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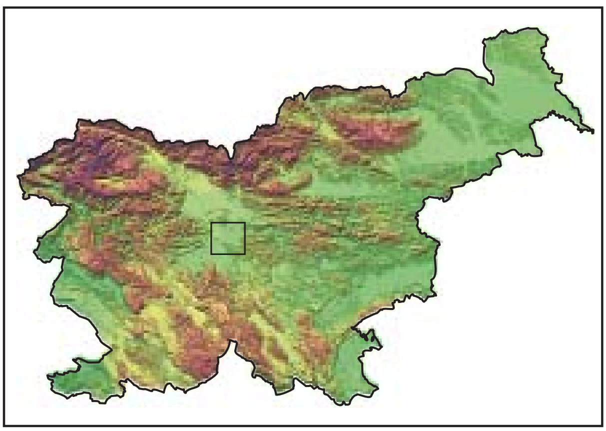
GRAVEL PLAINS IN URBAN AREAS: GRAVEL PITS AS AN ELEMENT OF DEGRADED LANDSCAPES

PRODNA RAVNINA V MESTNEM PROSTORU: GRAMOZNICE KOT PRVINA DEGRADIRANE POKRAJINE

Mimi Urbanc, Mateja Breg

Many gravel pits on the Jarški prod area have attracted illegal dumping (photography: Mateja Breg).
Številne gramoznice na Jarškem produ so postale priljubljeno odlagališče odpadkov (fotografija: Mateja Breg).



Gravel plains in urban areas: gravel pits as an element of degraded landscapes

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ABSTRACT: In the past, the excavation of gravel placed Jarški prod among areas of great opportunity, but this was followed by a major ecological blow: the filling of gravel pits with waste. The area started to regain significance with the construction of a drinking water pumping station and in accordance with the Spatial Plan of the City Municipality of Ljubljana is today seen as a forested area with a pronounced ecological or recreational importance. In spite of suitable legal foundations, as a protected water catchment area Jarški prod is in practice still unprotected. Considering the most important natural (shallow groundwater, easily permeable layer of gravel) and social characteristics (location near a densely populated area, irresponsible attitudes), the groundwater is an extremely endangered natural resource.

KEY WORDS: flood plain, gravel pits, illegal dumps, degraded landscape, Jarški prod, Ljubljansko polje, Slovenia.

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1 Introduction

Gravel plains and the development of cities have long shared a common history in Central Europe since the majority of cities developed beside the major rivers and their tributaries that created these plains (Galluser and Schenker 1992). The forces of nature that had previously shaped these areas acquired a rival, man, who more or less intensively intervened in the natural course of events. He reshaped them according to his needs and according, of course, to the level of technical and technological development. Human activities included not only the transformation of the cover layer, for example by changing forests into farm land, but also direct interference with the course of rivers, which caused extensive changes in the appearance of the landscape and often substantially changed the characteristics of groundwater that was directly linked to the rivers.

Gravel plains are a natural resource that serves the needs of a city and its population. In the course of time, they have acquired and lost various roles but throughout their history they have been a source of drinking water. On the other hand, water also presented a threat, so centuries ago people began to govern it to reduce its destructive power. River regulation, among other things, changed the dynamics of depositing gravel, the second natural resource linked to rivers. Unlike water, gravel is a non-renewable natural resource, even though the rivers continue to transport alluvial material. Gravel has accumulated on gravel plains over a longer geological period and is not renewable like water. The third natural resource, also non-renewable, is space, a basic precondition for any human activity to occur at all.

In Slovenia, where the greater proportion of the surface is uneven or quite rugged, gravel plains form the economic, transportation, and population settlement core of the country. Accordingly, the pressure on them is even greater because a variety of activities seek their own space. Areas in the immediate vicinity of cities or even within city territories are especially impacted. Because of different attitudes toward the natural resources of a particular area – and largely due to glorifying the economic exploitation of natural resources – such areas are (over)burdened and their other functions are ignored. A lack of suitable legal measures or their poor implementation and the ignorance of the people involved can bring anarchy to an area, destroying the natural balance and greatly reducing its value (economic, ecological, etc.). Instead of an open space within a city area that is highly valued ecologically and culturally, we therefore have a degraded riverine landscape whose primary function, supplying drinking water, is threatened, as are the health of the population and the quality of life.

Because of the intertwinement of mutually exclusive activities on them, their degradation, and their functional inclusion in urban areas, studies of gravel plains demand a holistic and integrating approach. This is the only way we can confront the natural, landscape-ecological, economic, cultural, and social challenges in crisis areas (Naveh and Lieberman 1984; Zonneveld 1995; Moss 2000).

The object of study is the landscape, which has many meanings and is thus the object of numerous scientific discussions. For the purpose of this article, we will use a general definition stating that the landscape is not only a complex phenomenon that can be described and analyzed using objective scientific methods but also a subjective and empirical phenomenon with perceived, esthetic, and cultural meanings (Antrop 2000). An observer analyzes, compares, and evaluates the perceived landscape in accordance with his knowledge and previous experience. Therefore the landscape is not just a thing in itself but also represents something.

The center of our interest is Jarški prod, a micro-landscape along the Sava River within the Ljubljana city limits. The aim of the article is to show how a combination of (un)favourable natural and social circumstances caused Jarški prod, a part of Ljubljansko polje that should be strictly protected because of its function as a source of drinking water, to become a degraded landscape. The principal cause of the current situation is man's attitude to the environment or rather the absence of a mature attitude toward his living environment. Jarški prod regrettably did not find a proper place in the value system of the population of Ljubljana, who saw it as no more than a natural resource. Its egocentric economic exploitation degraded the riverine landscape, further reducing its perceived worth. We also want to show that the changes in the landscape that occurred during the last half century are more the consequence of the attitude of society than any lack of official measures to protect the area.

In the case of Jarški prod, we will present the problem of gravel pits and their link with illegal dumping of waste. The activities that occurred here – the excavation of gravel, the filling of gravel pits, and the deposit of waste – are closely connected on one hand with the economic and social development of Ljubljana and on the other with its location within the wider urban area. The city spread onto former farm land, very busy roads run in the immediate vicinity of the pumping station, but at the same time the area itself is an »empty space« without activity – if we disregard the pumping of drinking water – and therefore invites illegal dumping. The area is easily accessible and crisscrossed with tracks, and illegal activities are encouraged by unclear and unregulated ownership. Furthermore, the numerous abandoned and unrehabilitated gravel pits attract dumping.

