consists in finding such combination of lands, which are projecting, in order to obtain a maximum yield in monetary terms with given resources.

To solve the problem by this method it is necessary that the situation described therein should meet three basic conditions:

- it must be related to limited resources, otherwise this problem would simply not exist,
- an exact aim of the research must be formulated (profit maximization or cost minimization),
- the problem should met the criteria of linearity and homogeneity.

The process of solving the problem by the simplex method has an iterative character: computational procedures (iterations) of the same type are repeated in a certain sequence until the optimal plan of the problem is received or it is found that it does not exist [Vitlinskiy et al. 2001].

The main economic and mathematical model of the problem is presented in expanded form:

To find out:

$$F_{\max} = c_1 X_1 + c_2 X_2 + c_3 X_3 + c_4 X_4 + \ldots + c_n X_n, \quad (1)$$

with restrictive conditions:

$$\left.\begin{aligned} &a_{11}X_1 + a_{12}X_2 + \ldots. + a_{1n}X_n \le B_1 \\ &a_{21}X_1 + \mathrm{a}_{22}X_2 + \ldots.+ a_{2n}\mathrm{X}_n \le B_2 \\ &\ldots\ldots\ldots\ldots\ldots \\ &a_{\mathrm{m1}}X_1 + a_{\mathrm{m2}}X_2 + \ldots. + a_{mn}X_n \le B_m \end{aligned}\right\} \quad (2)$$

where:

$F_{\max}$ – linear objective function (is subjected to maximization),
c_n, a_{mn}, B_m – specified constants,
X_n – parameters of the optimal use.

3. Results and discussion

The practical implementation of the research technology we will show on the example of the territory of the separate village council (Figure 2).

Thematic maps, which are created as a result of field measurements, were accepted as a basic cartographic material.

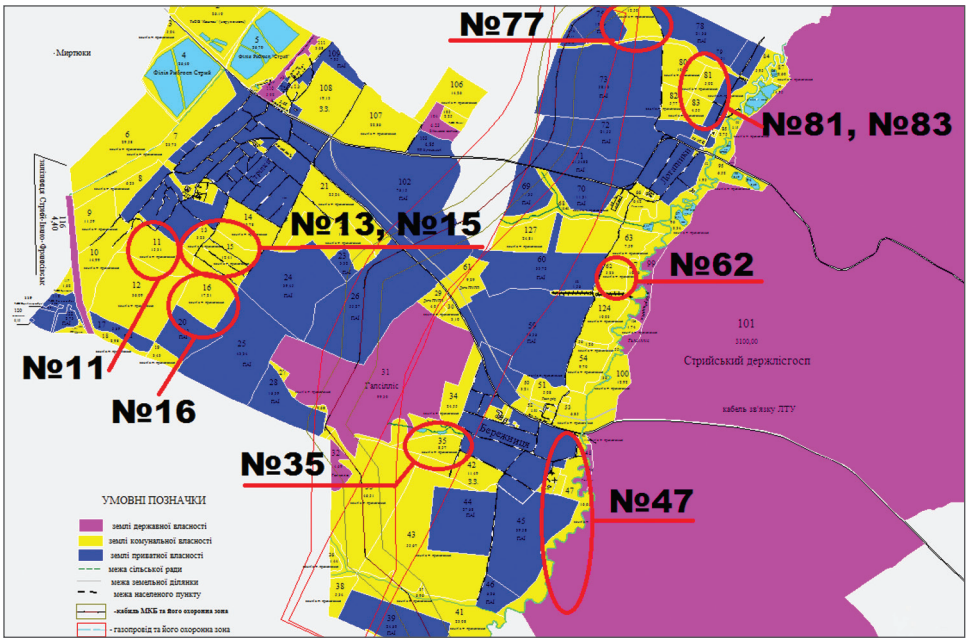
Pre-processing of initial data involves converting of collected data into a format which ArcGIS supports. If cartographic materials are made in different epochs and in different coordinate systems, then on the cartographic materials we can select typical uniquely identified contours whose coordinates we will define in a chosen unified coordinate system that will allow for the further to implement the transformation of all coordinate systems (if it exists on the different maps) to a unified system [Kazachenko et al. 2009].

On the thematic map we defined and analyzed those land plots (parcels) which would be advisably transformed from one type of the lands to another for their efficient and effective use.

The necessity in transforming of the agricultural lands is caused mainly by the fact that this village council is planning the development of meat and dairy industry, horticulture, so it is advisable to increase the number of perennial plantings, grasslands and to create a pasture for these purposes.

Chosen land plots which are offered to transform from one type of agricultural lands to another are depicted in Figure 2.

For the creation of the pasture (lands with adverse geographical conditions – such as swamp, high groundwater, high grass vegetation, etc.) we should allot a land plot no. 47 with an area of 16.65 ha which is currently occupied by the grassland. It is also advisable land plots no. 62, 81, 83 (total area – 14.8 ha) to transform from grasslands to arable lands, as they are near the limits of the settlement and have regular geometric shape – so in the future it will be easier to follow the plow. For the creation of the grasslands it is expedient to transform land plots no. 11, 16, 35, 77 which now are arable lands with a total area of 41.09 ha. Land plots no. and 15 (arable lands) with a total area of 15.64 ha are proposed to be transformed into perennial plantings in this paper.



Source: authors' study

Fig. 2. Highlighted land plots which are offered to transform from one type of agricultural lands to another

For better visualization all the data needed for transformation we can read in Table 1.

Table 1. Data for transformation

Agricultural lands, which are subjected to transformation	Projected lands				Areal size of agricultural lands suitable for transformation [ha]
	Cultivated pastures	Arable lands	Perennial plantings	Grasslands	
Grasslands	350* 2.4	200 2.8			31.45 (32)
Arable lands			1100 160	120 4.5	56.73 (57)
The value of gross output from 1 ha of agricultural lands, which are projecting, [$ per ha]	42.40	109.55	142.53	45.90	

Source: authors' study

* In the numerator – the financial resources spent on the transformation of 1 ha of agricultural lands [$ per ha], the denominator – the expenditure of labor [man-day per ha] spent on the transformation of 1 ha, which are obtained experimentally.

For this territory of village council there are restrictions in areas, so according to conditions of economic activity, the area of perennial plantings shall not exceed 200.00 ha and cultivated pastures' area – 140.00 ha. There are also restrictions in expenditures – agricultural enterprise in order to carry out the works related to the transformation of one agricultural lands to another can allocate $ 574 000 of financial resources and 135 000 man-days of labor resources.

Our task is to find such combination of lands, which are projecting, in order to obtain a maximum yield in monetary terms with given resources.

