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FOREWORD

International Mountain Forum is a very active group of people concerned with broadly understood development of mountain areas. As a member of this Forum I am very glad that some of us could publish the results of our research studies in this and previous issues of the scientific journal *Geomatics, Landmanagement and Landscape*.

The presented issue is also devoted to complex problems of rural areas development tackled in the context of spatial planning and modern geodetic and cartographic techniques. The first article is an analysis of practical aspects of calculation of transit times when turning working machines at the edges of rectangular land plots. The second article is devoted to using methods of cartographic representation and econometrics for defining correlation of real estate prices and a distance to a city centre. The third one deals with the issues of horizontal refraction in setting out tunnel control networks. The subject of the fourth article is an analysis of land cover changes in the Nowy Targ commune, with particular focus on Natura 2000 area. The fifth article is an extensive analysis of The Rural Development Programme for 2007–2013 in Poland, the Czech Republic and Austria. The sixth paper is about the determination of geodetic control network points using GPS technology in difficult terrain conditions. The seventh article is devoted to the financial results of accepting local spatial development plans.

I hope that this issue of *Geomatics, Landmanagement and Landscape*, when it gets into readers' hands, will encourage them to cooperation and exchange of ideas especially on the development of rural areas and rural geodesy.

Prof. dr hab. Andrzej Tytko
Vice-Rector for Education
of AGH University of Science and Technology in Krakow

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CALCULATION OF TRANSIT TIMES WHEN TURNING WORKING MACHINES AT THE EDGES OF RECTANGULAR PLOTS

Wojciech Anigacz

Summary

The article presents the derivation of formulas for calculating the length of the sector and transit times of working machines at the edges of a rectangular plot. Working width of machines and the width and length of the patch were taken into account. This article is the first in a series devoted to the influence of the path length and the transit times on the edges of plots upon the decrease of net profit in agricultural farms.

Keywords

agricultural economy • agricultural engineering

1. Introduction

The present article is the first in a series devoted to the influence of the sector length and the transit times on the edges of plots upon the decrease of net profit in agricultural farms. Below we present the derivation of formulas for calculating the length of the sector and transit times of working machines at the edges of a rectangular plot. The appropriate shape of land plots is an important consideration for the proper land organisation of any agricultural farm. The more regular shape of the plots, the more constancy and predictability can be introduced to the crop rotation fields, which is very important due to the requirements of mechanised agriculture. We shall define "patch" as a specific part of the plot, which is used in a homogenous way. Each patch shall include only one type of farmland, for instance arable land. Small size and irregularity of patches are the two factors, which have a very negative impact on the net profit generated by agricultural farms, decreasing that profit dramatically. The "decrease of net profit" is here defined as losses resulting from the faulty shape of the patches, compared to patches of the same total area, but with a shape of a rectangle with optimum ratio of its sides. Often, however, the conditions of the terrain do not allow the correct shaping of the patches. In those cases, the future patch is shaped so that – in the given terrain conditions – the decrease of net profit is as small as possible.

When determining the optimum (desired) shape of the patches, we should be guided by the following determining factors:

1. Harvest losses at the edges of the patches:
   - losses on the edges,
   - losses on the headland.
2. Time losses at the edges of the patches:
   - losses on the edges,
   - losses on the headland.
3. Time losses from the transportation within the field.

All the methods – known to date – for calculating the shape of crop rotation plots and demand for mechanical work are of very limited relevance, as they only address rectangular plots and similar. Therefore their practical application is narrow [Anigacz 1973, Urban 1984]. In Holland, research was conducted aimed at developing a method feasible for evaluating fields of any given shape. The method elaborated and presented by Sprik and Kester [1972] makes it possible to calculate, with a high degree of probability, the decrease of net profit on a given patch due to the shape of the latter. Losses in time and in harvest should be calculated for particular tillage tasks, and particular crops – which is very time consuming. The aforementioned method should find broad application in the design practices, used in agricultural land planning.

The purpose of this article is to present the derivation of formulas for calculating the length of the sector and transit times of working machines at the edges of a rectangular plot. Sprik and Kester [1972] did not present the ways by which they arrived at their algorithm. Due to the labour-intensity of the issue in the context of a wide variety of tillage tasks and applications, the range of the present discussion was limited to those tasks, which are necessary for potato growing.

2. Calculation of the total required time of passage at the edges of a rectangular patch, with circular work within the crop rotation plot, with an unlimited belt width for turning manoeuvres

In circular work at a crop rotation plot, tillage tasks are performed in a circular manner, in belts of a certain width. The circular work within a crop rotation plot consists in two turns of 90° each, therefore 180° in total, while the length of the path travelled is πr, plus a certain length across. The length of the path travelled across the plot depends on the width and the situation of the given crop rotation field – see Figure 1.

If the width of the crop rotation field is S, then the longest passage across (B) will amount to [hm]:

$$B = S - 2r - w \tag{1}$$

where:

- S – width of the crop rotation field [hm],
- r – radius of the rotation of the machine's centre [hm],
- w – effective working width [hm].

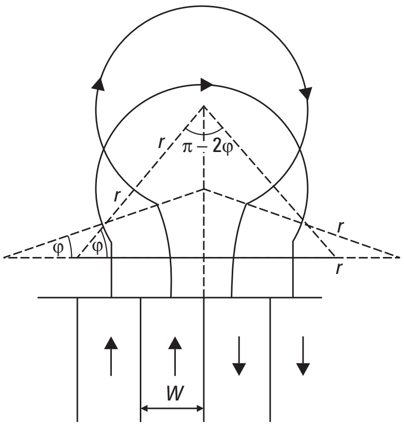

Fig. 1. Turning in the middle part, in the case of tilling crop rotation fields

As follows from formula (1) for the tilling of the mid-part of the crop rotation field with the width of less than $2r$, a passage across is not necessary, and the smallest length of the passage will equal w. Average length of the passage for the $S - 2r$ part will amount to in [hm]:

$$B_{Sr} = \frac{S - 2r - w + w}{2} = \frac{1}{2}S - r \tag{2}$$

The number of turns n for this part will equal:

$$n = \frac{S - 2r}{2w} \tag{3}$$

where:

$2w$ – one single turn.

Total length of the passage equals in [hm]:

$$D = \left(\frac{S - 2r}{2w}\right) \cdot \left(\frac{1}{2}S - r\right) = \frac{(S - 2r)^2}{4w} \tag{4}$$

Formula (1) is applicable only when the passage across is performed in parallel to the edge of the crop rotation field. Turning in the mid-part of $2r$, however, must be performed as shown in Figure 1 above.

The length of the passage for these turns is calculated as:

$$D = 4\varphi + (\pi - 2\varphi) + 2\varphi = \pi + 4\varphi \tag{5}$$

$$D = (\pi + 4\varphi)r \tag{6}$$

where:

D – length of the passage [hm],

φ – expressed in radians.

With the turn of 180°, and not in the middle part, that length equals πr, therefore the additional length of the path amounts to $4\varphi r$.

If the distance between the centres of two consecutive working passages equals nw then:

$$\cos\varphi = \frac{\frac{1}{2}wn + r}{2r} \tag{7}$$

$$\varphi = \arccos\varphi = \frac{\frac{1}{2}wn + r}{2r} \tag{8}$$

$$4\varphi r = 4r\ \arccos\varphi = \frac{\frac{1}{2}wn + r}{2r} \tag{9}$$

The length of the passage across from the last belt to the centre of the field will amount to in [hm]:

$$\frac{1}{2}S - \frac{1}{2}w - r \tag{10}$$

The length to the middle of the next crop rotation field equals in [hm]:

$$\frac{1}{2}S - \frac{1}{2}w - 2r \tag{11}$$

taking into account the r which is the sector travelled from the first working passage.

Table 1. Collation of the length of sector (turning path)

Transit	$\frac{w}{2r}$	0.2	0.4	0.6	0.8
---------->	1	$-r$	$-r$	$-r$	$-r$
---------->	2	$3.71r$	$3.18r$	$2.15r$	$1.13r$
---------->	3	$3.18r$	$1.35r$	$0.15r$	$0.17r$
---------->	4	$2.58r$	$0.10r$		
---------->	5	$1.80r$			
---------->	6	0			
Total		$10.27r$	$2.63r$	$1.30r$	$0.30r$
$n - 1 = \frac{2r}{w} - 1$		4		2/3	1/4
$(n - 1)\ 2.5r$		$10.00r$	$3.75r$	$4.67r$	$0.63r$
Deviation		$-0.27r$	$+0.12r$	$+0.39r$	$+0.35r$

Where:

$\frac{2r}{w} - 1$ – number of working passages in belt $2r$, in which turning should be performed

Due to the complicated form of formula (4), which is not suited for quick calculations, another one was developed empirically based on a large number of cases: formula (12) which has a simple structure and which can be used in an electronic calculator. The values obtained from the calculations using formula (12) are not too different from the values derived using formula (4), therefore in order to simplify further discussion we shall apply the formula:

$$\left(\frac{2r}{w} - 1\right) \cdot 2.5r \tag{12}$$

Total travel time in the turning belt amounts to:

$$\left(\frac{2r}{w} - 1\right) \cdot 2.5r = \frac{5r^2 - 2.5rw}{w} \tag{13}$$

As passages in the middle part consist of circular arcs only, the coefficient of 1.5 has been arbitrarily assumed, in order to reflect the decrease in the passage speed

$$\frac{(S - 2r)^2}{4w} \cdot t_r + \frac{\left(10r^2 - 5rw\right)}{4w} 1.5t_r \tag{14}$$

where:

t_r – time of passage during turning [min · hm^{-1}].

Because $2r/w$ is not always expressed as an integer, the length of additional travel 0.50 L to crop rotation field should be accounted for (L – length of crop rotation field) to the turning belt, which shall equal 0.25.

Total travel time to the crop rotation field and to the turning belt will amount to:

$$\frac{(S - 2r)^2}{4w} \cdot t_r + \frac{10r - 5rw}{4w} \cdot 1.5t_r + 0.25Lt_m \tag{15}$$

where:

L – length of the crop rotation field,

t_m – time of the working passage [min · hm^{-1}].

$$\frac{\left(S^2 - 4Sr + 19r^2 - 7.5rw\right)t_r + wLt_m}{4w} \tag{16}$$

Time of passage per hm of the turning belt will equal in minutes:

$$\frac{\left(S^2 - 4Sr + 19r^2 - 7.5rw\right)t_r + wLt_m}{4w} \cdot \frac{1}{S} \tag{17}$$

3. Conclusions

We have calculated the sector, which needs to be travelled in the turning belt, according to initial assumptions, as well as the time necessary to travel that path. Another stage will be to look for the minimum of the resultant function versus the sector, seeing that for given machines and conditions, the speed of passage is a constant.

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USE OF METHODS OF CARTOGRAPHIC REPRESENTATION AND ECONOMETRICS FOR DEFINING THE CORRELATION BETWEEN REAL ESTATE PRICES AND A DISTANCE TO A CITY CENTRE

Agnieszka Bitner, Piotr Nawrocki, Urszula Litwin

Summary

The article presents using methods of cartographic representation and econometrics and statistical description to defining the correlation between unit prices of an undeveloped land property and a distance to a city centre. Sold undeveloped land located within administrative boundaries of the city of Jasło have been the subject of the study.

Keywords

undeveloped land property • correlation "price – distance to a city centre" • cartographic representation • methods of econometrics

1. Introduction

The distance of an appraised real estate to a city centre is one of the elements of a broadly understood feature called location. Objective determination of impact of a distance to a centre on a value of a real estate can improve the quality of its valuation. The coefficient determining a studied correlation should be defined for a specific local market, especially if it determines a value relation of a price to distance. In this article the correlation was studied in the case of undeveloped land properties located within administrative boundaries of the city of Jasło. The correlation of a unit price of land property to a distance to a city centre is obvious. The more distant location of a real estate parcel to a centre, the lower its unit price. The authors will define the correlation quantitatively and visualize it by a cartogram, using the real transaction data.

The issues of defining correlation between price and distance to a city centre have been the subject of many studies. Gawroński and Prus [2005] analysed the influence of chosen factors determining agricultural property prices on the example of the city of Niepołomice. They found that with a decrease of distance to the city, the prices of agricultural properties increased, and that their price is also considerably influenced by the distance to centres of supply and sales. Spatial analyses of land property prices in urbanized regions were a subject of works, e.g. by Colwell and Munneke [1997] and Morris and Palumbo [2007]. The use of statistical and econometrics methods [Adamczewski 2011, Anselin 1988, Bitner 2010] in determining the influence of distance to a city centre on a price of residential real estates were presented e.g. in Chen and Hao [2008], Osland [2010] and Ottensmann et al. [2006].

2. The characteristics of the studied area

Jasło is situated in a valley of three rivers: Wisłoka, Jasiołka and Ropa. It was granted municipal rights on 20th of April 1365 by the king Casimir III the Great. Jasło has an area of 37 square kilometres, and has 37 thousand inhabitants. It is located in the south-east part of Poland, in the south-west part of Podkarpackie Voivodeship and is a seat of a district (powiat).

Source: authors' study

Fig. 1. Jasło – administrative map with a division into surveying sections

The Jasło district borders on the east with Krosno and Strzyżów districts and on the south – with Dębica district, and on the west – with Tarnów and Gorlice districts. The south border of the Jasło district is also the border of the Republic of Poland. The area of Jasło has a diverse landscape. Its south and north-east part lies in the Strzyżowskie

Foothills and it is dominated by a landscape cut by basin-like valleys, with a large number of slopes with an irregular gradient, with numerous escarpments, often forested. The areas of Jasło-Krosno Basin have less diverse landscape with gentler slopes of little gradient. Historically the Jasło region is related to oil, gas and glass-making industries. Refining, construction, furniture, chemical and food (mainly fruits and vegetables processing) industries are also well developed. There are 3636 business entities in Jasło. The majority of them are one-man and family companies. But decisive for the region's development are large companies, such as plastics factory Gamrat SA, Lotos Jasło refinery, a flooring panels producer Baltic Wood SA, Oil and Gas Exploration Company in Jasło ltd., Fabryka Armatur (Factory of Fittings) JAFAR SA, furniture factory "Nowy Styl", and fruit and vegetable processing plant Pektowin – A Naturex Company. There is a growing number of farms geared toward wine growing and production. There are already a dozen or so vineyards, and their number is still growing. Jasło has a good transport connections with Rzeszów, Nowy Sącz and also with border crossings with Slovakia and Ukraine.

The area of Jasło is divided into 24 surveying sections (Figure 1): 01 – Kowalowy, 02 – Ulaszowice, 03 – Błonie, 03A – PGR, 04 – Dzielnica Magazynowo-Przemysłowa, 05 – Hankówka, 06 – Zachód, 07 – Południe, 08 – Centrum, 09 – Górka, 10 – Sobniów I, 11 – Sobniów II, 12 – Gądki, 13 – Wądoły, 14 – Niegłowice, 15 – Żółków, 16 – Kaczorowy, 17 – Bryły, 18 – Gamrat, 19 – Krajowice, 20 – Podzamcze, 21 – Brzyszczki I, 22 – Brzyszczki II, 23 – Warzyce, 24 – Gliniczek.

3. The database and tools of econometrics used in the study

The data used in the study are the price and value of land and property register kept by the District Office (Starostwo Powiatowe) in Jasło and by the Statistical Office in Rzeszów. These are purchase and sales data of undeveloped lands from the first quarter of 2009 till the third quarter of 2011, and so they cover almost three years. The data refer to the area of the Jasło municipality. The following characteristics of undeveloped land properties were taken into account in the analysis:

- transaction price [zloty],
- area [m^2],
- seller (individual or legal person, the commune, private investor, State Treasury),
- buyer (individual or legal person, the commune, private investor, State Treasury),
- distance to the city centre [m],
- date of the transaction,
- kind of transaction,
- kind of land property,
- city section,
- class of land,
- additional remarks.

In the studied period 227 transactions of agricultural (mono- and multi-purpose) land properties were carried out. From the database 50 transactions for reasons of an incomplete information and transactions of developed land properties have been removed. The distances to the city centre have been defined by tools of Geoportal website. It was assumed that the centre of Jasło would be the central point of the Hugo Steinhaus Roundabout.

The data analysis began by determining the index of price changes trend. To this purpose the following formula was used [Prystupa 2003, Bitner 2011]:

$$T_r = (C_p - C_w) / C_w t \, 100\%$$

where:

- T_r – trend index of price changes,
- C_p, C_w – prices of similar properties,
- C_p – price of a property in a later transaction,
- C_w – price of a property in an earlier transaction,
- t – time interval between transactions (in this study: number of days).

The strength of the correlation of unit price of a land property to the city centre was measured by index of correlation coefficient. In order to quantitatively determine the correlation "price – distance to the city centre" the linear regression was used. Moreover elements of descriptive statistics were used to characterize the studied database [Aczel 2000].

4. The results of the analysis

The analysis of price changes trend of undeveloped land properties, carried out with the use of formula (1), showed that in the studied period the market was stable. The prices stayed on pretty much the same level. That is why there was no need to check the prices with regard to a date of the last transaction in the database. The analysis of influence of distances to the city centre on the prices of lands began with the determination of correlation coefficient. The value of the coefficient was –0.24. Its negative value means that the prices of land properties decrease as the distance to the city centre increases. However the correlation is not strong. The reason for it is e.g. popularity of chosen areas of the town that don't have to be in the city centre. Moreover cities expand more or less concentrically [Batty and Longley 1994].

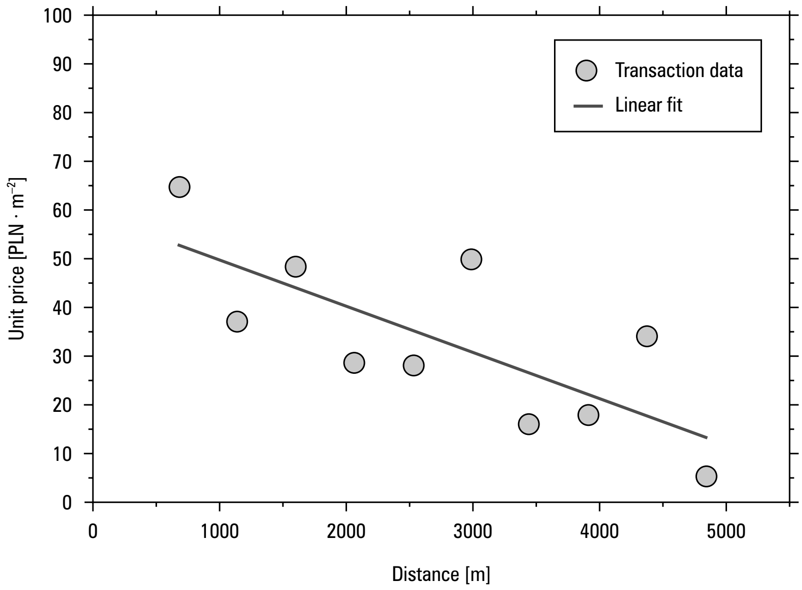
In order to quantitatively determine the correlation between the unit price of a land and the distance to the city centre, the correlation of linear regression was established. The lines of regression in a formula $y = a + bx$ were adjusted to data by means of the method of least squares [Aczel 2000]. The analysis was carried out for three different ways of grouping data into class ranges. Table 1 shows comparison of the results.

The results presented in Table 1 show that values of regression coefficients, when using different divisions into classes, are comparable. It means that the results do not depend on the division into classes. The negative values of slopes of straight lines confirm the results obtained by means of correlation coefficient and indicate the fall of the land prices along with growing distance to the city centre. In practical applications one can assume averaged value of regression coefficient, equal to 0.0101 zloty · m^{-2} (based on data presented in Table 1). It means that when we get away from the city centre with each kilometre the prices fall by about 10 złoty.

Table 1. Comparison of linear regression coefficients calculated for three ways of division into class ranges

Number of class ranges	Regression coefficinet *a*	Coefficient error *a*	Regression coefficinet *b*	Coefficient error *b*
10	59.02	9.2	–0.009486	0.00030
15	61.32	9.5	–0.010058	0.00310
20	60.84	7.2	–0.010619	0.00241

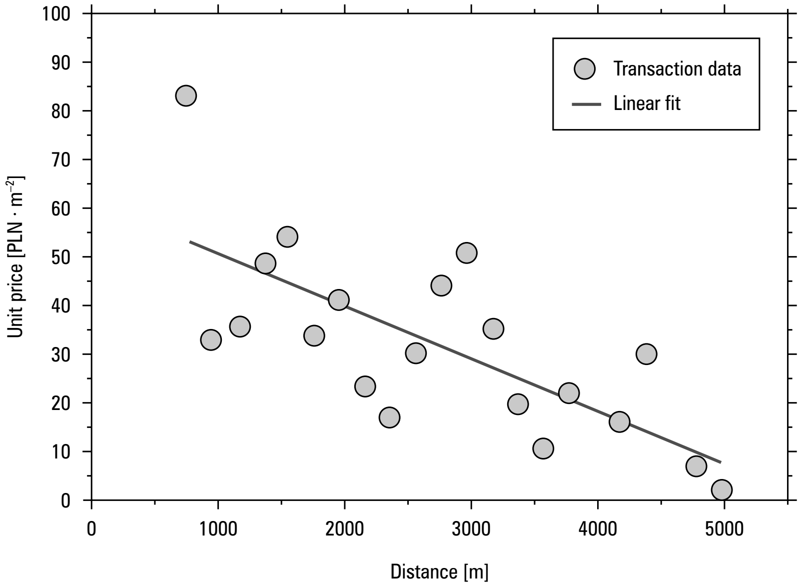
Source: authors' study



Source: authors' study

Fig. 2. The correlation between a unit price of a land property and the distance to the city centre with 10 class ranges

Figures 2 and 3 show the correlation between the unit price of a land and the distance to the centre of Jasło. As a central point of the city the middle of the Hugon Steinhaus Roundabout has been chosen. A closest was a land situated at 443 m distance from it, and the most remote was a land located at 5060 m from the city centre. The range of distances of transaction lands to the city centre has been divided into adequately 10 and 20 class ranges. Using method of least squares regression line was adjusted to data. The calculations were made. Coefficients of regression line were shown in Table 1.



