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Design of a spatial database of standardized blocks of flats for the purpose of population sheltering in the town of Uherské Hradiště

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Abstract: - This article describes the process of creating a database of standardized blocks of flats in the territory of the town of Uherské Hradiště. From the perspective of municipalities, one of the issues in the field of sheltering is the lack of a systematic approach unified for all municipalities in the CR. That is why there is ample space for standardization. This is main problem of sheltering in the CR. The design and creation of a database containing buildings suitable as improvised shelters in Uherské Hradiště is the aim of research in this paper. The methods of analysis and synthesis of obtained data were used in the research. For the creation of the spatial database MS Excel was used for the initial outline of the database. Subsequently, QGIS version 2.6.0 and QGIS Browser version 2.6.0 were used. The main spatial data were the OpenStreetMap (OSM) dataset. The blocks of flats were categorized in order to facilitate the design and preparation of population sheltering in the town. The categorization is based on the presumption of consistency in the construction of groups of buildings, which can be divided into concrete high-rise blocks of flats and those of brick. The article maps individual blocks of flats in the territory of Uherské Hradiště and inputs them into the database. The final database consists of two types of the residential buildings structures - brick and panel type. Structural type series are identified according to the type of construction of each object. The database of the most widespread structural type series in Uherské Hradiště contains a total of 364 objects, of which 271 objects are OP 1.11., 33 objects are G32 and 15 objects are OP 1.31. structural type series. The structural type series of 45 objects was not possible to identify. However, 16 objects belong most likely to the brick structure type. The type oneness can be used in the area of population sheltering planning and designing of improvised shelters. The resulting database is then created as a spatial database to support the use of GIS tools.

Key-Words: - Geographic Information System, Risk Assessment, Civil Protection, Crisis Management, Information Support, Sheltering.

1 Introduction

Sheltering is one of the basic tools for protecting the population. The task of population sheltering is to provide shelters against negative phenomena. Historically, sheltering is perceived primarily as a tool for protection against the effects of weapons of mass destruction (WMD). However, it has gradually evolved and nowadays sheltering is also being used as protection against large-scale industrial accidents and natural emergency situations. For such situations, the inherent protective properties of buildings are used for the purposes of sheltering; these can be further enhanced to achieve a higher degree of protection. From the perspective of the protection against WMD, it is above all protection against the effects of pressure wave and thermal, flash and penetrating radiation caused by nuclear weapons. Furthermore, protection against biological agents and chemical warfare agents is also provided by this type of sheltering.

In the Czech Republic (CR), sheltering is defined by the Ministry of the Interior in the following manner: "The population sheltering is defined as the use of shelters and other suitable premises in order to protect population against effects of flash and thermal radiation, penetrating radiation, contamination by radioactive dust, chemical or biological substances and against blast effects of weapons of mass destruction. For this purposes, the improvised and permanent shelters are used" [1]. Apart from the actual definition, the tools used for sheltering are also specified. These tools are permanent shelters (PS) and improvised shelters (IS).

PS are structures used for population sheltering or they are used in a dual-purpose regime, which

also includes civil use (garages, cinema, etc.). These structures are primarily intended for sheltering and they provide a high degree of protection. Nevertheless, the disadvantage of their use is the material and financial demands connected to their construction and operation [2]. IS are structures commonly used for various activities. If needed, these structures serve for population sheltering or they are modified in order to be used as shelters. In some cases, the IS may also include various shelter roofs, tents, etc. Their advantage is lower material and financial demands. However, the disadvantage is a lower degree of protection [3]. Due to the fact that the threat of WMD has been reduced over the past 30 years (since the end of the Cold War), the PS ceased to be built in the CR and sheltering has been gradually moved into the IS [4]. Nowadays, there is a limited number of PS available in the CR; they can accommodate 5 to 10 % of the population. Therefore, the remaining capacity is to be covered by the IS [5].

2 Problem Formulation

In the CR population sheltering falls within the jurisdiction of the municipalities [6]. However, municipalities often contend with the workload of their employees. It often happens that sheltering is addressed only formally and the IS are not planned at all.