We want to present gravel pits as an element of the landscape that plays a leading role in its degradation. Their unsuitable management and the unsuitable management of the Jarški prod area in general are why the area of water protection zones around the Jarški prod pumping station is a fragile system. The fact that in spite of appropriate legislation there is no corresponding protection in practice is of great concern. We want to show that the area, which in the past offered a number of opportunities, can very soon become a burden. For the time being, water analyses still indicate that the water is potable, but due to the anarchy in the past, which still continues to a smaller degree, the area is also threatened because we do not know what its »underground« hides. Clean-up and removal operations will not suffice for a comprehensive and long-term solution of the problem; it is necessary to reestablish the cultural and social value of the area and place it in the value system of the city population.

2 Study Area and Work Methods

Jarški prod is an area on the left bank of the Sava River, south of the Črnuče industrial-commercial-services zone that stretches from west to east between Črnuče and Nadgorica; its narrower part is a water protection area for the Jarški prod pumping station that covers 216.7 hectares within the borders of water protection areas 0, I, and IIA. The Jarški prod pumping station ranks among the more important water resources of the city of Ljubljana, and the quantities of water pumped here will increase in the future.

Jarški prod, like the entire Ljubljansko polje region, was formed primarily by the Sava River and its tributaries. Throughout its course, the Sava runs over its own poorly resistant gravel alluvia, cutting its riverbed in it and depositing the removed material elsewhere. The alternation of erosion and accumulation is connected with the geological foundation, specifically with the alternation of solid bedrock and gravel detritus and the gentle slope and consequent meandering, as well as with the river regime or the oscillation of the volume of flow throughout the year. High waters that can cause considerable changes in a short time play the most important role in the reshaping or shifting of the riverbed. In the past, catastrophic waters could move the riverbed by a hundred meters. During these events, the Sava carried large quantities of gravel and deposited it where its power diminished for various reasons. Usually this occurred at meanders or in places where the river divided into branches. Due to the depositing of gravel, part of the water overflowed, which additionally weakened its carrying power. The shifting of the riverbed was not even over the entire course of the flow; it is most extensive around the Gameljne and Tomačevo bends.

Along the Sava River, poorly developed shallow riverine soils covered with tree and shrub vegetation and meadows developed on the Pleistocene and Holocene carbonate gravel. The soils that developed on gravel beds that were still active a good hundred years ago are not suitable for agricultural use. In places, a humus horizon formed of loose organic matter that collected around the roots of the sparse vegetation. Farther back from the river, the soils on the younger gravel terraces are still shallow, but riverine soils have developed: rendzina and brown soils. The production capacity of soil depends largely on the amount of gravel it contains: a larger proportion of gravel means poorer fertility. The soil here is ready to till soon after rain because the water quickly sinks into the ground (Brečko 1998). Tree and shrub vegetation grows on the shallow soils, particularly groves of hornbeam and sessile oak (Hrvatin and Perko 2000). On deeper soils, the meadows and cultivated fields that once existed are currently overgrown with thorny shrub vegetation.

The waste dumps offer unique and very diverse possibilities for the development of soil, depending of course on the composition of the waste. Due to the biological decomposition of organic waste (leaves, pine needles, twigs), a thin layer of »soil« slowly occurs that allows the growth of pioneering species of moss. In certain cases where the excavation of gravel was more extensive, the gravel pits were filled with various excavated materials and trees were planted on this layer (e. g., the area between the pumping station and the Sava River) or the area was left to overgrow naturally (e. g., the gravel pits beside the garden allotment area).

Relative to the self-cleaning capabilities of groundwater, the thickness of the aquifer's gravel-conglomerate layer is of great importance. In the area of Jarški prod, it is more than 70 meters thick, while the groundwater is at a depth of 4 to 8 meters during high water conditions and 8 to 11 meters under low water conditions (Analiza … 1995). Because of the partially removed cover layer of the aquifer and the total removal of the surface cover (soil and vegetation), the groundwater lies even closer to the surface in the gravel pits. The vulnerability of aquifer in this area is therefore very high, and as a result there is a permanently present possibility of the sudden pollution of the groundwater.

The methodology of identifying gravel pits and establishing their properties offers two approaches that we used to achieve optimal results in our study. To determine the influences of dumps in gravel pits on the groundwater, we further complemented the geographical methods with the chemical sampling of the gravel layer underneath dumps.

The first approach is based on identifying and studying gravel pits in the field. Initially, it is necessary to define a suitable time of the year when this spatial phenomenon is most visible and suitable for study. As in geomorphological studies (geomorphological mapping) of gravel pits that are of anthropogenic geomorphological configuration, thick vegetation (forest, shrubbery) is a major obstacle. The most suitable time is therefore from late autumn (November) to early spring (March) when trees and shrubbery are »bare«; the illegal dumps are also more visible in this period. The gravel pits discovered are first located with the proven method of field mapping. On a 1 : 1,000-scale digital orthographic photograph, the position, shape, and size of the gravel pits are determined in relation to inventoried dumps. The properties of each gravel pit can also be measured using the GPS. A gravel pit is identified by the recognizable edge of its basin, and simultaneously its position (Gauss-Kruger coordinates) and shape are recorded in the GPS. The digital data thus acquired is necessary for further analyses in geographical information systems and for comparison with existing data. The description sheet contains the basic characteristics of the gravel pit as defined in the field. All the acquired descriptive data on the gravel pits is combined in an interactive database. The interactive database of gravel pits contains the following data fields for each object that is marked on the raster base (digital orthographic photograph 1 : 1000):

- Name and surname of surveyor;
- Date of survey;
- Time of survey;
- Identification number of gravel pit;
- Coordinate y;
- Coordinate x;
- Altitude of gravel pit (meters);
- Cadastral Municipality of gravel pit;
- Parcel number of gravel pit;
- Name and surname of landowner;
- Address of landowner;
- House number of landowner;
- Addition to house number;
- Water protection area in which gravel pit is located;

- Distance of gravel pit from water protection area (meters);
- Distance of gravel pit from nearest asphalt or dirt road (meters);
- Type of access to gravel pit;
- Length of gravel pit (meters);
- Width of gravel pit (meters);
- Depth of gravel pit (meters);
- Type of gravel pit;
- Proportion of filled bottom in freshly excavated gravel pit (%);
- Thickness of deposit above the surface level (meters);
- Photograph of gravel pit;
- Notes.