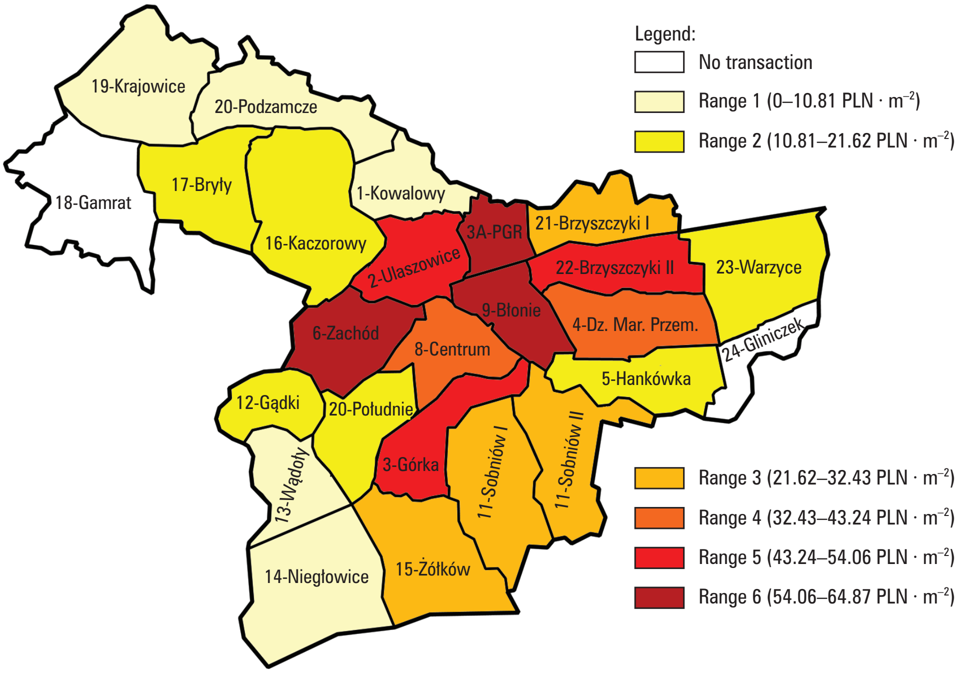
Source: authors' study

Fig. 3. The correlation between a unit price of a land property and the distance to the city centre with 20 class ranges

Figure 4 shows, previously quantitatively determined, correlation between of a unit price of an undeveloped land and the distance to the city centre. The highest unit prices occur in the areas near the centre, the lowest – on the outskirts of the town.

The correlation between the number of transaction and distance to the city centre has also been analysed. The results are presented in Table 2 and Figure 5.

Table 2 and Figure 5 show that the highest number of transactions in the studied period was conducted in a ring situated concentrically around the city centre, of around 700 m and 3500 m radii. The distribution of number of transaction in relation to the city centre is positively skewed. At the centre itself and on the outskirts of the city very few transactions of lands have been carried out. Small number of transactions in the centre of the city is related to small supply of lands that can be a subject of transaction. City centres have usually stable ownership structure and owners are reluctant to get rid of attractively located real estates. The high prices of lands in city centres is also an important factor. On the other hand, the small number of transactions on the outskirts of the city results from little interest of purchasers in land located 4 km from the city centre because of e.g. poor transport accessibility.



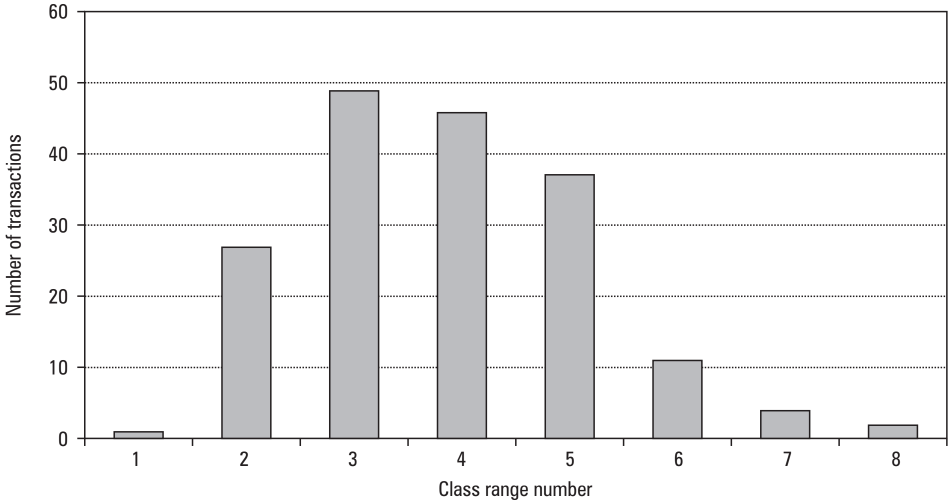
Source: authors' study

Fig. 4. Cartogram of unit prices of undeveloped land properties in Jasło

Table 2. The number of transactions in relation to the distance to the city centre. The second column shows right ends of class ranges

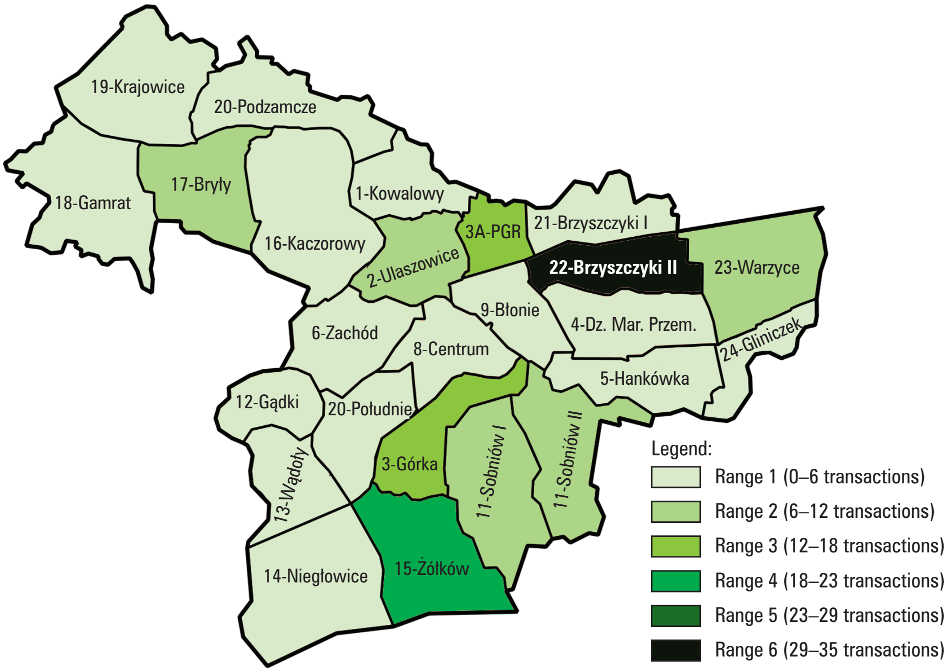
Number of class range	Distance to the city centre [m]	Number of ranges
–		–
	0	
1		1
	687.5	
2		27
	1375	
3		49
	2062.5	
4		46
	2750	
5		37
	3437.5	
6		11
	4125	
7		4
	4812.5	
8		2
	5500	
–		–

Source: authors' study



Source: authors' study

Fig. 5. The number of transactions in relation to the distance to the city centre. Class range numbers on the *x*-axis correspond to ranges shown in Table 2.

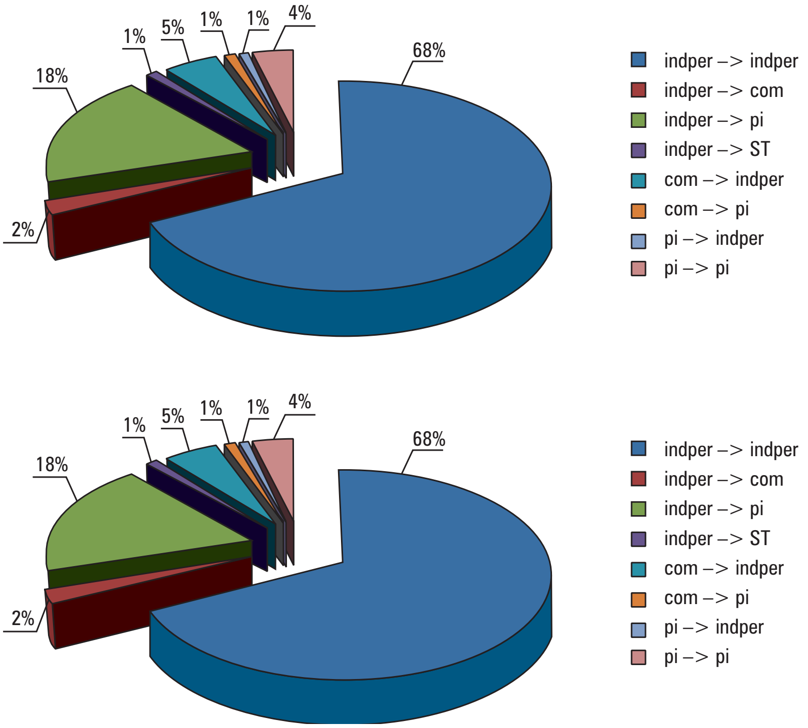


Source: authors' study

Fig. 6. Cartogram of intensity of undeveloped land transactions in Jasło

The intensity of transactions within the borders of Jasło is shown in Figure 6. The largest number of transactions has been noted within the section of Brzyszczki II, there were 36 of them. It is a section situated by the road Jasło – Krosno. The second in terms of number of transactions is the Żółkowie section. The attractiveness of lands in this section results from its location near the road to a boarder crossing. Within the Gamrat section, an industrial area, no transaction was noted. Little interest in lands was observed in the Gądki section, situated in the flooded area, and in the Warehouses and Industrial section. In most sections at least 6 transactions were made.

In the analysed real estate database the sides of transaction were various entities, such as, individual person, commune, private investor, the State Treasury. Figure 7 presents percentage share of particular entities taking part in undeveloped land transactions. The following entities were singled out: indper – individual person, com – commune, pi – private investor, ST – State Treasury.



Source: authors' study

Fig. 7. Percentage share of particular entities taking part in undeveloped land transactions

Figure 7 shows that the largest number of transactions was made between individual persons (67%), and 18% are transactions in which a individual person sold a land to a private investor. Some 6% were the transactions in which the commune was the seller.

5. Conclusions

The article presents the methods of using cartographic representation, econometrics and statistical description to define the correlations in the real estate market. As the object of the study an undeveloped land properties market was chosen, located within the administrative borders of Jasło. Transaction data cover almost three years period. In the studied period 227 transactions were made, but only 177 were the subject of the authors' analysis.

In the studied period the market of undeveloped lands in Jasło was stable and the prices stayed on pretty much the same level. Almost 70% of transactions have been carried out between individual persons. The largest number of transactions was noted in sections situated near the road Jasło – Krosno, and to the road leading to a border crossing. The studied correlation between a unit price of a land property and the distance to the city centre showed that along with growing distance to the city centre the unit price of land fall by about 10 złoty with each kilometre. The results of the study can be used directly in evaluation of land properties on the local market or by creating a development strategy of a studied area.

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THE PROBLEM OF HORIZONTAL REFRACTION IN SETTING OUT TUNNEL CONTROL NETWORKS

Henryk Bryś

Summary

The paper presents the problem of the influence of non-uniform horizontal refraction field of the measurement environment on the results of determining the astronomical azimuths and transferring the coordinates in the geodetic tunnel network. The concept of a modular network alignment with simultaneous elimination of the effects of horizontal refraction is presented. Automatic TOTAL STATION and the results of precise angles and distances measurements allow currently effective multi stage linear-angular networks adjustment during tunnelling. The results of the innovative group tunnel networks adjustments are the coordinates of the network points and the elimination of existing disruptions in the course of the sight line. The results achieved so far for theoretical studies of horizontal refraction elimination and error ellipses forecasts for long tunnel networks were presented.

Keywords

tunnelling • horizontal tunnel network with traverses • multi stage alignment • azimuth transfer • elimination of horizontal refraction

1. Introduction

Geometry of the sight line and in particular its unilateral deviation – horizontal refraction, is of fundamental importance in determining the astronomical azimuth or direction angle during the setting out of the tunnel. Local conditions in the measuring environment in the tunnel, such as: inhomogeneous field of atmospheric air temperature gradients, humidity and air currents, fumes, dust rock, darkness, shocks, vibrations and others, cause significant disruption in the course of light waves and measurements of angles and distances, and as a result they reduce significantly the accuracy of results of geodetic observations. Significant influence on the accurate determination of direction has the horizontal refraction caused by large gradients of air temperature in the vicinity of the tunnel walls, the value of which can reach up to more than 2° C. The temperature of the Alps rocks is up to 50° C at the depth of 1000 m and at the depth of 300 m to 30° C [Hennes 1998]. For several years a detailed theoretical and experimental studies are conducted to develop alternative strategies to minimize the influence of refraction

[Beluch 1990, Beluch and Bryś 2010, Bryś and Osada 2010, Hennes 1998, Hennes et al. 1998, Heister 1997, Korrittke 1992, Wilhelm 1993]. The problem is particularly important in the case of long (up to more than twenty kilometres), tunnel control network. Currently the longest tunnels in the world are: SEIKAN-TUNEL – 53.850 km (Japan), EUROTUNEL – 49.940 km (the English Channel) and GOTTHARD-BASISTUNNEL – 57.000 km (Switzerland).

Detailed simulation analysis of the influence of the horizontal refraction for established for the entire length of the tunnel, realistic and permanent transverse temperature gradient of 0.1 $K \cdot m^{-1}$ showed for the length of 12 km deviation in the direction of 6.62 m. The accuracy required currently for the breakthrough in the transverse direction is from 1 to 2 $cm \cdot km^{-1}$. These data clearly confirm the importance and significance of the problem of the negative influence of refraction during the setting up work. In the fundamental publication the author [Korritke 1992] reported about the difference in the sum of the apical angles determined using a theodolite and a gyrotheodolite obtained in the course of Eurotunnel setting up, amounting 47.0 $mgon \cdot 2800\ m^{-1}$, which corresponds to the transverse deviation of 1.11 m in the direction of the tunnel axis. During the measurement campaign in March 1989, in the traverse of "serpentine" course, the author finds that on the length of 6.487 km lateral deviation amounts + 1.052 m. Subsequent control traverse measurements made strictly in the axis of the bored tunnel showed in continuation unexpected linear deviation of + 0.521 $m \cdot 13.85\ km^{-1}$ [Korrittke 1997]. As a result, the concept of surveying in the tunnel was changed and additional, time-consuming observations of astronomical azimuths using GYROMAT 3000 were introduced for on average every 6^{th} side of the traverse to define a correction for horizontal directions. Figure 1 shows the results of analysis of the influence of the horizontal refraction on the deviation of the direction for alternative cases of locations of traverses and for different values of temperature gradients in a tunnel with a length of 12.600 km and the theoretical length of the sides of the traverse with a length of 600 m. The lengths of the sides applied in straight tunnels average from 300 to 450 m.

As results from above data, both theoretical analyses and the results of geodetic measurements of long traverse networks confirm the presence of significant systematic influence of refraction on the values of coordinates deviations, significantly exceeding the precision requirements imposed on modern measurements of tunnel (Bryś i Osada 2010).

Minimization of the effect of the horizontal refraction in determining the azimuthal angle or astronomical azimuth and most probable coordinates values for points of the control network can currently be obtained in the following ways:

- Through the control measurements of astronomical azimuths using gyrotheodolites of latest generation (GIROMAT 5000) with a standard deviation of 0.8 mgon (the so-called "internal") and 1.7 mgon (the standard "external" deviation) and the introduction of appropriate correction to the measured or set out directions. This method is a measuring strategy currently most commonly used in the setting out works fort long tunnels, but effective on sections of the underground network from 1.5 kilometres.

- Introduction of physical amendments to the measured angles / directions. The method practicable for use only during the research in experimental tunnels, it requires extensive work. Impossible during tunnel setting out surveying.
- The use of appropriately designed geodetic networks structures and the strict alignment of measurements and coordinates of control network points. Auxiliary control gyrotheodolite measurements. Optimal and widely used method.
- Measurement of horizontal angles of the network using THEODOLITE-DYSPERSOMETER [Hennes et al. 1998], i.e. electronic total station equipped with two or trichromatic carrier waves. These instruments are currently being used as prototypes in laboratory and experimental measurements in tunnels.
- The simultaneous use of a combination of several ways to minimize the influence of refraction, which often is done in geodetic tunnel measurements.

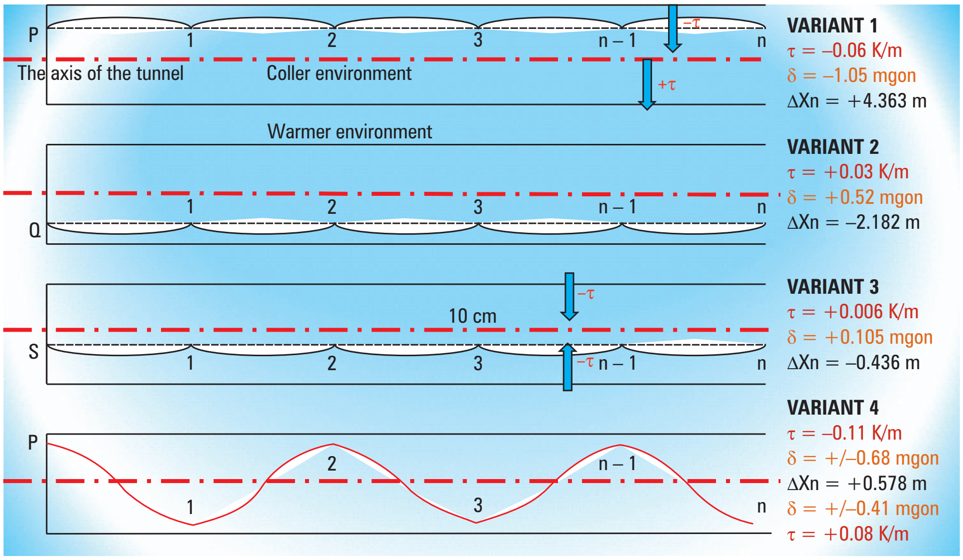

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Fig. 1. The effects of horizontal refraction for 4 variants of the location and the course of traverses in the tunnel for the following data: $L = 12.600$ km – length of the traverse, $D = 600\ m$ – the lengths of the sides, and τ – horizontal air temperature gradient perpendicular to the wall of the tunnel, δ – partial angle of horizontal refraction, ΔX_n – lateral deviation in the direction of the tunnel axis

Implementation of modern tunnel network in the case of bilateral horizontal tunnelling, requires its connection to a superior portal networks (before the entrance to the tunnel) and satellite networks, as shown graphically in Figure 2.

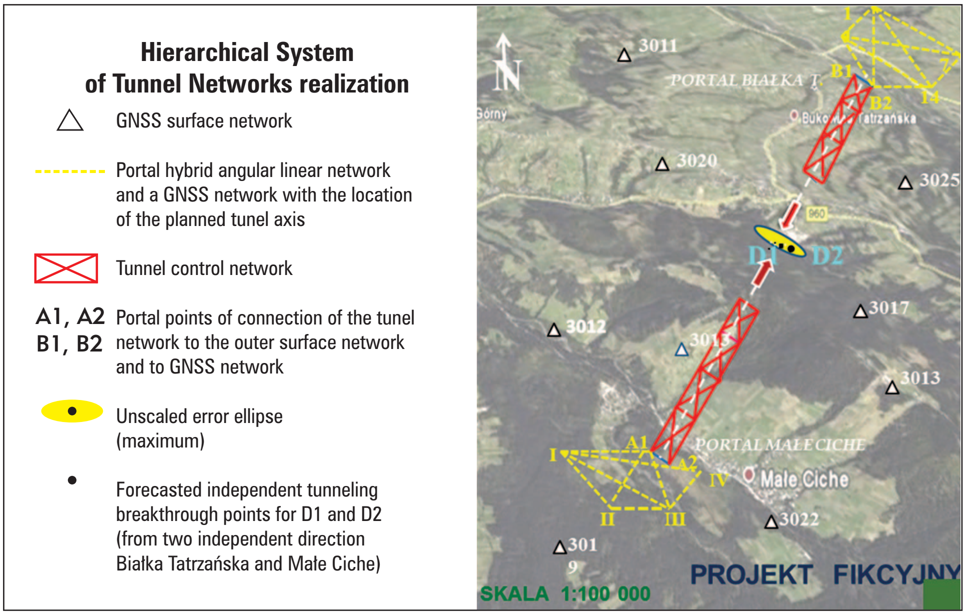

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Fig. 2. The structure of geodetic networks for the tunneling of long tunnels

The author present the results of theoretical research work on the innovative multi stage method of adjustment of a symmetrical control network with traverses assuming lack of knowledge asymmetrically occurring partial angles of horizontal refraction during the measurement process. The aim of adjustments of the network coordinates based on simulated data of horizontal angles and length of sides, was to demonstrate that the elimination of the systematic influence of side refraction in the horizontal control networks is possible and fully realistic.