The problem is too the absence of information about the construction type of block of flats in the town. The municipalities have not appropriate database of this information. The creation of this database and the mapping of the infrastructure of block of flats in the town Uherské Hradiště are main aim of research in this paper.

The current situation is reasonable because of the low likelihood of threats that would require sheltering, and the resulting low priority of the problem. With the gradual changes in the areas relating to security in recent years, slight changes in sheltering might have been observed in the CR [7]. Municipal authorities only become aware of the importance of sheltering when dealing with specific threats, particularly those related to the use of WMD. The actual preparation of sheltering consists of selecting premises for IS, designing the shelters, and their implementation in the event of a significant increase in the risk of the threats. Step by step, municipalities increase their efforts in the field of preparation of sheltering. However, this increase is somewhat gradual. From the perspective of municipalities, one of the issues in the field of sheltering is the lack of a systematic approach unified for all municipalities in the CR. That is why there is ample space for standardization. A crucial part of solving the problem of sheltering planning is its complexity. Planning the sheltering for all residents is rather demanding and complicated. Individual IS must be designed for a total capacity of hundreds to thousands of persons. Modifications of the IS within a given range requires large quantities of construction materials and equipment. The amount of this material can be reduced by using local resources. However, the amount of materials remains substantial. Another way of lowering logistic demands associated with the need for building material is to standardize its use. Standardization makes it possible to use fewer types of construction materials and thus lower demands for their transportation. Other crucial options of facilitating the preparation of sheltering are the standardization of design of each individual IS. This very part of the standardization of the IS design is the subject of the research article. Also the town of Uherské Hradiště contends problems associated with sheltering planning. Thanks to the cooperation of the staff of the emergency management in this town, it is possible to verify the hypothesis of solving this problem. The solution was verified by means of a case study devoted to planning of sheltering.

3 Problem Solution

The planning of individual IS in the territory of particular municipalities/towns is a problem. In particular, the problems are time demands and the large number of required IS. Given the priority of sheltering, the demands required for the preparation caused most villages/towns not to even try to address the problem. A solution to this problem is to lower the time needed for preparation of plans for sheltering and designs of individual shelters.

There are several ways of reducing the time needed for the selection of premises suitable for the IS and preparation of their design. For instance, it is the expensive increase in the number of staff, or involvement of the academic sphere represented by students and the involvement of the population itself. However, these approaches are either costly, or they do not provide the necessary standardization and quality of outputs. There is also the possibility of using the unification of the IS which is based on the standardization of premises intended for the IS. Standardization of the premises can be used in towns and larger villages. It is advantageous because the large numbers of blocks of flats are needed in the territory of these towns/villages. The

idea of using standardized premises for the IS is based on the hypothesis of unification of housing structures at the time of their construction. However, only few types of such blocks of flats exist (made either of concrete or brick). Especially in the case of concrete structures, there is a low presumption of any extensive constructional adjustments to the basement in these buildings. With this in mind, the main idea is a significant reduction in the number of IS designs, which would reduce the time needed to plan the population sheltering in the given town/village. The hypothesis was verified in a case study performed in the town (municipality) of Uherské Hradiště (UH). In this town the mapping of the majority of blocks of flats and the division of basements into individual types was carried out to facilitate designing of the IS. Due to the spatial character of sheltering and individual objects, the resulting database was created as a spatial database.

The example of creation of this database is presented in a case study (chapter 2.2)

2.1 Materials and methods

The methods of analysis and synthesis of obtained data were used in the research. These methods were applied through the whole research but they were mainly used for evaluation of structures and identification of individual types of blocks of flats within the first part of the research. In this section, the most widespread types of blocks of flats in the Czech Republic were mapped and then the comparison method was used. In the case study, the main methods used were observation and interviewing. These methods were used to identify the blocks of flats in the territory of UH and to divide them based on their type, and to determine the suitability of the premises for the IS. For the creation of the spatial database MS Excel was used for the initial outline of the database. Subsequently, QGIS version 2.6.0 and QGIS Browser version 2.6.0 were used. This software helped to spatially present identified objects of individual types, and to implement the spatial database. In addition, the demographic database OpenStreetMap (OSM) was used in order to acquire the reference data.