Realizing that a vast quantity of visible waste is concentrated in or beside gravel pits, we must ask where the old abandoned gravel pits are hiding and what has happened to the waste if any is »stored« in them. Old ecological burdens whose contents are unknown present a potential threat to the groundwater, and locating them is therefore of key importance for the preservation of water resources. We acquired information about the locations and size of old gravel pits by analyzing old aerial photographs. After a detailed inspection of the available photographs of the study area, we determined a period within which we monitored the development of gravel pits, between 1959 and 2003. The history of excavations reaches back to the end of the 1950's when the first smaller gravel pits appeared, and for the »historical« analysis we used aerial photographs taken in 1959, 1964, 1970,1975, 1979, 1985, 1989, and 1995. On older photographs, we did not identify any major gravel pits but only followed the perceptible process of intensive overgrowing of gravel banks.

We first converted the aerial photographs to digital form and harmonized them with the coordinate system of the digital 1 : 1,000-scale orthophotographic map from 2002, on which the locations of dumps and gravel pits described in 2004 are based. This part, using the *ArcGIS* software program, is technically very demanding and time-consuming (Petek and Fridl 2004). We used it to update the current situation with data on the occurrence of surface excavations in the second half of the 20th century.

3 Gravel pits and dumps as elements of the (degraded) landscape

The fundamental problem of gravel plains, when considering the surface exploitation of gravel, is the inadequate remediation of abandoned gravel pits, which very frequently become illegal dumps. The environmental protection problem of gravel pits in Slovenia is not new. They were first studied by experts from the technical sciences field, primarily in relation to dealing with individual cases or the possibilities for extracting gravel. Jakič (1995), Hanjže (2001), and Konjar (2001) studied gravel pits in a general way, while Kosmač (1988) studied gravel pits in detail from the viewpoint of illegal dumping. Šebenik (1994a; 1994b) also studied illegal dumps and established their influence relative to the type of landscape. That the authorities began to take the problem seriously is proven by the fact that several projects in this field have been commissioned and carried out in the last few years (Berden Zrimec 2004; Špeh 2001; Smrekar et al. 2005).

Dumps in abandoned gravel pits are found most frequently on the plains at the edge of urban settlements, where they are also the largest. They are usually used for the disposal of construction debris because they almost »demand« filling. Most often it is the same construction companies and individuals that – often without permission – excavate and use the gravel and sand from gravel pits who fill them with construction debris and other waste when their exploitation is finished. Since this waste is dumped without supervision in various forms and unknown quantities, its effects on the groundwater are unpredictable and can possibly be severe. Construction debris includes hazardous waste (e. g., asphalt, various types of plastic material, leftover paints, varnish, asbestos), and the groundwater is closer to the surface because of the material removed. The gravel beds in Jarški prod both west and east of the main city road are dotted with

Figure 1: Dynamics of changes to the surface areas of the gravel pits.

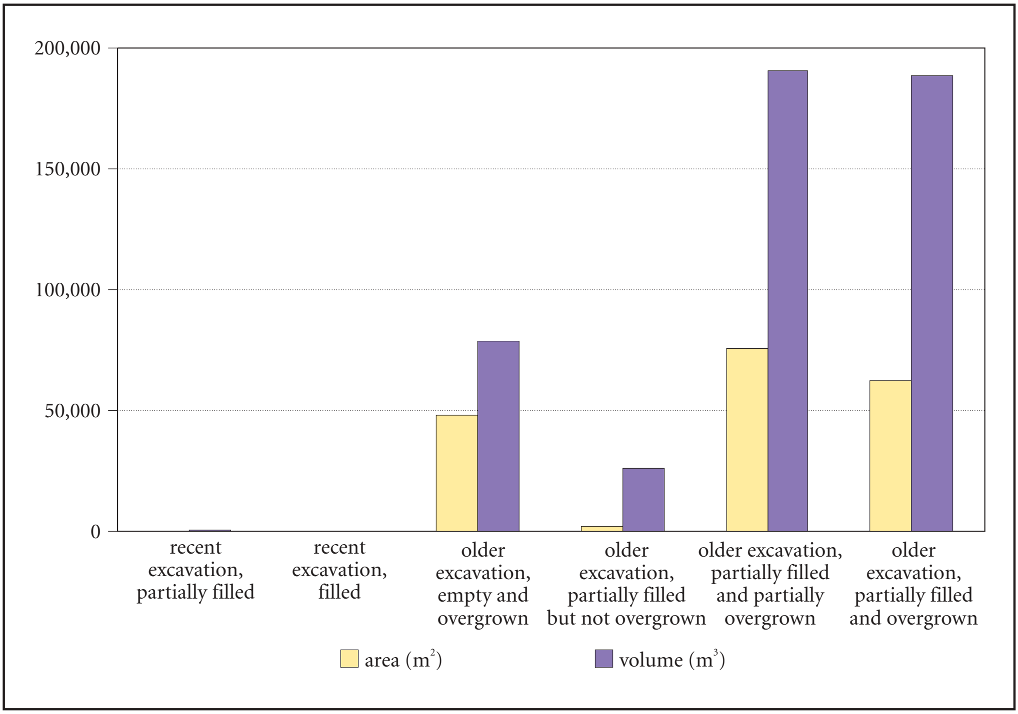

Figure 2: Surface area and volume of gravel pits relative to their state (Smrekar et al. 2005).

gravel pits. In the fall of 2004, we discovered twenty-two gravel pits with extensive and largely research fieldwork. Their surface areas range from twenty-five square meters to 65,000 square meters, their volume ranges from fifty to 130,000 cubic meters, and they can be up to six meters deep, and in one case, more than ten meters deep. The average gravel pit therefore measures 8,550 square meters and has a volume of 22,042 cubic meters.

Excavation was usually followed by rehabilitaion, which was left to individuals and companies. Rehabilitation is the last phase in the process of excavation of mineral raw materials and can be carried out in a natural or anthropogenic way. Regrettably, this process has been and still is today unsuitable in the majority of cases and completely unsupervised. Gravel pits rehabilitated in an anthropogenic way are usually filled and planted with trees or left to overgrow naturally with vegetation. The soil and vegetation cover the bottom and the slopes where various types of waste have been deposited. It is often difficult to determine the quantity of waste due to the vegetation cover. The time of the rehabilitation (and more often the overgrowth) helps us determine the age of the deposited material and distinguish between old and new burdens. The excavation of an individual gravel pit and the subsequent process of rehabilitation take a certain period of time.