2. Line-angle modular tunnel network with traverses

Traditional, single and double, open traverses – straight and serpentine, has always been critically evaluated horizontal networks for the carrying out of the tunnel measurements in the absence of any controls of the sum of the apical angles closure. They are the simplest, but now exceptionally used tunnel networks. Currently, the most commonly used control networks structures are different combinations of linear-angular networks [Beluch 1991, Beluch and Bryś 2000]. The author present a hybrid-modular model of a special network constructed of intersecting traverses with additional segments – traverses and the traverse networks along the side walls (the walls of the excavation) of the tunnel. As shown by the results of the model adjustments, presented variant of the optimized linear-angular network is a structure of the network characterized by an almost total elimination of the partial angles of the horizontal refraction. The principle of strict alignment of coordinates of simulation network consists in the group, successive step adjustments, from the portal to the front of the driven tunnel. Alignment is performed by ReTuNetz autor's computer program based on the program MATHCAD 14. The entire section of being gradually extended tunnel network is divided into n equal parts (in presented calculation example of 1800 m), adjusted in sequence together with the progress of drilling works.

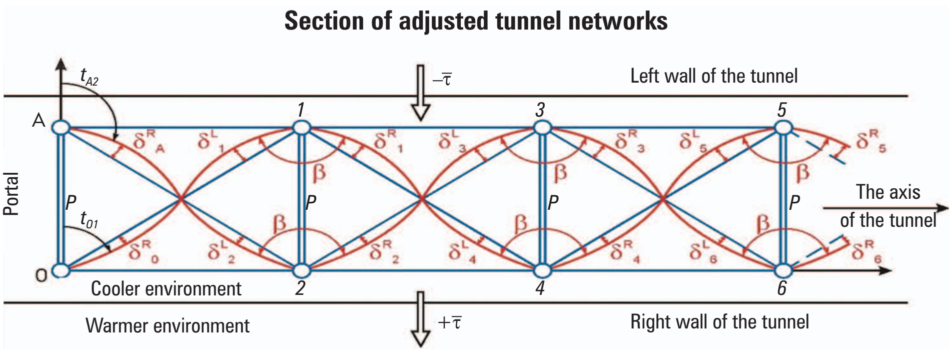

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Fig. 3. Part of a horizontal tunnel hybrid network with the course of the deformed lines of sight in a heterogeneous field of refraction

After every stage adjustment are obtained the coordinates of the points of cross-beams network being the basis for the further carrying out of the surveying tasks, i.e. setting out working points of the network as free positions using motorized instruments of TOTAL STATION type. From this positions the fixed positioning of the direction is performed on the monitor of the control system of the drilling machine TBM (Tunnel-Bohring-Machine) and control of the geometric parameters of the proper drilling of the excavation of the tunnel – horizontally and vertically.

3. Algorithm of a hybrid tunnel network alignment and example of calculations

Functional model of a stage alignment of the presented tunnel network with effective elimination of partial refraction angles according to the Least Squares Method rules designed on the basis of the following algorithm in matrix notation:

$v = Ax + l$ – vector of measurements correction (1)

$N = A^T PA$ – matrix of normal equations (2)

$Q = N^{-1}$ – matrix of weights reverses (3)

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$n = A^T Pl$ – vector of constant terms in the normal equations system (4)

(P = weight matrix)

$x = (A^T PA)^{-1} A^T Pl$ – vector of unknowns – adjusted results (5)

$C_X = (A^T PA)^{-1}$ $i = 1, 2$ – covariance matrix of adjusted coordinates (6)

Network points and refraction angles

$A^T Pv$ – adjustment control (7)

where:

A – matrix of coefficients (partial derivatives),

l – matrix of shortened constant terms.

$$S_0 = \sqrt{\frac{v^T Pv}{w-u}} \quad \text{– standard deviation of an observation with weight } p = 1 \tag{8}$$

$$S_{l_i} = S_0 \cdot \sqrt{Q_{l_i l_i}} \quad \text{– standard deviation of an observation after adjustment} \tag{9}$$

where:

$Q_{l_i l_i} = AQA^T$

w – number of observations,

u – number of unknowns,

$w - u = r$ – number of redundant observations.

$$|v_i| \le k \cdot S_0 \quad \text{– test of standardized corrections} \tag{10}$$

$$S(t)^2 = S^2_{X_i} \cdot \cos(t)^2 + S_{X_i Y_i} \cdot \sin(2t) + S^2_{Y_i} \cdot \sin(t)^2 \tag{11}$$

Equation (11) describes the curve of the position error of a point of the relative error ellipse with semiaxes A and B in either direction angle or azimuth t.

This equation enables user to determine deviations of the measurement dependent of the direction. For the direction angles $t_A = 0^g.0000$ and $t_B = 100^g.0000$, we obtain for the semiaxes A and B of the relative unscaled error ellipse (Figure 4):

$$A = S(t)_A = S_Q \quad \text{and} \quad B = S(t)_B = S_L$$

where: S_Q i S_L are radial vectors of the relative error curve (11).

Results of staged adjustments are believed to be correct, if they met the condition: $S_0 \cong 1.0$, with the possible tolerance not exceeding 10%.

For test adjustments of consecutive parts of the tunnel network, the following realistic measurement data, standard deviations and the partial horizontal refraction the angles were assumed:

$L = 1800.00$ m – length of the part of the simulated network,

$D = 600.00$ m – length of the sides of the network,

$p = 5.00$ m – crossbeams lengths,
$\beta = 198^g.9380$ – the bend angles (apical),
$t_{A_2} = 100^g.5305$ – initial directional angle of tunnel network connection,
$S_{tA2} = 0.2$ mgon, $S_\beta = 0.2$ mgon, $S_D = 1.0$ mm, $S_p = 1.0$ mm,
δ = from 0.2 mgon to 0.8 mgon – partial angles of horizontal refraction.

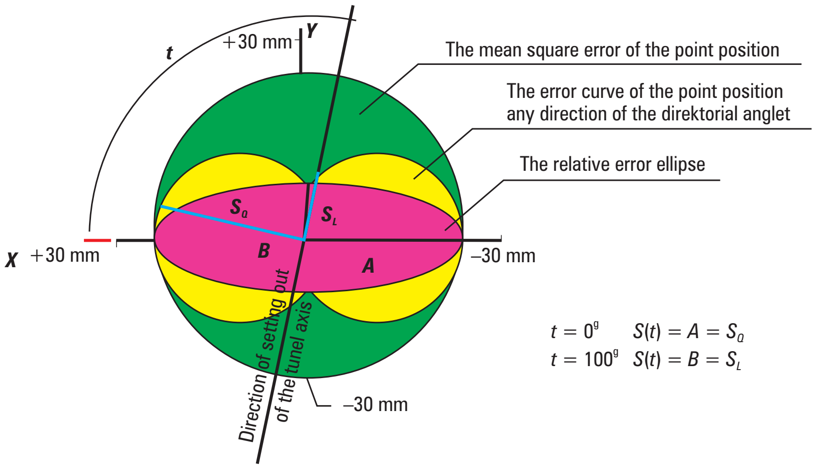

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Fig. 4. Graphic image of curves characterizing the deviations of points coordinates of tunnel network after simulation adjustment

Separate analysis of the systematic deviations and random errors of the tunnel network allows to estimate the influence of refraction on directional angles and coordinates X for the whole adjusted hybrid network and the network in the form of "serpentine" traverses (O, 1, 4, 5, … *n* and A, 2, 3, 6, … *n*). The lateral deviation of the *X* coordinate of the end for "serpentine" running traverse without adjustment can be calculated according to the following formula in the arc angle measure [Beluch and Bryś 2000]:

$$Q_{Pn} = \Delta Y_{An} \cdot \left|\delta_A^R\right| - \Delta Y_{2n} \cdot \left|\delta_2^L + \delta_2^R\right| + \Delta Y_{3n} \cdot \left|\delta_3^L + \delta_3^R\right| - \Delta Y_{6n} \cdot \left|\delta_6^L + \delta_6^R\right| + \ldots \pm \Delta Y_{(n-1)n} \cdot \left|\delta_{(n-1)n}^L + \delta_{(n-1)n}^R\right| \quad (12)$$

where:
δ_i^R, δ_i^L – partial angles of horizontal refraction (Figure 3).

To evaluate minimization of systematic refraction influence in implemented modular tunnel network the author propose that the following criterion of external reliability should be used:

Table 1. Summary of the results of the simulation adjustments, calculation of deviation of the tunnel hybrid network model and breakthrough forecasts

Section of network	Lengths: of network section/ Network side [m]	Simulated angles of refraction [mgon]		Network point number	Adjusted X coordinates Mean deviation Average X of crossbeams The outer reliability factor Zi	Standard deviation S_X S_O forecasts for S_X S_O [mm]	Lateral deviation without adjustment of refraction [mm]
		Left wall of the tunnel	Right wall of the tunnel				
1	2	3	4	5	6	7	8
A	1 800/600	0.4	0.2	8 7	+5.001 +0.001 +2.500 0.4403	7.6 1.0 7.5 1.1	+11.3 +5.5
A + B	3 600/600	0.4 0.6	0.2 0.4	13 14	+5.011 +0.011 +2.511 0.4467	17.4 1.01 17.4 1.5	+32.1 +35.8
A + B + C	5 400/600	0.4 0.8 0.8	0.2 0.4 0.6	20 19	+5.025 +0.001 +2.525 0.6160	29.3 1.07 29.3 1.8	+81.1 +71.5
A + B + C + D	7 200/600	0.4 0.8 0.6 0.8	0.2 0.4 0.6 0.6	25 26	+5.015 +0.014 +2.514 0.6819	43.1 1.07 43.1 2.1	+133.9 +137.1
A + B + C + D + E	9 000/600	0.4 0.8 0.6 0.8 0.8	0.2 0.6 0.4 0.6 0.6	32 31	+5.011 +0.011 +2.510 0.7238	58.6 1.04 58.6 2.4	+216.7 +207.6

A + B + C + D + E + F	10 080/600	0.4 0.6 0.8	0.8 0.8 0.8	0.2 0.4 0.6	0.6 0.6 0.6	37 38	+5.004 +0.004 +2.504 0.7575	75.5 1.09 75.5 2.6	+312.6 +310.2
A + B + C + D + E + F + G	12 600/600	0.4 0.6 0.8 0.8	0.8 0.8 0.8	0.2 0.4 0.6 0.6	0.6 0.6 0.6	43 44	+5.003 +0.004 +2.504 0.7782	94.1 1.05 94.0 2.8	+435.6 +411.9

Source: Bryś and Osada 2010

$$Z_i = 1 - \frac{Sx^2}{Q_{PM}^2} \tag{13}$$

where:

S_X – the standard deviation of the X coordinate for the stepwise adjustment,

Q_{PM} – average deviation of the X coordinate of the point from two traverses.

The increase in the value of Z together with the length of the network part means an increase in its reliability, as well as the degree of efficiency in minimizing the impact of refraction on the determined X coordinates. Detailed results of the simulated stepwise adjustments based on realistic angles of horizontal refraction are presented in Table 1.

Analysis of the results of the strict adjustment of the optimized tunnel network (Figure 3) showed unequivocally that it is possible to eliminate effectively asymmetrical horizontal refraction caused by non-uniform temperature field. The deviation of the last X coordinate of the network (Table 1, column 6, D = 12.600 km) amounts to 4 mm, and is insignificantly small in relation to the predicted value of the semiaxis A of the relative error ellipse SQ = 94 mm. While the average lateral deviation of the end points of nonadjustable, "serpentine" traverses is equal 43 cm (Table 1, column 8) and significantly exceeds the precision requirements imposed on forecast values of the tunnel breakthrough using techniques and technologies of the latest generation (automated TOTAL STATION).

4. Conclusions

- Non-homogeneous field of refraction in measurement environment occurring in close proximity to the tunnel walls (approx. 30 cm), produces systematic deviation of direction, which can be up to 10 mgon/400 m.
- Measurement errors analysis showed that the greatest impact on the lateral deviation of the X coordinate of the end points of the network are induced by the effects of refraction on the first horizontal directions of the sides of the network, just behind the portal. This fact is of fundamental importance in planning, design and modification of the geometry of the network and in strategies of minimizing the impact of the horizontal refraction phenomenon in the performance of precise angular measurements and transmission of directional angle or azimuth.
- The proposed variant of the modular tunnel network with the crossbeams, thanks to the large number of redundant elements, is characterized by a higher internal reliability.
- Setting out precise direction angle or azimuth and the X coordinate with a submillimeter accuracy is currently obtained with the use of motorized total stations with automatic tracking of the prisms on the points of the network, and specialized software such as: *SmartWorx* – standard software: *RoadRunner Tunnel – LEICA GEOSYSTEMS*.

- Presented in the work, modular network alignment method with effective elimination of the phenomenon of refraction is an alternative to traditional methods of realization of tunnel control networks of special purpose.
- If the results of investigations of model modular networks in geodesic practice are confirmed then carrying out time-consuming measurements of astronomical azimuths using precision gyrotheodolites with an "external" standard deviation of 1.7 mgon and introducing the necessary directions corrections, would become unnecessary.

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THE ASSESMENT OF LAND COVER IN THE NOWY TARG COMMUNE WITH PARTICULAR FOCUS ON THE AREA OF NATURA 2000

Barbara Prus, Łukasz Budz

Summary

The rural landscape in Poland has been changing for the past several dozen years. The changes are visible in the land use and land cover. Technological progress, changes in people's outlook and a low profitability of agriculture resulted in transformations of rural landscapes, especially in the areas of high level of land fragmentation, as it is the case in the south part of Poland. These changes are accompanied by growing awareness of environmental or cultural landscape protection related issues. Recent years have also brought new forms of environmental protection, for example the programme Natura 2000, being the result of agreements with European Union. The network of Natura 2000 cover the areas of special protection of birds, habitats, and according to the Act on Nature Conservation – areas of special interest for the Community. The goal of this form of protection is a preservation of valuable or engendered elements of biodiversity. The question arises then whether in the era of landscape transformations and changes of land cover qualifying a particular area as part of Natura 2000 network has any influence on the way of land use. The aim of the article is an analysis and evaluation of land cover changes, also in the areas covered by Natura 2000 programme, within the piedmont commune of Nowy Targ in Małopolskie Voivodeship. Moreover, a thesis is proposed that submontane lands, specifically used, due to large terrain height differences, are faced with less intense urbanization pressures and land transformations. Is it also the case of the Nowy Targ commune, covered in more than 22% by the Natura 2000 areas?

Keywords

Natura 2000 areas • land cover changes • landscape transformations

1. Introduction

The rural areas take up more than 90% of Poland's territory [Staniak 2009]. It means that they have a considerable influence on the country's natural environment. For centuries mosaic of cultivated lands, permanent grasslands, forests and rural settlements have been creating typically Polish, traditional rural landscape [Staniak 2009, Baran-Zgłobicka and Zgłobicki 2012]. The environmental and cultural value of rural areas in Poland is highly valued in Europe, because most of the unique habitats and plant communities is related to rural areas, and is used as meadows and pastures [Andrzejewski and Weigle 2003].

Historically, agriculture was a direct cause of creation of rural landscapes characterized by rich biodiversity. The changes in agriculture of the last fifty years, including specialization, intensive farming economy, technological development, led to better crop efficiency and increased the competitiveness of agriculture. All this resulted in land use changes, in introduction of new kinds of crops, acreage increase of agricultural plots. The characteristic mosaic of lands [Baran-Zgłobicka and Zgłobicki 2012] and transformations have an adverse impact on water environment, soils, air quality, biodiversity and rural landscape [Kozłowski 2004, Burchard-Dziubińska 2010].

The forms of land use influence the picture of land cover, which can both be a result of natural and anthropogenic factors. It is proved that land cover influences many elements, for example local climate, development of physiographic conditions, including soil conditions, but also visible forms of natural and cultural landscape [Richling 1996]. Land cover includes [Ciołkosz and Bielecka 2005]:

1) vegetation, including forests, grasslands, agricultural lands),
2) open areas (sands, solid rocks),
3) waters.

There is a strong correlation between "land use" and "land cover". Zwoliński [1998] says that land use is a result of combining land cover with its use. In this view the notion of land use is prior to the notion of land cover.

Land cover and land use as well as their changes for a long time have been the subject of interest for specialists of many domains. And it applies to changes on a local and global level. In 1985 the Council of Europe decided to implement programme CORINE Land Cover (Coordination of Information on the Environment), supervised by the European Environmental Agency (EEA). The first stage of the programme was the study of changes in land cover in 1990 on the basis of aerial photographs taken by a satellite Landsat by means of a TM scanner. Ten years later the land cover changes were significant enough to update the databases already in 2000. The changes were so fast that decision was made to update the databases more often, that is not every ten but every five years. The land cover changes were noted in three levels. The first one includes fives basic types of land cover [Ciołkosz and Bielecka 2005]:

1) anthropogenic (artificial) surfaces,
2) agricultural areas,
3) forests and semi-natural areas,
4) wetlands,
5) water bodies.

In the second level 15 forms of land cover are distinguished, and the third one is the most precise with 44 classes. In Poland 31 out of 44 defined classes of land cover were noted, and in Małopolskie Voivodeship itself 28 classes were observed. In the CORINE databases raster data are stored, with a minimal size of a classified area of 25 ha and width of at least 100 m, but an annotation is made when a visible change of 5 ha division range occurs or 25 ha change in case of new forms of cover.

CORINE Land Cover enables spatial analyses for environmental protection purposes and creation of thematic maps. The programme offers the first complete and uniform digital picture of land cover in Poland.

Poland has more than 32% of the country covered with protected areas, 11% of which are national parks, landscape parks and natural reserves, characterized by strict environmental protection rules [Radziejowski 2004]. Implementing another type of protection means an expansion of areas of great natural interest with spaces that were not under other forms of protection before. The principal goal of the Natura 2000 programme, created by the EU member countries, was preservation of biodiversity in Europe. These areas include especially places where flora and fauna populations are declining and natural habitats at risk of deterioration or shrinking [Tarchalska 2008]. According to the Act on Nature Conservation of 2004, the network of Natura 2000 areas (established by the same act) covers the areas of special protection of birds, habitats, and areas of special interest for the Community. By definition the established network Natura 2000 can cover a part or the whole of areas under other forms of environmental protection. The environmental protection related activity consists in preserving, sustainable use and restoration of resources, formations and elements of nature. Landscape is also included in this definition. Therefore it can be concluded that areas under environmental protection of any form, when taken into account in ecological policies, in programmes of environmental protection, in development plans for the whole country, in development strategies of voivodeships and communes, in voivodeships, communes and local spatial development plans, in communes studies of land use conditions and directions, would undergo less intense transformations that the non-protected areas. The conclusion is confirmed by the principal assumption of Natura 2000 programme, which is to preserve the protected area in a state found when the necessity of protection appeared. Covering some part of a commune area by the Natura 2000 protection may slow down the area's economic development and impede administrative processes in undertakings carried out within this area or in its immediate vicinity [Tarchalska 2008]. The task to reconcile the needs for development of rural areas and agriculture with environmental and landscape protection is very difficult to accomplish [Staniak 2009].

The presented work aims at presenting land cover changes observed in the CORINE Land Cover databases with regard to the piedmont commune of Nowy Targ, situated in Małopolskie Voivodeship. The additional goal of the article is an analysis and estimation of changes in agricultural lands, with particular focus on changes within the Natura 2000 area located in the studied commune.

