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The Issue of Landfill Location: Example of the Tarno Site (Zagreb County, Croatia)

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ABSTRACT Considering the growing problem of waste disposal, this paper analyses the spatial distribution, legal and sociological framework, and relevant environmental components of existing waste landfills in Zagreb County (geological, hydrogeological and geomorphological features of the locations, climate). In addition to potential ecological and health consequences, waste disposal often has complex social and economic consequences for the surrounding locations. Therefore, these environmental aspects were also used to analyse the justification of decision to select the location Tarno as a potential county waste management centre. This is an interesting case since it aroused negative reactions from political structures and the local population of the nearby Town of Ivanić Grad. In addition to the environmental parameters, the topographic exposure index of the wider area was determined. This is based on the characteristics of the wind rose in order to identify areas of maximum exposure to the negative impact of odour due to the prevailing air currents. Special attention was paid to the buffer zone up to 3000 m from the location of potential landfill sites. Considering the strong resistance towards the selection of this location for a county waste management centre, the attitudes of local residents, their level of knowledge and their awareness of the issue were also examined. The existence of the NIMBY syndrome and YIAMBY was also tested.

Key words: waste management, waste landfill, location, topographic exposure, NIMBY syndrome, YIAMBY syndrome.

1. Introduction

One of the consequences of demographic and socioeconomic development and the development of a consumer mentality is an increase in the amount of waste, particularly in urban regions. According to the World Bank, some 1.3 billion tonnes of solid waste are produced in cities each year and it is expected that this quantity will rise to 2.2 billion tonnes by 2025 (Hoornweg and Bhada-Tata, 2012). The per capita quantity of waste in the past ten years, according to the same estimates, has increased from 0.64 to 1.24 kg/day. In 2010, 2.7 billion tonnes of waste was produced in the territory of the EU-27, of which 220 million tonnes was household waste. In Croatia, the quantity of municipal waste increased until 2008 (1.79 million tonnes), though this decreased by 9% in 2010 to 1.63 million tonnes (AZO, 2010). A declining trend can be interpreted as part of the economic crisis, increase in the share of weighed waste and other factors. Therefore, a strategy based on reducing quantities of waste, reuse and recycling are becoming primary in spatial management. The increasing influence of the local community has created new circumstances in determining optimal locations for waste landfills.

2. Theoretical Framework and Research to Date

Several topics can be highlighted in the research of waste management issues. The first concerns the issue of the impacts of the landfill on the environment and problems associated with its reclamation (Breg, Kladnik and Smrekar, 2007; De Feo, De Gisi and Williams, 2013; Guerrero, Maas and Hogland, 2013). The second concerns the stance of the local community. Research on the stance of citizens regarding ecological matters and behaviours in response to those matters first arose in the 1970s. Initially, analyses dealt with the relationships between awareness, ecological issues and activities taken to mitigate them. Since the 1990s, a new topic arose: the relationship between ecological awareness and waste management issues (Kufrin, 1996). With increasing awareness of health issues relating to waste management, syndromes such as NIMBY (Not In My Back Yard) and NIABY (Not In Anyone's Back Yard)[1] appeared. Authors addressed the matter of public relations in determining locations for landfill sites (Ishizaka and Tanaka, 2003), perspectives and procedures in waste management (Purcell and Magette, 2010), and conflicts between those included in the issues of landfill reclamation and waste management, such as nongovernmental organisations and local administration units (Korucu and Erdagi, 2012). In the past decade, the collection of municipal waste and the methods for its disposal have become significant topics of discussion (Magrinho, Didelet and Semiao, 2006; Rogge and De Jaeger, 2012; Sokka, Antiklainen and Kauppi, 2007; Sundberg, Gipperth and Wene, 1999; Taylor, 1999; Taylor, 2000).

These topics are still relatively poorly addressed in the Croatian literature. The majority of authors deal with the environmental impacts of landfills, landfill reclamation is-

[1] Today, syndromes such as NIMBY, NIABY, BANANA, LULU and YIMBY are more commonly considered in the context of local industry and energy plans, and landfills for chemical and nuclear waste (Devine-Wright, 2005).

sues and waste collection systems. An analysis of the current state of waste management in Croatia was given by Fundurulja, Mužinić and Pletikapić (2001) and Kučar Dragičević (2006), stressing the fundamental problems and differences between illegal and organised municipal waste landfills, and giving examples of reclamation of municipal waste landfills. Šundalić and Pavić (2009) investigated the connection between place of residence (rural-urban) and environmental problems considering various demographic variables (education, age, gender etc.). Several papers have dealt with issues concerning the largest landfill in the City of Zagreb, also the largest in Croatia, Jakuševec (Ahel, Terzić and Tepić, 2006; Barčić and Ivančić, 2010). Reclamation of landfills has been addressed by Kovačić (1994) and Miličić (2012).