2.2 Case Study

The case study was carried out in the territory of the town of Uherské Hradiště in which objects suitable for construction of the IS were localized. The main emphasis was placed on blocks of flats made of bricks and especially those with concrete construction.

The first stage of the implementation of the case study was the collection of data relating to the most widespread structural types of high-rise blocks of flats in the CR. Based on the data obtained, the design types of blocks of flats located in the territory of the town were identified. The most frequent types of blocks of flats were OP 1.11, OP 1.31 and G 32. These blocks of flats are located in UH in compact areas of housing estates. The given housing estates are as follows: "Východ", "Štěpnice", "Pod Svahy", "Malinovského", "Jarošov" and other objects located in the vicinity of the streets "Stará Tenice" and "Na Rybníku". The locations of individual housing estates and objects are depicted in Fig. 1 by means of color captions. The list of several objects is presented in Tab. 1.

Tab. 1. The objects of housing estates.

id.	č.p.	ulice	konstrukční typová řada
1	969	Na rybníku	OP 1.31
2	970	Na rybníku	OP 1.31
3	971	Na rybníku	OP 1.31
4	974	Na rybníku	OP 1.31
5	975	Na rybníku	OP 1.31
6	976	Na rybníku	OP 1.31
7	977	Na rybníku	OP 1.31
8	978	Na rybníku	OP 1.31
9	979	Na rybníku	OP 1.31
10	980	Na rybníku	OP 1.31
11	981	Na rybníku	OP 1.31
12	965	Na rybníku	OP 1.31
13	966	Na rybníku	OP 1.31
14	967	Na rybníku	OP 1.31
15	968	Na rybníku	OP 1.31
16	984	28. října	nebyl určen
17	985	28. října	nebyl určen
18	986	28. října	nebyl určen
19	987	28. října	nebyl určen
20	988	28. října	nebyl určen
21	989	Pod Svahy	OP 1.11
22	990	Pod Svahy	OP 1.11
23	991	Pod Svahy	OP 1.11
24	992	Pod Svahy	OP 1.11
25	993	Pod Svahy	OP 1.11
26	994	Pod Svahy	OP 1.11
27	995	Pod Svahy	OP 1.11

A data model was designed for the purpose of keeping a record of identified objects. This data model was implemented in three steps. The first step

involved making a conceptual model in which the basic parts of the database were defined. This was followed by a logical model describing details of creating the database, which was then followed by a physical model. The data model contains a single entity, which is an **Object of the block of flats (IS object)** and seven basic attributes. These attributes are as follows: **ID of the object** (premises for the IS); the **construction category** of the given construction type; the **type** of basement and its interior arrangement; the **house number** of the given block of flats; the **housing estate** in which the object is located; the **street**, and the **construction type** of the block of flats. The proposed data model is not final and it focuses on assembling the data needed to determine the type and conformity of objects in UH. The data model can be extended by other attributes within further research [13, 14, 15)].

The description of the entity and its attributes for the purpose of creating the data model is given in Tab. 2. The table represents the conceptual data model of the resulting spatial database. The conceptual model in UML diagram is presented at fig. 4.

Tab. 2. Entity and attribute of data model.

Entity	***Attribute***
IS object	*Id*
	Type of object
	Category of object type
	Construction type
	Hausing estate
	House number
	Street

The second step in creating the spatial database was processing the logical part of the data model. The logical data model is shown in Tab. 3. The table specifies abbreviations of individual attributes, their formats, domains, and topology types.

