

Jana Korytárová, Vít Hromádka, Leonora Marková¹

DETERMINATION OF LAND PROPERTY INDEX FOR RESIDENTIAL AREAS

Abstract

The main objective of the article is to introduce a partial output of a research project having the form of the process of determination of the Land Property Index. The Land Property Index expresses the value of the Representatives of Real Property in the area in the reproduction price related to a unit of area. It is an important quantity when determining the value of property in an area whose determination is necessary for the calculation of the damages caused by a flood. In the article, the process of the determination of the Land Property Index is characterized in several basic points which have to be fulfilled for its calculation. In practice, the defined process has been verified by a calculation of the Land Property Index for A area category - residential areas.

Introduction

The consequences of floods are becoming an annual financially expensive burden of public as well as private budgets in the Czech Republic. Since 1997 when the floods affected ca 5 per cent of our territory, the investments of the public sector into flood control have been a relevant problem continually. In view of the fact that the protective measures are demanding as regards investments, it is necessary to consider their economic cost-effectiveness within the context of the amount of the potential flood damage which they can prevent or mitigate its overall impact at least.

A team of the employees of the Institute of Structural Economy and Management has prepared, within the framework of a grant project of the Czech Science Foundation (GA ČR), a methodology for the determination of the potential damage in the area affected by a flood. The methodology consists of the following steps [1]:

Specification of the territorial property valuation:

- Specification of property representatives in the territory.
- Estimation of property representatives.
- Specification of territorial category.
- Specification of territorial representative.
- Estimation of territorial property ratio in reproduction price level.

Evaluation of damage on the territorial property caused by floods:

- Specification of damage on the property representatives.
- Evaluation of damage ratio of the territorial representative formulated in %.
- Specification of damage on the territorial representative in reproduction price level.

¹ Jana Korytárová, doc., Ing. Ph.D., Vít Hromádka, Ing., Ph.D., Leonora Marková, doc. Ing., Ph.D., Brno University of Technology, Faculty of Civil Engineering, Institute of Structural Economy and Management, Rybkova 1, 602 00 Brno, Czech republic

















- Specification of damage in the monitored territory in reproduction price level.

In their article, the authors have concentrated on more detailed introduction of a partial output of a grant project, namely the determination of the Land Property Indexes, which are an important aid in determining the real property value in the area. The Land Property Index expresses the value of the Representatives of Real Property in the area in the reproduction price related to a unit of area and is given in CZK/m².

Area Categories

The basic quality of the Land Property Index is that it respects the generally defined structure of the real property in the given area. Thus the entire real property which is usually present in the given area expressed by the value of the Representatives of Property in the area in the reproduction price contributes to its value. However, many different kinds of property can exist in an area. Because of this, it is practical to split up the whole area surface into different area categories, which can be defined from the planning point of view by prevalent functional utilization of the individual areas. The Land Property Index is then calculated for the individual area categories. The area categories are specified in relation to the Regulation No. 501/2006 Coll. on general requirements for area utilization. A basic overview is presented by the Table 1 below.

Tab. 1 Area Categories

Colour	Marking	Area Category
	A	Residential areas
	B	Recreational areas
	C	Areas of Civil Infrastructures
	D	Green Areas
	E	Mixed residential areas
	F	Transport infrastructure areas
	G	Technical infrastructure areas
	H	Areas for production and storage
	I	Mixed production areas
	J	Water and water-management areas
	K	Agricultural areas
	L	Woodland areas
	M	Natural areas
	N	Mixed parts of unbuilt-up area
	O	Mineral working areas
	P	Specific areas

Before the values of the Land Property Index are calculated for the individual area categories, it is necessary to describe the individual area categories from the viewpoint of their functional utilization. Virtually in every area category we can find more ways of area utilization (utilization of areas for habitation, infrastructure, amenities, industry, etc.) and it is therefore necessary to specify not only the prevalent ways of utilization of the area falling into the given category but also their percentage for each area category. Then the result is the Representative of Area, which can be defined as a characteristic area described by areal representation of lands of the statistically most often occurring Representatives of Property.

In the following text, the methodology of the determination of one of the above-mentioned area categories is being introduced, namely A area category – residential areas.

