THE INFLUENCE OF THE ENVIRONMENT ON REAL ESTATE APPRAISAL

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***Abstract**: The existence of adverse environmental conditions may reduce the value of a real estate property, so the appraisers must identify the factors and conditions that influence this value. One of the environmental factors that may influence the real estate value is climate. The paper presents the analysis of thermal comfort in a hot summer day, in the central area of Cluj-Napoca City. The results show an overview of the climate in this urban area in the mentioned period and can be used to analyse the best use of the property. In order to appraise a real estate property, the appraisers must take into account how the thermal comfort can influence the value of the real estate property.*

***Keywords:** environment, real estate, thermal comfort*

1. Introduction

The appraisal process includes several stages, one of these being gathering information and description of real estate. In this stage, the appraiser collects information about a certain market area, about subject-property and comparable properties. The necessary data for an analysis includes general and specific data. The general data refers to general characteristics of the region, city and neighbourhoods; the specific data refers to information about subject-property and comparable properties. Through the analysis of market area, one can identify the borders of that market area and the influence of factors on properties in the area. Forces that have an impact on real estate value are of social, economic, physical/environmental and governmental nature (Appraisal Institute, 2011). It is important for the appraiser to recognize the four forces and to be able to identify and measure the market reaction to the respective force.

The physical/environmental factors refers to natural or artificial features contained in the market area studied, or which have an impact on it. The most important ones are location, climate, topographical features, public transport access, street layout, the size, type and density of buildings and other. Microclimate features refer to wind, or temperature and humidity differences between riverside areas and their surroundings. Thus, the assessors analyse the use of the land and in relation to local climate conditions (Appraisal Institute, 2011).

Nowadays, interest in studies of thermal comfort has increased, mainly because of the development of cities, in the context in which climate changes have also occurred. Due to these changes, to the density, shape and height of buildings, to the material used on the roads and to pollution, the rise of temperatures in large cities does not come as a surprise. These changes lead to the occurrence of ‘heat islands’ (Carfan at al., 2012). The existence of adverse environmental conditions may reduce the market value of real estate (Appraisal Institute, 2011). This paper studies the thermal comfort in the city of Cluj-Napoca, during a hot summer day, from 2015. The study area is the city centre, with urban texture densely built with little vegetation. For this study, the methods chosen were PMV (Predicted Mean Vote) and PPD (Predicted Percentage of Dissatisfied) to calculate the thermal comfort index. The software used for the simulation was ENVI-met V4 which is a "holistic three-dimensional non-hydrostatic model for the simulation of surface-plant-air interactions not only limited to, but very often used to simulate urban environments and to asses the effects of green architecture visions" (ENVI-MET).

2. The influence of the environment on real estate appraisal. Case study: the analysis of thermal comfort in a given area

Cluj-Napoca city is situated in the NW of Romania, in the middle of Transylvania, sprawling over the Someșul Mic and Nadăș valleys. The climate is continental, with warm dry summers and cold winters, influenced by the Apuseni Mountains. In August, the average high is around 24,3 °C, the daily mean 17,8 °C and the recorded high is 38,0 °C. The average precipitation in this month is 60 mm (INS, 1901-2000; NOAA, 1961–1990). Regarding the composition the city centre has taller buildings, very densely built, with narrower streets and less vegetation. The study area is 830 x 830 m.

For this work the software used was ENVI-met version 4.0 Preview III. The grid input model presented in Figure 1, has a resolution of x = y = 4,98 m and z = 2,00 m.

Fig. 1. Grid input model for the city center of Cluj-Napoca

The simulation date was 12.08.2015, when, according to NOAA meteorological data, was recorded a temperature of 35,6 °C and no precipitations, which was the hottest day in 2015 summer. The simulation time was 4 hours, starting from 7:00 AM. The input data for the ENVI-met model is presented in Table 1.

Table 1. Data input model

Day	12.08.2015
Simulation start time	07:00:00
Total hours of simulation	4 hours
Wind speed in 10 m height	0,3 m/s
Wind direction	90°
Roughness length at measurement site	0,1
Initial temperature of atmosphere	308,75 K
Specific humidity at model top (2500 m)	7,3 g/kg

After running the simulation, the PMV and PPD were calculate, using Biomet, to study the thermal comfort in the areas of interest.

Thermal comfort

Thermal comfort has been defined as “a state in which there are no driving impulses to correct the environment by the behaviour” (Hensen, 1991). Another definition, provided by The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), is “the condition of the mind in which satisfaction is expressed with the thermal environment” (ASHRAE, 2004). There is no absolute standard for thermal comfort as even persons in the same space, same climate and having a similar cultural background express different opinions about their sensation (Djongyang at al., 2010). Still, a number of factors that influence thermal comfort were defined by MacPherson in 1962. These are: air temperature, air velocity, relative humidity, mean radiant temperature (4 physical variables) and clothing insulation and activity level/metabolic rate (2 personal variables).