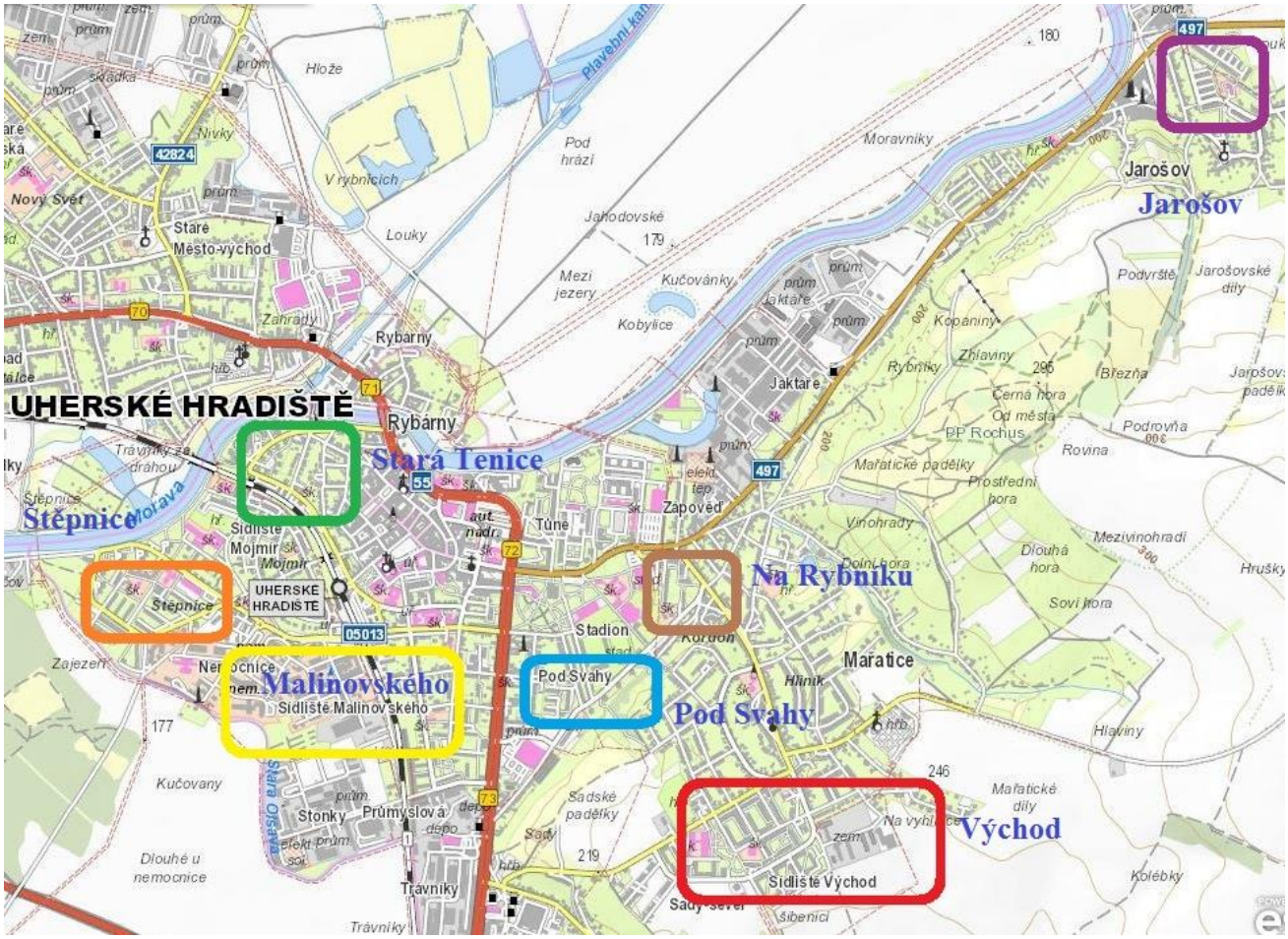

Fig. 1. The locations of individual housing estates.