The main economic and mathematical model of specifically given to us problem is presented in expanded form:

To find out:

$$F_{\max} = c_1X_1 + c_2X_2 + c_3X_3 + c_4X_4, \tag{3}$$

with restrictive conditions:

$$\left.\begin{aligned} &a_{11}X_1 + a_{12}X_2 \le B_1 \\ &a_{23}X_3 + a_{24}X_4 \le B_2 \\ &a_{31}X_1 \le B_3 \\ &a_{43}X_3 \le B_4 \\ &a_{51}X_1 + a_{52}X_2 + a_{53}X_3 + a_{54}X_4 \le B_5 \\ &a_{61}X_1 + a_{62}X_2 + a_{63}X_3 + a_{64}X_4 \le B_6 \end{aligned}\right\} \tag{4}$$

$$X_1 >= 0;\ X_2 >= 0;\ X_3 >= 0;\ X_4 >= 0 \tag{5}$$

where:

$F_{\max}$ – linear objective function (is subjected to maximization),
X_1 – area of grasslands that can be transformed to the cultivated pasture,
X_2 – area of grasslands that can be transformed to the arable lands,
X_3 – area of arable lands that can be transformed to the perennial plantings,
X_4 – area of arable lands that can be transformed to the grasslands,
B_1, B_2, B_3, B_4 – the maximum allowable areal sizes of transformation of each type of agricultural lands,
B_5, B_6 – monetary and human resources allocated for the purposes of transformation;
a_{ij} – expenditures for the purposes of transformation of *i*-type of land,
c_1, c_2, c_3, c_4 – gross income per unit area of transformed agricultural lands respectively.

In expanded form of economic and mathematical model (formulas 3, 4) we substitute the value of technical and economic factors and resources that we took from the project of transformation of agricultural lands for this territory of village council.

To find out:

$$F_{\max} = 42{,}4\, X_1 + 109{,}55\, X_2 + 142{,}53\, X_3 + 45{,}9\, X_4 \tag{6}$$

with restrictive conditions:

$$\left.\begin{aligned} & X_1 + X_2 \le 32 \\ & X_3 + X_4 \le 57 \\ & X_1 \le 140 \\ & X_3 \le 200 \\ & 350\, X_1 + 200\, X_2 + 1100\, X_3 + 120\, X_4 \le 574\,000 \\ & 2{,}4\, X_1 + 2{,}8\, X_2 + 160\, X_3 + 4{,}5\, X_4 \le 135\,000 \end{aligned}\right\} \tag{7}$$

$$X_1 >= 0;\ X_2 >= 0;\ X_3 >= 0;\ X_4 >= 0 \tag{8}$$

In order to find the economic optimum we have to solve this system of inequalities and, for this, we should lead it into canonical form where all conditions are presented in the form of equations [Nakonechniy and Savina 2003]. For this purpose, to the left part of the system of inequalities (7) the positive variables x_{n+1}, called complement unknown values, are added. In the objective function the complement variables are introduced with zero coefficients.

The complement unknown values are written as:

X_5 – area of grasslands that cannot be transformed,

X_6 – area of arable lands that cannot be transformed,

X_7 – the area of cultivated pastures, which is lacking to the maximum allowable areal sizes of these cultivated pastures in the farm,

X_8 – the area of perennial plantings, which is lacking to the maximum allowable areal sizes of these perennial plantings in the farm,

X_9 – underused financial resources allocated for the purposes of transformation,

X_{10} – underused labor resources allocated for the purposes of transformation.

Then, we can write the economic and mathematical model of the problem in canonical form:

$$\begin{aligned} F_{\max} = {} & 42{,}4\, X_1 + 109{,}55\, X_2 + 142{,}53\, X_3 + 45{,}9\, X_4 + \\ & + k_1 X_5 + k_2 X_6 + k_3 X_7 + k_4 X_8 + k_5 X_9 + k_6 X_{10} \end{aligned} \tag{9}$$

with restrictive conditions:

$$\left.\begin{aligned} & X_1 + X_2 + X_5 = 32 \\ & X_3 + X_4 + X_6 = 57 \\ & X_1 + X_7 = 140 \\ & X_3 + X_8 = 200 \\ & 350\, X_1 + 200\, X_2 + 1100\, X_3 + 120\, X_4 + X_9 = 574\,000 \\ & 2{,}4\, X_1 + 2{,}8\, X_2 + 160\, X_3 + 4{,}5\, X_4 + X_{10} = 135\,000 \end{aligned}\right\} \tag{10}$$

where:

$k_1, k_2, k_3, k_4, k_5, k_6$ – zero coefficients (every coefficient is equal to zero).

The solution of equation (9) with restrictive conditions (10) was made in simplex tables in Microsoft Excel software. The criterion for the solution of equation (9) with restrictive conditions (10) is obtaining of the positive values in the index string of simplex tables. From this solution in the final version we obtained the values of main unknowns X_1, X_2, X_3, X_4 – the parameters of the optimal use of land resources (Table 2). The solution was obtained as a result of three iterations.

Table 2. Comparison of agricultural lands' transformation [ha]

Unknown values	Initial version	Version obtained by computing
$\boldsymbol{X_1}$ (grasslands → cultivated pasture)	16.65	16.60
$\boldsymbol{X_2}$ (grasslands → arable lands)	14.80	11.14
$\boldsymbol{X_3}$ (arable lands → perennial plantings)	15.64	12.69
$\boldsymbol{X_4}$ (arable lands → grasslands)	41.09	46.03
F_{max}, [$]	5436.10	5955.26

Source: authors' study

From the data (according to Table 2) it can be seen that the maximum value of gross output has increased by 9.6% and makes up 5955.26 $. The decision about the transformation of grasslands to cultivated pasture on the area of 16.65 ha turned out to be the best and optimal, as the results of calculations are very close to the original values. As for the transformation of grasslands into arable lands, then, in accordance with the initial data, their area should have been 14.80 ha, but eventually after conducting of transformation it emerged that for the optimal use of these lands their area should be reduced by 3.66 ha. For the rational use, it is advisable to transform the arable lands in perennial plantings on the area on the 2.95 ha less than it was provided in the initial version, in other words on the area of 12.69 ha. Also, as the calculations show, that it is expedient to increase the area of transformation of arable lands to grasslands by about 5 ha to 46.03 ha.

4. Conclusions

When resolving the issues of sustainable land use new theoretical concepts and practical approaches about the optimization of agricultural land use deserve the attention and they should be based on the national legal system, economic valuation of the land and agricultural produce, local, regional and state programs of territory development, new technical and technological approaches.

The implementation of the algorithm of transformation of agricultural lands by simplex method allows to find the parameters of the optimal use of land resources and, as a result, it would lead to an increase of economic efficiency of agricultural lands and to obtaining of greater net income.

Practical implementation of transformation of agricultural lands on the territory of one of the administrative-territorial units has shown the effectiveness of this approach, which has resulted in an increasing of value of gross output by 9.6%.

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WHERE IS THE RURAL TERRITORIAL DEVELOPMENT GOING? REFLECTIONS ON THE THEORY AND PRACTICE

Holger Magel

Summary

This paper presents the results of broad analyses of current situations in the field of rural development in Bavaria and the Federal Republic of Germany. It focuses on programs and European Union legal and financial frameworks in the years 2014–2020. The author proposes many ideas or approaches that can be applicable to all rural development actors, such as politicians, local governments administrators, scientists and local communities. In addition, the author presents own experiences as a former Head of Department and Director General of the Bavarian Administration of Rural Development in the Bavarian State Ministry of Food, Agriculture and Forestry. Also, the author's experience as a university professor is invaluable. Its conclusions evoke further research and implementation for projects in the field of rural development, for both research and teaching institutions and administration at all levels – from European Union to the municipal level.