The period of existence or life span of gravel pits can be very diverse. Some are visible in only one aerial photograph, which means that the entire morphological cycle from excavation to filling and overgrowth was completed in few years. Part of the study area has an especially dynamic history of excavations and presents a model case of an unremedied burden from the past. From 1959, the first smaller gravel pits began to appear southwest (Figure 1) of today's pumping station. Until 1975, gravel was excavated in numerous smaller gravel pits with an average surface area of 5,000 square meters. After 1975, we can talk of an extensive exploitation area covering 75,000 square meters. This gravel pit appears active until 1985. At the end of 2004, researchers described the largest dumps in this area as up to 5,000 square meters in size.

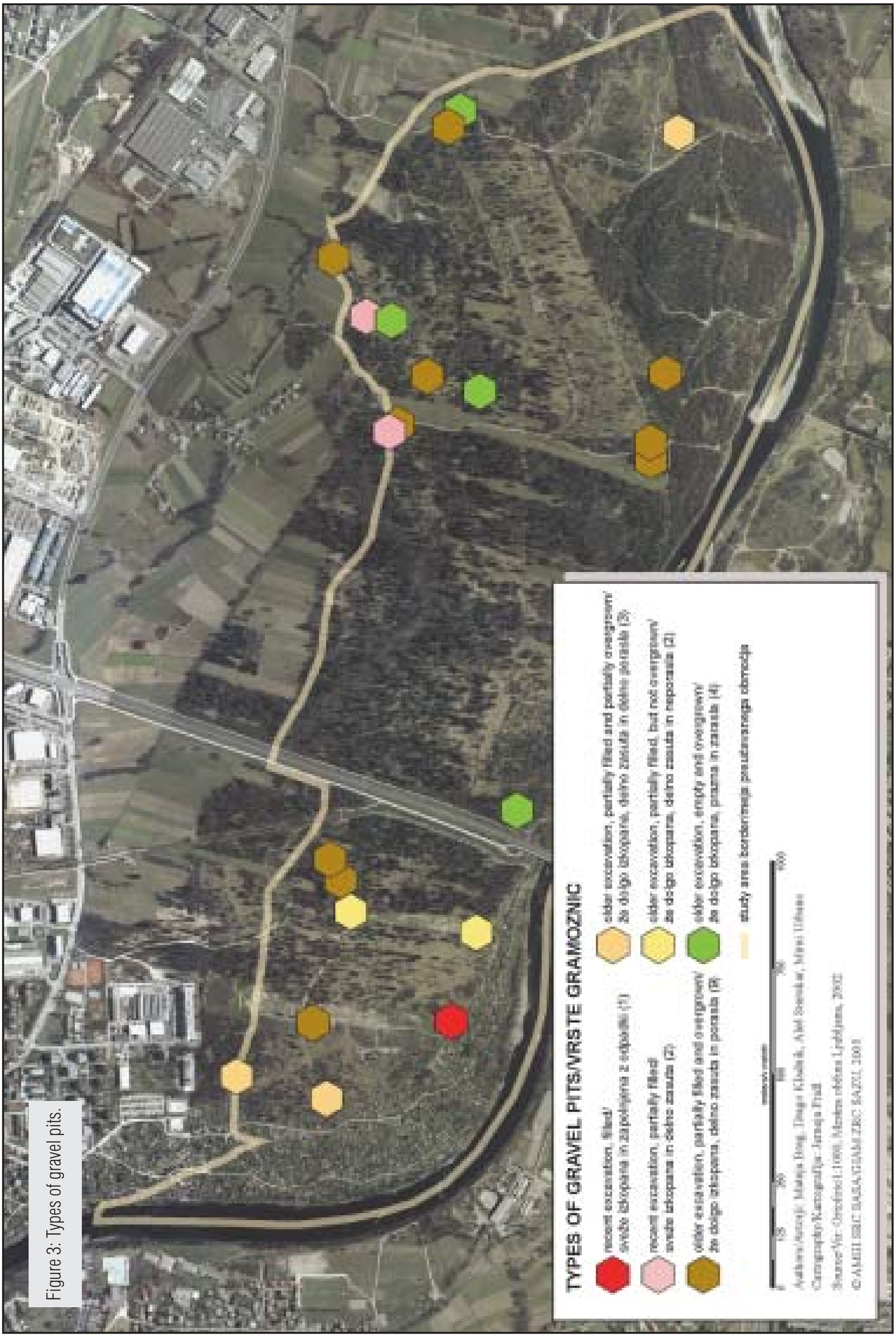

Figure 3: Types of gravel pits.

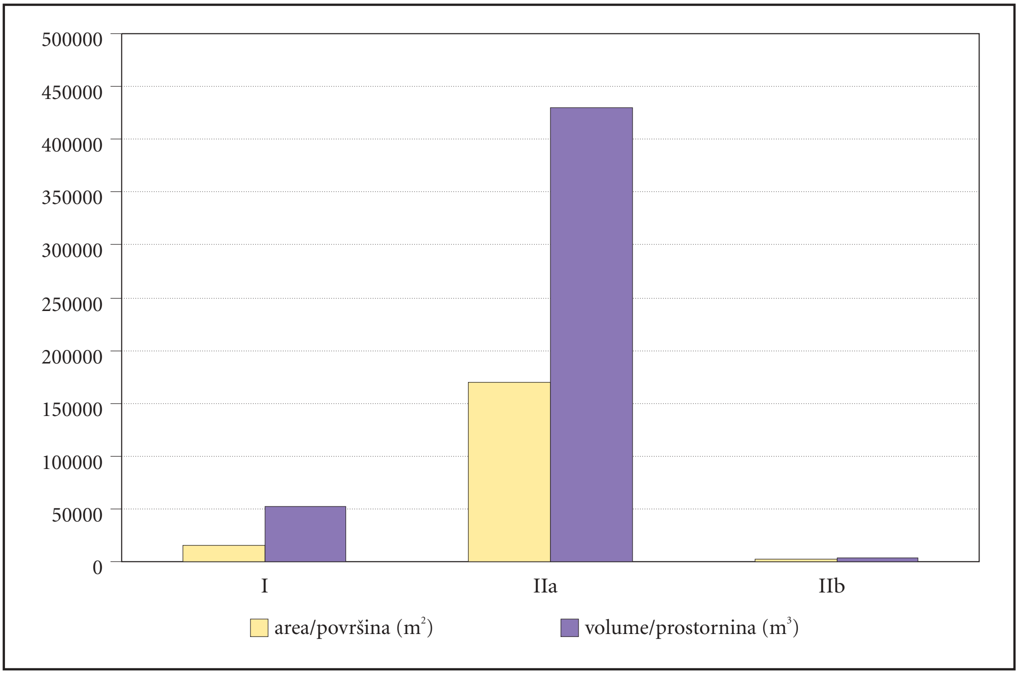

Figure 4: Surface area and volume of gravel pits relative to the water protection area (Smrekar et al. 2005).