Table 1. Land cover classes in the CORINE Land Cover databases

Level 1	Level 2	Level 3		ID
1. Anthropogenic surfaces	1.1. Urban fabric	1.1.1	Continuous urban fabric	1
		1.1.2	Discontinuous urban fabric	2
	1.2. Industrial, commercial areas and transport units	1.2.1	Industrial or commercial units	3
		1.2.2	Road and rail networks and associated land	4
		1.2.3	Port areas	5
		1.2.4	Airports	6
	1.3. Mine, dump and construction sites	1.3.1	Mineral extraction sites	7
		1.3.2	Dumps sites	8
		1.3.3	Construction sites	9
	1.4. Urban green and leisure areas	1.4.1	Green areas	10
		1.4.2	Sport and leisure areas	11
2. Agricultural areas	2.1. Arable land	2.1.1	Non-irrigated arable land	12
		2.1.2	Permanently irrigated arable land	13
		2.1.3	Rice fields	14
	2.2. Permanent crops	2.2.1	Vineyards	15
		2.2.2	Orchards and plantations	16
		2.2.3	Olive groves	17
	2.3. Meadows and pasturesa	2.3.1	Meadows, pastures	18
	2.4. Heterogeneous agricultural areas	2.4.1	Annual crops associated with permanent crops	19
		2.4.2	Complex cultivation patterns	20
		2.4.3	Land principally occupied by agriculture, with significant areas of natural vegetation	21
		2.4.4	Agro-forest areas	22
3. Forest and semi-natural areas	3.1. Forests	3.1.1	Broad-leaved forests	23
		3.1.2	Coniferous forests	24
		3.1.3	Mixed forests	25
	3.2. Shrub and herbaceous vegetation	3.2.1	Natural grassland	26
		3.2.2	Heathlands and shrubs	27
		3.2.3	Sclerophylous vegetation (Mediterranean)	28
		3.2.4	Transitional woodland / shrub	29
	3.3. Open spaces, with little or no vegetation	3.3.1	Beaches, dunes, sands	30
		3.3.2	Exposed rocks	31
		3.3.3	Sparsely vegetated areas	32
		3.3.4	Burnt areas	33
		3.3.5	Glaciers and permanent snowfields	34

4. Wetland	4.1. Inland wetland	4.1.1	Inland marshes	35
		4.1.2	Peat bogs	36
	4.2. Coastal wetland	4.2.1	Salt marshes	37
		4.2.2	Salines	38
		4.2.3	Intertidal flats	39
5. Water bodies	5.1. Continental waters	5.1.1	Water courses	40
		5.1.2	Water bodies	41
	5.2. Marine waters	5.2.1	Coastal lagoons	42
		5.2.2	Estuaries	43
		5.2.3	Seas and oceans	44

Source: authors' study (based on Ciołkosz and Bielecka [2005])

2. Material and methods

The analysis of land cover changes in the studied area has been carried out based on a raster terrain model CORINE Land Cover of 1990, 2000 and 2006 with a resolution of 100 m per pixel. The models were acquired free of charge from the site of the European Environmental Agency (www.eea.europa.eu/data-and-maps/explore-interactive-maps/corine-landcover). The CORINE data were calibrated to the reference coordinate system WGS 84. The analysis of features of the land were carried out based on a digital terrain model (DTM or MNT) from ASTER GDEM (Global Digital Elevation Map) with a resolution of 30 m. Based on the DTM and assumed range classes the study of slopes was conducted. Thanks to this conversion an analysis of landform features in confrontation with land use was possible. In the same reference coordinate the DTM area range was adjusted and it required additional processing with regard for longitude and latitude, for which it can be acquired. On the basis of gathered information maps were worked out as a spatial intersect of layers. The results of modelling were created by means of software using GIS analyses: Idrisi Andes and Golden Software Surfer 8. To analyse the land use for areas of Natura 2000 and inside the limits of Nowy Targ commune, reclassification of raster and layers intersect of particular thematic maps. Multicriteria spatial analyses allowed the presentation of studied problems in the form of output layers and additionally their composition by means of simple statistical analyses.

3. The scope of the study

The commune of Nowy Targ belongs to Nowy Targ district and is situated in Małopolskie Voivodeship. It is the biggest commune in the district, covering 21 villages: Dębno, Długopole, Dursztyn, Gronków, Harklowa, Klikuszowa, Knurów, Krauszów, Krempachy, Lasek, Ludźmierz, Łopuszna, Morawczyna, Nowa Biała, Obidowa, Ostrowska, Pyzówka, Rogoźnik, Szlembark, Trute and Waksmund.

Source: authors' study

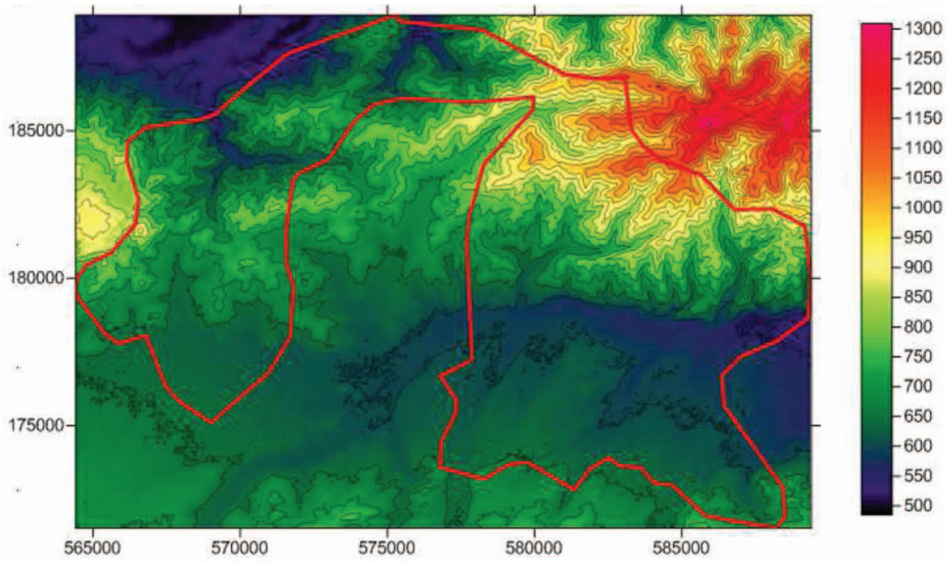
Fig. 1. Location of the Nowy Targ commune in Małopolskie Voivodeship

Geographical location of the Nowy Targ commune is very diverse. In the northern part it lies in the mountain range Gorce in Western Beskids. The southern part of the commune is located in the plain of the Orava-Nowy Targ Basin. It is also the lowest part of the Orava-Podhale Depression (Podhale-Magura Area), between Beskids in the north and the Spisko-Gubałowskie Foothills in the south. The southern and northern borders of the commune reach as far as Pieniny Klippen Belt. Location and landform features of the Nowy Targ commune influences the structure of land use (Table 2). Out of total area of about 207.6 km^2 a little above 56% are covered with agricultural lands, 37% of which are arable lands, and less than 20% is used as permanent grasslands. About 37% of the commune area are covered with forests, and less than 2.5% of lands was classified as under water. Therefore the land use structure shows the agricultural and forest character of the studied commune. Its piedmont location is also the reason of large height differences and slopes.

Table 2. The size and percentage of agricultural lands in the Nowy Targ commune

Group of agricultural lands		Area [ha]	Share in the total area [%]
Użytki rolne	Arable land (AL)	7 566.88	36.44
	Orchards (O)	21.34	0.10
	Meadows (M)	2 999.96	14.45
	Pastwiska (Ps)	1 098.35	5.29
	Pond bottoms (Wsr)	3.27	0.02
	Ditches (W)	7.35	0.04
	Total agricultural areas	11 697.15	56.33
Woodlands, tree-covered areas and shrublands		7 610.21	36.65
Built-up and urbanized areas		741.58	3.57
Wastelands		207.10	1.00
Areas under water		500.02	2.41
Mixed areas		9.14	0.04
Total		20 765	100%

Source: authors' study based on data from the Communal Office of Nowy Targ, status as at December 2013



Source: GIS of Nowy Targ commune [http://nowytarg.e-mpzp.pl]

Fig. 2. Aster GDEM of the Nowy Targ commune

The digital terrain model analysis showed that 30% of the area of the Nowy Targ commune (6065 ha) is situated on slopes of 0–3°, which means the areas are almost flat. Around 18% of the commune area is situated on slopes of 3–6°, and 21% (4224 ha) – on slopes of 6–10°.

Within the slope range of 10–15° there is 21% of the commune area, and above 15° of slope there is about 12% of the area, and around 529 ha is situated on slopes above 20°. It means that the commune has a high percentage of lands located on steep slopes. These conditions affect largely the way of land use, and consequently the land cover.

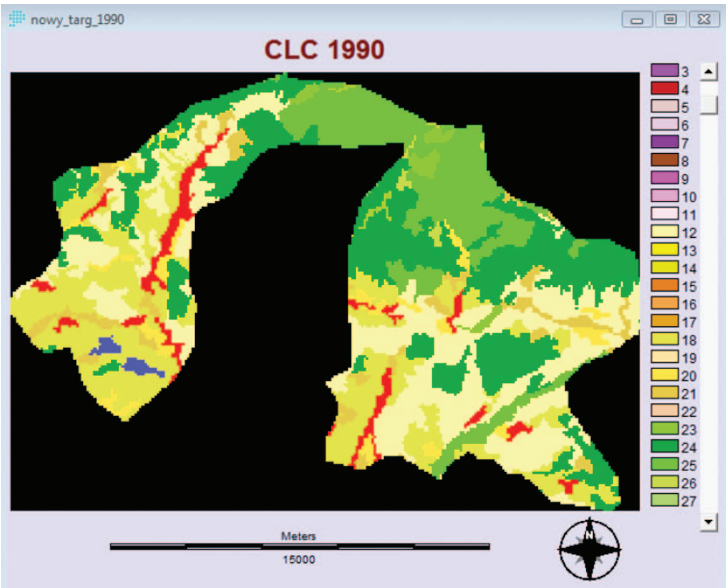
High natural and landscape values resulting from the commune's location and landform features contributed to the fact that its large part (around 22.36%, which is equivalent to 4553 ha) found itself under the environmental protection of Natura 2000. In the Nowy Targ commune Natura 2000 areas are covered in 82% by forests, in 16% by agricultural lands and in 2% by wetlands and anthropogenic surfaces that existed there before Natura 2000 was Hestablished.

4. Results and discussion

Data spatial analysis of CORINE Land Cover of 1990, 2000 and 2006 for the Nowy Targ commune (Figures 3a, b, c) showed visible land use changes of lands marked according to land cover classes (Table 1) as: 2 – discontinuous urban fabric, 12 – non-irrigated arable land, 18 – meadows and pastures, 20 – complex cultivation patterns, 21 – areas principally occupied by agriculture, with significant areas natural vegetation, 23 – broad-leaved forest, 24 – coniferous forest, 25 – mixed forest, 26 – natural grasslands, 29 – transitional woodland/shrub, 36 – peat bogs, and 41 – water bodies (distinguished only for CLC 2006).

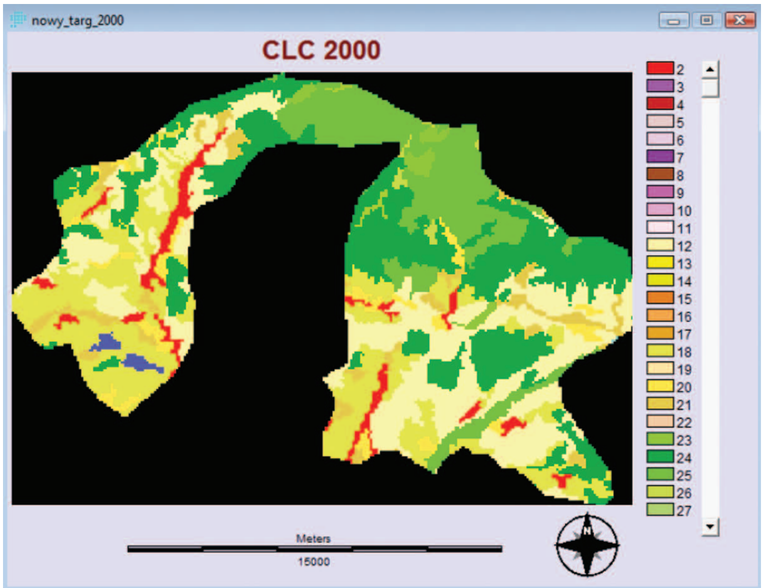
When comparing land cover in 1990, 2000 and to 2006 one can see that in sixteen years there have been some changes in land cover. Changes between 1990 and 2000 ware notably smaller than these between 2000 and 2006. In the whole studied period decrease of anthropogenic areas by 11 ha, arable lands by 6 ha, cultivation patterns by 2 ha was observed. However there was an increase of 246 ha of meadows and pastures. In general comparison the size of agricultural lands decreased by 361 ha (3.08%). The changes have also been observed in woodlands. The size of broad-leaved forests increased by 381 ha and coniferous forest grew by 35 ha. At the same time the size of mixed forests decrease by 322 ha. And water bodies were larger by 4 ha.

When comparing the results of the land cover in the Nowy Targ commune with changes noted in the Małopolskie Voivodeship [Piskulak 2012] one can see that, in Małopolskie Voivodeship and in the Nowy Targ commune alike, the differences were related to land cover in the following classes: 1 – complex cultivation patterns (which is a mosaic of small adjacent plots under various kinds of cultivation, and small meadows and pastures), 2 – agricultural lands with significant areas of natural vegetation, and 3 – discontinuous urban fabric. An increase was noted in discontinuous urban fabric together with a decrease of size of continuous urban fabric.



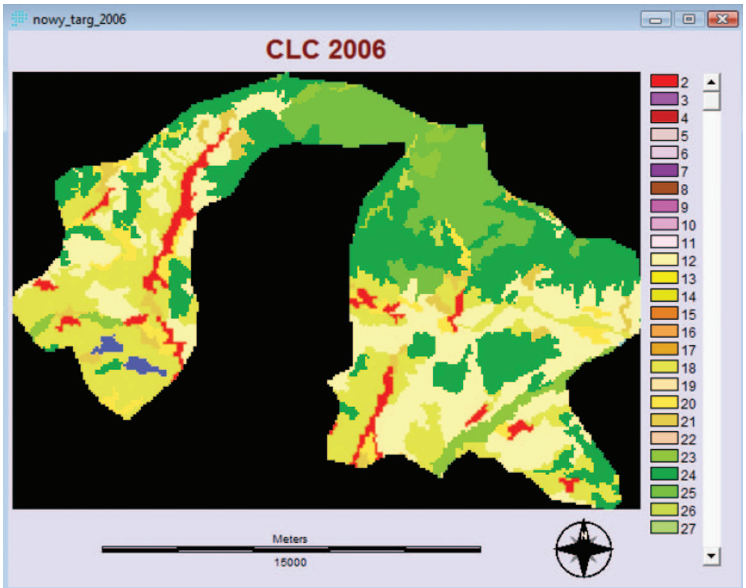
Source: authors' study

Fig. 3a. Spatial analysis of land cover in the Nowy Targ commune in 1990



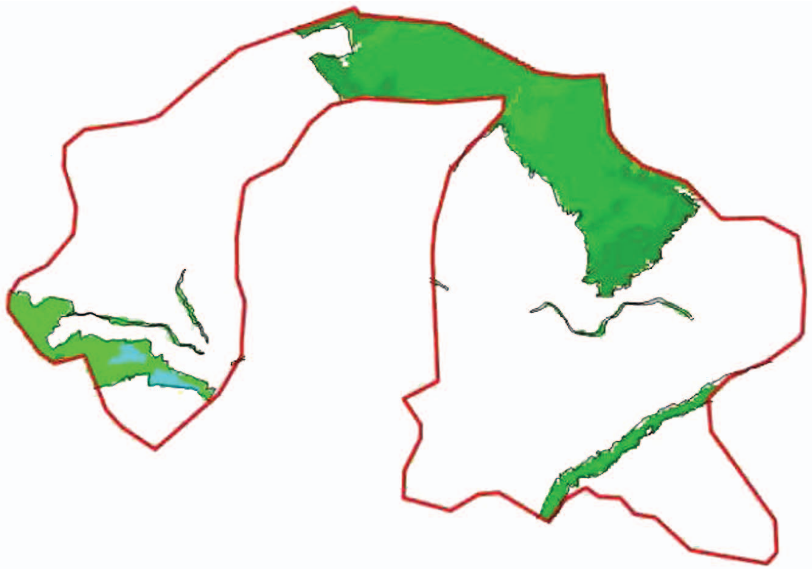
Source: authors' study

Fig. 3b. Spatial analysis of land cover in the Nowy Targ commune in 2000



Source: authors' study

Fig. 3c. Spatial analysis of land cover in the Nowy Targ commune in 2006



Source: authors' study

Fig. 4. The area of the Nowy Targ commune with an information CLC 1990 showing land cover within Natura 2000 areas

After limiting the scope of analysis to the Natura 2000 areas the following regularities were observed (Figure 4). The analysis showed that within Natura 2000 areas in the Nowy Targ commune eleven land cover classes can be singled out, such as: 2 – discontinuous urban fabric, 12 – non-irrigated arable lands, 18 – meadows and pastures, 20 – complex cultivation patterns, 21 – areas principally occupied by agriculture, with significant areas natural vegetation, 23 – broad-leaved forest, 24 – coniferous forest, 25 – mixed forest, 26 – natural grasslands, 29 – transitional woodland/shrub, 36 – peat bogs. For comparison, project CLC 2006 showed most significant land cover changes with regard to size of forests and agricultural lands. During the sixteen years the size of agricultural lands within Natura 2000 area have decreased. However the size of forests in the area increased in the studied period by 43 ha.

5. Conclusions

Apart from a suburbanization phenomenon observed in recent years, a visible process of transformations of rural landscapes can be seen. It is noticeable in changing ways of land use. The global changes can be viewed with the help of satellite pictures. Thanks to the programme CORINE, launched in the mid 1980s, observation of land cover changes in the territory of Europe was possible. Poland's territory was also included in the programme. Satellite pictures processed into raster images taken in 1990, 2000, 2006 show considerable land cover changes. It has been observed that changes are more and more faster. When comparing two studied periods: 1990–2000 and 2000–2006, the authors found that more considerable changes took place in the second period. In the studied sixteen years period land cover changes in the Nowy Targ commune are also visible, especially in the size of agricultural lands and forests. In that period the size of meadows, pastures and forests increased, but the share of arable lands and anthropogenic areas in the land use structure decreased.

The communal areas of Natura 2000 have also undergone changes in land cover. The changes led to a decrease of size of agricultural lands in favour of forests surfaces. It proves that in the studied commune the Natura 2000 programme, being a form of protection aimed at preserving the terrain in its original state, resulted in an increase of forest area at the expense of the size of agricultural lands. In the CORINE databases there were no suburbanization changes visible in these areas. One can assume that protection of Natura 2000 contributed to the lack of anthropogenic changes in the studied area. Today, however, within the Nowy Targ commune there is an increase of discontinuity of urban fabric, which moves to areas of unfavourable topographic conditions (steep slopes). The areas of high natural and landscape values are also endangered by the expansion of building development. The phenomenon occurs mostly on southern slopes of Gorce, hilltop range of Pieniny Klippen Belt and valleys of streams and in agro-forest boundary areas. The changes are not visible in the CORINE databases because of high degree of generalization of the picture.

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RURAL DEVELOPMENT PROGRAMME IN POLAND, THE CZECH REPUBLIC AND AUSTRIA

Małgorzata Dudzińska, Katarzyna Kocur-Bera

Summary

For several reasons, rural areas in Poland developed much more slowly than urban areas, and to a large extent, they have been neglected. The situation was much improved after Poland's accession to the EU, with continuous flow of funds for the development of agriculture. These actions facilitated faster development of such areas, while the structure of the latter has improved. The current instrument for the implementation of the EU policy for rural areas, operating within the second pillar of the Common Agricultural Policy, is the Rural Development Programme for the years 2007–2013 (RDP 2007–2013).

The present document contains a comparative analysis of the Rural Development Programme 2007–2013 as implemented within three states, namely: Poland, Austria, and the Czech Republic. General conditions and limits to the granted financial assistance have been determined in the EU regulations, therefore they can not differ between Poland, the Czech Republic, and Austria. What differs, however, is the projects and investment tasks implemented within particular measures.

In the article, the aforementioned countries have been compared in terms of rural areas, and in terms of measures implemented within the Rural Development Programme in each of them.

It has been noted that there have been 44 measures implemented within the Rural Development Programme 2007–2013, while only 19 of these are implemented within thematic axis 2 – improving the environment and countryside. Poland is implementing 26 measures in total, the Czech Republic is implementing 32, and Austria – 31. The highest amount of financing per country's area went to Austria, and the lowest – to the Czech Republic. The Czech Republic possesses the most favourable structure of the rural areas, while Poland possesses the least favourable structure thereof. In the present work, the method of logical and descriptive analysis was employed, based on the Polish and international subject literature.

Keywords

rural areas • European Union • financing

1. Introduction

Rural areas in Europe are heterogeneous in terms of their inhabitants and social structures as well as in terms of their economies and labour markets. These differences are desirable, as they represent the uniqueness of each of the European countries and regions. At the same time, rural areas everywhere in Europe often share common objectives and ambitions. Development of rural areas is an important sphere of European policy. In 2008, rural areas constituted 91% of the European Union territory. They were inhabited by more than 59% of all EU citizens, including 24% of the population in the areas with the majority of rural areas, and 35% residing in mixed areas – sub-regions, in which between 15% and 50% of the inhabitants live within local units (municipalities) classified as rural (i.e. with population density below 150 persons per square kilometre). These regions are responsible for 56% of all employment and they generate 49% of the gross added value within the European Union [Rural Development… 2011].

Within the EU-27 countries, there are approximately 14 million agricultural farms in operation. Agricultural and silvicultural activity covers 77% of all area of the European Union. Many areas still face problems of soil degradation, eutrophication, ammonia emissions, and decrease of biodiversity. Fortunately, ecological (organic, environmentally friendly) agriculture is becoming increasingly popular (5.4 million ha) as well as land use for the purpose of obtaining renewable resources, for instance, the production of bioenergy. Another instrument for combating the disappearance of biodiversity is the Natura 2000 programme, which covers approximately 12–13% of the EU farmland and forests.