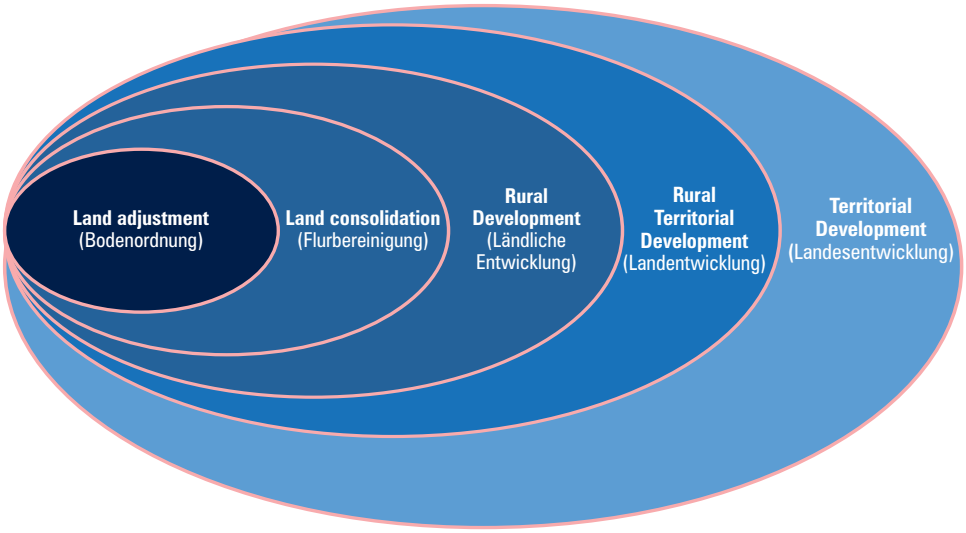
Keywords

land consolidation • land management • rural development • rural territorial development • territorial development

1. Towards understanding relevant German terminologies

On my desk, whether in the Bavarian Ministry of Agriculture or at the Technische Universität München (TUM), I have always had different notes, including cautions of Johann Wolfgang von Goethe. From him, I gained a lifetime advice that I still use today – whether as a professor at the university or as an adviser in other countries. "Explain terms first, before you talk, exchange ideas on whether they can work together". In Germany, we have a different terminology for some of the concepts used in English. For instance, the following terms have their German equivalents: rural territorial development (*Landentwicklung*); rural development (*ländliche Entwicklung*). Other terminologies include development of rural areas (*Entwicklung des ländlichen Raumes*); a new order of rural areas (*ländliche Neuordnung*) and land consolidation (*Flurbereinigung*). What does each of these terms mean? Do we speak about the same thing, or not? It is usually difficult for my students at Technische Universität München (TUM) to find the

right answers to this question. Most of them are only capable of answering this question correctly only after they have learned and understood the application of these terms and their contents. In this regard, it is important to cite the famous "onion" (Figure 1), which was first presented by Prof. Joachim Thomas, former head of the rural development administration in North Rhine-Westphalia (Figure 1).



Source: Adapted from Thomas (2006)

Fig. 1. The territorial development "Onion"

In the beginning, some terms may be difficult for outsiders to understand. As a result, I present in the following sub-sections explanations necessary for understanding some terms that, in many respects, should be considered as basic.

1.1. *Bodenordnung*

This means authoritative or private land adjustment. After the formation of the so-called urban land readjustment in the building areas (exchange of building land) could be defined as rural land readjustment.

1.2. *Flurbereinigung*

This means statutorily rooted land consolidation. It has a long tradition in many European countries, although they have partially different names. It can be mentioned here that, for instance, in Austria, Slovenia and Serbia it is called *commassatio*. Land consolidation is based on the central task – that is, land readjustment – meaning exchange of the ownership of land and property and their uses. It includes a lot more

than a mere exchange of land parcels. For example, planning and construction of roads, waterways, biotopes, etc. Its high point is the inclusion of new state of ownerships in the cadastre and land register to ensure the necessary legal security, which has the term of secure land tenure globally the highest political priority. Due to the prevalence of agricultural land ownership around the world, land consolidations still have more or less "agrarian" nature. Globally, the Food and Agriculture Organization of the United Nations (FAO) refer to it as land consolidation. Many authors have rightly pointed out that the concept originated as a result of the quest to create improved or new order of rural areas (*Ländliche Neuordnung*).

1.3. *Ländliche Entwicklung*

This term is relatively new in Europe, but not in the international context. It means rural development. This is the European Union term, but unfortunately, is defined by the content related to a support for more or less agriculture. This term is not at all widespread, as it is sometimes believed, certainly not in the sense of a comprehensive development of rural areas. Also in the new EU program for 2014–2020 [Regulation (EU) No 1305/2013], it is not presented with a broader focus. Perhaps this is due to some appropriate changes, in particular concerning the necessity of the need to create additional non-agricultural jobs. Rural development programs in the EU include at least the possibility of using land consolidation and village renewal (*Dorferneuerung*). Within the framework of international cooperation for development, rural development is quite ambiguously used and implemented. Often it includes only the construction of wells or support of agricultural products marketization and structures, among others.

1.4. *Förderung der Landentwicklung*

By definition, this term is much wider than it is usually used. It was used for the first time in the Federal Land Consolidation Act of 1976 [Flurbereinigungsgesetz 1976] to mean the "promotion of rural territorial development". Friedrich Quadflieg, the creator of the Act, presented in his then famous commentary an unforgettable definition and explanation which in this generation gives credence to a new era of land consolidation. Quadflieg [1978] explained:

"Rural territorial development is a part of spatial or territorial planning, which integrates and implements the planning and development strategies for rural areas. They include planning, preparation and execution of *all activities which are appropriate* to preserve and improve the housing, economic and leisure functions, in particular in rural areas, so that in long-term they support and improve living conditions outside urban areas".

The statement "all activities which are appropriate" points to the fact that the Act refers to only support of or promotion of rural territorial development. It is to some extent, a kind of order of cooperation for all institutions acting in rural areas – because to some degree, all of them are rural territorial developers.

Quadflieg provides another important methodological explanations. This implies that the promotion of rural territorial development should always include both traditional tasks of land consolidation. Such tasks may include measures for improving agricultural production and work conditions in agriculture and forestry; and support of sustainable land use (*Landeskultur*). For this reason, in Germany one speaks now about threefold mission of land consolidation, which leads visibly to the term rural territorial development (*Landentwicklung*). Unfortunately, this term does not occur in the professional language of the EU. This makes the roots of today's rural development or integrated rural development (*integrierte ländliche Entwicklung*) not clear enough for the present generation, politicians and experts in other specialties.