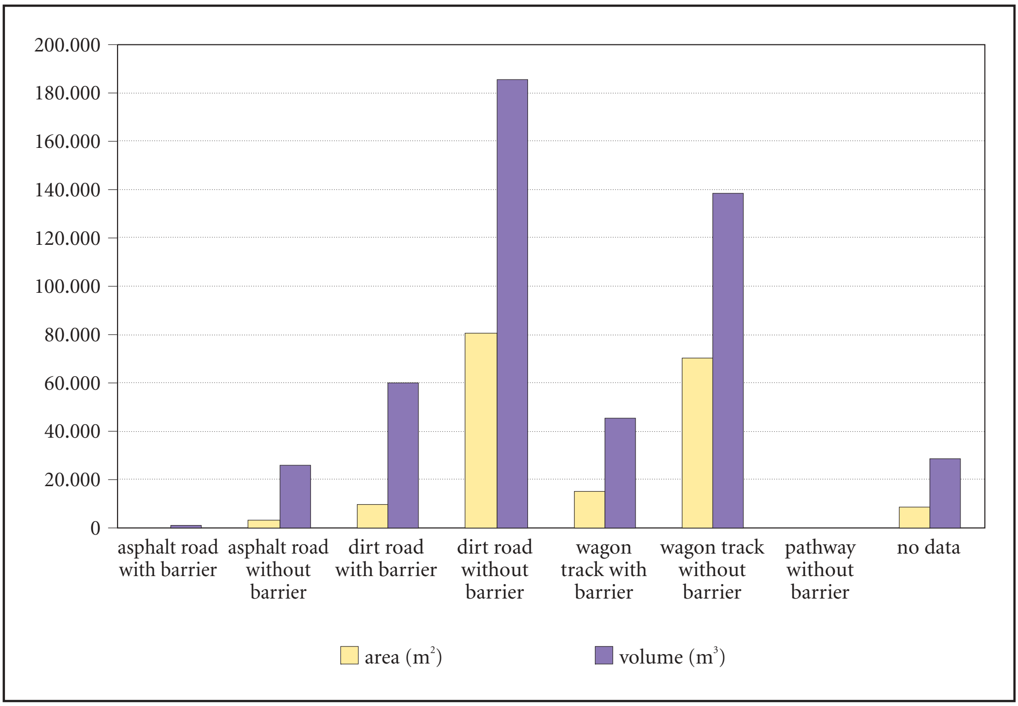

Figure 5: Surface area and volume of gravel pits relative to accessibility (Smrekar et al. 2005).

In the 1980's, the gravel pit was gradually filled and later its central part was planted with trees (conifers). Inside the gravel pit, the still surviving network of dirt roads was used to haul out large quantities of gravel during the excavation period, and later these roads were of key importance in bringing in waste.

In 1995, there were only two smaller gravel pits left within the area, and in 2004, only one (inactive). The described gravel pit – the entire exploitation area – is a large surface area where various types of waste of unknown composition have been deposited. The possibility that hazardous waste has been deposited here presents the constant threat of filtered water leaching directly into the water resource. In spite of findings that construction debris that does not present a major hazard to the groundwater dominates on the surface, the composition of the deposited material is heterogeneous and its influence on the groundwater is therefore unpredictable.

One of the key factors for the occurrence of dumps in gravel pits is accessibility. An asphalt road leads to four gravel pits, dirt roads lead to seven, and wagon tracks to another eight. Although barriers were placed across some of the access roads, it is usually possible to bypass them and thus easily transport waste material to the gravel pits. The only exception is one small gravel pit that is only accessible by a footpath.

4 Gravel pits and the impact of dumps on the groundwater

Regular measurements of the quality of the groundwater indicate a relatively favourable situation in spite of the numerous illegal dumps located in the immediate impact area of the pumping station. On numerous dumps we found hazardous wastes whose decomposition products are leached out with the percolation of surface waters and that could over a certain period threaten the quality of the underground drinking water. We therefore decided to additionally examine the composition of the waste in critical dumps and establish the consequences of leaching into the groundwater. We selected three gravel pits polluted by waste in the vicinity of pumping station on both the inflow and outflow sides (taking the occurrence of a depression sink into consideration) and collected samples of the gravel base under the dumps at eleven sites in total. Relative to the period of dumping and the activity of dumps, we distinguished old and new ecological burdens. Analyses of the samples were made in cooperation with the National Institute of Chemistry for substances that could result from leaching from the dumps, some of which exceeded the permitted concentration levels or values that are hazardous to health (heavy metals, chlorides, sulphates, polycyclic aromatic carbohydrates – PAO, absorbent organic halogens – AOX, volatile aromatic carbohydrates – BTX, polychlorinated biphenyls – PCB etc.).

Gravel pit 1 (V1; Figure 6) is an older excavation, partially filled, and overgrown. It is hard to define it in situ since it is almost imperceptible due to the thick tree vegetation and indistinct edge. The pit is located in the immediate vicinity of the pumping station, 260 meters northwest of Water Protection Area 0 on the inflow side of the pumping station. Various types of waste have been dumped here at different locations (along the edge and inside the pit) and mostly covered. Construction debris dominates on the surface, mixed with hazardous waste items (metal barrels containing paint and varnish, asphalt, asbestos sheets). According to the features of all the described dumps, dumping occurred here during different periods and is largely an older ecological burden.

On the cadastral map, the area of the gravel pit is shown as a large oblong parcel reminiscent of a riverbed whose cadastral use is marked as social property in common use, which proves the course of the Sava River (a meander and thus an area of gravel accumulation) prior to the regulation of the river. Today the site looks like a dry riverbed. A detailed analysis of aerial photographs and digital orthophotographic maps (period between 1959 and 2003) established that the pit appeared at the beginning of the 1960's. Its greatest extent is evident on an aerial photograph from 1964, when the pit covered about 80×100 meters. Between 1970 and 1975 the pit shrank in size (30×50 meters), and in 1979 it was already becoming overgrown.