In the second group are papers on the stances of citizens and local communities, their level of knowledge concerning waste disposal matters and their level of ecological awareness and care for the environment. Šućur (1992) analysed a case of cohabitation between a waste landfill and the local community. The NIMBY syndrome was examined by Čaldarović (1996). Kufrin (1996; 2003) investigated the level of ecological knowledge of the local community and its willingness for active involvement. Similar topics were address by Cifrić (2005). Mustapić (2010) analysed the stance of the population of the Makarska Riviera on the topic of the disposal of municipal waste. Among geographic papers on the topics of municipal waste and landfills, Šiljković (1993) gave an overview and analysis of the state of the management of municipal waste in countries around the world. The same author (2004) gave an overview of the collection of municipal waste in the peri-urban belt around Zagreb, in Zagreb County. Fundurulja et al. (2001) gave an overview of reclamation works performed at several landfill sites, including the Mraclin landfill near Velika Gorica and the Lazarevac landfill near Vrbovec. A significant source of data is the Waste Management Agency, which publishes annual reports on the quantities of waste. Zagreb County publishes the periodical *Report on the State of the Environment*. In 2008, it published the *Waste Management Strategy of Zagreb County*, outlining the present state and the objectives and waste management measures to 2015, and a proposal for the site of the future county waste management centre.

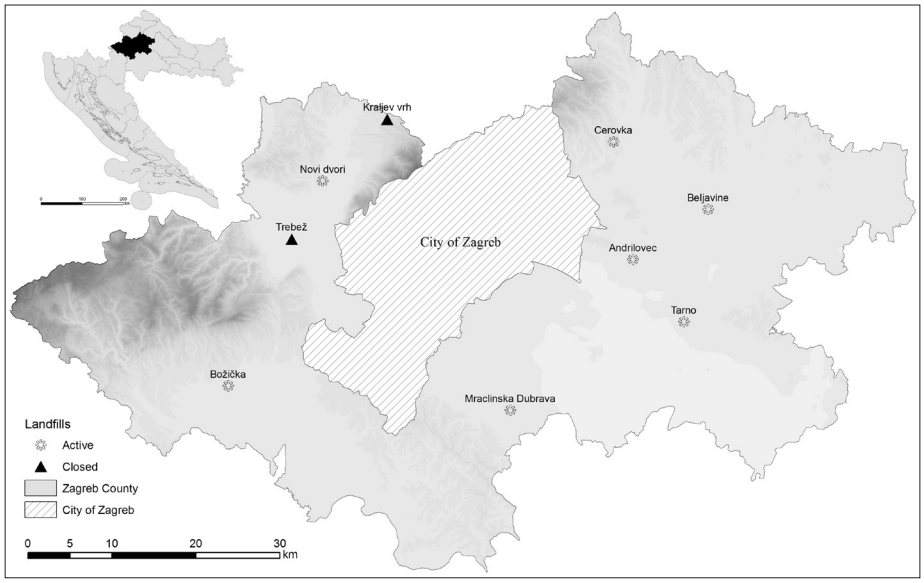
3. Framework of the Research

3.1. Spatial Framework of the Research

Zagreb County is situated in NW Croatia. The county includes 9 towns (Zaprešić, Samobor, Sveta Nedelja, Jastrebarsko, Velika Gorica, Dugo Selo, Ivanić-Grad, Vrbovec, Sveti Ivan Zelina) and 25 municipalities. In 2011, the county had a population of 317,606 (7% of the national population). In comparison to 1991, the population has increased by 12%, while in comparison to 2001, by only 2.5%. This increase is the consequence of migration during the 1990s from war-struck areas of Croatia and Bosnia Herzegovina. This increase in the post-war period, in addition to migration here from other parts of Croatia, is also the consequence of the process of suburbanisation and emigration from the City of Zagreb.

There are 9 municipal landfills in the county, of which 7 are active and 2 are closed (Fig. 1). This paper analyses the potential impacts of the waste landfills on the state of the environment and the role of citizens in shaping waste management policy. The Tarno landfill was selected for this case study, as this has been considered as a potential location for the future county waste management centre, where large quantities of waste from around the county would be disposed of, thereby having a possible negative impact on the environment and the quality of life of the local population.

Figure 1
Waste landfills in Zagreb County



3.2. Methodological Framework

Among the relevant environmental components important for the landfill location, the geological and hydrogeological properties of the terrain, hydrological network, relief and climate were analysed. With regard to the transfer of airborne pollutants, particular attention was given in the analysis to air currents and relief. The analysis was conducted using the topographic exposure method (Mikita and Klimanek, 2010).

A survey was conducted in the town of Ivanić Grad, as this is the largest urban centre near the Tarno site. The reasons for selection of this location for the analysis of the attitudes and reactions of the local community are based on the reactions of the political structures and citizens. Sampling for the survey was conducted using the snowball method. The survey was posted on the official website of the Town of Ivanić Grad, and distributed via e-mail. A total of 112 persons participated in the

survey. The authors are aware that the non-probable sample ("volunteers" willing to fulfil the survey) and the technique of internet survey have many disadvantages primarily present in the sphere of auto-selection of the interviewees who have to have certain knowledge of IT communication to participate in the survey and who also have to have a certain interest in the topic. Therefore we are aware that the sample group will be relatively small and homogenous and that results cannot be generalized to the level of entire settlement. A total of 112 persons participated in the survey: 58% men and 42% women. Age groups were as follows: 73% from 18–40 years, 24% from 41–60 years, 3% 60+ years. A minimum age of 18 years was set for participation, as this is the legal voting age allowing citizens to participate in a referendum. A small percentage of the older participants can be observed. This level of participation is likely the result of the survey method.

One of the objectives was to reveal the level of ecological knowledge, which is a precondition for ecological behaviour and attitudes. Assessments by the individuals regarding their own level of knowledge on the topic were used, though we are aware that this issue was significantly simplified with such an approach. The second objective was to determine the existence of the NIMBY syndrome and the perception of risk. The survey results were processed using descriptive quantitative analysis.