It would be necessary to know to what extent the term, rural territorial development (*Landentwicklung*) is understood in Poland or other European countries, and what are its historical roots there. In Germany, as was mentioned earlier, the term is still ubiquitous. At the Chair of Land Management in TUM, we still refer to it in its German version as *Bodenordnung und Landentwicklung* – that is, Land Readjustment and Complex Rural Areas Development. The union of all the German land consolidation administrations is called the Working Group for Landentwicklung (such as the European Working Group ARGE Landentwicklung und Dorferneuerung). Its publications, such as guidelines or expertise in flood protection, renewable energy sources or cooperation with town planning, always use the title and term, rural territorial development (*Landentwicklung*). Some Polish and other European colleagues know the names of Bavarian schools of rural territorial development and village renewal in Thierhaupten and Plankstetten. Unfortunately, the Bavarian land consolidation administration was not allowed to decide for the new name *Landentwicklung*. Having been a witness and an active participant, I want to assure that our ministry proposed this in 1992. However, we had to give in as a result of disputes on matters of competence and naming. The most opposing to this was the Ministry of Territorial Development (*Ministerium für Landesentwicklung*). The Prime Minister, who was previously the minister of territorial development, successfully intervened at the prime minister. They were afraid of mixing terms of territorial development (*Landesentwicklung*) and rural territorial development (*Landentwicklung*). So as a compromise an entirely new name, rural development (*ländliche Entwicklung*) was created. This was the time when European funding programs and the so-called second pillar had not yet discovered this term! This happened in the years 1999–2000.

1.5. *Landesentwicklung*

As a consequence, *Landesentwicklung* – meaning territorial development – was born. The term is considered superior to all other terms. This also applies to rural territorial development and more than ever, rural development. It is used as a synonym for spatial development within the federal state. It entails the overall effort to ensure equivalent conditions of life and work throughout a whole region and as a result in cities and rural areas. About the term, *landmanagement* will be discussed at the end of this article.

2. Rural territorial development (*Landentwicklung*) requires theoretical and methodological foundations

The science and practice of land consolidation support sustainable rural territorial development to achieve equivalent living and working conditions in rural areas. The objective is not just about farming or agriculture. It is very clear that the tasks of rural territorial development must extend to all aspects of life, work, housing, leisure or communication in given rural areas (area of operations). This implies that it extends to all basic functions of human existence. Therefore, the rural municipalities should serve as key partners for all actors implementing rural territorial development. That is, according to the EU, using an adequate approach focused on a particular place (called place-based) and not only sectoral oriented. It also involves taking into account all historical, cultural and socio-economic ties, etc. As well as enhancing linkages between small and medium-sized urban centers in rural areas –together with their interrelationships with larger agglomerations. If this is not done, cooperation between urban centers and rural areas; and between town and country will not work. This requires a suitable spiritual-mental conditions and fair spatial enablement of all entities. Through our studies at the Chair of land management (*Lehrstuhl für Bodenordnung und Landentwicklung*) of the TUM, we have come to know that achieving these objectives cannot be limited to the financial support. It has far-reaching professional consequences due to some specialist and methodological questions that usually arise. Some of these critical questions relate to the development of the term, separation of space, determination of the cooperating entities (not forgetting about the economy and small and medium-sized enterprises). Others include organizational structures, management processes, processes of participation and decision-making processes. It also has implications for the proper use of the instruments of land readjustment and conflict resolution, as well as support to raise funds from all possible directions. Above all, it requires competence based on the education and training of staff and various professional partners –such as architects, planners, but also municipal officials and other experts. Who can say that he is a born moderator or even a mediator? Nobody! For this reason, a system for conflict resolution is necessary concerning of education, training and research. The persons responsible for rural territorial development (*Landentwicklung*) must be broadly educated at the university level, not just as mere technicians. It is all about the education of graduates as "well-grounded specialized generalists".

3. Integrated rural development (IRD) as a universal remedy – overrated or not?

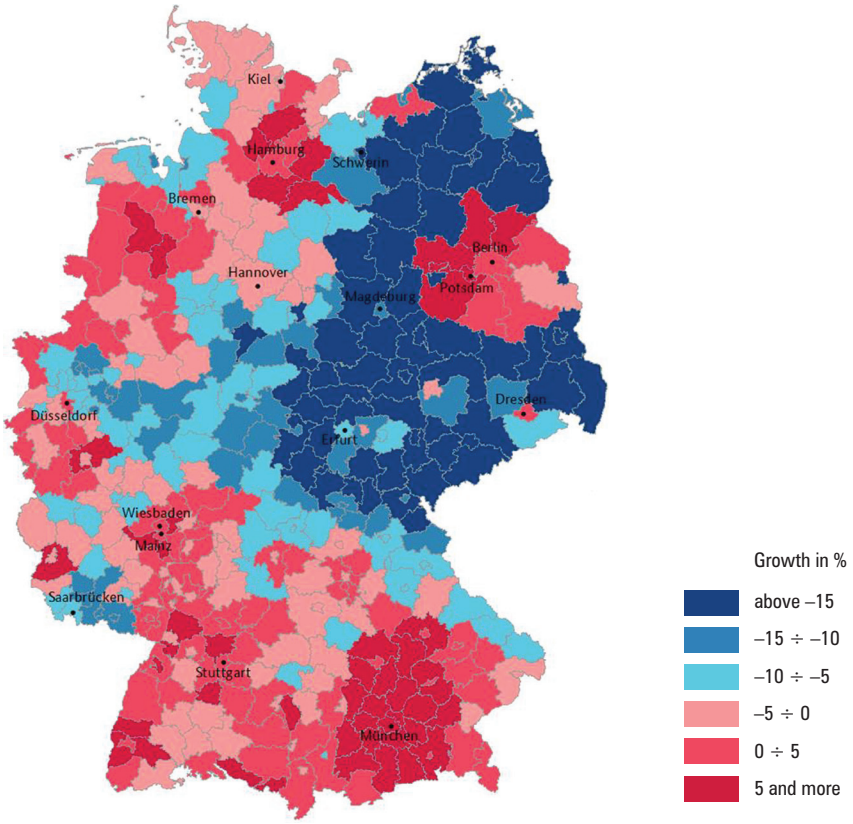
At some point, it became apparent (due to the financial support and requirements of the EU) that the level of the villages and the municipalities are not enough for effective structural changes in rural areas. From then onwards, it became necessary that new areas of action created by a number of municipalities (areas or regions) must be activated. In other words, it depends on the so-called geometric variables. This is

particularly necessary for the face of globalization and continentalization, increasing local competition, demographic and climate challenges, etc. This instrument is called in Germany, Integrated Rural Development (IRD), and it lies within the competence of the land consolidation administration but focuses on municipalities and body of participants according to Land Consolidation Act. However, there are other integrated terms and spaces of action or support within the competence of other ministries and programs. This leads to some confusion and partial overlapping of competences. This is how it is. In any case, this excess of competencies speaks for communication and collaboration in horizontal and vertical ways. This is urgently needed because within the framework of IRD are opportunities for rendering or receiving assistance and support from other ministries, primarily to support regional economic development, urban planning, etc. Otherwise, the desired rural territorial development made possible by the use of IRD Concepts – followed by the individual instruments of land readjustment, village renewal, and infrastructure and so on – would be fragmentary. Then it will be possible to solve individual conflicts realistically to enable respect in uses and ownership pertaining to the implementation of flood protection, construction of power stations and improvement of the agrarian structure and so on. This would not provide any broad impact on the entire area covered by the IRD and the population living there – especially the young population – which should be kept in rural areas. It is well noted in the publication, "The new rural paradigm", that broader approach and closer cooperation are necessary (The Organization for Economic Cooperation and Development 2006). That means – authorities, municipalities; economy and all actors should cooperate in the process.