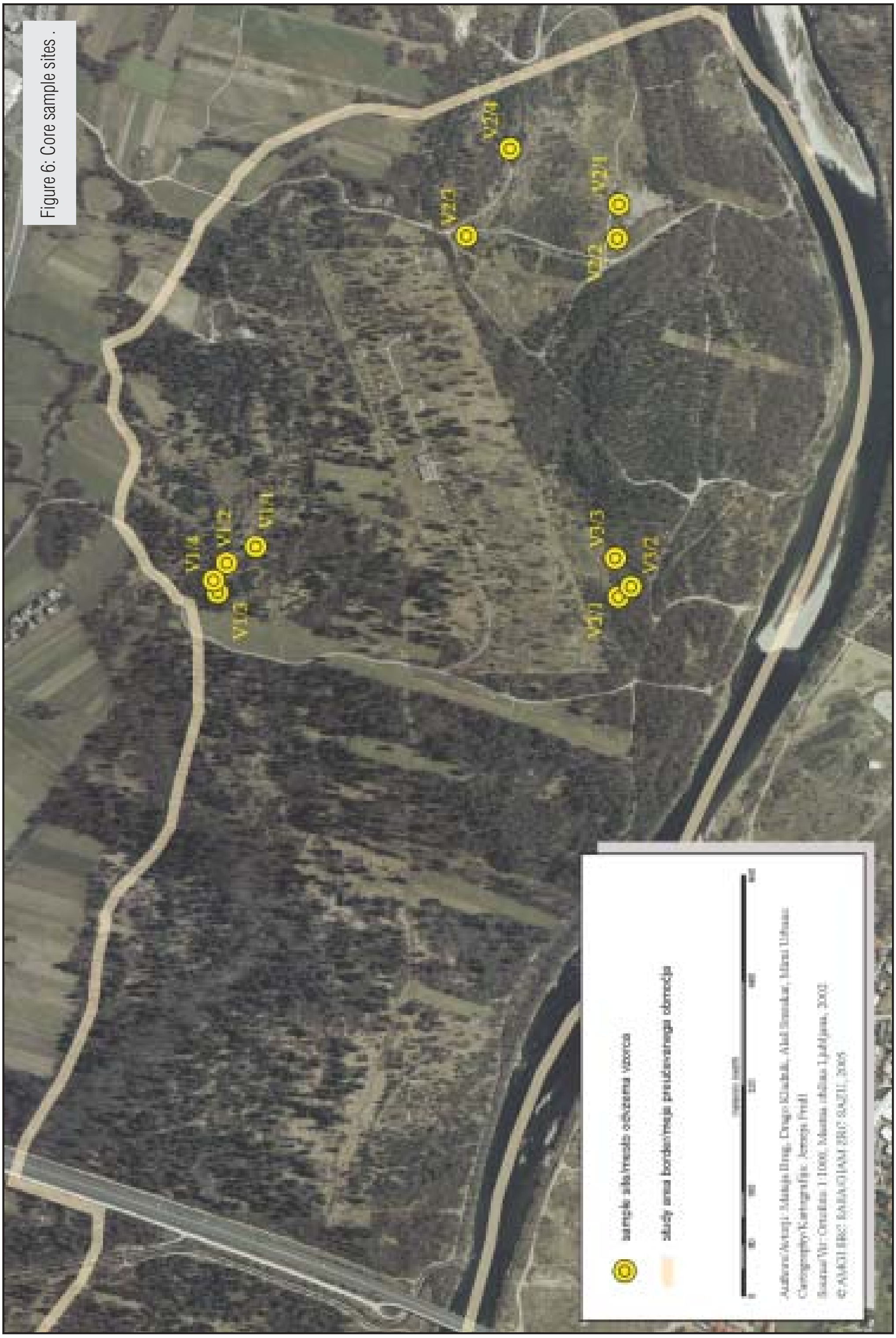

Figure 6: Core sample sites .

Table 1: Core sample sites in the gravel pit V1.

Sample site	Description of sample sites
V1/1	Five 200-liter barrels containing discarded paint and varnish are located on the surface. On average there is between ten and fifteen centimeters of soil below the barrels. We temporarily removed the barrels to take a core sample of the soil and underlying gravel to a depth of two meters. Autochthonous gravel dominates over the entire depth.
V1/2	Core sample site V1/2 lies fifty meters northwest of core sample site V1/1. On the surface to the depth of 0.5 meters there is soil brought from elsewhere, further on to the depth of two meters there is autochthonous gravel. We took a core sample of the entire depth.
V1/3	Core sample site V1/3 lies thirty meters northwest of core sample site V1/2. On the surface there is a 10-centimeter layer of asbestos sheets. Below the sheets is autochthonous gravel. We took a core sample of granular consistency (without the sheets) of the entire depth below the sheets.
V1/4	Core sample site V1/4 lies next to core sample site V1/3 but is potentially polluted by completely different waste. On the surface to the depth of 0.5 meters there is a layer of crushed asphalt with an estimated volume of three cubic meters. Under the asphalt is autochthonous gravel. We took a core sample of the entire depth to about 2.5 meters.

The composition of the waste visible in the profiles from gravel pit V1 is a reflection of the waste dumped on the surface where construction debris dominates. The results of the analysis do not show values exceeding the allowed or border limits for individual hazardous materials, but the values are the highest compared with the core sample sites of gravel pits V2 and V3.

Gravel pit 2 (V2; Figure 6) touches the southeastern edge of the narrowest water protection zone on the outflow side of the pumping station where there is a danger of groundwater flowing in from the area outside the water protection zone due to a growing depression sink. The pit is partially filled and overgrown, but there is a section on the southern edge that has been recently excavated and is currently not covered. We record-

Figure 7: Photograph of core sample site V1/3 (photography: Mateja Breg).

ed the largest dumps in this pit. Various types of construction debris dominate the waste. We took core samples at three dumps, twice on the largest dump with a distance of fifty meters between. The history of excavations in this pit has already been described and reaches back to 1959 when separate major excavations are already visible in this area, which by 1975 altogether covered the largest surface area of 75,000 square meters.

We selected four core sample sites.

Table 2: Core sample sites in the gravel pit V3.