3.3. Legislative Framework

The legislative regulations pertaining to waste disposal and environmental impacts in Croatia after its independence came into effect in January 1995 with the adoption of the first Waste Act (Official Gazette [OG], 34/95). In October of the same year, the Croatian Parliament adopted the Waste Management Strategy. Today, waste management is regulated under several pieces of legislation, the most important of which are: Waste Act (OG 178/04, 111/06, 60/08, 87/09), Waste Management Strategy of the Republic of Croatia (OG 130/05), Waste Management Plan of the Republic of Croatia for the period 2007–2015 (OG 85/07) and the Environmental Protection Act (OG 110/07, 80/13). Environmental protection is encompassed under the Environmental Protection Strategy of the Republic of Croatia (OG 46/02) and the Waste Management Plan, which is an implementing document of this Strategy.

The conditions for waste landfill location and the monitoring of environmental parameters are regulated by the Ordinance on the manner and conditions of waste disposal, categories and operating conditions for waste landfills (OG 117/07, 111/11, 17/13, 62/13). Pursuant to the Ordinance, the location of the landfill must be at least 500 m from inhabited areas where people are permanently settled. They may not be in protected water zones, protected zones with thermal or mineral waters, on terrain with flowing ground waters (if the highest point of the water table is less than one metre below the foundation of the landfill), or in floodplain areas and areas threatened by geohazards.

The possibility of including the local community regarding waste issues was made possible in 2008 with the adoption of the Regulation on the informing and participa-

tion of the public or the interested public in environmental protection matters (OG 64/08). One year later, Croatia ratified the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters.

In the long-term period, the Waste Management Strategy envisages the establishment of regional and county waste management centres. Zagreb County and the City of Zagreb are required to envisage a maximum of one centre as a location for the collection, processing and deposition of waste. The objectives of such a regional concept include the rational use of space and reduction of waste handling costs. County physical plans will provide detailed outlines of the facilities of the waste management centres, technological waste processing, receipt, distribution, intended reloading stations and the flow of all types of waste within the county/region, and the possible impacts on people and the environment.

4. Waste Landfills – Social and Environmental Aspects

With the modernisation of society and the increase in the urban population, quantities of waste are increasing (Mustapić, 2010). Waste management is an exceptionally complex system, considering that a number of different factors influence the system, and these factors can be divided into three basic groups. The first group includes the socioeconomic factors responsible for the generation of waste (economy, transport, population). The second group includes the environmental and natural factors (geological and hydrogeological conditions, climate, biosphere). The third group are the actors involved in waste management (political and economic). Meanwhile, local government, which is responsible for the organisation of municipal waste management systems, is often faced with organisational and financial issues and with the complexity of the organisation of waste management (Guerrero et al., 2013).

4.1. Social Aspects of Waste Management

In addition to ecological and health consequences, waste disposal often has complex social and economic consequences (Eskandari, Homaee and Mahmodi, 2012). One is the appearance of the NIMBY syndrome. The syndrome itself began to be studied in the 1980s. According to Čaldarović (1996), NIMBY is a "generalised rejection syndrome concerning a certain political structure of decision-making, the self-legitimising choice of the development of a society, which is contextualised in every specific situation in relation to the individual conjunctures". Pol et al. (2006) defined the NIMBY syndrome as the social rejection of a structure, infrastructure or service necessary for the community but which has negative connotations. Some of the characteristics of the NIMBY syndrome are: distrust in the administration and government, resistance of the local community towards the decisions of government and experts, perception of projects on health and the quality of living, fears and risks as a consequence of different positions of experts (Mustapić, 2010; Šućur, 1992; Čaldarović, 1996).

In addition to the NIMBY syndrome, several similar phenomena have appeared: the LULU effect (Local Unwanted Land Users), BANANA effect (Building Anything at all Near Anyone), NIABY (Not In Any Back Yard), and YIMBY (Yes In My Back Yard). Very often, the NIABY syndrome is not only a fear of environmental pollution, but also a fear of the quality of life, decreases in land value and a type of stigmatisation of the location due to social or psychological repulsiveness (Pol et al., 2006; Čaldarović, 1996). One of the ways to minimise these syndromes is through the communication of risks, which includes the procedure of more effective risk management. It is necessary to adequately explain the risks and advantages to all those interested (Čaldarović, 1996; Ishizaka and Tanaka, 2003) and to develop trust in the information and its sources (Čaldarović, 1995). The media often take over the role of informers. A common problem, however, is that the interested public is exposed to only partial information from interested parties, and the 'big picture' is lacking.

4.2. Waste Management and the Environment

By law, waste management must be implemented in a manner that does not threaten human health or the environment. It is necessary to avoid pollution of the sea, water, air and soil, the appearance of noise and unpleasant odours, threats to the biosphere, detrimental impacts in areas of cultural, historical, aesthetic and natural value, and to prevent explosions or fires.

Until the 1970s, little attention was given to the issues relating to the disposal of waste in nature. It has been estimated that more than 40 million tonnes of municipal waste was disposed of in nature in Croatia until the mid 1960s (Mustapić, 2010). Over time, numerous direct negative impacts of waste landfills on the environment were reported: pollution of water, soil and air, noise, vibrations, habitat alteration and threats to the biosphere, increased concentrations of insects, rodents and birds. Many other negative effects arose, such as the increased threat of fire and explosion, spread of unpleasant odours, smoke and dust, and increased concentrations of detrimental biological agents (bacteria, viruses, etc.), in addition to negative impacts on health, alterations to the landscape, threats to water resources and a drop in land value (De Feo et al., 2013; Milanović, 1992; Urbanc and Breg, 2005).