Land consolidation works are carried out in this manner of cooperation with other authorities for years on a statutory basis. They have never been a single player. The Land Consolidation Act repeatedly points to the need for coordination and cooperation, which leads to combining multiple planning studies into one coherent task. In the era of the IRD being in force, land consolidation can be used due to its tested practice, which involves broad experiences in cooperation and comprehensive thinking. Additionally, this should lead to a better coexistence of the three European Structural Funds [Regulation (EU) No 1303/2013]. This has so far been achieved with limited success. In each of them the management rules are too complicated. In Germany, the experiment on a State scale including the *Länder* was abandoned. That was, of course, a fatal error. Equally disastrous is when the EU is critical of the traditional strength of activating German land consolidation administration, and ignores the warrant to shape their area by body of participants according to Land Consolidation Act. These bodies of participants have existed in Bavaria for nearly 100 years. That is long before the creation of the LEADER program. According to the idea of subsidiarity, they have vigorously implemented grassroots initiatives of people and landowners, which conflict with EU guidelines, because EU requires prior attachment to everything. In some cases, the bodies of participants somehow lost their influence in shaping their territories. As a consequence, Bavaria has to consider its application of EU rules, which have in some cases been seen as strangulation.

One more important note: to really help IRD become a success, it is necessary to support – and not just morally – spatial planning and territorial development. They should care about this so that all administrative bodies can at last cooperate and do not play their different games. The cooperation of these bodies can help in making necessary improvements. They can contribute to improving the use of all structural measures, taking into account the proven principle of central place hierarchy and priority of the development of structurally weak areas through clear (local) political signals. Territorial development policy should put emphasis on inter-municipal cooperation and support the relatively new topic of urban-rural partnerships.

Many times it is a completely new approach. Therefore, at full speed the accompanying research are carried out on the principle of learning by doing. If it is not possible to implement a comprehensive development and strengthening of the area, then the countryside will become too unattractive, with deserted villages and decaying infrastructure (see data in Figure 2).



Source: Bundesinstitut für Bau-, Stadt- und Raumforschung; Berechnungen: BiB (geometrische Grundlage: © GeoBasis-DE/BKG 2012)

Fig. 2. Changes in population size in districts of Federal Republic of Germany 2009–2030

The situation will even get worse if IRD is not used in a more consistent way to realize both soft tasks and tackle hard challenges, such as acquisition of land for economic zones and allocation of infrastructure facilities. In the federal land of Mecklenburg-Western Pomerania, the term "countryside waiting for the wolves" is now commonly read in the newspapers [Schrumpfvergreisung 2014].

In Bavaria, the issue of growing imbalance between the predominantly urban areas and rural regions is a heated debate. That is why the Bavarian Parliament launched *Enquete-Kommission* (Equivalent living conditions throughout Bavaria) to pay more attention to the needs of implementing the aspirations of the EU Territorial Agenda [TA 2020] in all areas. However, the massive urbanization challenge happening now in Bavaria means that there will be a difficult road ahead in achieving this vision.

4. Today's theory is the practice of tomorrow

The road to rural territorial development, which is as already mentioned much more than the traditional agrarian land consolidation, always had and has to be accompanied and enhanced by theoretical, methodological and educational activities. Prof. Karl Rinner from Austria, known as the one of the last universal geodesists, repeatedly said, "There is nothing more practical than a good theory!" [Magel 2012]. Indeed, regulation of financial support and administrative provisions of the EU will not replace any theory, methodology, or even scientific surveys. Rural territorial development (*Landentwicklung)* is much more than merely clever acquisition, equitable distribution and proper allocation of resources. For this reason, the development engineers (*Landentwicklungsingenieure*) need to have access to research institutions, which is e.g. for Bavaria the Chair of Land Management at TUM. Countless research projects on behalf of the administration have helped to create the theoretical and methodological basis for practical action for sustainable rural or regional development. They have also helped in intercommunal cooperation, which is now in demand in the context of integrated rural development. Additionally, they have helped in village renewal, landscape planning and shaping the cultural landscape, the involvement of residents. Also, they have contributed to the practices concerning comprehensive land management -up to the urban-rural partnerships, which is today a boiling topic within academic, professional, and policy debates. Especially beneficial in our case is that the administration as a partner had and still has its department of applied research.

New scientific theories and methodological proposals should then be discussed at the independent ground in the presence of experts. Such a role is handed through the annual conferences at the TUM, entitled "Münchner Tage der Bodenordnung und Landentwicklung". Other fora for this include the annual rural territorial development conferences at Agricultural University in Kraków or the conferences of German Academies of Rural Areas or their union Arge Ländlicher Raum. Numerous events involving the highest dignitaries and proven experts provide discussions and confirmation of substantive guidelines for improvement of knowledge.

After leaving my position at the Bavarian Ministry of Agriculture for the TUM, I started an international English postgraduate Masters (MSc) program. It is called "Land Management and Land Tenure in Urban and Rural Development" and has its focus on professionals from developing countries. By so doing, I created a second pillar of (international) education at the Chair of Land Management in TUM. The lecturers in the program are particularly encouraged to study definitional issues concerning all the concepts and terms as mentioned earlier. For instance, definitions of land consolidation (*Flurbereinigung*), rural territorial development (*Landentwicklung*), rural development (*ländliche Entwicklung),* land use planning (*Bauleitplanung*) and land management in an international context. They also wrestled with understanding the differences between the various other terms used in the international community.