Predicted mean vote (PMV)

Predicted mean vote (PMV) was originally developed by Fanger in 1972, who carried out different experiments on groups of people to investigate when thermal neutrality would occur. He obtained an equation, which, related to the ASHRAE thermal sensation scale, was developed into the PMV index and further into the PPD index (Djongyang et al., 2010). PMV is considered to be the most representative thermal comfort model (Kim et al., 2013). The index takes into account a large population, exposed to a given environment and predicts the mean response of the group. It is seen as an international thermal environment indicator (Fanger, 1970). The range of the PMV index is between -3 and +3, where -0,5 and +0,5 is considered the comfortable range and -3 is very cold and +3 very hot.

Predicted Percentage of Dissatisfied (PPD)

The PPD index represents the percentage of people who felt some discomfort about the environment, determined for each class of PMV. According to Fanger, 1972, people who responded ±2 and ±3 are considered uncomfortable and those within ±1 and 0 are considered comfortable, using the seven-point scale of thermal sensation (Fanger, 1970). There is a direct relationship between PPD and PMV, given by the formula, (Candas, 2000):

$$PPD = 100 - 95\exp[-(0{,}03353\,PMV^4 + 0{,}2179\,PMV^2)] \quad (1)$$

Even when the value of PMV = 0, there still is a percentage of dissatisfied people of 5%, which can be explained by the variation of interpretation of thermal comfort from person to person.

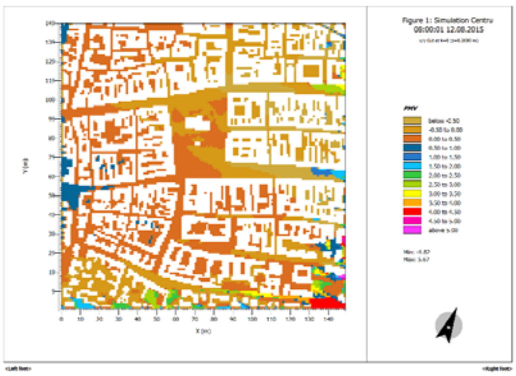
For this work, the following variables showed in Table 2 were used in BioMet (post-processing tool) (ENVI-MET), for the calculation of PMV/PPD:

Table 2. Human parameters for BioMet

Age of person (years)	35
Gender	Male
Weight (kg)	75
Height (m)	1,75
Static Clothing Insulation (clo)	0,5
Basal Rate (W)	84,49
Work Metabolism (W)	80,00
Walking speed (m/s)	1,21
Sum metabolic work (W)	164,49

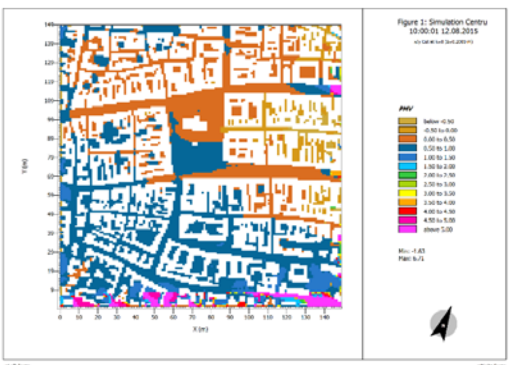
3. Results and discussion

Figure 2 displays the results of the PMV index for the City centre of Cluj-Napoca from 8:00 am to 11:00 am. The range of the PMV index has lower values at 8:00, from -1,82 to +5,67 and it increases until 11:00, where the values range from -1,52 to +7,50. We can see that in all 4 situations there are areas that are in the thermal comfort range of -0,5 and +0,5. These areas are mostly in the narrow streets or in large streets where high buildings are present, and in the main square, Unirii Square (paved with granite single stones), located in the city centre. But most values are outside the accepted range pointing either to slightly cool or to very hot.