Population in the rural areas on average has low-level educational qualifications. In many member states, persons in the rural community finish their education at primary or first grade secondary school more often than their city counterparts. Approximately 15% adults in the rural areas and 20% inhabitants of urban areas go on to higher education. This is often linked with migrations of qualified people to the cities. Due to broader potentials and higher possibilities of finding a job, graduates from higher education institutions remain in urban areas after completing their studies [Communication from the Commission to the Council… 2006].

The current instrument for the implementation of the European Union policy for the development of rural areas, operating within the second pillar of the Common Agricultural Policy, is the Rural Development Programme 2007–2013 (RDP 2007–2013).

Just as in the previous years, each member state was obligated to define their own rural development program, and to determine the amount of financing directed for particular measures implemented throughout the programming period of 2007–2013 [Polityka UE… 2008].

Basic principles of rural development policy for the years 2007–2013 as well as political instruments at the disposal of the member states and regions are defined by the Council Regulation (EC) no. 1698/2005 of 20 September 2005 on supporting the development of rural areas by the European Agricultural Fund for Rural Development (Dz. U. L 277, 21/10/2005). Authors of the document conducted a comparative analysis of the measures implemented under the Rural Development Programme 2007–2013, as applied within three states, namely: Poland, Austria, and the Czech Republic.

These countries have been selected for the analysis, as member states of the European Union. Another significant factor in the selection was the fact that Poland

and the Czech Republic are Eastern bloc countries, which joined the EU at the same time, while Austria has been a member of the community for over twenty years.

2. Study material and method

In the present work, the method of logical and descriptive analysis was employed, based on a critical study of Polish and international subject literature. The heart of the method is adjusting the new problem to the knowledge to date, and it consists in demonstrating similarities, differences, interdependencies and significant features in scientific theories, hypotheses and assumptions, ideas and principles of operation, beliefs and opinions in terms of the value system and word view [Apanowicz 2000]. The study uses the latest available data from the European Communities Statistical Office (Eurostat) and the Polish Statistical Office (Główny Urząd Statystyczny, GUS).

3. RDP (Rural Development Programme)

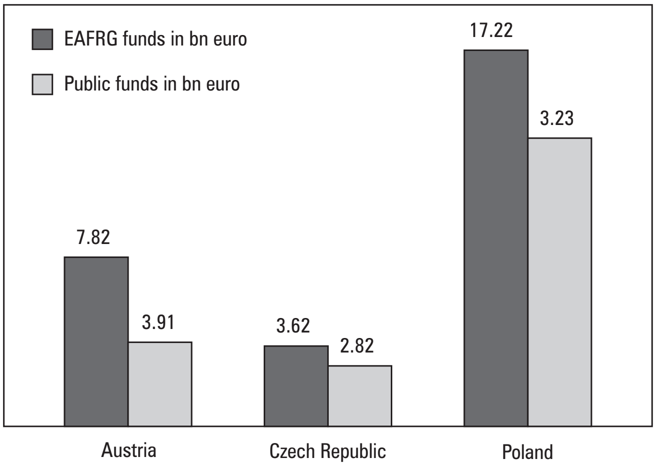
Each member state or region, participating in the RDP 2007–2013, is obligated to subdivide the funds for the development of rural areas into three thematic axes: Axis 1. Improving the competitiveness of the agricultural and forestry sector (economic axis), Axis 2. Improving the environment and the countryside (environmental axis), Axis 3. Quality of life in rural areas and diversification of the rural economy (social axis).

The fourth axis (the so-called LEADER axis) is of methodological character, and focuses on supporting individual rural development projects, implemented in order to solve particular local problems. It facilitates combining the three aforementioned objectives and fields – competitiveness, the natural environment and quality of life. In the framework of the LEADER axis, the local rural communities elaborate their local strategies for the rural development, with innovative projects, combining knowledge, skills, and resources of the representatives, are then implemented in real life. Public-private partnerships constitute the so-called local action groups. The support within the framework of the LEADER axis is also granted for the projects of trans-regional or international cooperation, which can be implemented by the local action groups. Thanks to such activities, the LEADER axis involves the local players in the decision making process, therefore reinforcing the sense of local community, where local players identify with European projects.[Council Regulation (EC) no. 1698/2005… 2005]

3.1. RDP financing in 2007–2013

Measures and activities conducted within the framework of the RDP are co-financed from the European Agricultural Fund for Rural Development (EAFRD) and the State budget. Poland has over 17 billion euro in total to distribute, where approximately 3 billion of the total sum are the commitments made on the basis of the Rural Development Plan of 2004–2006. EAFRD invested 13.23 billion euro in the development of rural areas in Poland – the largest amount of all UE–27 member states.

Comparison of the public funds granted for Poland, the Czech Republic and Austria for rural development is presented in the Figure 1 below.



Source: author's study based on Przegląd unijnych... 2010

Fig. 1. Total amounts of EAFRD funds and public funds for rural development between 2007–2013

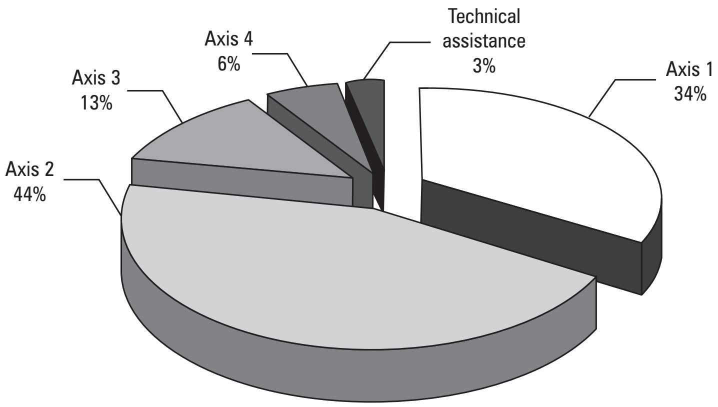
If we divide the whole amount allocated for the implementation of RDP 2007–2013 by square kilometres of rural areas and number of persons residing in these areas, the highest financial assistance is paid to the Austrians, and the lowest – to the Czechs. In Poland, the amount is approx. 1169 euro per person residing in rural areas, and 59.1 thousand euro per square kilometre of rural areas respectively. The figures are presented in Table 1.

Table 1. RDP 2007–2013 financing calculated per areas and population of rural areas

Country	Thousand euro per 1 km^2 of rural areas	Euro per person residing in rural areas
Poland	59.1	1169
Czech Republic	46.4	402
Austria	103.6	1194

Source: authors' study based on National Strategic Plan… 2007, Europa. How the EU…, Dudzińska 2013

The largest amount of EAFRD funds was allocated for the implementation of the economic axis (axis 2), and the smallest, for the social axis (axis 3) and the LEADER axis. Technical assistance will consume approximately 3% of all funds. Figure 2 presents percentage share of respective thematic axes in the total amount of EAFRD funds.



Source: authors' study based on Przegląd unijnych… 2010

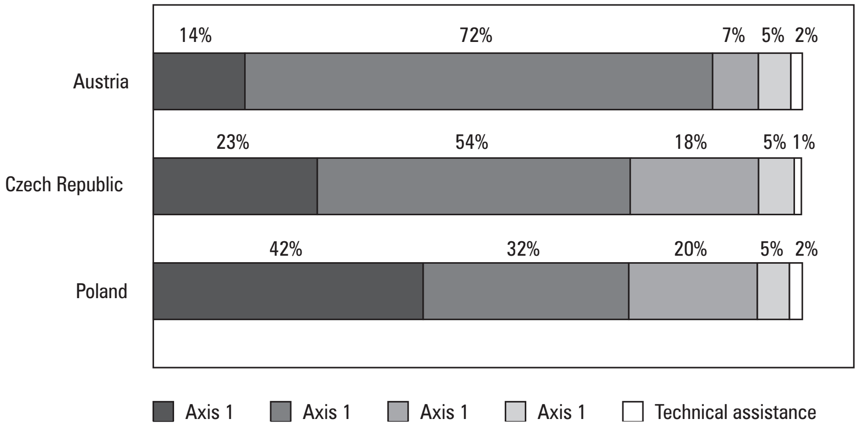
Fig. 2. Subdivision of EAFRD funds between respective thematic axes (without the national public funds)

By the force of the Council Regulation (EC) no 1698/2005, the institutions of the European Community imposed upon the member states an identical structure of the Rural Development Programmes for the years 2007 – 2013, consisting of three basic axes, and the fourth, additional LEADER axis. Minimal level of financing was planned for each of the axes. For axis 1 and 3 the minimum was set as 10% each, and for the axis 2, at least 25% of the European Community funds. These ranges are aimed to guarantee the creation of programmes, which correspond to the main tasks of the European agricultural policy, and at the same time, they are sufficiently low for each of the member states and regions to adjust the measures to their own needs. The minimum amount for the implementation of the LEADER axis was set as 5% (and 2.5% for new member states) of the total funding.

Similarly to the Community funding, the minimum percentage share was set also for the public funds in the implemented Rural Development Programmes, respectively:

a) for the implementation of the axis 1 measures – the minimum of 25%,
b) for the implementation of the axis 2 measures – the minimum of 20%,
c) for the implementation of the axis 3 measures – the minimum of 25%,
d) for the implementation of the axis 4 measures – the minimum of 20%.

Considering the total outlay of public funds (both from the particular states and the Community), it is envisaged that their largest portion will be spent for the implementation of the second, environmental axis. Across the whole European Community, the measures under axis 2 will consume 46.2% of the public funds, contracted for all the Rural Development Programmes. The next position in terms of public funds consumed falls to axis 1 (33.0%). Expenditures for the measures under axis 3 average at 12.0%, and for the LEADER axis, at 6.0% of all public funds directed towards RDP 2007–2013. The detailed planned subdivision of funds granted for the four axes of the RDP 2007–2013 in the selected countries is shown in Figure 3.



Source: authors' study based on Przegląd unijnych… 2010

Fig. 3. Subdivision of funds granted for the respective axes of RDP 2007–2013

We can note that Austria directs the largest amount of financial support to axis 2 – improvement of the natural environment and rural areas, which consumes as much as 72.3% of all resources of the RDP 2007–2013; also in the Czech Republic this axis is promoted and the share of 53.8% goes towards its financing. Only in Poland, the most substantial support is directed towards axis 1 – improved competitiveness of the agricultural and forestry sector.

The amount of Community funding for rural development, the subdivision of the funding for respective years, as well as the minimum amounts focused on the regions which qualify for convergence objectives – these are decided by the Council of the European Union. On the other hand, the European Commission watches over annual total allocations of community funds, including the EAFRD, not exceeding particular economic parameters. Each Rural Development Programme is set by the respective member state and consulted with the European Commission and appropriate agencies and entities, defined by the given member state by the force of national practices and regulations. Member states are obligated to submit the draft of each programme to the European Commission. The Commission verifies the correctness and compliance of the programme with the rulings of the Council Regulation (EC) no 1698/2005, strategic Community guidelines and the national strategic plan [Council Regulation (EC) no. 1698/2005 … 2005].

It is a particular task of each member state to assign the following for each Rural Development Programme: the managing authority, the accredited financing agency, and the certification body. The member state is also obligated to establish the monitoring committee, which shall ensure the correctness and efficiency of programme implementation. The managing authority (which can be national, regional, local; or a public-private organisation) of each programme has the obligation to submit annual reports of programme's implementation progress to the European Commission.

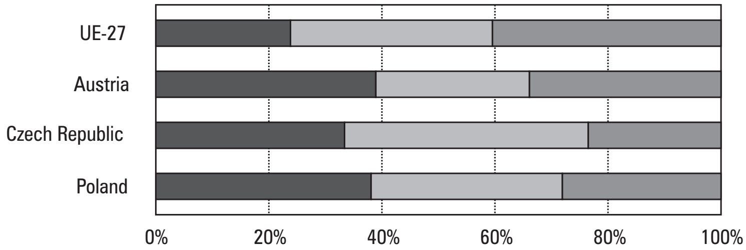
In order to improve the quality, efficiency, and effectiveness of the implementation of Rural Development Programmes, these are evaluated *ex-ante*, mid-term, and *ex-post*.

Financial assistance is granted to farmers, entrepreneurs, local self-government units, and forest owners. Beneficiaries may apply for co-financing from EAFRD funds via contact with the managing authority or the financing agency, or by checking the information on the current offers, calls for proposals, and financing guidelines on the Internet [Przegląd unijnych… 2010].

4. Comparative analysis of selected countries

In the analysed countries, the total area of rural land according to OECD typology is significant: in Austria, it exceeds 72% of the whole state territory, in Poland, 55%, and in the Czech Republic, 48%. Also in the Czech Republic, according to the same classification, we find the largest percentage of urban areas, namely 14.6%. In Poland, territorial structure, in terms of breakdown into the different types of areas (rural, urban, and mixed) resembles the European Union average.

Comparison between the different states in terms of the subdivision of areas according to the OECD typology has been presented in Figure 4.



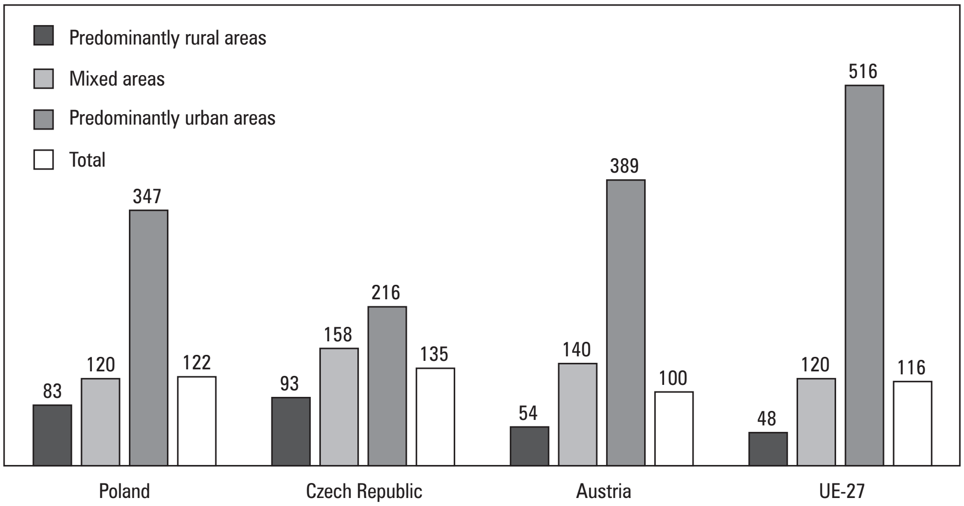
	Poland	Czech Republic	Austria	UE-27
Predominantly rural areas	38%	33%	39%	24%
Mixed areas	34%	43%	27%	36%
Predominantly urban areas	28%	23%	34%	41%

Source: authors' study based on Rural Development… 2011

Fig. 4. Territorial division of selected countries according to the OECD methodology (2008)

Austria has the highest share of population residing in rural areas, that is, above 72%. In Poland, this share is 55% – just like the EU average, and in the Czech Republic

– only 48%. On the other hand, population density in rural areas in the highest in the Czech Republic, reaching 92.7 persons · km^{-2}.



Source: Dudzińska 2013

Fig. 5. Population density in Poland, the Czech Republic, Austria and the EU-27 in 2008

When comparing the demographics in the rural areas of Poland, the Czech Republic, and Austria, we clearly see that the highest share of agricultural population, as well as of the working population employed in agriculture, is observed in Poland. In 2009, this share reached 15.2% for agricultural population and 7.9% for working population employed in agriculture. In Austria only between 2 and 3% of population are involved in agricultural production (Table 2).

Table 2. Agricultural population and the working population in agriculture in 2009

	Agricultural population		Working population in agriculture	
	Thousand	% of all population	Thousand	% of all population
UE	22 527	4.5	11 090	2.2
Austria	293	3.5	150	1.8
Czech Republic	666	6.4	336	3.2
Poland	5798	15.2	3036	7.9

Source: authors' study based on Rocznik Statystyczny Rolnictwa 2011

The share of agricultural farms with arable land below 5 ha is 68% in Poland and 50% in the Czech Republic. In Austria, there is the highest share of farms with the size of arable land between 5 and 20 ha (40%). The Table 5 below presents the subdivision of farms according to arable land size groups in the three analysed countries, and the European Union as a whole.

Table 3. Number of farms by area groups of agricultural land [in thousands] in 2009

	Total	Below 5 ha	5–20 ha	20–50 ha	Over 50 ha
UE	13 700	9645	2553	804	698
Austria	165	55.3	65.5	33.3	11.3
Czech Republic	39.4	19.8	8.5	4.5	6.6
Poland	2391	1637	629	101	23.6

Source: authors' study based on Rocznik Statystyczny Rolnictwa 2011

Table 4. The average farm size in 2007

	Average size of farm	Share of farms in particular classes (according to size)		
		< 5 ha	< = 5 < 50 ha	> = 50 ha
UE	12.6	70.4	24.5	5.1
Austria	19.3	33.5	59.7	6.8
Czech Republic	89.3	50.4	33.0	16.7
Poland	6.5	68.5	30.5	1.0

Source: authors' study based on Rural Development… 2011

In Poland, fragmentation is high, and size of agricultural farms is small. In 2007, average area of an agricultural farm amounted to 6.5 ha, which is far below the European average of 12.6 ha. In Austria, the average size was even greater than the EU average, that is, 19.3 ha. The Czech Republic very clearly takes the lead, with the average size of agricultural farms scoring 89.3 ha (Table 4).

Table 5. Average economic size of a farm in 2007

	Average economic size of an agricultural farm	Share of farms in different size classes		
		< 2 ESU	< = 2 < 100 ESU	> = 100 ESU
UE	12.6	70.4	24.5	5.1
Austria	16.7	29.4	68.7	1.9
Czech Republic	41.2	50.5	43.0	6.5
Poland	3.6	67.9	31.9	0.2

Source: authors study based on Rural Development… 2011

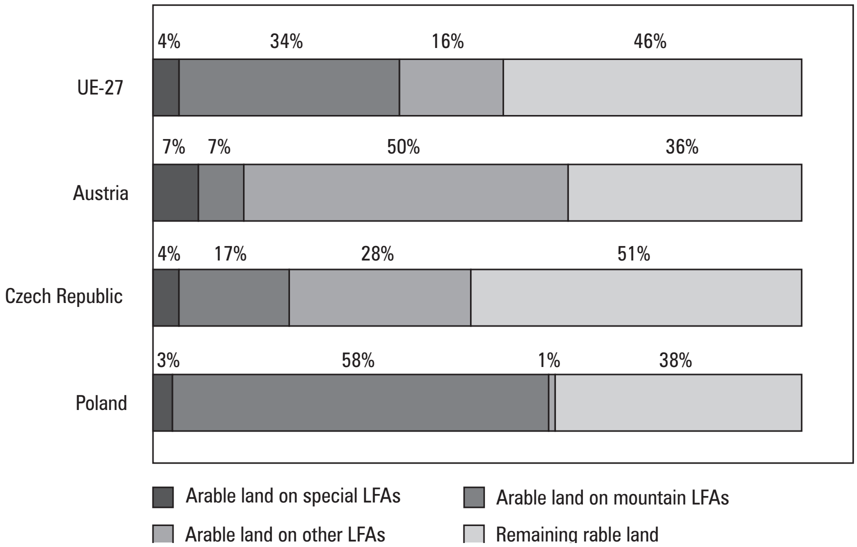
When comparing the average economic size of farms, the Czech Republic comes first with their average of 41.2 ESU (European Size Unit). In Austria, the value of this index is 16.7 ESU, and in Poland, it is lower than the European Union average (of 11.3 ESU), amounting to only 3.6 ESU.

In the category of ecological (organic) farming, Austria is at the forefront among the discussed countries. Austria's territory is four times smaller than Poland's, and yet it has almost 4 thousand more organic farms than Poland has, and over 150 thousand ha of arable land in those farms. Furthermore, out of the three discussed countries, Poland is the only one with the share of arable land in organic farms below the European Union average, which is 4.40% (Table 6) [Rocznik statystyczny rolnictwa 2011].