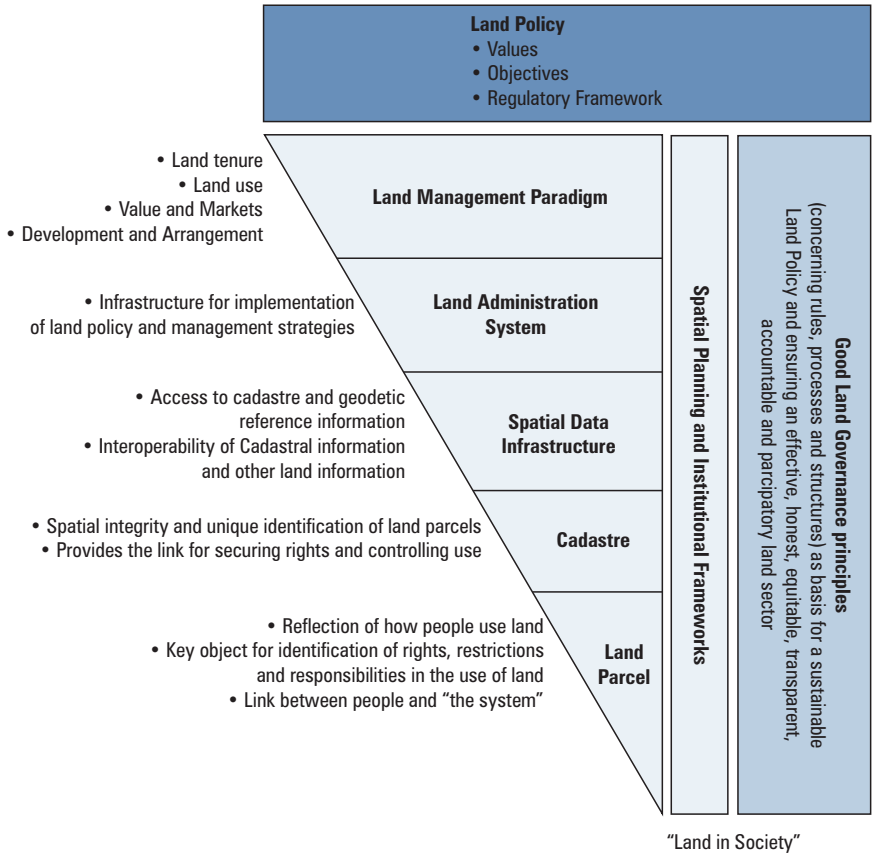
First of all, thanks to my eight-year experience at the head of the International Federation of Surveyors (FIG) and thanks to the scientific and didactics works at the TUM. Due to these experiences we were able –and based on the works of UN bodies, the World Bank, and Professors Larsson, Enemark, van der Molen and Williamson to develop two globally understood definitions. They are "The Munich pentaphony of land management," and above all, "The triad of land management" (see Figure 3). They correspond to the goals mentioned above and objectives of rural territorial development and territorial development (*Landentwicklung and Landesentwicklung*). It was possible due to the geodetic expertise of the authors that relates to five essential components of each *Landentwicklung* (Pentaphony):

- ensuring equivalent living conditions in urban and rural areas,
- activation, consulting and directing,
- surveying, documenting, planning, linking and coordination,
- approval of plans, implementation, and financing,
- land arrangement and conflict resolution (on the ground) and updating cadastre and land registry.

The triad land management is based on the system thinking. It recognizes that the whole is more than the sum of the parts. System thinking is essential for action. We need to understand the land sector as a system, but not as separated or independent components. The term *Landmanagement* (land management) provides that advantage. Although, as an English term, it entered into in the German language or vocabulary a long time ago. Besides multilingual Switzerland, in Germany almost all of the chairs involved in land management have adopted the term. My Chair in TUM uses it in English. Our Institute at the TUM is known, similar to the German Association of Surveying (DVW), for more than ten years as Institut für Geodäsie, GIS und Landmanagement.

The highest scientific body, the German Geodetic Commission of the Bavarian Academy of Sciences decided for the new name Land and Real Estate Management. The advantage of the new English name is to improve its international profile. Nevertheless, it is important to acknowledge that European countries remain the birthplace of the

original land management and brought it into international discourse. Land management (*Landmanagement*) should be based on the key benefits of *Landentwicklung* and Land readjustment and in accordance with established goals and plans for the creation of equivalent living conditions in the city and the countryside.



Source: Magel et al. (2009)

Fig. 3. Triad Land Management

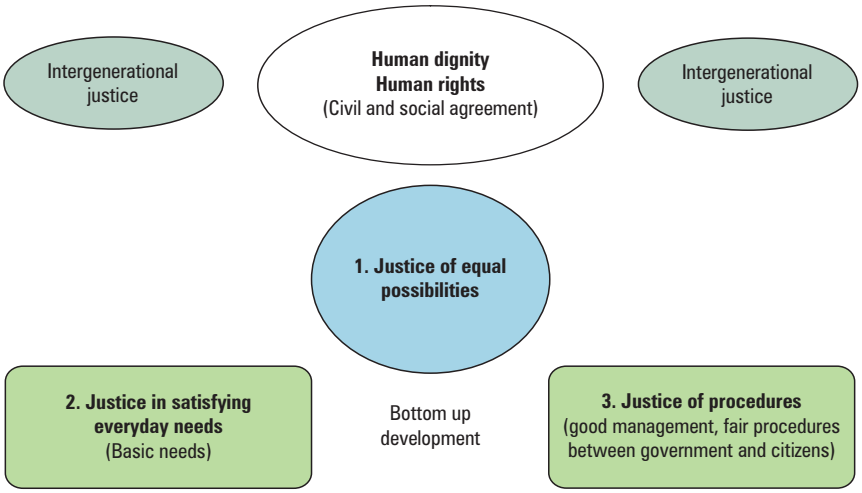
5. It is all about human dignity and justice

Landentwicklung is in my opinion – without putting it in a scientific language – a matter of the heart. Those who do not like people, villages and the countryside should not handle the task of developing them –whether as rural experts or developers. The experts and developers of rural areas should be those who recognize the dignity of people (especially weaker rural populations) and their rights. This precondition for handling rural tasks is important because rural experts must be people who can ultimately act justly.

That is why I refer to my other ethical-moral compass that has always guided me. It is captured in the main messages of a magazine called "Global aber gerecht" – meaning "Global but fair". The Magazine is a combined publication of Misereor, the College of the Jesuits in Munich, Potsdam Institute for Climate Change Consequences Research and the well-known Munich Re. In the name of human dignity and human rights – the observance of which recently President of the Republic of Poland, Mr Bronisław Komorowski, described in a speech to the German parliament as a pillar of democratic Europe. The message is that it should be always and everywhere about:

- justice and opportunities for people to develop their potentials and the perception of emerging opportunities,
- justice in meeting everyday needs for a fair share of daily needed goods and infrastructure of daily living (basic needs),
- justice in the procedures for the recognition of people as partners for full participation in the process of discussion and decision-making – the keyword here is "good governance" [Lotze-Campen et al. 2010].

Neither the EU nor its member countries can have these justices, manage and regulate them by means of administrative rules. The experts who deal with rural territorial development (*Landentwicklung*) need to feel a positive addiction to these qualities in themselves. They should live these qualities and pursue them in their private and professional lives. In everyday life, it is something more beautiful, more satisfying and liberating to be involved in this thing every day!



Source: Adapted from Lotze-Campen et al. [2010]

Fig. 4. Three kinds of justices

When we talk about equivalent living conditions in towns and villages, we must speak of the human dignity and human rights. For this reason, adhere to the three kinds of justice (see Figure 4). So where is *Landentwicklung* going to? Towards human, sustainable, just and comprehensive development of rural areas! We are still on the way – I am glad that Bavaria and Poland are united in this journey with joint projects.

Special Thanks go to Dr.Ing. Eugene Chigbu, TUM, for carefully editing this article.

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BDOT500 DATABASE OF PHYSICAL TOPOGRAPHIC OBJECTS – BASIC QUALITATIVE ANALYSIS

Marek Ślusarski

Summary

Official databases, which gather spatial data, should include sets of metadata, which serve to describe the information within. The fundamental element of a metadata set consists in the features describing the quality and relative importance of geospatial data. In the present work, we propose a method for the evaluation of database quality pertaining to databases of topographic objects (BDOT500) based on four criteria: location accuracy, completeness, validity (in the sense of being up to date) and logical coherence. Overall quality evaluation of the BDOT500 database was carried out using the calculation of two estimation factors: average absolute value and the coefficient of average variation. The method described herein is a useful device, which allows for a quick and credible evaluation of the BDOT500 data quality at a basic level. Applying the method does not require involving any additional means, as all the necessary information is already recorded inside the database.