Sample site	Description of sample sites
V2/1	There are several larger asphalt sheets and broken concrete pipes on the surface. Under the asphalt sheets and concrete pipes is autochthonous gravel. We took a core sample of the entire depth to about 3.0 meters below the surface, without the asphalt and concrete layers.
V2/2	Core sample site V2/2 is fifty meters west of core sample site V2/1. On the surface to the depth of about 0.5 meters, we found various waste materials (bricks, concrete, sheet metal, asbestos sheets, pieces of asphalt, wire, wood, and the like). Under this waste to the depth of 1.5 meters is dumped soil and rock. From here to the depth of four meters there is autochthonous gravel. We took a small core sample (<5 cm) of the entire depth to about 4.0 meters.
V2/3	Core sample site V2/3 lies 228 meters north of core sample site V2/2. On the surface to the depth of 2.5 meters, we found construction debris (bricks, concrete, rock, soil, and the like). Below this from the depth of 2.5 meters to 4.0 meters is autochthonous gravel. We took a core sample of the entire depth to 4.0 meters.
V2/4	Core sample site V2/4 lies 212 meters northeast of core sample site V2/2 and 149 meters southeast of core sample site V2/3. On the surface and to the depth of 2.0 meters, there is construction debris (bricks, concrete, rocks, pieces of asphalt, soil, and the like). Under the construction debris below the depth of 2.0 meters is autochthonous gravel. We took a core sample of the entire depth

The sample area shows this gravel pit is the most burdened according to the amount of waste. The core profile indicated a heterogeneous composition of construction debris, mostly concrete blocks, iron, tailings, asbestos sheets, etc. The results of the analysis do not indicate excessive values for any parameter.

Gravel pit 3 (V3; Figure 6) is an older excavation, partially filled, and overgrown. It is located between the pumping station and the Sava River. Access to this pit is difficult because it is completely overgrown with shrubbery and tree vegetation, which limited the collection of core samples. In the pit and on its edge, we observed variously sized heaps of unknown material below the vegetation, undoubtedly an old ecological burden that in spite of the difficulty encouraged us to take samples. Excavations here reach back to 1970 (70 m × 70 m), and between 1975 and 1979 the pit shrank (probably filling). In the aerial photograph from 1985, the pit is already overgrown.

Table 3: Core sample sites in the gravel pit V3.

Sample site	Description of sample sites
V3/1	On the surface and to the depth of 0.5 meters there is allochthonous soil. Below this soil from the depth of half a meter to 3.0 meters there is autochthonous gravel. We took a core sample of the entire depth to 3.0 meters.
V3/2	Core sample site V3/2 lies seven meters south of core sample site V3/1. We chose this short distance between the two core sample sites because there were large piles here and because we did not get the permission of the landowner to excavate farther down in the gravel pit. There is allochthonous soil on the surface to the depth of half a meter, and below this there is autochthonous gravel. We took a core sample of the entire depth to 4.0 meters.
V3/3	Core sample site V3/3 lies 57 meters northeast of core sample site V3/2. On the surface and to the depth of 0.7 meters, allochthonous soil and construction debris are mixed. Below this to the depth of 0.7 meters is autochthonous gravel. We took a core sample of the entire depth to 3.0 m.

Our excavations established that the dumped material was mostly tailings (waste material from building excavations, soil). Because tailings are very suitable for the remediation of dumps and for covering other waste, we suspected that old, unknown waste was hidden underneath. We did not find any hazardous wastes in the profiles of the excavations, which reached to the depth of the autochthonous gravel base. Similarly, the results of the chemical analyses of the gravel base did not exceed the allowed values for harmful materials. On the basis of our findings, we can conclude that the gravel pit was excavated by a construction company that probably also refilled it with waste tailings.

Table 4: Results of tests of representative samples of waste from selected illegal dumps.

Parameter	Unit	V1 (Leach according to SIST EN 12457–4)	V2 (Leach according to SIST EN 12457–4)	V3 (Leach according to SIST EN 12457–4)
Chlorides	mg/kg dry matter	17	6.5	5.8
Sulphates	mg/kg dry matter	33.7	9.0	6.8
PAO (polycyclic aromatic carbohydrates)	mg/L	<0.001	–	–
AOX (absorbent organic halogens)	mg/L	0.02	–	–
BTX (volatile aromatic carbohydrates)	mg/L	<0.01	–	–
PCB (polychlorinated biphenyls)	mg/L	0.0005	–	–
pH	°C	8.1 (22.7 °C)	7.3 (21.5 °C)	7.1 (21.4 °C)

Table 4 presents only some of the selected parameters of the analysis of samples where the differences in concentrations of individual substances pertaining to individual sample sites are evident. Using a geographical evaluation of the parameters and disregarding their chemical properties, we can establish that the values of parameters differ according to the selected area. The values are the highest in the V1 sampling area, somewhat lower in the V2 area, and lowest in the V3 area. The results clearly reflect the type of waste dumped since profile V1 contains dumped hazardous waste (barrels with paint, asphalt), V2 contains heterogeneous construction debris, and V3 contains tailings. The comparison of pH values at relatively similar temperatures shows a considerable change from almost neutral in V3 and V2 to slightly basic in V1. The different values of parameters are also the consequence of the intensity of leaching of material into the groundwater, which also depends on the distance between the bottom of the gravel pit and the level of the groundwater.

For determining the impact of water seeping from waste dumps in the gravel pits on the quality of the groundwater, the samples taken from only three gravel pits – of the twenty-two discovered in 2004 – are statistically too few to provide a realistic view of the overall situation. If hazardous waste is hidden in some other gravel pit, it is only a matter of time, speed of decomposition, and the self-cleaning abilities of the area as to when and how it will appear in the drinking water. The favourable results of the study of the core sample sites can certainly be reassuring, but due to the large quantity of waste dumped in and around the gravel pits, a potential threat to the water resources of the city still exists. Because the waste has been there for a long time, many of their decomposition products have already leached with surface water to the underground.

5 Rehabilitation of gravel pits and remediation of landfills

The 40,000 cubic meters of waste deposited on 216 hectares that are primarily intended for the protection and preservation of a perspective water resource undisputedly require deliberate and effective remediation measures in combination with preventive action, including above all raising public awareness and providing the population with information and education regarding the treatment of waste and the comprehensive protection of water resources.