Table 6. Organic farming in 2009

	A number of organic farms	Size of arable land of the organic farms	
		[ha]	Total arable land [%]
UE	208 866	8 288 733	4.40
Austria	21 000	518 757	18.5
Czech Republic	2 665	398 407	9.38
Poland	17 092	367 062	2.37

Source: authors study based on Rocznik statystyczny rolnictwa 2011



Source: authors' study based on Rural Development… 2011

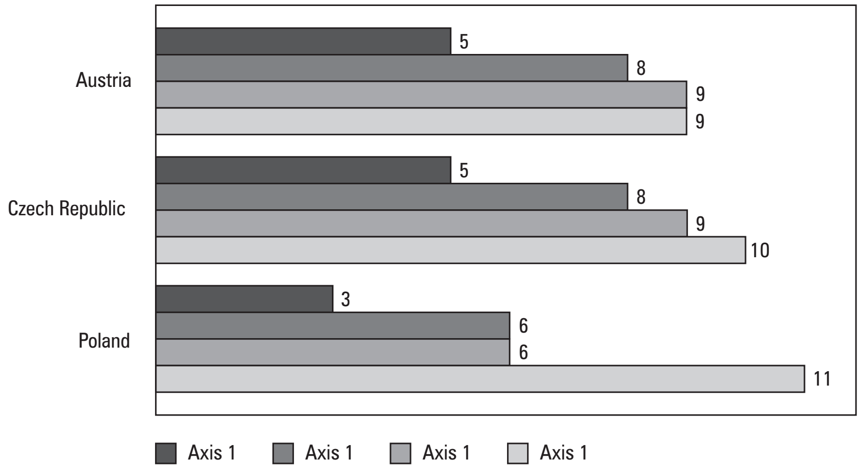
Fig. 6. Share of the area of LFAs in Poland, the Czech Republic, Austria and UE–27 (2005)

From the point of view of land use, and the measures undertaken within the framework of RDP 2007–2013, the so-called LFAs (Less Favoured Areas) are an important consideration. We find the highest share of favourable land in the Czech Republic (50.8%). Due to the specificity of the natural topography, the highest number of arable land on LFAs – both mountain areas and total – is found in Austria, and the lowest number – in the Czech Republic. The comparison of arable land areas in LFAs is included in Figure 6.

5. RDP 2007–2013 measures in Poland, the Czech Republic and Austria

Each state and region received an opportunity to structure their own programme, compliant with the general rural development policy guidelines of the European Union, but above all, also adjusted to their own particular needs. This opportunity is afforded through selecting particular measures co-financed by the European Community. In Table 7, particular measures were presented, as implemented within the RDP, and being the components of the four axes. The measures included in the national – Polish, Czech, and Austrian – Rural Development Programme for the years 2007–2013, were marked with an "x" in the last column. [Przegląd polityki... 2013, Wsparcie rolnictwa... 2013].

We immediately observe that RDP 2007–2013 contains 44 measures in total, including 18 measures within the framework of axis 1, 13 measures within axis 2, 8 measures within axis 3 and 5 measures within axis 4. Poland is implementing 26 of all measures, the Czech Republic – 32, and Austria – 31 measures. Each of the states uses also the technical support. The distribution of the quantity of measures implemented within each axis by the countries in question has been presented in Figure 7.



Source: authors' study

Fig. 7. Number of RDP 2007–2013 measures implemented in Poland, Czech Republic and Austria

Table 7. Listing of axes and measures of RDP 2007–2013, indicating which measures are implemented in the three selected member states

AXIS 1 Improving the competitiveness of the agricultural and forestry sector					
Thematic groups	**Code**	**Measures**	**Poland**	**Czech Republic**	**Austria**
Promoting knowledge and improving human potential	111	Vocational training and information actions	X	X	X
	112	Setting up of young farmers	X	X	X
	113	Early retirement	X	X	–
	114	Use of advisory services by farmers and forest owners	X	X	–
	115	Setting up of management, relief and advisory services	–	–	–
Restructuring and developing physical potential and promoting innovation	121	Modernisation of agricultural holdings	X	X	X
	122	Improvement of the economic value of forests	–	X	X
	123	Adding value to agricultural and forestry products	X	X	X
	124	Cooperation for development of new products, processes and technologies in the agriculture and food sector and in the forestry sector	–	X	X
	125	Infrastructure related to the development and adaptation of agriculture and forestry	X	X	X
	126	Restoring agricultural production potential after natural disasters and introducing preventive measures	X	–	–
Quality of agricultural production and products	131	Meeting standards based on Community legislation	–	–	–
	132	Participation of farmers in food quality schemes	X	–	X
	133	Information and promotion activities	X	–	X
Transitional measures	141	Semi-subsistence farming	–	–	–
	142	Producer groups	X	X	–
	143	Providing farm advisory and extension services	–	–	–
	144	Holdings undergoing restructuring due to a reform of a common market organization	–	–	–

AXIS 2 Improving the environment and the countryside					
Sustainable use of agricultural land	211	Natural handicap payments to farmers in mountain areas	X	X	X
	212	Payments to farmers in areas with handicaps, other than mountain areas (LFA)	X	X	X
	213	Natura 2000 payments and payments linked to Directive 2000/60/EC	–	X	X
	214	Agri-environment payments	X	X	X
	215	Animal welfare payments	–	–	X
	216	Non-productive investments	–	–	–
Sustainable use of forestry land	221	First afforestation of agricultural land	X	X	X
	222	First establishment of agro-forestry systems on agricultural land	–	–	–
	223	First afforestation of non-agricultural land	X	–	–
	224	Natura 2000 payments	–	X	X
	225	Forest-environment payments	–	X	X
	226	Restoring forestry potential and introducing prevention actions	X	X	X
	227	Non-productive investments	–	X	–
AXIS 3 The quality of life in rural areas and diversification of the rural economy					
Diversifying the rural economy	311	Diversification into non-agricultural activities	X	X	X
	312	Support for business creation and development	X	X	X
	313	Encouragement of tourism activities	X	X	X
	321	Basic services for the economy and rural population	X	X	X
	322	Village renewal and development	X	X	X
	323	Conservation and upgrading of the rural heritage	X	X	X
	331	Training and information	–	X	X
	341	Skills-acquisition and animation measure with a view to preparing and implementing a local development strategy	–	X	X

Table 7. cont.

AXIS 4 LEADER					
Implementing local development strategies	411	Competitiveness	–	X	X
	412	Environment/land management	–	X	X
	413	Implementing local development strategies	X	X	X
	421	Implementing cooperation projects	X	X	X
	431	Running the local action group, skills acquisition, animation	X	X	X

(X) – measure is implemented in the given country

(–) – measure is not implemented in the given country

Source: authors' study based on Przegląd polityki… 2013, Evaluierungsbericht 2010, Wsparcie rolnictwa… 2013, Průběžné hodnocení programu... 2010.

In the studied countries, the highest number of measures is implemented within the framework of axis 1, and the lowest, in axis 4 (the LEADER axis). The analysis has shown that the countries implement 19 measures in common. The highest number of common measures is found in axis 3, namely, 6 in total.

In the Czech Republic and Austria – the countries with a more favourable structure of rural areas – the number of common measures increases, amounting to as many as 28.

6. Conclusion

European Union is heavily diversified, as it brings together very different countries. A comparison of the same RDP 2007–2013 measures, implemented in different European states, demonstrates that the practical realisation of similar rural development issues is effected at the discretion of particular member states. General conditions and limits have been defined in the EU regulations, therefore they cannot differ between Poland, the Czech Republic and Austria. What differs, however, is the projects and investment tasks implemented within particular measures (for instance, environmental packages). Poland as a country, which has been benefiting from EU assistance for a relatively short time, received a large amount of financing – although, when calculated per inhabitant of rural area, the level of financial support is comparable to that in Austria, and when calculated per square kilometre, it is half of the Austrian figures. Among the analysed countries, the Czech Republic received the lowest amount of support, however, that country enjoys the best territorial structure. The states with better indices "portraying" the agricultural areas implement mostly axis 2 measures, while Poland implements mostly axis 1 measures, linked to the competitiveness of agricultural and forestry sector.

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DETERMINATION OF GEODETIC CONTROL NETWORK POINTS USING GPS TECHNOLOGY FOR THE PURPOSE OF MONITORING POWER LINES IN DIFFICULT TERRAIN CONDITIONS

Mateusz Jawor, Tadeusz Gargula

Summary

The present work discusses the issue of determining geodetic control network in order to monitor the condition of power lines. The problem was presented using the example of the physical survey of an actual infrastructure – a high voltage power line. Difficult terrain conditions constituted a significant factor for determining an appropriate measurement method. The measurement itself was conducted using two methods, independently of one another: the classical traverse method, and the RTK (Real Time Kinematic) GPS method. The following criteria were assumed for the purpose of the comparison: measurement effectiveness and the accuracy of the calculation result. Basic monitoring procedures of power lines were also presented, implemented based on the measurement network established beforehand.

Keywords

monitoring of power lines • control survey network • RTK GPS method

1. Introduction

In establishing a measurement matrix, it is increasingly common in the surveying practice to apply satellite technologies, which do not require the surveyor to locate the particular geodetic structures in the field [Góral et al. 2008, Lamparski 2003, Leick 2004]. The condition for the accuracy of measurement in this case is the availability of an appropriate number of satellites – and that condition is not always possible to meet. Satellite signals can be disrupted: by vegetation, buildings, landforms, etc. Therefore satellite technology cannot entirely replace the classical (ground) measurement techniques.

Furthermore, the overall development of technology in recent decades contributed to the improvement of measurement instruments, used in classical methods. Contemporary digital tachymeters facilitate the creation of wholly automated measurement and calculation technology: from reflector-less survey – via automatic registration of results – wireless transmission of data to a computer – to numerical elaboration (calibrating the observation and calculating the coordinates). Survey stations (Total Stations) are moreover equipped with software, which conducts the calculations directly on the spot, facilitating the delivery of complete coordinates for the determined control points.

The aim of the present work is to conduct a comparative analysis of the GPS technology versus the classical traverse method for establishing a measurement network in unfavourable terrain conditions. Two criteria were assumed for the purpose of the comparison: the accuracy of the calculation result, and measurement effectiveness. The characteristic features of the measured object consisted in varied terrain and prevalence of forest. The determined control network facilitated geodesic control measurements of high voltage power lines 110 kV [Jawor 2009]. In order to verify the accuracy of the measurement effected in the GPS technology, closed traverse was designed using the same control points. The objective was to demonstrate which of the methods is most suitable in difficult terrain conditions.

2. Principles of designing measurement networks

The first stage of establishing a measurement network is to develop a design thereof, after which follows the stabilisation of points, measurement, calculation, and elaboration of measurement results, completion of the report, and delivering the latter to the client. The purpose of designing and establishing geodesic networks in a given area is to ensure the required coverage of the land with a network of the appropriate class of accuracy, and to guarantee a determinate density of control points. The design must be preceded with a reconnaissance of the existing range of the newly designed network, terrain conditions, the general concept of the State network, as well as current and predicted future needs in terms of equipping the given area with a geodesic network. One must also select the most appropriate and useful structure of the network and the measurement technique, which facilitates as accurate designations as it is feasible, with the lowest possible costs of the project's implementation [Regulation… 2011, GUGiK 2002].

One of the stages of a properly conducted network designing process should consist in a prior accuracy analysis [Kadaj 2006]. Results of the said analysis provide foundations for the assessment of the network design, its correctness, and possible modifications to the structure or correction to the accuracy of measurement, assumed a priori. This task can be performed, for instance by using one of the calculation modules of the Geonet software [Kadaj 2006]. After entering the command in the main dialogue window: Geo-spec/ Initial analysis of horizontal network, a new window opens for the studied network (Figure 1).

The software does not require entering real observation measures; one only needs to declare observation plans, and approximate coordinates. This analysis makes it possible to determine the target model of network accuracy, which the results of the adjustment should aim towards. Initial accuracy analysis programme utilises the same data sets, identical in name and structure, as the rigorous adjustment programme. Declared observation measures can be expressed with any nonnegative number, for instance: instead of length measures, angles, directions and azimuths, zero can be entered.

Record structures should be identical as in the case of data collated for network adjustment. If the following conditions are met, then the network we prepare for adjustment (or one that is already adjusted) can be subjected to the initial accuracy analysis in the same data folder, based on the same data.

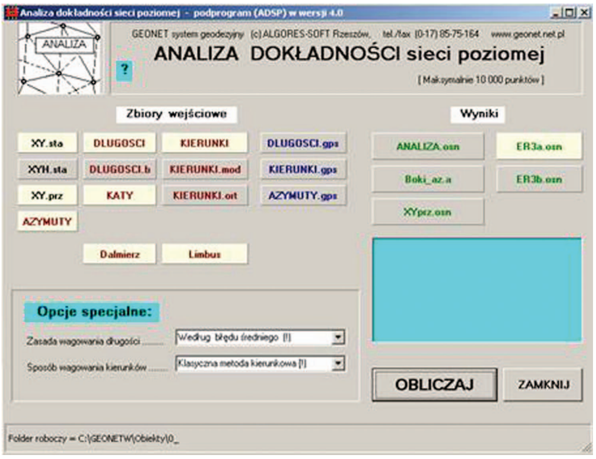

Fig. 1. Dialogue window of the Geonet software: "Initial analysis of horizontal network"

When designing area measurement using GPS technology, we should consider not only the target accuracy of point coordinates, but also a manner of relating to the frame of reference, measurement method, type of data transmission, types of receivers, and the method of data preparation from satellite observations. At present, a commonly used solution is linking the measurement data to the reference points of the ASG-EUPOS system [Bosy et al. 2008]. General determinants for using calculation services of the aforementioned system are shown in Table 1.

Table 1. Accuracy of GPS measurement in the ASG-EUPOS system

Type	Name	Method of measurement	Data transmission	Assumed accuracy	Minimum hardware requirements
Real time services	NAWGEO	kinematic (RTK)	Internet, GSM (GPRS)	Up to 0.03 m (horizontal) Up to 0.05 m (vertical)	L1/L2 RTK receiver, communication module
	KODGIS	kinematic (DGPS)		Up to 0.25 m	L1 DGPS receiver, communication module
	NAWGIS			Up to 3 m	
Post-processing services	POZGEO	static, rapid-static	Internet	Depending on measurement conditions (0.01–0.10 m)	L1 receiver
	POZGEO D	Static, kinematic			

3. Geodesic control of power lines

Control measurements of power lines, as in the case of any other infrastructure object, are aimed at determining any discrepancies between the setting out survey of the infrastructure, and the as-built survey. The results should be shown in working drafts and survey logs kept during the measurement process. All data is then collated in the acceptance protocol and handover inspection report. In the case of discrepancies with the state of construction, all differences should be approved by the designer, by the construction inspector, and by the user of the infrastructure. The list of the differences and their approval is entered in the handover inspection protocol. Resultant modifications should also be shown in the project documentation, with a note of control survey measurements conducted, and confirming that the users of infrastructure have been duly informed.

When surveying power lines, depending on the client's requirements, the following elements are taken into consideration [Migas 2000]:

- placement of the transmission towers in land lots (parcels of record),
- settings of electrical power appliances,
- length of the section, spans, insulation,
- height of the transmission towers,
- sag of live wires and arrester wires,
- any crossover with other power cables or telecommunications cables,
- height of trees, shrubbery, and buildings in the immediate vicinity of the power lines.

Land survey and height maps are prepared for the area within 30 m to 120 m from the axis of the towers (depending on the voltage of the given power line), coupled with longitudinal profiles of the cable route.

For the control measurement of cable sags, trigonometric correlations of the measured vertical angles and length measured at ground level are used. Based on the conducted measurements, spatial coordinates are calculated for the points of tower bases, points of cable suspension, and points of the maximum sag [Migas 2000].

Before measuring the sag, firstly centre point of the span must be determined, whereby we shall calculate the sag and the perpendicular line. Afterwards, from the centre point of P we shall calculate the vertical angles α, β and calculate the heights (elevations) of h_1 and h_2 (Figure 2) from the relationship:

$$\tan\alpha = \frac{h_1}{a}, \quad \tan\beta = \frac{h_2}{a} \tag{1}$$

The heights of cable suspension and A and B are derived from a simple principle of trigonometric levelling:

$$H_A = H_P + i + h_1, \qquad H_B = H_P + i + h_2 \tag{2}$$

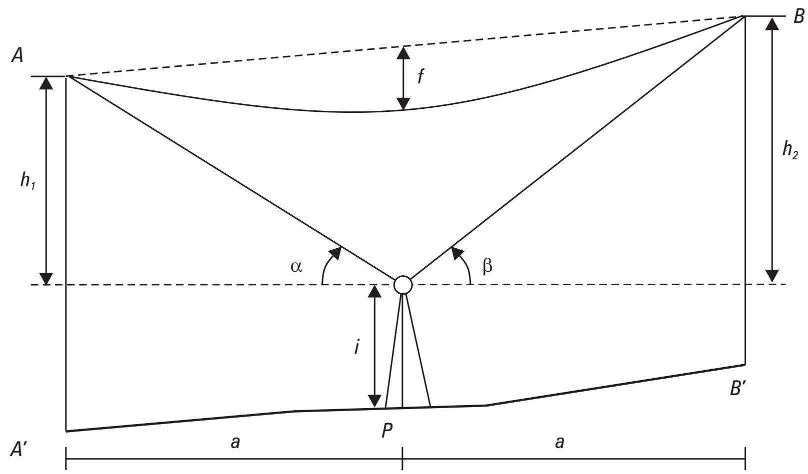

Fig. 2. Measurement of vertical angles for sag control

The height of base points of the towers *A'* and *B'* are also set using the method of trigonometric levelling, using the following formulas (Figure 3):

$$h_A = a \cdot \tan\alpha_1, \quad h_B = a \cdot \tan\alpha_2 \tag{3}$$

$$H_{A'} = H_P + i + h_A - l, \quad H_{B'} = H_P + i + h_B - l \tag{4}$$

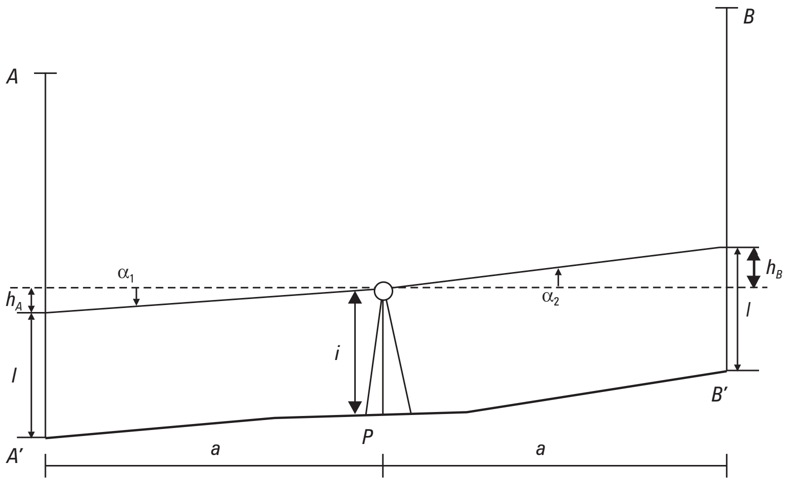

Fig. 3. Measurement of height differences in tower bases

Relative heights of h_A, h_B (3) may take either the positive or the negative sign (depending on the sign of the vertical angle α_1, α_2). The symbol l in Figure 3 and formula (4) denotes a certain, arbitrarily chosen, reading of the patch (for instance, l = 1.5 m).

Terrain conditions allowing, the heights of points of *A'* and *B'* can also be determined using geometric levelling.

The next step consists in tracing, from point *P*, a line perpendicular to the span, and thus determining point *P'*. On the line of *PP'*, starting from point *P*, we measure the value of *X* (horizontal distance of cable suspension to the centre of the span), arriving thus at the measurement point of the sag *P"* (Figure 4). The height of point *P'* is determined likewise, same as points *A'*, *B'*, *P*, using trigonometric relations or geometric levelling.

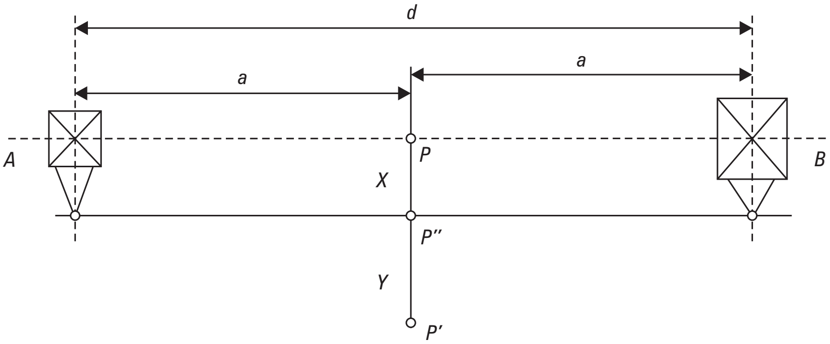

Fig. 4. Determining the point of sag measurement

We place the instrument in point *P'* and we measure the vertical angles to the cables in the vertical place of point *P"* of the cables. We derive the height of the sag from the relationship (see Figure 5):

$$H_C = H'_P + i + Y \cdot \tan\delta \tag{5}$$

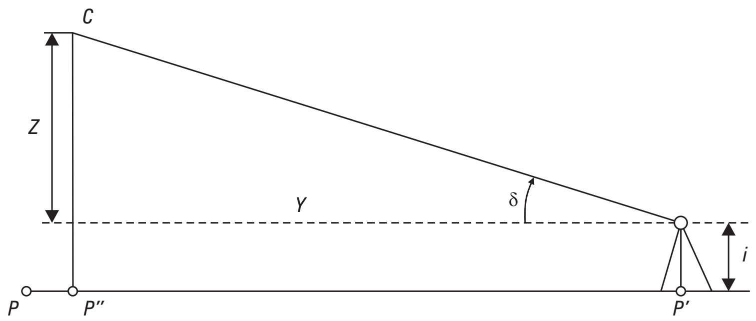

Fig. 5. Measurement of vertical angles for the control survey of cable sags

Based on the measurement method shown above, we arrive at a set of spatial coordinates of points, determining the cable sag:

- span length „*d*" from direct measurement,

- height of cable suspension *A'*, *B'* on the towers,
- height of tower bases *A*, *B*,
- height of cable sag *C*,
- height of measurement point for cable sag *P"*.