4.2.1. Basic Geological, Hydrological and Relief Conditions for Landfills in Zagreb County

The county landfills are located in areas composed of clastic lake-fluvial sediments and sediments of Eolic origin of Plio-Quaternary, Pleistocene and Holocene age. They are composed of gravel, sand, silt, clay, loess and loess-like sediments (Miko et al., 2009). With regard to the impacts on groundwater, it is positive that these sediments are primarily layers of very poor or poor porosity (Table 1). Water pollution represents a great threat, as water is an efficient medium for the transferral of pollution into the environment. Depending on the type of pollutant, this can be a long-term threat that is difficult to remove, and whose reclamation is very expensive,

often long-term and uncertain (Breg et al., 2007). All landfills are situated more than 500 m from the nearest water supply area and therefore do not represent a direct threat. The Trebež landfill, situated on the Sava fluvial terrace, represented a threat for the Strmec water supply area due to its position on terrain composed of deposits with very good permeability (Table 1). An additional problem is its position within the floodplain area of the Sava River, in a zone of increased groundwater levels of the Sava aquifer. For these reasons, the landfill was closed. With regard to its position, the Tarno landfill does not represent a threat for the analysed geological and hydrogeological parameters of the site.

Table 1
Geological and hydrological parameters of waste landfill sites.

Landfill	Lithological substrate	Age	Permeability of substrate	In or near floodplain area	Proximity to water supply area (<500 m)	In protected water zone
Andrilovec	loess	Pleistocene	very poor	no	no	no
Beljavine	loess	Pleistocene	very poor	no	no	no
Tarno	Pond sediments, clay, clay-silt	Holocene	very poor	no	no	no
Novi Dvori	loess, gravel, sand, clay	Pleistocene/ Holocene	poor	yes	no	no
Božička	gravel, sand, clay	Plio-Quaternary	poor	no	no	no
Cerovka	sand, sandy and clay marl, clay	Neogene	very poor	no	no	no
Mraclinska Dubrava	gravel, sand, clay	Pleistocene	poor	no	no	no
Kraljev Vrh	gravel, sand, clay	Plio-Quaternary	poor	no	no	no
Trebež	gravel, sand	Holocene	very	yes	no	yes

Source: Croatian Waters 2010; Miko et al. 2009

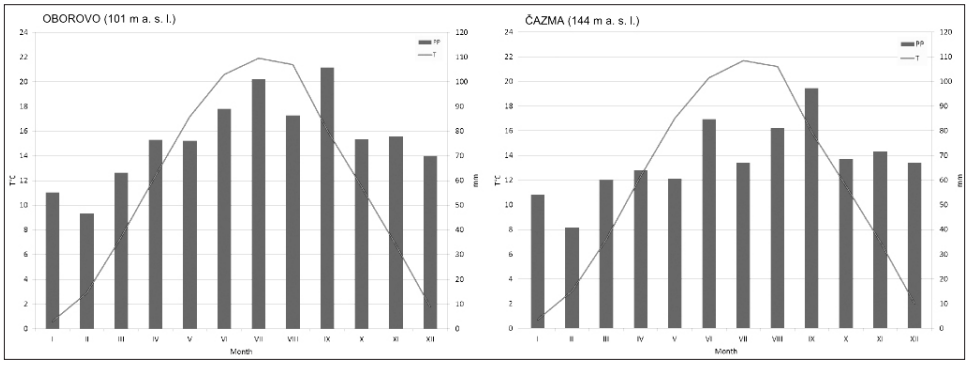
From the regional geomorphological perspective, the landfill sites are situated in the contact belt between the dynamic relief of the macro-geomorphological region of NW Croatia, which is characterised by the alternation of low hills, mountains, valleys and lowlands. Seven of the above landfills are situated in the lowland terrain, at elevations between 100–200 m, including Tarno. Three landfills (Kraljev vrh, Novi dvori and Cerovka) are situated not hypsometrically high, but in dynamic relief/ hilly areas with poorly divided relief (35–65 m/km^2). The hypsometric properties and vertical division of the relief, in combination with the geological structure and climatic properties are important elements for the positioning of a landfill, as they influence the runoff of water, temperature regime and aeration of the site, and on the visual isolation from the surrounding areas, which also influences the formation of public opinion.

4.2.2. Climatic Conditions

Climate influences the stabilisation of waste, the migration of matter, the production of gases and undesirable effects such as rinsing, filtering, unpleasant odours, and the production and stability of dust (Pleško, Šinik and Lončar, 1974; Chen, 1996; Vasarevicius and Baziene, 2011). In addition to the quantity of precipitation, air temperature is also significant, as it influences the temperature of waste, evaporation and transpiration and the associated biochemical processes that impact degradation, the development of gases and threat of fire.