Basic Principle of Determination of Representative of Area

To be able to determine the Representative of Area it is necessary to answer two basic questions:

1. What is the functional utilization of the area? (Or: Lands of what Representatives of Property occur in the given category?)
2. What is the share of the lands of the individual Representatives of Property in the total area of the given area category?

The functional utilization of the individual area categories (as given in Table 1) is generally defined by the Regulation No. 501/2006 Coll. on general requirements for area utilization (Regulation only in the following text). The Regulation states what kinds of lands occur usually in the given category. By way of example the characteristic of A area category – residential areas – can be given:

Tab. 2 Functional Utilization of A Area Category – Residential Areas

Colour	Marking	Area Category	Functional Utilization of Area
	A	Residential areas	one-family house lands block of flats lands related transport infrastructure lands related technical infrastructure lands public space lands related amenity lands (with the exception of business areas over 1000 m ²) other buildings and facilities not impairing the level of the environment other unbuilt-on lands

However, the Regulation does not deal with the usual shares of lands occurring in the given category. These shares have been determined by means of an expert estimate supported by a statistical survey. Within the framework of the survey, the shares of the lands in the areas of the individual area categories in the selected parts (e.g. municipalities) have been monitored and the mean values of these shares have been determined subsequently. This method is very precise but rather demanding on time and the necessary data.

Determination of Representative of Area of A Category – Residential Areas

The manner how to determine the Representative of Area can be demonstrated on the example of A category – residential areas. The outputs of the statistical survey carried out on a sample of 139 South Moravian municipalities with up to 50 thousand inhabitants have been used for the calculation.

In accordance with the Regulation, the total residential area has been split up into two basic groups of areas, namely areas built-up with building objects and unbuilt-on areas. Based on the established data the ratio of these areas has been set as 30 per cent to 70 per cent. The total area built-up with building objects has been further broken down into the following four parts:

- housing areas, areas including lands of objects designed for habitation and open spaces – hard or unpaved surfaces
- auxiliary objects areas
- amenity objects areas
- areas of objects of technical facilities

Thus it is possible to set the basic formula for the determination of the representative of A category – residential areas [2]:

$$CPB = PZB + PDO + PTV + POV + PN \quad (1)$$

where CPB is the total residential area
PZB is the housing area
PDO is the auxiliary objects area
PTV is the technical facilities area
POV is the amenities area
PN is the unbuilt-on area

The area of the land of an object (e.g. of a block of flats) depends to a certain extent not only on the size of the object itself but also on the type of development where it occurs within the framework of the given residential area. Because of this, the three following types of development have been defined [3]:

- Residential areas with open layout (living floor spaces, amenities and technical facilities, possibly also garages and other auxiliary objects are located in independent, freely standing objects);
- Residential areas with closed layout (living floor spaces are located in spatially connected objects of terraces houses, possibly also in objects forming blocks, amenities and technical facilities are located in functionally independent but structurally and areally concentrated objects);
- Residential areas with integrated layout (living floor spaces, areas of amenities and other functions are united in common objects, usually one on top of the other).

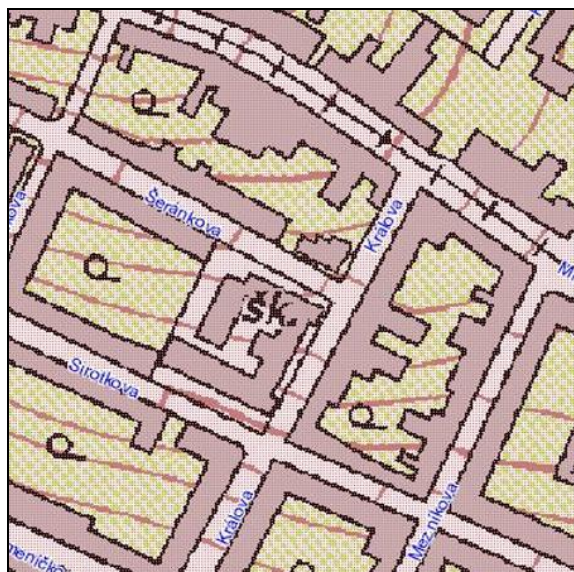
Residential areas

Each of the above-mentioned types of development can consist of different kinds of houses designed for habitation, the following three kinds of development have been considered in the calculations:

- dwelling houses up to four storeys
- dwelling houses with more than four storeys
- one-family houses

One of the possible combinations of the type and kind of development is shown in Figure 1.