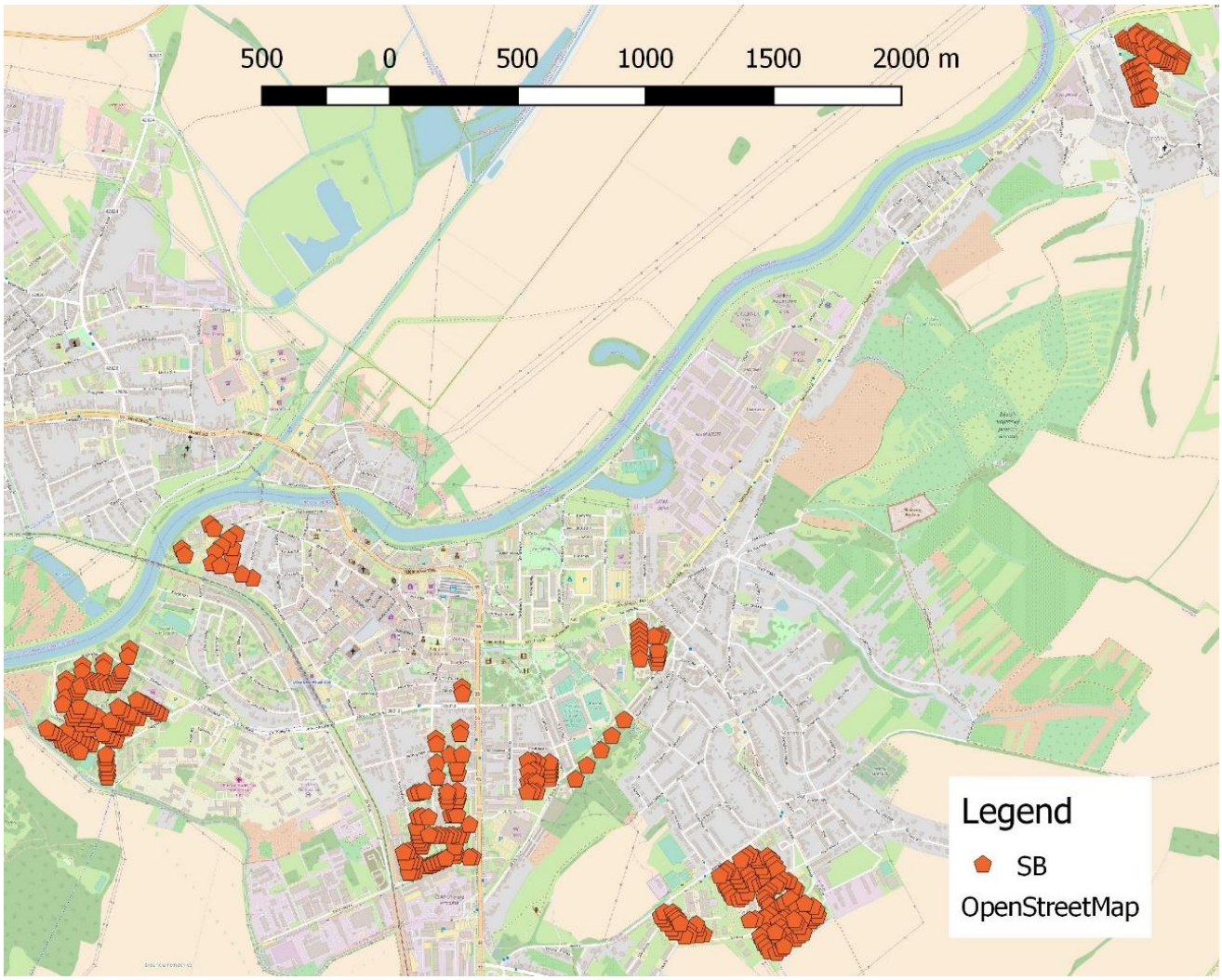

Fig. 2. The data model in the GIS application.

Tab. 3 Logical data model.

Entita	***Atribut***	***Format***
IS object	*Id*	*integer*
	Type of object	*string*
	Category of object type	*string*
	Construction type	*string*
	Hausing estate	*string*
	House number	*integer*
	Street	*string*

The physical data model in the GIS was created by converting the logical data model into target structures of the spatial database and file systems. For the actual conversion the SW QGIS Browser 2.6.0 and desktop QGIS 2.6.0 were used. In addition, physical structures and attributes were created. First, the file system of empty layers was created in the ESRI shapefile format with the .shp extension.

A vector data model has been chosen as it allowed for easier work with the analytical tools of the GIS compared to the raster data models.