Keywords

topographical object database • metadata • spatial data quality

1. Introduction

Information technology revolution in the second half of the twentieth century has led the world into the era of information, in which the resources of collected data are maintained by computerised information systems. These systems enable simple data sharing, as well as performing complex analyses in order to offer processed data. After a short period of belief that computer databases contain reliable information, research was started upon the quality of IT data, broadly understood.

According to Redman [2001] "data is of high quality when it is suitable for the use in operational, decision making and planning processes". Features of high quality data include: availability, coherence, and usefulness. Data should be equipped with appropriate imprints (data sheets). These imprints should be clear, measurable, easy to obtain, and they should facilitate comparability of results.

Compendium of geospatial data infrastructure, The SDI Cookbook [Nebert 2004], distinguishes discovery metadata, which makes it possible for the user to assess the

quality of the data set and determine the data of the set according to his needs. The main elements of the CSDGM standard (US Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata) include (in the order of importance) [Longley et al. 2006]: basic information on the data set, information on the data quality (general assessment of the quality of data in the set), manner of organisation, or ordering of geospatial data in the set, and more.

While describing the quality of geospatial data, different features or properties of data can be used. Data origin, precision of location, precision of attributes, logical coherence, completeness, semantic precision, and temporal quality are the main elements of data quality [Oort 2005, Devillers 2010].

According to Gaździcki [2008], the quality of data is described with the following features: completeness, logical coherence, positioning accuracy, temporal accuracy, thematic accuracy, as well as semantic accuracy and derivation. Completeness is understood as the incidence of all the intended data, without deficiency but also without excess. Logical coherence is the lack of inner contradictions in the data set. Positioning accuracy pertains to geodesic accuracy – the location of objects, expressed with coordinates. Temporal accuracy is linked to the change in data over time, and thematic accuracy, to the correctness of determining the qualitative properties, for instance. Semantic accuracy presented as a data set reproduces the area of discussion (that is to say, the subject matter of the problem). Derivation describes the manner and time of obtaining the data as well as the source materials, methods, and techniques.

European norms of the ISO 19100 series contain a wide range of terms pertaining to geographical information, and they possess a rich conceptual framework. The comprehensive description of the quality of data is included in the ISO Norm 19157 "Geographic information – Data quality" [ISO Norm 2013]. According to the record of the norm, quality equals "overall product characteristics, which depend on its capacity to meet particular and potential requirements". A complete identification of data should include both "non-quantitative" and "quantitative" information on quality. Non-quantitative information includes: purpose, origin, and application. Quantitative information includes, among others: completeness, logical coherence, location accuracy, temporal accuracy and thematic accuracy. Completeness is an element of data quality, which examines the deficiency and/or excess of the data set. Logical coherence is considered on four levels: conceptual, pertaining to the given area (domain), topological, and related to the format. Location accuracy is either absolute or external, or relative or internal. Temporal accuracy is the accuracy of time measurement, temporal coherence and temporal relevance. Thematic accuracy examines the correctness of classification, the precision of non-quantitative attributes, and the precision of quantitative attributes.

2. Subject of the research

Currently, for the area of all Poland, databases are maintained covering sets of geospatial data pertaining to the spatial data infrastructure. The main databases include:

- register of surveying grids / geodesic matrices (PROG, BDSOG),
- land and building register (EGiB),
- geodesic infrastructural network register (GESUT),
- national register of borders (PRG),
- real estate prices and value register (RCiWN),
- register of topographic objects (BDOT10K),
- register of geographic names (RNG),
- register of photographic images (RZF),
- database of topographic objects (BDOT500).

The database of topographic objects (BDOT500) – according to the provisions of the regulation on geodesic database for the infrastructural network register, database of topographic data and the master map [Regulation no. 383/2013] – is a database of topographic objects with the degree of detail which informs the creation of standard cartographic elaborations on the scale of 1 : 500 through to 1 : 5000. The content of the database includes objects of spatial infrastructure, which are not covered by the land and building register (EGiB) or the geodesic infrastructural network register (GESUT). The objects have been grouped in three levels of classification. The first level features categories of object classes, the second, the classes of the objects, and the third, the objects themselves.

Classes of the objects included in the BDOT500 are:

- engineering structures (bridges, overpasses, etc.),
- hydraulic engineering structures (weirs, dams, etc.),
- sports structures (tribunes, running tracks, tennis courts, etc.),
- tall technical structures (cooling towers, chimneys, etc.),
- technical tanks and reservoirs
- road, railroad or waterways reinforcements (groynes, retaining walls, etc.),
- earthworks (slopes, dikes, etc.),
- transport equipment (cranes, lifts, etc.)
- streets, tracks and surface waters,
- natural objects (trees, waterfalls, etc.).

BDOT500 database is established on the basis of the materials from the state surveying and cartographic resources. Basic sources of data include archival technical geodesic reports and assessments (operates), the master maps and other large-scale maps.

Empirical studies and experimental investigations of the BDOT500 data quality were conducted using a test object. The town selected for the study was of average size (town with administrative rights of a district, i.e. poviat) located in the Region of Silesia. It is an industrial town with over 62 thousand inhabitants, covering the area of approximately 64 square kilometres. Official databases of geospatial data are kept for

the town area in the digital format. The BDOT500 database was established chiefly on the basis of the master map and geodesic measurement reports (operates). The IT system supporting the BDOT500 database facilitates, among other functions, the updating of the data, cartographic visualisation of the data, and data provision (that is, making it available).

3. Research methodology

An empirical study has been conducted: an analysis of the information contained in the BDOT500 database. Information describing the objects in the following classes has been analysed: engineering structures, hydraulic engineering structures, sports structures, tall technical structures and earthworks. Assessment of the quality of the data included in BDOT500 was carried out based on four properties: location accuracy, completeness, relevance (up-to-date quality) and logical coherence. Assessment results for each particular property have been described as point values in the scale of 1 to 100.

Data quality for the property "location accuracy" was calculated based on data source attributes determined for each particular object in the BDOT500 database. For the studied object, there are three types of data sources. Data source marked with the symbol *O* designates the location of the object, determined on the foundation of geodesic measurements performed based on the geodesic network (Table 1); data source marked with the symbol *F* designates the measurement based on photogrammetrical surveying; while data source marked with the symbol *D* denotes the digitalisation of the master map. Point values for the assessment of location accuracy were calculated through analysing the numbers of objects which posses the attributes of *O*, *F* and *D* relative to the total number of objects.

Data sources were assigned measures of accuracy and weights (of relative importance). Subsequently, weighed values of points were assigned for the feature of "location accuracy" (Table 1).