In the analysis, data were used from the weather stations Zagreb-Maksimir, Zagreb-Botinec, Jastrebarsko, Pleso, Samobor and Zelina (for the period 2000–2009), and Oborovo and Čazma (for the period 2000–2011) (Fig. 2). All landfills are situated within the *Cfb* climatic subtype according to the Köppen classification. The mean annual air temperature is 9–11°C. The mean monthly temperature is from 0°C (January) to 23°C (July). The mean annual number of warm days (T≥25°C) is 50–60. The absolute maximum air temperature at all stations in summer exceeds 34°C. In such conditions, increased evaporation occurs and, with it, unpleasant odours appear. Depending on the air temperature and air currents, these odours can be carried a long distance. The most stable meteorological conditions, when the smells are not spread, are during inversion events, which are a common situation in winter in this part of the Pannonian basin (Šegota, 1988). The mean annual precipitation is 800–1100 mm. The mean monthly precipitation is 30–120 mm, with minimums in February and August/September. Spring and summer storms can also have a significant influence as, depending on their frequency and intensity, they can cause increased rinsing and an increase in the drainage of water, thus negatively impacting the direct vicinity of the landfill.

Figure 2
Trend of monthly mean air temperature (T) and precipitation (PP), 2000–2011



Source: Croatian Hydrological and Meteorological Service

The most important factor for the spread of odours and aeropollutants are air currents. Therefore, it is important to determine the dominant directions and their

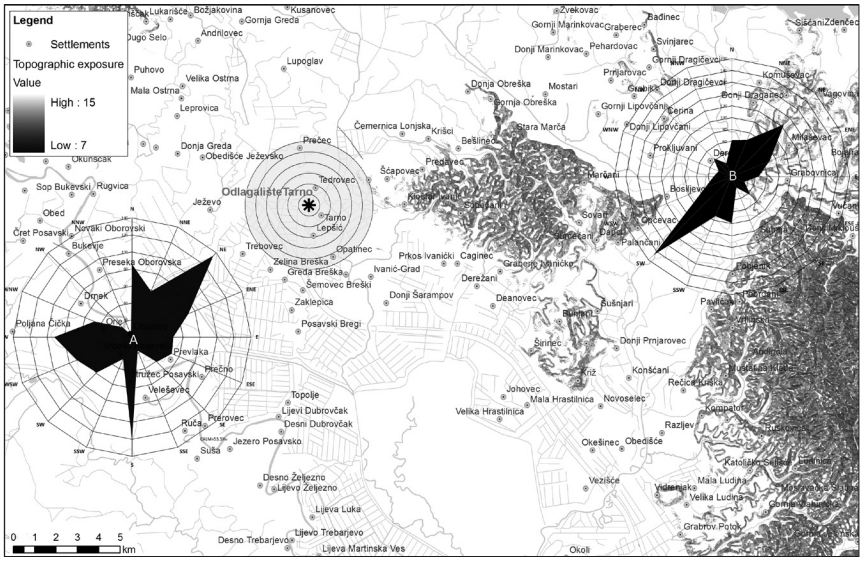
frequencies, and the thermal relations that impact them. Generally, the emission of odours has a very dispersive character, particularly in areas with frequent strong winds. Receptors positioned downwind of the landfill have a greater chance of receiving the negative impacts. Odours spread more slowly during calm weather and temperature inversions which hinder mixing and dispersion (CEQA, 2014).

Considering the local conditions, an analysis of the influences of air currents must be performed separately for each microlocation. An analysis for Tarno was performed on the basis of the nearest weather stations at Čazma and Oborovo for the period 2000–2011 (Fig. 3). Tarno is situated in the subgeomorphological region of the Lonja lowlands. The nearest increases in the relief are the low Marča hills, situated 7.5 km away to the east. The surroundings areas are dominated by lowland arable landscapes with sparse forests in the area between the Zelina and Lonja Rivers. The surroundings of the locality itself are in contact with mesophilic meadows and sparse mixed oak-hornbeam woodlands. This kind of vegetation can have very little influence on reducing the spread of pollutants and odours by air. However, even sparse forest vegetation increases the roughness of the surface and causes increased mechanical turbulence, i.e. air mixing. Furthermore, the alternation of vegetation types and surfaces affects the radiation, thermal and aerodynamic properties of the Earth's surface. This contributes to the absorption of gases; reduced wind speed influences the deposition of dust, and affects the direction and height of air currents. Therefore, vegetation is an important landscape element in planning the location (Belt et al., 2007; Geiger, Aron and Todhunter, 2009; Neff and Meronej, 1997).

In the wider proximity of the locality, the dominant quadrants of wind direction are NE (26.2–26.5%) and W (28.5–33.7%) (Fig. 3). The wind rose clearly shows the influence of the relief on the ground level air circulation. Due to the geographic position of Čazma between the Marča hills to the west and the Moslavačka Gora hills to the southeast, there is a tunnelling effect which is reflected in the increased share of winds from the NE and SW directions (12.6%:18.8%) and a reduced share of winds from the W and SE directions (3.1%:4.4%). In order to consider the influence of the surrounding relief in addition to wind direction, GIS analysis was carried out to determine the topographic exposure (TE), which reflects the degree of exposure or isolation of the locality from air currents caused by the local topography, i.e. from the properties of the relief, such as its height, extension and separation (Mikita and Klimanek, 2010). To ensure greater precision, this is calculated on the basis of 16 directions. According to the results for the general area, the index ranges from 7 (terrain with hindered aeration due to relief barriers) to 15 (flat terrain with unhindered aeration). Possible direct effects on air quality in the surrounding areas are marked with a buffer with a division of 500 m to a distance of 3000 m from the current site of the landfill. These distances were taken as the limit distances pursuant to the Croatian regulations and practices of certain countries (Allen et al. 2003; CEQA, 2014; EPA, 2005). Tarno is situated on flat terrain, far from higher ground, and is therefore characterised by good aeration (TE=15). Considering the predominant wind directions and relief, it can be expected that the odours and aeropollutants will most strongly spread towards the SW, N, E and NE. The site is somewhat protected from the direct effect of the wind from the east due to the higher Marča woods. The protective effect