Fig. 2 illustrates the implemented data model in the application QGIS 2.6.0. The individual objects, which represent the mapped blocks of flats in UH, were entered into the map. A detail of the map of blocks of flats in UH is depicted in Fig. 3. A part of attributes table of blocks of flats in UH layer is depicted in Tab. 4.

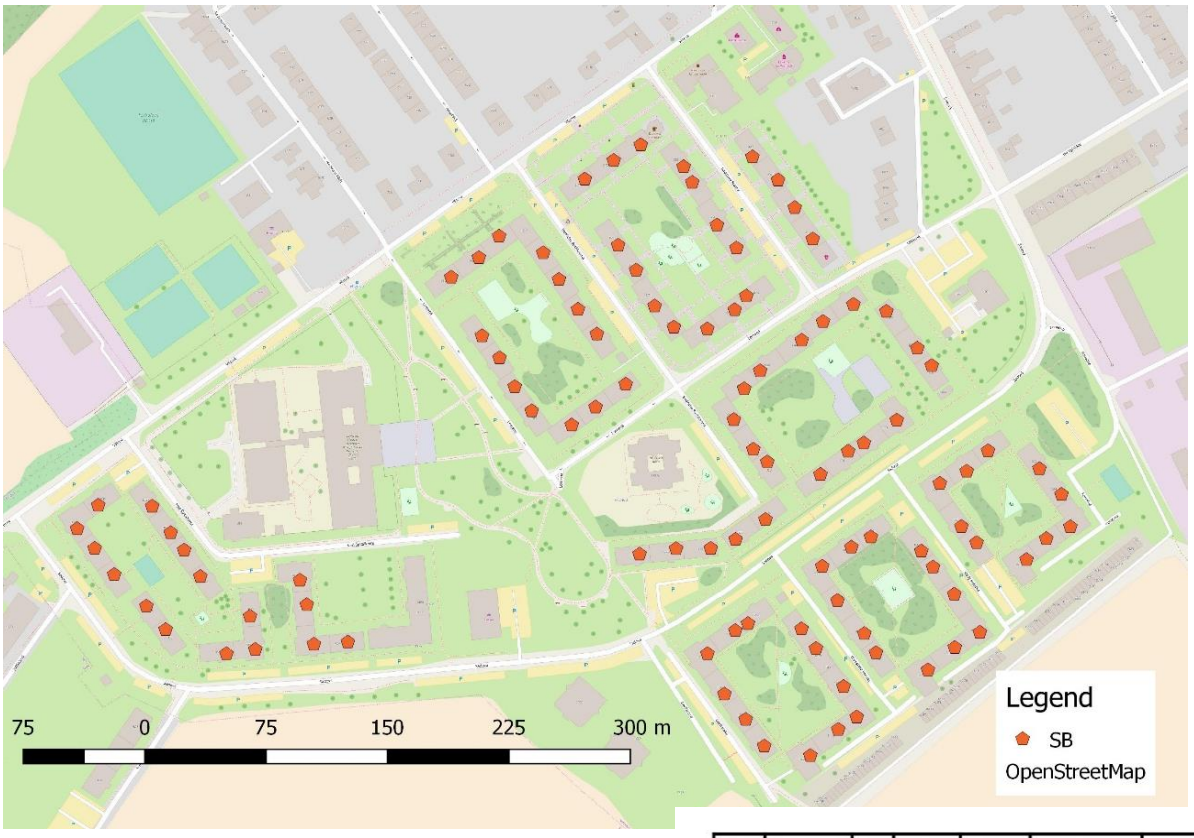

Fig. 3. The detail of data model in the GIS application

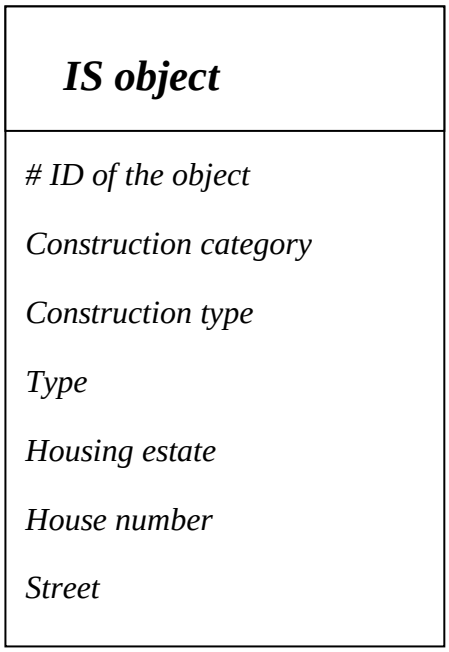

Fig. 4. The conceptual data model in UML

Tab. 3 A part of attributes table of blocks of flats in UH layer.

ID	Category	Type	H.N	H.E	Street	Con. Type
1	1	1	886	Vychod	Lomena	OP 1.11.
2	1	1	887	Vychod	Lomena	OP 1.11.
3	1	1	888	Vychod	Lomena	OP 1.11.
4	1	1	889	Vychod	Lomena	OP 1.11.
5	1	1	890	Vychod	Lomena	OP 1.11.
6	1	1	891	Vychod	Lomena	OP 1.11.
7	1	1	892	Vychod	Lomena	OP 1.11.
8	2	1	879	Vychod	BBuchlovana	OP 1.11.
9	2	1	880	Vychod	BBuchlovana	OP 1.11.
10	2	1	881	Vychod	BBuchlovana	OP 1.11.
11	2	1	882	Vychod	BBuchlovana	OP 1.11.
12	1	1	883	Vychod	Vetrna	OP 1.11.
13	1	1	884	Vychod	Vetrna	OP 1.11.
14	1	1	885	Vychod	Vetrna	OP 1.11.
15	2	1	872	Vychod	BBuchlovana	OP 1.11.
16	2	1	873	Vychod	BBuchlovana	OP 1.11.
17	2	1	874	Vychod	BBuchlovana	OP 1.11.
18	2	1	875	Vychod	BBuchlovana	OP 1.11.
19	1	1	876	Vychod	Lomena	OP 1.11.

4 Conclusion and discussion

The case study of mapping the blocks of flats in UH confirms the hypothesis which assumes that the use of the unified space suitable for the IS greatly facilitates the planning of population sheltering in the territory of UH.

The case study mapped the total number of 364 blocks of flats in the territory of UH. The mapping revealed that 271 objects fall within the construction type OP 1.11, while 33 objects are of the construction type G32, and there are also 15 objects of the type OP 1.31. For 45 objects the structural type was not identified; however 16 of them are probably constructions made of bricks. Therefore, 319 objects, out of the total number of 364, are made of concrete. The results demonstrate the importance of using