Fig. 1 Closed type of development, one-family houses – urban development



The average size of the area of the development designed for habitation should respect the type of the development (open, closed and integrated layout), kinds of development (dwelling houses up to four storeys, dwelling houses with more than four storeys and one-family houses) and their shares in the total development designed for habitation. Thus the average size of the area of the development designed for habitation can be determined by means of the following formula [2]:

$$PZB = \sum_{i=1}^3 \left[a_i \cdot \sum_{j=1}^3 b_{ij} \left(\frac{PO_{ZMIN}^{ij} + PO_{ZMAX}^{ij}}{2} + \frac{PV_{ZMIN}^{ij} + PV_{ZMAX}^{ij}}{2} + \frac{PV_{NMIN}^{ij} + PV_{NMAX}^{ij}}{2} \right) \right], \quad (2)$$

where PZB	area of the development designed for habitation
PO _{ZMIN}	built-up lands of objects – minimum value
PO _{ZMAX}	built-up lands of objects – maximum value
PV _{ZMIN}	hard open spaces – minimum value
PV _{ZMAX}	hard open spaces – maximum value
PV _{NMIN}	unpaved open spaces – minimum value
PO _{ZMAX}	unpaved open spaces – maximum value
i	type of development (1 – open, 2 – closed, 3 – integrated)
j	kind of development (1 – dwelling houses up to four storeys, 2 – dwelling houses with more than four storeys, 3 – one-family houses)
a	weight for type of development
b	weight for kind of development

Areas of Auxiliary Objects, Areas of Technical Facility Objects and Areas of Amenity Objects

The areas of the auxiliary objects and technical facility objects can be determined in the same way as the areas of the development designed for habitation the only difference being that the areas of the auxiliary objects and technical facility objects do not depend on the kind of the development but only on the type of the development (open, closed, integrated). Thus the resulting relationship can be expressed in the following way:

$$PDO = \sum_{i=1}^3 a_i \cdot \left(\frac{PO_{ZDMIN}^i + PO_{ZDMAX}^i}{2} + \frac{PV_{ZDMIN}^i + PV_{ZDMAX}^i}{2} + \frac{PV_{NDMIN}^i + PV_{NDMAX}^i}{2} \right) \quad (3)$$

$$PTV = \sum_{i=1}^3 a_i \cdot \left(\frac{PO_{ZTMIN}^i + PO_{ZTMAX}^i}{2} + \frac{PV_{ZTMIN}^i + PV_{ZTMAX}^i}{2} + \frac{PV_{NTMIN}^i + PV_{NTMAX}^i}{2} \right) \quad (4)$$

where PDO areas of the auxiliary objects
PTV areas of the technical facility objects

Note. The other terms of the formula have the same meaning as in the formula for the calculation of the area of the development designed for habitation the only difference being that the D index represents the terms for the calculation of the areas of the auxiliary objects and the T index the terms for the calculation of the areas of the technical facility objects.

Same as for the above-mentioned areas, also the areas of the amenity objects can be determined by the following formula:

$$POV = \sum_{k=1}^n \left(\sum_{i=1}^3 a_i \cdot PP_{ki} \right) \quad (5)$$

where POV areas of the amenity objects
PP_{ki} areas of the land of the k-th amenity object of the i-th type of development
a_i weight of the i-th type of development
n the total number of the amenity objects taken into account

Structure of Representative of Area of A Category – Residential Areas

The weights for the type of development (a_i) and kind of development (b_{ij}) have been established for the determination of the Representative of Area of A category – residential areas – by means of the statistical survey mentioned in the preceding text. After transforming the outputs of the formulas defined above it was possible to describe the Representative of Area of A category – residential areas – by proportional representation of the partial units of the total residential area. The structure of the representative is given in the Table below:

Tab. 3 Structure of Representative of Area of A Category – Residential Areas

Area	Share
Residential area (CPB)	100.00 %
Built-up residential area out of it	30 %
- Area of the development designed for habitation (PZB)	83.83 %
- Area of the auxiliary objects (PDO)	1.86 %
- Area of the technical facility objects (PTV)	0.45 %
- Area of the amenity objects (POV)	13.86 %
Unbuilt-on area (PN)	70 %

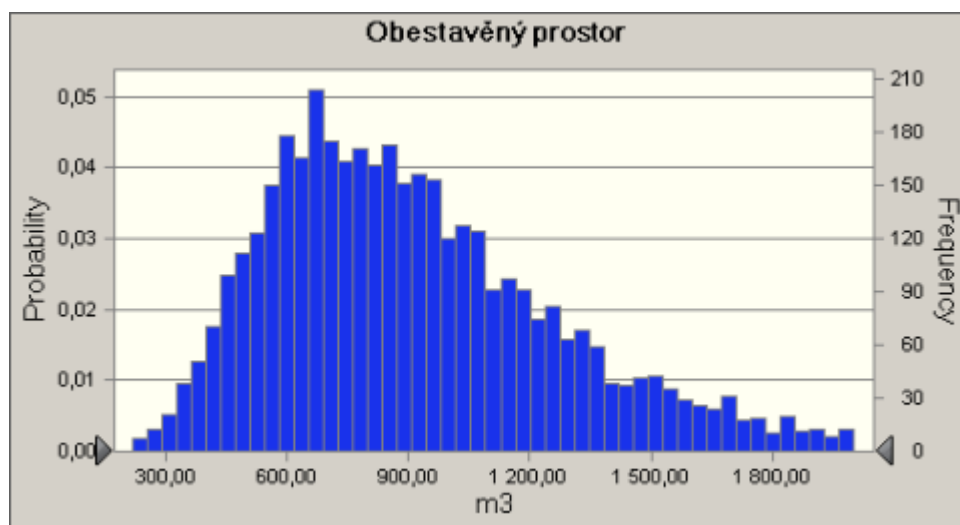
Determination of Land Property Index

The individual areas of the development are determined by a certain number of the representatives of one type of the real property – building objects. To determine the Representatives of Real Property, the budget index cards collected during the last five years for teaching as well as research purposes in the Institute of Structural Economy and Management of the Faculty of Civil Engineering of the University of Technology in Brno have been used. From the viewpoint of the methodology of the determination of the Land Property Index, the technical characteristics of building volume (OP) and built-over surface (ZP) are decisive with the individual Representatives of Property. Then the set of the quantified characteristics of the individual building objects has made possible to evaluate statistically the data occurring most often. Based on them, the representative of a certain kind of real property has been specified by means of the technical characteristics. Crystal Ball software has been used for evaluation of the data.

The Representative of Property of one-family house, which forms one kind of the development in the residential area, has been selected for the following example [4].

The values of the building volume and built-over surface have been processed by the program to clearly arranged charts and tables. Figure 2 and Table 4 below demonstrate the outputs of OP values. The horizontal axis of the chart represents the values of the building volume in m³ and the vertical axis shows the number of possible occurrences. The median value, which has been gained from the variant models, has the size of 853 m³.

Fig. 2 Probabilistic Configuration of Building Volume of One-family House [4]



Notice: *Obestavěný prostor* = Building volume

Tab. 4 Probabilistic Characteristics of Building Volume of One-family House [4]

Statistics:	Forecast values
Trials	4 000
Mean	925.48
Median	852.73
Mode	---
Standard Deviation	384.34
Variance	147 718.10
Skewness	1.10
Kurtosis	4.72
Coeff. of Variability	0.4153
Minimum	216.89
Maximum	2 894.87
Range Width	2 677.98
Mean Std. Error	6.08

Fig. 3 Card of Representative of Area of A Category – Residential Areas, A1 One-family Houses

A1	<p>One-family house JKSO 803 6. OP 853 m³ ZP 128 m² RU 4 847 CZK/m³ (CÚ 2007) Reproduction price of representative: 4 134 thousand CZK</p>	
-----------	--	---

The desired Land Property Index is determined by means of the methodology mentioned above as the quotient of the total value of the real property in the area and its area using the following formula [3]:

$$\acute{U}MU = \frac{HM\acute{U}}{CPB} \quad (6)$$

where:

$\acute{U}MU$ Land Property Index
 $HM\acute{U}$ value of property in the area
 CPB total residential area

The value of the Land Property Index represents the value of the real property in the area in CZK per 1 m² of the given area category. The following example demonstrates the $\acute{U}MU$ value for A area category – residential areas.