of this higher ground was explained earlier, with the example of the Čazma station. At the nearby station Oborovo, where there are no such relief barriers, there are no protective windbreak effects. Considering the distance and microclimatic properties, the following surrounding settlements would be most affected by the county centre: Tarno, Tedrovec, Lepšić, Opatinec and Prečec. The population of this area in 2011 was 741. The impacts of the spread of odours can be reduced with the implementation of well-known methods such as regular covering of waste, handling of leachate waters and gases, and planting protective vegetation belts (Xiangzhong, 2004).

Figure 3
Topographic exposure of the terrain. Station: A - Oborovo, B - Čazma (source of wind data: Croatian Hydrological and Meteorological Service)



5. Results of Testing Public Opinion in the Town of Ivanić Grad

Following the political and economic processes of transition and the poor economic situation, concern for the environment is often classified as a less important issue in contemporary Croatian society (Mustapić, 2010). According to research conducted by Cifrić (2005), the ecological issue of the greatest concern was the inadequate handling of municipal waste. It is interesting that residents of the City of Zagreb and Zagreb County assessed the issue of inadequate handling of municipal waste as being either of very little concern or little concern, despite the inadequate waste disposal solution currently in place.

In order to obtain clear insight into the perspective of the local population and their perception of their own influence in creating waste management policy, a questionnaire survey was conducted among the residents of the Town of Ivanić Grad. It was selected as it is the only town in Zagreb County which has seen a reaction of its

citizen in recent years concerning the issue of the site for the county waste management centre. Although their reaction was spontaneous and not organized, they can be considered as *civilian actors* of social change (Seferagić, 2008). The proposal to locate the county waste management centre at Tarno aroused a reaction from the Town Council. At their session of 21 May 2010, the Council passed a decision to issue a negative opinion to the proposal, and on 1 June 2010 passed a decision to call a referendum on the matter. The referendum was held on 27 June 1010, and a total of 5487 (42.46%) voters turned out. Among them, 96.8% voted against the site, and only 2.5% for it. Furthermore, protests were held in front of the Zagreb County administration building in Zagreb in May 2010.

Considering the strong opposition to the centre's proposed location, the objectives of the survey were: to determine just how informed the local community really is on the waste disposal issue, i.e. the level of ecological information; the scale of ecological knowledge; the primary source of their knowledge on the subject; the extent to which the referendum results are the consequence of the NIMBY syndrome; and the corroboration of objectivity and subjectivity, i.e. to what extent public opinion is formed by objective knowledge of the situation and to what extent by a subjective opinion of citizens and their perception of risks.

Table 2
Percent of completed surveys

No.	Question	No. of answers	Percent (%)
1	Do you live in Ivanić Grad?	112	100
2	In your opinion, how familiar are you with the location of Tarno as the site for the county waste management centre?	112	100
3	How did you acquire information about the location of Tarno?	111	99.1
4	Do you think that your level of information is a result of:	99	88.3
5	In your opinion, how would you rate the role of local population in shaping waste management policy in Ivanić Grad?	111	99.1
6	In your opinion, how could the role of citizens in the shaping of waste management policy be increased?	112	100
7	Did you attend the referendum on the location of Tarno as a county waste management centre held on 27 June 2010?	112	100
8	Do you think that your answer at the referendum was in line with your knowledge of the issue?	81	72.3
9 and 10*	What were your reasons for voting against? What were your reasons for voting for?	84	75
11**	If you like, please provide your comments on the location of county waste management centre in Tarno	32	28.5

* Interviewee could answer either question number 9 or 10 but not both.
** Question number 11 was not a compulsory question.

A total of 112 persons participated in the survey: 58% men and 42% women. Age groups were as follows: 73% from 18–40 years, 24% from 41–60 years, 3% 60+ years. A minimum age of 18 years was set for participation, as this is the legal voting age allowing citizens to participate in the referendum. With regard to education level, 49% of those surveyed had completed university, 32% had completed secondary school, and 19% had completed other higher education. As seen in Table 1, question 8 ("Do you think that your response at the referendum is in line with your knowledge of the problem") had the lowest number of answers. Also, questions 9 and 10 should be calculated together since interviewees could answer only one of those questions. In total, 28 interviewees answered neither question 9 nor 10. Finally, question number 11 was not obligatory since it was intended to be for comments.

To fulfil the first objective of the survey, citizens were asked the following question "In your opinion, how well are you informed on the issue of the location of Tarno as the site for the county waste management centre?" As a response, citizens were offered a scale of five answers: "very poor, fairly poor, well, very well, extremely well". In response to that question, almost two-thirds surveyed believed they were well informed or quite well informed on the issue. Adding to this the 16% who stated they were very well informed, the share of those well informed was increased to 79.5%. This response is considered to be a subjective assessment by the persons surveyed, though it is a significant indicator of their activity.

Table 3
In A your opinion, how familiar are you with the location of Tarno as the site for the county waste management centre?