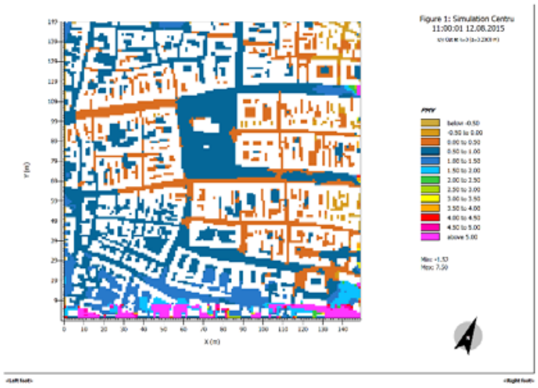


a. 08:00 am

b. 09:00 am



c. 10:00 am

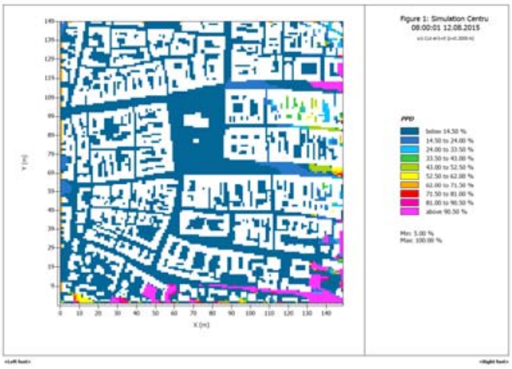


d. 11:00 am

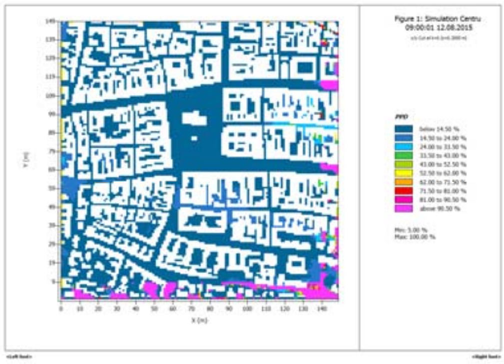
Figure 2 a, b, c, d. PMV index for the City center

During the studied interval of time, the values of the PMV index increase, which means there is a hotter environment at 11:00 am. Also, the areas change, as in the first 2 hours (Figure 2a and 2b) the areas that are considered slightly cooler are in the S, NE and E, occupying much more than in the last 2 representations (Figure 2c and 2d) where we can see that these areas now become hotter, with higher values of the index: Unirii Square and the southern part of the studied area. An explanation for this would be the position of the sun, more high in the sky, and the lack of shading in the square. Even with this increase, the areas have values between +0,50 and +1,00, in the slightly warm range.

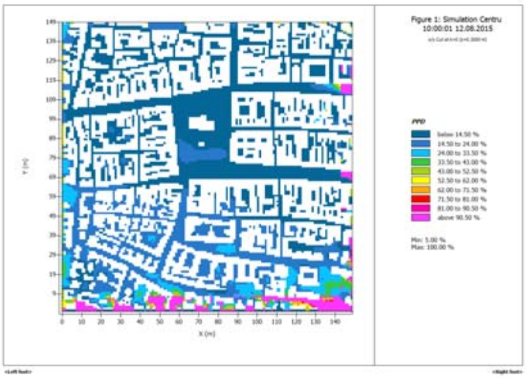
In Figure 3 we can see the results for the PPD index for the city centre. The areas with percentage below 14,50% are in the city square and in the larger streets, while the areas with more dissatisfied people are in the eastern and southern part of the city. Thus, we can see a correlation between PPD and PMV, as where PMV values are out of the comfort area, the percentage of dissatisfied people is higher.



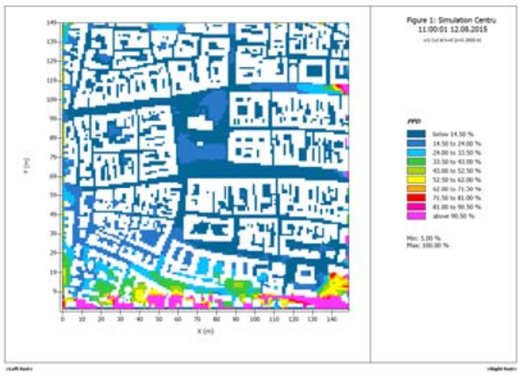
a. 08:00 am



b. 09:00 am



c. 10:00 am



d. 11:00 am

Fig. 3 a, b, c, d. PPD index for the City centre

4. Conclusions

The results show an overview of the climate in this urban area and could be used to asses the differences between areas in order to see where each one scores higher and lower. Thus, measures could be taken to improve the quality of life in these environments.

In order to the assessment of real estate property, it is necessary to determine the highest and best use of the property, this representing the fundament of the market value. The highest and best use is estimated following a complex and correct analysis procedure, based on which a credible opinion may be issued, concerning the market value (Roib, 2011).

A first step is data collection, indicating the best use of the site, as being free, in order to assess the value of the land for a particular use. The future use of the land must be consistent with the environment. The climatic advantages and constraints must be analysed to determine the best use of the land. The best use is also affected by the extent to which the existent constructions contribute to the value of real estates. A site may be affected by exposure to sun, wind or other environmental factors. A location that is very exposed to the sun is not suitable for retail stores. The shady side of the street is more circulated by pedestrians and the stores located here records higher sales, even if they have higher rents and, the value at which the land is estimated. The existence of adverse environmental conditions may reduce the market value of the real estate.

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