We calculate the value of the sag arrow from the following formula:

$$f = 0{,}5(H_A + H_B) - H_C \tag{6}$$

The measurement of the arrow of cable sag should be conducted twice, having additionally determined points *P'* and *P"*. The result is the mean value of both measurements. Measurements of distance, necessary for determining the sags, should be conducted using the rangefinder, which ensures the accuracy down to ±1 cm. At present, sag control is performed using available reflector-less tachymeters.

While measuring the cable sag, the temperature of the cable should be taken. As contact with the cables is not possible (they are suspended at considerable height, and they are live power wires), measurements should be conducted on a cloudy day, which shall prevent excessive cable overheating. Also wind conditions are important, as wind causes the cable to incline. Even on windless days, movement of air causes the cables to sway, therefore when measuring the vertical angle, one should make sure that the crosshairs touch the cable at the lowest possible viewpoint of the scope.

The above description of the procedures for power line control was presented in order to demonstrate the role, played in this process by the measurement stations (points of the control network).

4. Practical example

In the present work, we have used some of the observational data from a comprehensive survey, aimed at preparing a land survey and height map in the scale of 1 : 1000 (Figure 6), including the elaboration of profiles under the high voltage power line of 110 kV, up to 30 m from the axis of towers, in the area of three districts (poviats): Lesko, Sanok and Przemyśl – at the length of 79 km [Jawor 2009]. A sample fragment of the map, shown in Figure 6, illustrates the degree of difficulty of terrain conditions in the context of conducting geological surveying; the ordinates show the differences in height.

As a result of reconnaissance in the field, 4 points of detailed control network of class II and III were determined, and used as tie points for establishing the measurement network (Table 2; according to the wish of the client, the coordinates were collated in the "1965" format).

The next step was to design a classical measurement network (Figure 7). For the purpose of a comparison (with the GPS method), a 4-kilometer section of the Sanok poviat, Tyrawa Wołowska municipality, Rozpucie area was selected. It is a hilly area, with elevations up to approx. 100 m – therefore there are often limitations to views and aiming directions. Most spans are located within woodland areas, where clearance was conducted to ensure a safe distance between the cables and the trees.

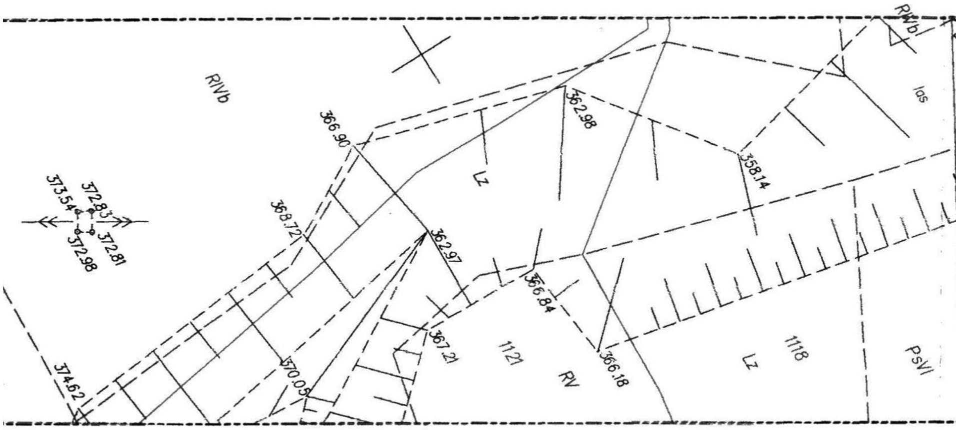

Fig. 6. A sample fragment of a land survey and height map of the area, for the purpose of power line control

Table 2. Collated coordinates of base and detailed control network ("1965" format)

Point number	Network class	X	Y
450	II	5354949.430	4731584.650
451	II	5354419.840	4732988.250
457	II	5351156.330	4731216.000
1074	III	5350907.550	4731231.980

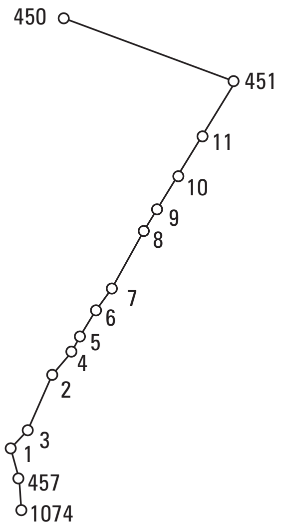

Fig. 7. Draft of measurement network points' placement

In the selected area, there are 11 high voltage transmission towers. Considering the requirement that for each span, there should be at least one measurement point, from which measurement of the situation and cable sags will be made [Migas 2000], 11 points have been designated. Measurement points have been designed in the previously marked locations, designated beforehand using GPS receivers. All points constitute a closed traverse.

As detailed control points were considerably far from each other, the length of the designed traverse exceed the permissible value (4.5 km [Regulation… 2011]) and amounted to approx. 6.533 km, with an average length of side at approx. 0.466 km. As the terrain is hilly, in some cases the designed sides of the network are larger than 600 m.

The established network was measured using the classical method (angles and horizontal distances) and using the GPS method. The measurement at points of the control network and traverse (detailed) network was effected using kinematic method in time intervals of 60 seconds, applying the NAWGEO service of the ASG-EUPOS system. For each designated point, the receiver registered signals from at least four satellites.

For the measurement of control network, the following surveying instruments were used:

- Tachymeter of the Total station type: Leica TCR 407 ultra,
- GPS receivers L1/L2 RTK VRS: Trimble 5800 and Trimble TSC2 controller.

Trimble 5800 GPS receiver combines a two-frequency GPS receiver, an antenna, a UHF radio and a power source (all in one unit). This facilitates the control of measurements without the use of cables – thanks to using short-range wireless technology (Bluetooth). The receiver may be used in many different ways – it can be set up as a portable receiver or a base station, whereby the instrument performs in changeable conditions of operation. The Bluetooth module is compatible with mobile telephone networks, which facilitates complete RTK measurements.

Trimble 5800 receiver, in collaboration with the ASG EUPOS system, uses the real time service – thanks to the principle of RTK differential positioning [Lamparski 2001] performed based on reference stations. Receivers which conduct field measurements communicate with the computing centre in order to obtain observational adjustments. The whole data exchange process happens in real time, via the GPRS Internet connection, therefore the user obtains the results directly in the field.

Results of the adjustment of traverse deviations performed using the Geonet software have been collated in Table 3. The mean error for the measurement of the angle and the distance is assumed at: 30^{cc} and 0.01 m respectively. The adjustment procedure is based on a known method of least squares. [Ghilani 2010, Wiśniewski 2005].

Resulting from the calculations, we obtained the mean error for the point location at $m_p = \pm 0{,}033$ m. The points which are most encumbered with error ($\pm 0.054 \div 0.058$ m) are those in the middle of the sequence (points 6, 7, 8).

Based on the GPS measurement, coordinates of control points were calculated in the coordinate system 2000/21 [Regulation… 2000], and then based on previously determined points of the traverse network (Table 2), affine transformation was conducted to the 1965 format in zone 1 (Table 4) [Kadaj 2000].

Table 3. Adjustment of the survey network using the classical method ("1965" format)

Point number	X	Y	m_x	m_y	m_p
1	5351398.239	4731152.241	0.016	0.010	0.019
2	5352013.415	4731492.803	0.026	0.038	0.046
3	5351556.051	4731291.085	0.026	0.029	0.039
4	5352211.133	4731646.989	0.028	0.040	0.049
5	5352334.169	4731719.613	0.031	0.044	0.054
6	5352526.992	4731841.413	0.033	0.046	0.057
7	5352726.688	4731983.328	0.034	0.047	0.058
8	5353198.272	4732245.779	0.033	0.043	0.054
9	5353371.001	4732355.921	0.031	0.040	0.050
10	5353650.740	4732534.580	0.026	0.032	0.041
11	5353975.342	4732732.032	0.018	0.020	0.027

Table 4. Coordinates of the measurement network using the GPS method ("1965" format)

Point no.	X	Y	dx	dy	dL
1	5351398.238	4731152.238	0.001	0.003	0.003
2	5352013.433	4731492.804	–0.018	–0.001	0.018
3	5351556.050	4731291.080	0.001	0.005	0.005
4	5352211.150	4731646.990	–0.017	–0.001	0.017
5	5352334.180	4731719.610	–0.011	0.003	0.011
6	5352526.999	4731841.408	–0.007	0.005	0.009
7	5352726.691	4731983.322	–0.003	0.006	0.007
8	5353198.278	4732245.776	–0.006	0,003	0.007
9	5353371.002	4732355.917	–0.001	0.004	0.004
10	5353650.739	4732534.577	0.001	0.003	0.003
11	5353975.340	4732732.030	0.002	0.002	0.003

In the presentation of results (in Table 4) deviations of coordinates were also listed (dx, dy) as well as line deviation (dL) compared to the results from the classical measurement method (Table 3). We immediately observe that the differences are only slight; the maximum line deviation does not exceed 2 cm (for points 2 and 4). As these values are far below the location errors in the classical method (which ranged around ± 5 cm, compare Table 3), we can conclude that the GPS method is sufficient for obtaining the desired accuracy.

5. Conclusions

In the present work, we discussed the role of geodetic control network, established for the purpose of monitoring the location of power lines. The task constitutes a particular application of survey measurements. Appropriate control (for instance, determining span length or cable sag) requires a correct design and establishing a measurement network. We have noted the aspect of accuracy of situational location of points, based on the RTK GPS method. For the analysis, we have used a certain subset of data for a real-life object (high voltage power line at the distance of 79 km). For comparative purposes, classical situational survey of the network was conducted, using the Total Station type instrument.

For GPS measurements, modern receivers (Trimble 5800) were used as well as options offered by the ASG-EUPOS system of reference stations, coupled with the NAWGEO service.

Particularity of the task consisted – among other things – in selecting the optimal measurement method for difficult terrain conditions. In this context, the RTK GPS method turned out to be decidedly more comfortable and more efficient, and the results it rendered were not substantially different (in terms of accuracy) from those rendered by the classical method. In the case of difficulties in obtaining the proper exposure of the measurement station to satellite signals (for instance, in a woodland area), we propose that the GPS measurement be supplemented with classical methods. Of course, the best solution would be to apply an integrated measurement method (both classical and GPS). That, however, would require an appropriate preparation of observations at the stage of numerical analysis of results (consisting in bringing different types of observation down to one mathematical model [Gargula 2009]). This latter issue will be the topic for further studies into geodetic control methods of power lines.

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FINANCIAL IMPACT OF ADOPTING LOCAL SPATIAL DEVELOPMENT PLANS

Joanna Gil-Mastalerczyk

Summary

Under the Law on Spatial Planning and Development of 27 March 2003, many municipalities and cities in Poland are obligated to draw up a zoning plan – one of the main instruments (in addition to the budget, local development program of a territorial unit, and the feasibility study) for the implementation of local economic policy. This situation exposes local government units to considerable financial implications associated with the adoption of the plan and its consequences.
In the current formal and legal reality, urbanization and space management generate huge costs, resulting in negative financial results.
Failing to prepare the local plan can protect municipal budget from those costs, on the other hand, as a consequence the lack of such plan prevents rational implementation of spatial planning. This can lead to investment activities conducted under random, uncoordinated decisions, and even to urban chaos.
The article makes an attempt to analyze this problem, presented on the basis of pertinent laws, and insights arising from the direct experience of the author – as a practitioner who handles the contents of local development plans daily.

Keywords

spatial development (zoning) plan • spatial planning • financial effects of the plans • claims for damages

1. Introduction

In the light of the present laws and regulations, in Poland, local spatial development plans (zoning plans, which establish the designation of areas, manner of their development, respective functions, and construction development) are the basic tools of the municipality's planning policy. Therefore the adoption of the local plan becomes the basic condition for the rational spatial planning at the local level.

Under the Law on Spatial Planning and Development of 27 March 2003 [Ustawa… 2003], which – among other things – has declared null and void all the planning documents adopted before 1995, many municipalities and cities in Poland are obligated to draw up a zoning plan[1]. According to many experts, consultants, and specialists active in the real estate market, this situation burdens municipalities and towns with serious financial implications resulting from the adoption of the plan and its consequences. In the current formal and legal reality, urbanization and space management generate huge costs, often resulting in negative financial results. The cost of preparing planning documents is a factor detrimental to municipal planning. Therefore failing to prepare the local plan might protect municipal budget from those costs – but on the other hand, as a consequence the lack of such plan prevents proper control over the development and the spatial planning[2], as well as it precludes the possibility of obtaining financial resources from zoning change fees, betterment levies, and real estate taxes. As a result, this would prevent rational spatial planning, and the proper economic development of any municipality. Therefore the principle of balancing the particular and the public interests becomes of chief importance.

Errors in spatial planning are usually irreversible, while faulty management of urban or communal spaces generates irrevocable losses. The vast scale of the problem in question touches both upon legal regulations, and the proper spatial policy of the country, the regions and the municipalities. The legal and financial impact of the adopted spatial plans, in addition to the units of territorial government, concerns also the owners, perpetual lessees, and buyers of property encompassed by the plan, or by the given planning or zoning change. The costs borne by the municipalities and towns vary in range and in character. Depending on legal provisions, pertinent regulations, and the development of a given investment process, they are revealed at different times and in different sizes, so to speak.

Planning activities at the municipal level – that is, at the level of developing and adopting a study of conditions and directions of spatial planning and management,

[1] Universal obligation of adopting a spatial development plan – under the Law of Health Resorts and Spas, Resort Areas and Municipalities of 28 July 2005 [Ustawa… 2005], concerns municipalities, which possess in their area a potential for health resort activity in the so-called "A" health resort zone.

[2] Article 2, paragraph 1 of the Law on Spatial Planning and Development – spatial order – should be understood as such spatial organisation which creates a harmonious whole, and takes into account, in ordered relationships, any conditions and requirements: functional, social and economic, environmental, cultural, compositional and aesthetic; "[…] spatial order is a multi-aspect concept, which concerns not only aesthetic issues but also combines those with social and economic, environmental and cultural aspects. […] In the social aspect, the introduced changes […] reduced bureaucracy of procedures, and served to decrease administrative costs of the developed plans (by cancelling the obligation to send personalised notification letters) and limited the legal rights of real estate owners to benefit the communal interests. Replacing the veto and the plea with the comment (2003) increased the freedom in making planning decisions, and particularly in developing local plans. […] Designers as well as local self-government authorities acquired possibilities of shaping the space, especially in its functional aspect (that of communication and transportation) but also in terms of urban planning, zoning and architecture, while taking into account the collective interest of inhabitants. In addition to decision-making powers grounded in procedures, as well as powers resulting from the property law, the changes made to legal acts and regulations are leading towards improved spatial standards in the aspect of urban parameters" [Zastawnik 2013, 19–20].

planning decisions for public utility purposes – are seen as constructing the framework, in which our lives ensue. A municipality, as a unit of local self-government administration, must abide with regulations of pertinent legal acts, while spatial management should be based upon the model of success [Heczko-Hyłowa 2001].

2. Legal bases and resulting financial implications for municipal budgets following the adoption of spatial development plan

2.1. Municipal responsibilities (financial costs resulting from shaping and conducting spatial policy)

In article 7 of the Law on Municipal Self-government of 8 March 1990 [Ustawa... 1990], the following municipal tasks have been defined.

"Art. 7.1. Meeting the collective needs of the community lies within the municipal tasks and responsibilities. In particular, the tasks and responsibilities of the municipality include the following matters:

1) spatial order, real estate management, environmental and natural protection, and water management,
2) municipal roads, streets, bridges, squares, and organisation of road traffic,
3) waterworks and water supply, sewage system, sewage removal and treatment, maintaining cleanliness and order as well as sanitation, rubbish dumps, waste disposal and utilisation, power and heating supply and gas supply".

Spatial planning is listed among the tasks of the given municipality, and it is financed from the own funds of the self-government unit, within municipal budget[3] [Zastawnik 2013].

The Law on Spatial Planning and Development of 27 March 2003 leaves no doubt as to the fact that the "municipal spatial plan is a local planning act" (article 14, paragraph 8). According to article 3, paragraph 1 of the law:

"Article 3.1. Shaping and conducting spatial policy within the area of the municipality, including the adoption of the study of conditions and directions of municipal spatial planning and management as well as local spatial development plans, excluding

[3] The level of prices of planning studies, resulting from the analysis of tender procedures over the recent years:
- the change of spatial development study for the whole area of the municipality – generates costs in the amount of between several tens of thousand to over a hundred thousand Polish złoty;
- development of the zoning scheme (local development plan) for an area of several to under twenty thousand hectares – generates the cost of between ten and twenty thousand Polish złoty. The cost of the local development plan (zoning scheme) for the whole municipality by far exceeds a hundred thousand Polish złoty (the exact cost depends on the area and the price standards of the given design studio, which presents the offer for tender procedure);
- spatial policy based on WZ (planning decisions) – issuing several tens of decisions over the period of one year may cost the municipality between ten and twenty thousand Polish złoty; when hundreds of decisions are issued, the financial load increases to tens of thousand Polish złoty [Zastawnik 2013, 97].

inner coastal waters, territorial waters, exclusive economic zone (finishing zone) and enclosures, lies within the tasks and responsibilities of the given municipality".

Article 4 of the quoted act of the law directs as follows:

"Art. 4.1. Defining the function (designation) of the given area (zoning plan), placement of the public utility investment projects, and defining ways of and conditions for land development and construction are all included in the local spatial development plan".

Being the basic unit and entity within the structure of the local self-government administration, municipalities have at their disposal the planning power, and they can create local land development plans independently – that is, they can decide the designation and principles of spatial planning[4]. Spatial development plan is regulative in its character, therefore it is a form of a municipal law act, which shapes the content of the real estate ownership law[5] [Niewiadomski et al. 2009].

Planning documents, which are obligatory to prepare according to the quoted Law on Spatial Planning and Development include:

- Study of conditions and guidelines for spatial development, which can be modified in the situation of modified conditions and/or in connection with the need for changes in the directions that the municipal spatial planning should take. Due to budgetary constraints, many municipalities postpone the modification of their studies, or when necessary, they initiate only a partial change thereto.
- Spatial development plan – elaborated for the whole area of the municipality or for selected areas, according to municipal funds availability, with possible distribution of costs over several years.
- Planning and construction decisions (location decisions and planning permissions)[6] – ULI and WZ[7].

[4] Only the municipal planning decisions are binding, and they are decisive for the owners and perpetual lessees. No other unit of territorial self-government has such powers (neither does the State administration) [Niewiadomski 2002].

[5] According to article 6, paragraph 1 of the Law on Spatial Planning and Development – "the provisions of the local spatial development plan, along with tat of other regulations, impact the execution of the real estate ownership rights".

[6] ULI – location decisions pertaining to public utility investment projects (decision on the site location of a public-purpose line-investment project), WZ – decisions on the construction conditions (planning permissions, which define the function of the permissible developments in the area and conditions for the construction and investment projects therein), according to article 4, paragraph 2 of the Law on Spatial Planning and Development.

[7] "In the situation of filling in or additions to the existing developments in the area, WZ decisions (planning permissions) provide a format for fast and effective administrative processing of an investment project. With a large number of applications for WZ decisions (planning permissions), the financial load for the municipality greatly increases. It is not possible to deny the planning decision due to the lack of funds in the municipal budget – therefore municipality must possess such funds. In the case of spending large amounts on procedures and decisions to issue planning permissions, other planning initiatives may effectively become impeded or delayed, including the making available of new areas for economic activity, which as a result curtails the economic growth in the given municipality" [Zastawnik 2013, p. 97].

2.2. The planning process (costs for the municipality, without the profits)

The process of spatial development planning on municipal level is of a nature of a local law passed by the appropriate organ of municipal authority, however other public administration bodies (on the national and regional level) also play an important role in the process. As such, the system of spatial planning is mutually complementary.[8]

In practice, the planning process on municipal level – based on the existing legislation – generates enormous costs for territorial self-government units, while not bringing them any profits in return. Therefore the cost of planning studies and documents often becomes a factor, which is detrimental to municipal planning.

Financial burden linked to the handling of the planning process concern the following: the development of the study of conditions, spatial development (zoning) plan, and preparing cost estimates for compensation payments and real estate purchase or buy-out.

The adopted local plan "may be treated as a special case of a public promise", which, when not fulfilled, may give grounds to the complaint against the municipal authorities and to accusing them of inaction, and it may even "give rise to financial claims, if the complainant is able to demonstrate that he suffered financial losses as a result" [Jakóbiec 2013, 1–19].

2.2.1. Prognosis of financial result (economic aspects of the spatial planning process)

Based on article 17, paragraph 5 of the Law on Spatial Planning and Development, the lawmakers place the municipality (the village mayor or the town mayor – after the municipal council passes the decision on preparing the local development plan) under the obligation to elaborate the projection of financial impact resulting from the adoption of the local development plan (while taking into account article 36 of the aforementioned act of law) – in addition to the projected environmental impact study and taking into account the provisions of the study of conditions and directions (guidelines) for spatial development. The projection is an obligatory document, and it must be prepared during the elaboration of a draft spatial development plan or a modification thereof – as the responsible authority, which is creating the local development plan must know the consequences of the adoption of such a plan, already at the time of its passing. Based on the projection, it is still possible to verify the originally envisaged tasks. The purpose of the projection is to analyse and to determine the results of the provisions included in the plan, in terms of how realistic they are, and what is their economic effectiveness[9]. The

[8] Article 46 of the Law on Spatial Planning and Development – the Ministry proper for the issues pertaining to local development: 1) coordinates the compliance of the spatial development plans of the voivodeships (regions) with the concept of the spatial development of the country as a whole; 2) coordinates trans-border and cross-border cooperation in terms of planning and spatial development.