standardized objects for the IS. Three basic types of objects that enable designing three basic projects for the IS are located in UH. These projects can then be used for designing IS in all of the objects of the given construction type. The creation of a database of blocks of flats is therefore the first stage in planning of population sheltering in UH. The case study has shown the importance of standardization of the high-rise blocks of flats. However, the only downside of this hypothesis is the prerequisite of the blocks of flats, especially those made of concrete, which must be located within the mapped area. UH is a town with a population of approximately 25,000. Nevertheless, there are many villages and small towns in the CR where the high-rise blocks of flats are hardly to be found. In such places, the use of standardized blocks of flats is not very practical. This method is therefore suitable for medium and large towns or cities. According to the statistics focused on housing units in the CR in 2009, 55 % out of the total number of housing units were located in blocks of flats. Undoubtedly, this statistics illustrates the importance of the hypothesis which suggests using standardized blocks of flats.

By means of the GIS tools the spatial database can be used for a better presentation of the acquired data to professionals and the population, and thus it reduces the time needed to get the required information.

The objective of this research was to provide the basis for further work related to the planning of population sheltering. The actual updating the database is subject to further work in this field. The possible expansion of the research also includes designing IS for individual construction series and their implementation into the GIS as a support for planning of population sheltering. Also this area is in the forefront of the authors' interest. In addition, the resulting spatial database provides a lot of options, such as adding further attributes and entities.

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