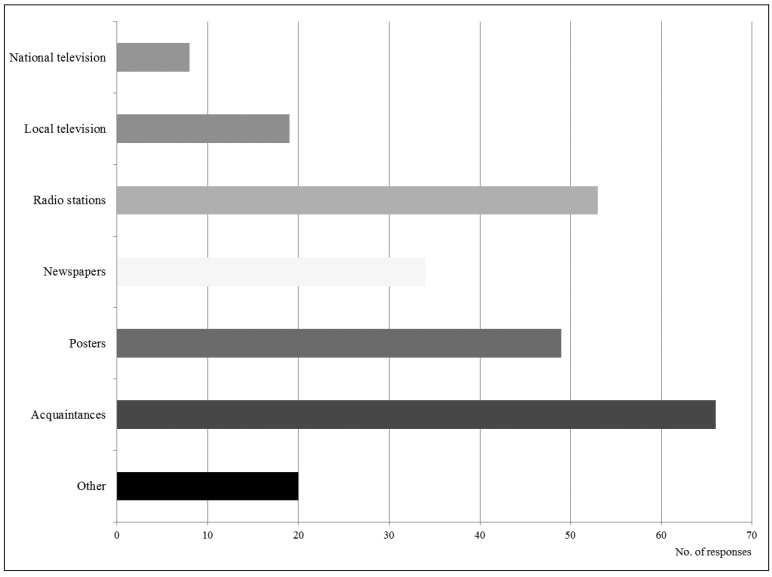
	Number of answers	Percentage (%)
Very poor	3	2.7
Fairly poor	20	17.9
Well	39	34.8
Very well	32	28.6
Extremely well	18	16.1

Source: survey

In order to fulfil the second objective of the survey and to determine the source of their knowledge, citizens were asked two questions. The first question was "How were you informed about the issue of the Tarno site?" Interviewees could choose between the following answers "radio, national TV, local TV, public presentations, Internet, posters, newspapers, from friends or relatives, from acquaintances". The second question was an open type question, stating "What do you think is the reason for your level of knowledge about the Tarno?" The majority of those surveyed specified acquaintances, local radio stations and posters (Fig. 4). Only 8 people (8%) stated that they had received their information from the national television station, and 34 (33%) from the newspapers. From this, it can be concluded that the local

authorities failed to use the available media channels to better inform the citizens about the issue. The authorities neglected the fact that the importance of informing the public is an exceptionally significant segment of administration, considering that public opinion is often more important than the actual expert assessment of the ecological issue, and that public pressure can serve as a catalyst for the conduct of the local administration. This was confirmed by the results of the survey, in which 26% of those polled claimed that the reason for their poor level of information on the issue was due to a lack of information from the town itself. A further 26% listed poor representation of the topic in the media as a reason for their lack of information.

Figure 4
Sources of information regarding the proposal of the Tarno site for the future county waste management centre



Source: survey

In order to gain information about citizens' attitudes on their role in shaping waste management policy, citizens were asked two questions. The first question was "In your opinion, what is the role of the local population in shaping waste management policy in Ivanić Grad?" Interviewees were offered a scale of five answers "none, poor role, medium role, large role, extremely large role". It is somewhat worrisome that more than half those surveyed did not have faith in their government and administration. 56.7% of those surveyed believed that the role of the local community in waste management is poor to none. The second question was an open type question in which they could write their comment on the role of citizens in waste management policy. This distrust is seen in one of the responses given:

> Response 1 (male, 18–40): *"Everything has already been decided, and so what the people think doesn't matter at all".*

Table 4
In your opinion, how would you rate the role of local population in the shaping of waste management policy in Ivanić Grad?

	No. of answers	Percentage (%)
No role	22	19.8
Poor role	41	36.9
Medium role	19	17.1
Large role	17	15.3
Extremely large role	12	10.8

Source: survey

When asked about the role of citizens in shaping waste management policy, it was somewhat unexpected that those surveyed "took responsibility", with 59.8% of interviewees stating that the local population should take a more active role. As part of this question, those polled were given the opportunity to propose several measures on how to increase the role of citizens in shaping waste management policy. In addition to greater citizen participation, the second most common answer was raising awareness of the importance and means of environmental protection, beginning from the earliest age, and organising meetings and round tables on the subject.

Of all those surveyed, 66% came out and voted at the 2010 referendum. When asked why they voted against the proposal, 28.4% of those asked thought that the landfill would negatively impact the health of the population. The second most common answer was "I don't want garbage near my town". This indicates a developed NIMBY syndrome and fear that the existence of the landfill would negatively impact the quality of life. The existence of the NIMBY syndrome was also evident in several of the freely provided answers by those polled:

> Response 2 (female, 41-60): "*I believe that Tarno cannot be a location for the disposal of waste from the county as it gravitates towards Ivanić, which is a relatively small town in comparison with others from Zagreb County. The county landfill should be positioned near a town with a larger population and greater generation of waste (for example, Velika Gorica). It is unfair that garbage is deposited near a small town when it is mostly not produced in that town, while other larger towns are completely freed from their own garbage*".

The responses from some of those who voted for the county waste management centre at Tarno in the referendum were particularly interesting. Some of these responses correspond to the existence of the YIMBY syndrome:

> Response 3 (male, 18-40): "*The issue of the waste landfill will not disappear if we move it to another location. I believe that pushing our garbage into*

other people's backyards is morally irresponsible behaviour. If we will be able to adequately resolve the waste management issue with this solution, then I don't see how this could be bad for our town".