[9] Projection of financial implications is developed at the working stage of the draft plan, that is, before applying for opinions and compliance statements of the draft plan, and before presenting it for public consultation – so that there is an opportunity to verify the proposed solutions at that stage, and therefore limit the costs of spatial planning.

projection should take into account the costs and the benefits – both direct and indirect – as well as the balance between costs and benefits. In a situation where the sum of benefits exceeds the sum of costs, it can be assumed that the plan will be beneficial to the development of the municipality – and therefore it will serve its development well. In the contrary situation, the adopted plan in a longer time perspective may lead to a bad financial standing of the municipality, and in extreme cases even to its insolvency [Jakóbiec 2013].

According to the secondary legislation of the Regulation by the Minister of Infrastructure dated 26 August 2003 on the required range and content of the municipal spatial development plan [Rozporządzenie… 2002]:

"§ 11. Projection of financial implications of adopting the local spatial development and management plan should include, in particular:

1) Projection of the impact, which the provisions of the local spatial development plan shall have upon the income and the costs of the municipality, including the revenue from real estate taxes and other revenues pertaining to real estate transactions within the municipality as well as disbursements and compensation payments listed in article 36 of the Law;
2) Projection of the impact, which the provisions of the local spatial development plan shall have upon the expenditures pertaining to the implementation of technical infrastructure investment projects, which remain within the responsibilities of the municipality;
3) Conclusions and recommendations concerning the adoption of proposed solutions in the draft local development plan, resulting from taking into consideration their financial implications".

2.3. Financial impact on the municipal budgets as a result of adopting the local development plan

Financial implications of conducting spatial policy by the agencies of territorial self-government[10] can be subdivided into two categories, namely:

1. Direct expenditures pertaining to the preparation of the plan or its modification

[10] According to E. Czekiel-Świtalska, financial impact of the adoption or modification of the local spatial development plan may be described with the following formula: "B = Kp + Pn ± O ± Rp, where: B – the change in municipal budget caused by the adoption or the modification of the plan, Kp – costs pertaining to the preparation of the plan, Pn – the difference in real estate taxes (revenues from the tax before the adoption of the plan minus the value of the tax charged after the adoption or the modification of the plan), O – profit or loss resulting from article 36. of the Law on Spatial Planning and Development, Rp – costs and revenues linked to the implementation of the provisions of the plan or its modification over a particular period of time (for instance, within 5 years); this value is expressed with a formula as needed, for instance: Rp = ± Po ± S – I + A, where: Po – personal income tax, S – the difference in the sum of real estate sales before and after the adoption or the modification of the plan, I – costs pertaining to the construction of technical infrastructure, A – betterment levies" [Cienkowski 2014, 145, quoting: Czekiel-Świtalska 2005].

– cost of compensation payments, buy-out of real estate property, which has been designated in the local plan for public utility investments, or decrease in the revenues from real estate taxes. Potential income, on the other hand, may result from the revenues derived from re-zoning fees or increased revenues from real estate taxes.

2. Indirect financial implications of spatial policy implementation. These appear in a long-term perspective, and they are linked to the construction of technical infrastructure (costs of investment outlays and revenues from betterment levies), revenues from local taxes and charges, revenues from the municipality's participation in income taxes, or the decrease or increase of the local unemployment rate (as a result of the implementation of new investment projects or, conversely, of limiting the investment projects within the given area covered by the plan) [Czekiel-Świtalska 2005].

2.3.1. Compensations, fees, taxes (negative and positive financial result of planning decisions)

Solutions adopted by Municipalities as a result of passing new plans of spatial development or changing the existing spatial plans influence the change in the market value of real estate property – causing either its increase or decrease in value. Therefore, they bring advantages or cause losses to municipal budgets. In the case of increased value of real estate, resulting from the change in the designation of land (re-zoning) – for instance, from farming to construction/services, the given administrative organ may introduce fees and taxes. In the case of decreased value of real estate property, it is obligatory to pay our compensation. The level of such compensation can be disputed, but not its fact.

According to the provisions of the Law on Spatial Planning and Development:

"Article 36. 1. If, in connection with the adoption of the local spatial development plan, or the modifications to such a plan, the use of real estate property or its part in the manner it had hitherto been used has become impossible or significantly limited, the owner or perpetual lessee of the real estate may (with the exception of paragraph 2) claim from the Municipality:
   1) that the Municipality pays compensation for the real damage accrued or,
   2) that the Municipality buys out the real estate or its part.

2. The practical realisation of the claims listed in paragraph 1 may also be effected through the Municipality offering the owner or the perpetual lessee another real estate property in return. On the day of the exchange contract being signed, the claims become void.
3. If, in connection with the adoption of the local spatial development plan, the value of the real estate property decreases, and the owner or the perpetual lessee is selling the property and has not taken advantage of the options mentioned in paragraphs 1 and 2, he can demand from the Municipality the payment of damages equal to the sum, by which the value of the property had decreased".

According to article 37, paragraph 3 of the quoted act of law – the claims mentioned in article 36, paragraph 3 can be made to the municipal administration agency within 5 years since the day that the given local plan of spatial development or its change came into force.

Based on article 36, paragraph 4 of that same act of law, in the case on an increase in the value of the real estate property,[11] the Municipality may charge a re-zoning fee (zoning change fee).

"Article 36.4. If, in connection with the adoption of the local spatial development plan, the value of the real estate property increases, and the owner or the perpetual lessee is selling the property, the village mayor or the town mayor charges a one-time fee defined in the aforementioned plan, and formulated as a percentage of the increase in the value of the property. The charge cannot be higher than 30% of the increase in the value of the real estate property".

Financial advantages for municipalities, resulting from planning decisions, and impacting the increase in the value of real estate – as a result of the divisions of a real estate property, dividing and merging properties, as well as construction of technical infrastructure, bring revenues to the municipal budget in the form of charging betterment levies. The amount of the levy is set by the municipal council, and the conditions of its appointment[12] are determined by an act of law of 21 August 1997: the Real Estate Management Act [Ustawa… 1997], while in the situation of betterment levies calculated for:

- division of a real estate property (with the application of provisions of articles 98a and 98b of the Real Estate Management Act) – the fee may not exceed 30% of the increase in the value of the real estate property,
- dividing and merging (article 107 of the Real Estate Management Act) – the fee may not exceed 50% of the increase in the value of the real estate property,
- share in the costs of constructing technical infrastructure (with the share of State Treasury funds, funds of the regional self-government administration, funds from the European Community budget or non-refundable funds from foreign sources) – that is, the construction of roads or building underground, on the ground, or over ground, cables and appliances: water pipes and waterworks, sewage, heating, electricity, gas or telecommunications, following the articles 143–148 of the Real Estate Management Act – there is no obligation to charge a fee; the municipality itself decides whether it is necessary to charge a fee).

[11] The increase in the value of the real estate property is the difference between the value of the property determined while taking into consideration the land use applicable before and after the change or the adoption of the plan. The task is completed by an expert evaluator, who must determine the vale of the real estate property according to the status after the plan has been adopted/modified, and according to the status before the plan has been adopted/modified [Jakubiec 2013, p. 4–5].

[12] Charging the betterment levy is effected in the following situations: 1) increase in the value of a real estate property as a result of its division (while the division of the property must already have been approved, and remain in accordance with the principles of the plan), 2) merging and dividing a real estate property, and then assigning new properties to the owners, 3) after the construction of roads and technical infrastructure [Jakubiec 2013, p. 5–6].

The source of municipal revenue when implementing the provisions of the adopted local plans of spatial development derives from the **taxes**:

- revenue from real estate tax (change in the land tax depending on the land use, building tax and taxation of buildings and structures constructed within the area encompassed by the plan),
- revenues from taxes on civil law transactions (revenue liked to the sale and purchase of real estate property),
- personal income tax (tax paid by private persons residing within the given municipality as well as tax paid by legal persons with registered seat within the area of the municipality).

Provisions made in the local plans of spatial development, in most cases, create broad opportunities for locating investment projects (as a result of changing the designation of lands into construction-related – residential, services […]) and either improving economic growth of the municipality or impeding that growth (by purposefully limiting the intensity of development in the given area). Implementation of new investment projects resulting from provisions of the local plan has an advantageous impact on the municipality's revenues in terms of **increased taxes**, that is:

- increased real estate taxes – on land, buildings, constructions,
- increased share in personal income tax in the case of residential development and settling of new residents/owners [Jakóbiec 2013].

3. Summary and conclusions

3.1. Legal impediments and financial consequences of the administrative reforms

The present legal regulations in force, pertaining to spatial development and management in Poland, have been moulded after 1989, during the systemic and administrative reforms, as well as the reform of the planning system and spatial development. As a result of those changes, the "continuity of knowledge and methodology has been broken. […] At the level of municipal planning, defective studies and local development plans are created, compounded with low efficiency of institutions" [Zastawnik 2013]. The lack of legislative standards required in the case of regulations and acts by which local plans are adopted often results in the inclusion therein of provisions, which are unclear and impossible to interpret unambiguously. "Local plans of spatial development are drafted with the breach of any principles of proper legislation, which later must necessarily cause problems in their implementation" [Niewiadomski et al. 2009].

The range of issues with the spatial planning, as well as the financial and economic aspect connected thereto, still requires a broad public debate – with the participation of experts, scientists, practitioners – over the need for legislative changes pertaining to spatial policy, and their strong exposure in the laws. It seems essential to find the correct formula for the legal regulations and provisions – so that designing spatial structures with increased usable and technical standards as well as improved conditions and quality of life of the residents takes priority over financial constraints.

According to Barbara Bartkowicz: "Undisputed necessity to introduce instruments that would condition the sustainable, harmonious development of our country, requires the re-establishment of a coherent system of spatial planning and developing obligatory rules for conscious, deliberate, and effective management of spatial development at all levels of decision making, supported with a whole range of economical incentives and restrictions, to enforce responsibility, accountability, and rational action. Otherwise, uncoordinated sectoral policies and selective activation or development of areas within the new policy of strategic intervention – instead of leading to the desired growth – may significantly compound the spatial chaos and inflame conflicts, thus destroying the most attractive areas of our country". [Bartkowicz 2011]

The issues pertaining to and surrounding spatial planning bring with them a multitude of financial and economic aspects. In the current legal system, the costs of local spatial development burden almost in their entirety the municipal budget. This concerns both the spatial planning process and the implementation of infrastructure within the municipal responsibilities (construction of technical infrastructure (water pipes and waterworks, sewage, […] implementation of road investments, buyout of land for public utility purposes pertaining to the implementation of municipal responsibilities as well as claims of the owners / perpetual users in the case of the decreased value of real estate property as a result of planning provisions).

At present, financial consequences of planning are becoming a very grave problem for many municipalities, and they result in adopting financially safe solutions, which as a result of the adoption of the plan shall not generate high costs or present problems in terms of buy-outs or compensations.

As planning practice indicates, it is a widespread phenomenon to develop local plans for fragmentary and dispersed areas. Such actions often result in equally fragmentary and dispersed plans – of the areas designated for single, particular investment projects, as well as lack of organisation and ordering of the space and the functional structure of the municipality as a whole. Many of the developed plans, in the sphere of spatial management, limit the proliferation of construction – not merely as a condition of sustainable development, but mostly for economical reasons – in order to minimise any spending resulting from planning decisions. These constraints also express themselves in defining, within the plan, of only the basic area functions (residential, services), while ignoring solutions that would ensure the satisfaction of residents' needs and could potentially increase usable qualities (for instance, using the green areas of public access in proportion to built areas or to the number of inhabitants). These actions, for many municipalities, are associated with additional costs (of designating and separating such green areas) simultaneous with the creation of new urbanised areas [Blazy 2007]. With increasing frequency, planning documents also tend to limit the areas for development – those designated for residential housing, as an irrational allowance of such areas generates serious financial liabilities for the municipalities (costs pertaining to the buy-out of land for access roads). Public roads are only planned in locations, where their construction is envisaged in realistic time perspective.

To venture a general statement, we can argue that the liabilities or responsibilities contained within the local plans of spatial development, particularly those concerning public infrastructure, integrate the regulations of spatial planning and financial (investment) planning. As a result, the practice of designating private areas for public investment projects causes the necessity for expropriation, and it is linked to payment of compensation or damages (buyout of land for the implementation of municipal obligations – the construction of roads and other public utility purposes, for instance, technical infrastructure).

It should be stressed that in the present realities, local self-government units are not equipped either financially or organisationally for the immediate provision of full communication and infrastructure servicing of the whole area of a given municipality or town [Niewiadomski et al. 2009].

To sum up, there is no doubt that one of the barriers, which impedes or slows down the planning process at municipal level lies in the aforementioned very high cost of planning documents, which is borne by the municipality in its entirety. Probably it is due to that fact that by the end of 2010, only a little more than 25% of the country's area had been covered by the local plans of spatial development [Cienkowski 2014]. In Mirosław Cienkowski's opinion: "This argument, often raised by local self-administration officials, is unconvincing, to say the least. […] All costs, significant as they are, which go towards the development of a local plan, should be treated not merely in spatial planning categories, but also in the category of an investment – an investment with a particular, attractive rate of return. Thanks to using the instrument of the spatial plan, the municipality not only achieves the very much needed ordering of space, but it also receives other opportunities: for instance, effective sale of municipal property, the price of which significantly depends on the designation of area function in the spatial development plan, which allows for the increase of revenue to the municipal budget. Moreover, after the spatial development plan has been adopted, the municipal self-government unit acquires an opportunity to conduct energetic activities in the field of local marketing, business promotion, and therefore also to shape and position investment offers, and ultimately, to attract investors who shall guarantee a number of advantages for local communities, while implementing the planned investment projects (increased number of jobs, revenues from different kinds of taxes to the municipal budget, and so forth)" [Cienkowski 2014].

3.2. Conclusions

Judging from the aforementioned description as well as cost analysis of the development, adoption and implementation of the provisions of a local spatial development plan, it clearly follows that the Polish planning process is complicated and excessively prolonged. Adopting the local plan for spatial development obligates municipal authorities to implement the adopted provisions and to incur a number of costs of varied character, including:

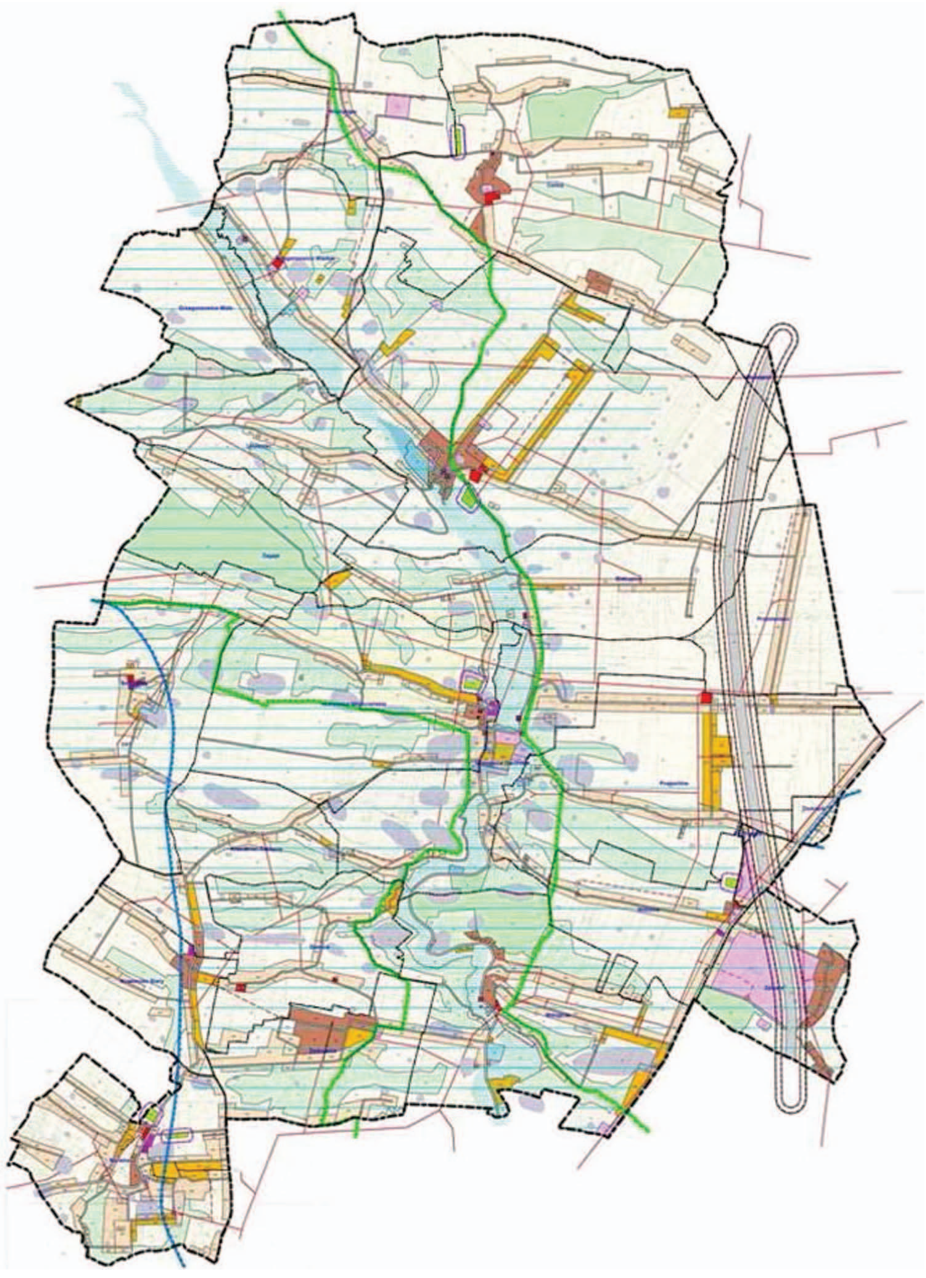
- financial burden resulting from negative impact on the value of real estate properties,
- financial burden pertaining to the buyout of real estate for the implementation of public utility investments,
- financial burden pertaining to the costs of building and fitting technical infrastructure,
- financial burden pertaining to the servicing of the investment process [Cymerman et al. 2008].

Independently of the economic, social and other factors influencing the solutions adopted in local plans of spatial development, it is the spatial planning itself that is decisive for the proper usage of space, its appropriate organisation and management, according to public expectations and the postulates of environmental protection. Adopting the plan of spatial development is extremely important for the shaping of municipal development processes, but also for the implementation of investment processes[13]. Planning decisions should take into account not only the financial aspects and the intentions of social and economic transformations, but they should also constitute "a plane for working out a consensus upon the right direction and range of development of a given area, which brings real effects in the actual space. […] In the present economic awareness of the decision makers, where most investment decisions at municipal level are made under the slogan of job creation, the knowledge and widespread awareness of long-term impact of those actions is necessary, as perceived short-term economic benefits too often obscure the threat of irrevocable loss of unique values of particular areas, and even whole regions".

To conclude, the discussion over the costs of spatial development in our country, and over the problem of preparing development plans and exposition to its financial implication, still continues. This is seen in the sphere of events, with the participation of self-government administration representatives, legal experts as well as architects and city planners[14].

[13] In terms of timing – the process of preparing the investment and receiving a construction permit is much shortened. According to article 35 paragraph 1, point 1 of the Construction Law of 7 July 1994 [Ustawa… 1994] – before issuing the decision on the planning permission or a separate construction permit for the given construction design, the appropriate authority verifies whether the construction design complies with the provisions of the local plan of spatial development. Wherever there is no such plan – then according to article 33, paragraph 2, point 3 – the Investor is obligated to attach to his application for the construction permit a planning decision on the development conditions and land function […], which greatly lengthens the investment and construction process. Furthermore, before making an application for the planning decision (development conditions), the Investor must additionally provide a number of other documents in order to fulfil contractual obligations pertaining to such decision (including for instance the environmental conditions for the given investment project – if required according to the environmental protection regulations).

[14] On 5 December 2013, in Poznań, a conference took place on the "Financial Impact of Spatial Planning – Implications For Local Development".



Source: www.iwanowice.malopolska.pl (accessed: 20 October 2014)

Fig. 1. The area covered with the local spatial planning (zoning) and management plan of the Iwanowice municipality, Kraków poviat (*powiat krakowski ziemski*) of 2002 – approximately 20 km away from Kraków; with a small number of new areas designated for residential development, farmsteads and services

Source: www.zielonki.malopolska.pl

Fig. 2. The area covered with the local spatial planning and management plan of the Zielonki municipality, Kraków poviat (*powiat krakowski ziemski*), region within the administrative borders of Bibice village, of 2005 – next to the border with the city of Kraków; with a prevailing number of new areas designated for residential development (one family homes as well as ribbon developments) and services

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

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