Tab. 5 Land Property Index – A Area Category – Residential Areas

Total value of the real property	10 099 000 CZK
Total land area S	10 000 m ²
Land Property Index	10 099 CZK/m ²

A number of European countries work at determination of the Land Property Indexes. The values determined by the research are compared with the foreign sources [5]. The values given in EUR/m² have been converted on the basis of the current exchange rate. The comparable 2007 price level has been determined by means of the inflation index [6].

Tab. 6 International Comparison of Land Property Indexes

	Area Category	Value of Land Property Index CÚ 2007 [CZK/m ²]				
		Germany	Switzerland	France	Netherlands	Czech Republic
A	Residential areas	10 382	10 827	8 894	10 370	10 099

Conclusion

The main objective of the grant project has been the determination of the damage to property in an area affected by a flood. The Land Property Indexes for the individual area categories enable quick valuation of the real property in this area. This value is an important input datum for the application of the next part of the methodology, namely the determination of the damage in case that the real property is affected by a flood. Within the framework of the grant project, also the damage curves, which are designed for the basic flood parameters (water height and speed, duration of the flood) have been made more precise for the individual Representatives of Property. On the basis of these data, it is possible to determine the amount of the damage to the real property in the given area in the reproduction price.

Literature

- [1] KORYTÁROVÁ J., TICHÁ A., HANÁK T. Metodika stanovení výše škod na majetku v území postiženém povodněmi, *Sborník příspěvků 3. vodohospodářské konference 2004, Práce a studie Ústavu vodních staveb FAST VUT v Brně, Sešit 4*. Brno, 2004. ISBN 80-86433-26-9. (Methodology of Specification of Property Damage within the Territory Affected by Floods, *Collection of Contributions of the 3rd Water Management Conference 2004, Papers and studies of the Department of Water Structures of the Faculty of Civil Engineering of the Brno University of Technology*)
- [2] HROMÁDKA, V., KORYTÁROVÁ, J., TICHÁ, A. Podklady pro stanovení územního majetkového ukazatele. *Sborník ze semináře s mezinárodní účastí Cena, životnost a ekonomická efektivnost stavebního díla, Práce a studie Ústavu stavební ekonomiky a řízení, sešit 4*. Brno, 2007. ISBN 978-80-214-3403-5. (Sources for Specification of Land Property Index. *Collection from a workshop with international participation, Price, Lifetime and Economic Cost-effectiveness of Civil Engineering Work, Papers and studies of the Institute of Structural Economy and Management*).

- [3] NAVRÁTILOVÁ, A. a kol. *Plochy pro bydlení, uspořádání urbanistické struktury ploch bydlení*. Podkladový materiál zpracovaný experty územního plánování. (*Residential Areas, Layout of Urbanistic Structure of Residential Areas*. Source material prepared by the planning experts).
- [4] TICHÁ, A., HROMÁDKA, V., ŠANCOVÁ, L., PROCHÁZKA, P. Stanovení reprezentanta vybraných stavebních objektů pro výpočet územního majetkového ukazatele. *Sborník konference Lidé, stavby a příroda 2006, Práce a studie Ústavu vodních staveb FAST VUT v Brně, Sešit 10*. Brno, 2006. ISBN 80- 7204-475-3. (Determination of Selected Building Objects Representative for Calculation of Land Property Index. *Collection from People, Structures and Nature Conference 2006, Papers and studies of the Department of Water Structures of the Faculty of Civil Engineering of the Brno University of Technology*).
- [5] Atlas der Überschwemmungsgefährdung und möglichen Schäden bei Extremhochwasser am Rhein, <http://www.iksr.org/rheinatlas/Start.pdf>
- [6] <http://epp.eurostat.et.europa>

This contribution has been written with the support of the grant project of of the Czech Science Foundation (GA CR), project No. 103/05/0160 The procedures of Support of the Decision-making in the Field of Construction Investment toAssure the Territory Stability against Flood.