Response 4 (female, 18-40): "*I believe that facilities like this today, under the EU regulations, are built based on rigorous ecological standards. I believe that we, the citizens of Ivanić, could benefit from such a significant investment*".

The last question regarding the referendum was "Do you think that your answer at the referendum was a result of your knowledge of the topic?". The interviewees could choose among the responses: "yes, partly, no". 67% percent of the interviewees stated that in their opinion, their answer at the referendum was based on their knowledge of the issue, and 21% thought it was partly based on their knowledge. Having in mind that response, responses on the reason for voting against (health issue as the prominent cause) and the geographical analysis of the site which did not show large impact of the landfill site on the air quality of the town, it could be concluded that citizens have a perception of their knowledge which is not entirely based the real situation but on partial information, which again stresses the importance of government and local administration in informing the public.

6. Conclusions

There are currently seven active municipal waste landfills in the territory of Zagreb County. Considering the natural conditions, these active landfills are all situated in appropriate locations. All are situated further than the prescribed minimum (> 500 m) from settlements. Only one settlement represents a direct threat to ground waters due to its proximity to the Sava aquifer and water pumping station, and has been shut down.

The discussion on the location for the future county waste management centre, as the central location for the collection, processing and disposal of waste, has been ongoing for some time in Zagreb County. One of the sites discussed was Tarno, which aroused reactions of the local government and population of the nearby town of Ivanić Grad. In the selection of the location for the waste management centre, it is necessary to take account of the environmental, social and economic effects. An important element of the environment that was considered in this research was the microclimatic conditions that have an important influence on the spread of aeropollutants. The topographic exposure index can be successfully employed in this regard, and shows how the area is differentiated according to greater or lesser exposure to aeration, and the spread of odours. According to its parameters, the Tarno landfill site is situated in a well aerated lowland area, where the direction of the spread of odours and aeropollutants can easily be predicted using the wind rose. There are no settlements within the stipulated radius of 500 m from the site. In the zone of a radius of 3000 m, where the most pronounced direct impact on air quality can be expected, there are five settlements (total population 741). Based on the distance,

relief and microclimate parameters, it can be assumed that the impact of the Tarno site on the air quality in the town of Ivanić Grad would be small. For a more detailed analysis, it would be necessary to perform modelling on the basis of site data on the air currents and chemical composition of air at various heights and distances from the potential site; however, such data currently do not exist for this area. For that reason, it would be necessary to establish continuous multi-parameter environmental monitoring at this site prior to making the final decision on the location of the landfill and county waste management centre, and at other similar situations. On the basis of the theoretical assumptions, practical experience and the local conditions, proper decisions can be made to ensure a surface buffer zone and measures for the absorption and neutralisation of undesirable effects for the environment and local population. Only then would these data clearly show how founded the rejection of the local population to the proposed waste disposal site is, and to what extent this is due to prejudice and distrust. For the time being, the survey results indicated that the knowledge of the local population is not based on the results of geographical analysis, but on partial information gained through different channels.

Though ecological awareness in Croatia is somewhat behind that of developed European countries, it is increasing. The citizens and NGOs are becoming increasingly prominent factors in the planning and realisation of projects concerning the environment. However, the survey conducted in Ivanić Grad showed that the public is poorly informed and showed the problem of a feeling of mistrust for the government and experts. This in part can be interpreted as being poorly informed. It is significant that the majority of those surveyed believed that the citizens should take a more active role in the community, and that it is necessary to ensure better education about the environment from the earliest age. The survey also showed the presence of the NIMBY syndrome, and fear that the local waste management centre will negatively reflect on the quality of life and health. Meanwhile, the YIMBY syndrome is also present, as some citizens are trying to extract the "economic maximum" from the situation. However due to the sampling method used and homogeneous participants in the survey with the regard to the interest on the topic of the survey, the results cannot be generalized to the entire population of the Town of Ivanić Grad.

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Problem zbrinjavanja otpada: primjer lokacije Tarno u Zagrebačkoj županiji

Sažetak

S obzirom na sve veći problem zbrinjavanja otpada analizirana je prostorna distribucija, zakonski okvir, sociološki okvir, te relevantne sastavnice okoliša postojećih odlagališta otpada Zagrebačke županije (geološka podloga, hidrogeološke i geomorfološke značajke terena, klima). Uz potencijalne ekološke i zdravstvene posljedice, odlaganje otpada često ima kompleksne socijalne i ekonomske posljedice za obližnje lokacije. Stoga su analizirani okolišni parametri upotrebljeni za analizu opravdanosti odluke o izboru lokacije Tarno kao potencijalnog Županijskog centra za gospodarenje otpadom. Taj je slučaj interesantan jer je izazvao negativne reakcije političkih struktura i lokalnog stanovništva Ivanić Grada. Uz navedene parametre okoliša na temelju značajki ruže vjetrova određen je indeks topografske izloženosti za šire područje radi identificiranja zona najveće izloženosti negativnom utjecaju smrada s obzirom na prevladavajuća zračna strujanja. Posebna pozornost posvećena je zoni do 3000 m od lokacije potencijalnog odlagališta. S obzirom na snažan otpor izboru ove lokcije za Županijski centar za gospodarenje otpadom ispitani su stavovi lokanog stanovništva, razina poznavanja problema i informiranosti, te je testirano postojanje NIMBY i YIAMBY sindroma.

Ključne riječi: gospodarenje otpadom, odlagalište otpada, lokacija, topografska izloženost, NIMBY sindrom, YIMBY sindrom.