Table 1. Calculation of point values of the data quality assessment for the property of "location accuracy"

Symbol of data source	Measure of accuracy [m]	Weight	Points	Weighted points
O	0.15	1.00	38.6	38.6
F	0.25	0.36	9.3	3.3
D	0.45	0.11	52.1	5.8
Total			100.0	47.7

Source: author's study

Completeness is the criterion, which determines the ratio of the number of collected data entries to the number of data entries, which should be collected according to the assumed theoretical model [ESDIN 2010]. For the studied databases, completeness of

data was calculated based on the analysis of objects of the BDOT500 type, which exist only in the digital master map. These objects have not been registered in the BDOT500 database, mostly due to the lack of complete identification.

Relevance, or the up-to-date quality of data depends on the character of data (its variability) and the assumed method of its updating. Ensuring a high level of relevance requires the application of on-going updates, therefore, entering updated information to the BDOT500 database, each time the new information or information change occurs. Analysis of waiting times (delay in entering the new or changed information into the database of geodesic reports) allowed for determining the value of the "data relevance" criterion.

Logical coherence is defined as the lack of contradictory relations within the data. For BDOT500, what needs to be checked is collinearity and the correctness of line objects segmentation [Bielecka 2010]. For the analysed database, conditions of collinearity and continuity of objects have been checked as well as the correctness of line objects segmentation. Research was conducted using the tools of the QGIS software.

Logical coherence of the database has been graded very highly, due to the conformity with pertinent legal regulations and technical norms when establishing the BDOT500 database. Table 2 presents scores (point values) of data quality assessment for the four characteristics, described using point values in the scale of 1 to 100.

Overall estimation of the BDOT500 database quality was conducted using the calculation of two estimators: mean absolute value (Sa) and mean coefficient of variation (Λ). The values of estimators were calculated based on point assessment of the data quality criteria as well as assumed weights (Table 2). Coefficient Sa – the mean of all data quality criteria – indicates which portion of the data meets the assumed criterion of 100 points. Parameter Λ facilitates a comparison of variation in different distributions [Czaja 2001] – in this case, the BDOT500 database which is heterogeneous in terms of data quality. In the ideal model, mean coefficient of variation model equals zero.

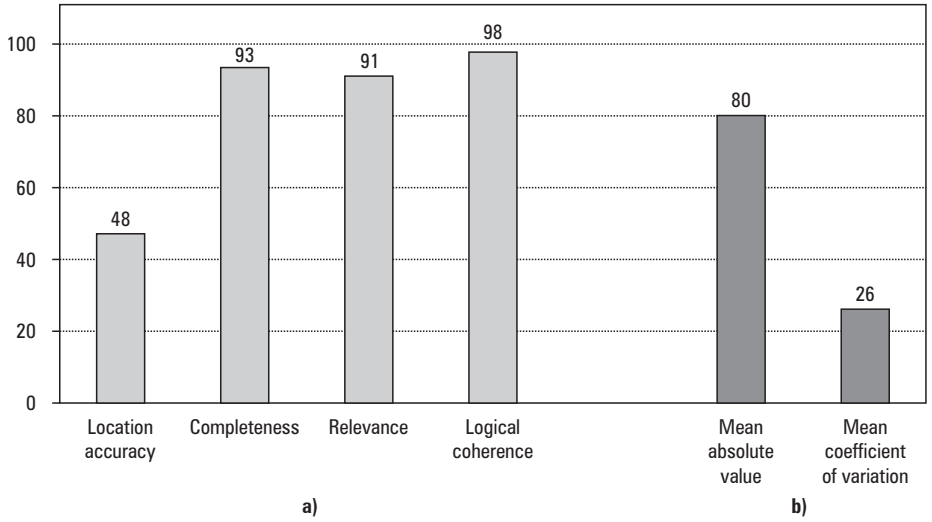
Table 2. Point values of the data quality assessment and calculated values of estimators

Criteria of data quality				Assessment estimator	
Location accuracy	Completeness	Relevance	Logical coherence	Mean absolute value (Sa)	Mean coefficient of variation (Λ)
weight = 1	weight = 1	weight = 1	weight = 0.5		
48	93	91	98	80	26

Source: author's study

Point values of data quality assessment presented in Table 2 and in Figure 1 indicate that the BDOT500 database of the examined object displays a decidedly average value of the location accuracy parameter (48 points). Other quality criteria – completeness, relevance, and logical coherence – display high values (above 91 points). Mean absolute value for the given object scores at 80 points, while the mean coefficient of variation

(expressed as percentage) is 26. Values of assessment estimators demonstrate, that the conceptual model of the BDOT500 database has been implemented to a high degree of completeness. However, not all aspects impacting the quality of the collected data have been sufficiently taken into account – which is particularly visible in the case of location accuracy.



Source: author's study

Fig. 1. Point values of the data quality assessment (a), values of estimators (b)

4. Conclusions

Official databases, which gather spatial data, should include sets of metadata, which serve for the description of the information within, in such a way as to facilitate the determination of data usefulness. The fundamental element of a metadata set consists in the features describing the quality and relative importance of geospatial data.

The method for the evaluation of database quality pertaining to databases of topographic objects (BDOT500), proposed in the present work, is based on four criteria: location accuracy, completeness, validity (in the sense of being up to date) and logical coherence. Empirical studies and experimental investigations of the test object have shown that the four parameters allow for a quick and credible evaluation of the BDOT500 data quality at a basic level. Applying the method does not require involving any additional means, as all the necessary information is recorded inside the database.

BDOT500 database of the test object is a set of reliable geospatial data. The data quality criteria – completeness, relevance, and logical coherence – meet the stated criteria in over 90%. Only the criterion of location accuracy is not met in approximately

50% of the analysed cases. The reason lies in the fact that the analogue master map was the main resource for the establishment of the BDOT500 database. Very high overall data quality score of the examined BDOT500 database encourages the use of that set as base material for creating other geospatial databases, for instance the BDOT10k register of topographic objects.

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The journal *Geomatics, Landmanagement and Landscape* features original English language scientific articles related to all aspects of spatial and environmental processes.

Preparation of the manuscript

1. **Length of the text:** manuscripts should not exceed 12 pages (A-4 format), including tables and illustrations. The text must be typed in a 12-point font (Times New Roman), 1.5 spaced with wide margins (2.5 cm).
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- Title: concise name of the paper, appropriate to its' contents.
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  Ergenzinger P.E., de Jong C., Christaller G., 1994. Interrelationships between bedload transfer and river-bed adjustment in mountain rivers: an example from Squaw Creek, Montana. [In:] M.J. Kirkby (ed.), Processs models. John Wily, New York, 140–144.

  Oliver M., Webster R., 1986. Semi-variograms for modelling the spatial pattern of landform and soil properties. Earth Surf. Proc. Landforms 11, 45–60.

  Rodrigo F.S., 2002. Changes in climate variability and seasonal rainfall extremes: a case study from San Fernando (Spain), 1821–2000. Theor. Appl. Climatol. 72, 193–207.

Young C.E. Jr., Klaiwitter R.A., 1968. Hydrology of wetland forest watersheds. Proceedings of the CUCOH Hydrological Conference, Clemson University, 28–29 March 1968, 29–38.

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