The overall management of gravel pits is defined by the Law on Mining, which states that after acquiring permission to abandon the exploitation of mineral raw materials, the bearer of the mining rights must carry out a final rehabilitation of the area and eliminate the consequences that occurred during mining operations. In areas where such consequences are impossible to rehabilitate or erase completely, the bearer of the mining rights is obliged to implement protection measures to remove any danger to the health or lives of people and animals and potential sources of environmental pollution and predictable damage to buildings and the environment (Law on Mining, article 60/*Zakon o rudarstvu, 60. člen*).

It is not possible for an area exposed to the excavation of mineral raw materials and later to dumping to be restored completely to its natural, pre-exploitation state, but there are numerous remediation methods for restoring the natural (sustainable) condition as closely as possible; however, in doing so it is necessary to consider the knowledge and demands of various fields. The difficulty arises in the search for the most sustainable method of remedying specific gravel pits, where different experts advocate different approaches to the degraded areas. Rehabilitation can be carried out in a natural or anthropogenic fashion. In the first case, the gravel pit is transformed into a secondary habitat with the overgrowth of various vegetation. Slopes form at the edges and become overgrown with shrubbery and trees, and the shape of the basin remains visible. This is certainly a beneficial and sustainable rehabilitation of the surface of gravel pits after exploitation is concluded in areas of replacement biotopes with the possibility for developing passive recreation since the surface of mining sites, especially those fed by underground water, are considered areas of the greatest biodiversity in agricultural and urban areas (Globevnik 2003). This method of rehabilitation, however, is not effective in gravel pits degraded due to deposited waste since the habitat for all living beings is quite altered or even unsuitable. In such cases, planned remediation is necessary, defined according to the level of the deposited waste hazard. Anthropogenically remedied gravel pits can only be filled and/or planted with trees, and in the event of hazardous waste, the latter must be removed. Given the favourable results of the chemical analyses done on the basis of sampling the gravel layer below the waste in the gravel pits of Jarški prod, individual gravel pits filled with waste could be remedied simply by leveling the material and planting grass. This approach would accelerate the remediation of the gravel pits and at the same time ensure a safe supply of drinking water and the sustainable permanent development of the Jarški prod area. Further illegal dumping of waste in gravel pits and in the area in general could be prevented by effectively placing impassable barriers on the access roads. On the basis of the comprehensive analysis of the water protection area of Jarški prod and considering the elaborated degree of priority for the remediation of individual dumps and the features of the network of access roads, we established locations for just three functional barriers that would stop all types of delivery vehicles (trucks, cars) bringing in waste. The barriers are located at points where there is no possibility of bypassing (for example, dense trees by the road, gravel pits) or there are embankments that make bypassing the obstacles impossible, which is often the case with the already existing barriers. We also considered the fact that the parcels on which barriers could be set up are not problematic vis-à-vis acquiring appropriate permissions for use (consent of owners), which could defeat the results of the study.

6 Conclusion

»… *Societies interpret their environment according to the way they manage it, and they manage their environment according to the way they interpret it* …« (Berque et al. 1994). This statement shows how important the understanding of people and their relationship to the environment in which they live are. Décamps (2001) builds on this statement, pointing out that an understanding of the landscape includes not only a knowledge of the morphology or of the physiology of human understanding but also a knowledge of the cultural, social, and historical causes of this conception, i. e., about what creates the human reality. From this perspective, Jarški prod appears as an »ecosymbol,« which is as much an ecological unit as a symbolic unit. Jarški prod must take shape and start to live as a landscape. This happens when a series of conceptions gives this symbolic unit a precisely defined esthetic scheme that is appreciated enough for people to adopt (Décamps 2001). In other words, Jarški prod will become an appreciated and valued landscape where all measures will be in harmony with the principles of sustainable management when it becomes a part of people. As long as proper management and protection do not find their proper place in the consciousness of the population, any formal measures will have a limited effect.

For now, Jarški prod is a burden and threat, a symbol of the unsuitable management of space to those who are aware of the hazard. However, it could – with suitable planning, of course – become an opportunity. Ljubljana's Space Plan/*Prostorski plan Mestne občine Ljubljana* (2002) states: »… *A safe supply of drinking water* *is a priority task of the City Municipality of Ljubljana, and it is therefore necessary to adapt spatial development to the needs of preserving sources of drinking water*…« The function of pumping water, which has priority and to which all other activities must be subordinate, could be enhanced with recreational and educational activities. It would be necessary to balance the exploitation of all the natural resources the area offers. Drinking water naturally has the paramount role and to protect it the tradition of exploiting the gravel and the subsequent illegal dumping of waste must cease completely. The role and meaning of the third resource, space, should be emphasized. The area lying within the city limits must be given a new role. As it becomes a kind of natural park in the urban setting, it will acquire a new function and new meaning in which there will be no room for dumping waste. In this way, the citizens of Ljubljana will get an open space accessible to everyone, and simultaneously its inclusion in their lifestyle will prevent its further unsuitable management.

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Prodna ravnina v mestnem prostoru: gramoznice kot prvina degradirane pokrajine

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IZVLEČEK: Izkopavanje proda je Jarški prod v preteklosti povzdignilo med območja velikih priložnosti, čemur je sledil hud ekološki udarec polnjenje gramoznic z odpadki. Ponovno je območje začelo pridobivati na pomenu z izgradnjo črpališča pitne vode in je danes v skladu s prostorskim planom Mestne občine Ljubljana predvideno kot območje gozdov s poudarjenim ekološkim ali rekreacijskim pomenom. Kljub ustreznim zakonskim temeljem, je Jarški prod kot zavarovano območje pomembnega vodnega vira še vedno v praksi nezaščiten. Ob upoštevanju najpomembnejših naravnih (plitva podtalnica, lahko prepusten sloj proda) in družbenih značilnosti (lega v bližini gosto naseljenega območja, neodgovoren odnos) je podtalnica zelo ogrožen naravni vir.

KLJUČNE BESEDE: obrečna pokrajina, gramoznice, divja odlagališča, degradirana pokrajina, Jarški prod, Ljubljansko polje, Slovenija

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Vsebina

1 Uvod

Prodne ravnine in razvoj mest imajo v srednjeevropskem prostoru dolgo skupno zgodovino, saj je večina mest nastala prav ob velikih rekah ali njihovih pritokih, ki so te ravnine ustvarili (Galluser in Schenker 1992). Naravne sile, ki so do takrat oblikovale ta območja, so dobile tekmeca, in sicer človeka, ki je bolj ali manj intenzivno posegal v naraven tok dogodkov. Preoblikoval jih je v skladu s svojimi potrebami in odvisno od stopnje tehničnega in tehnološkega razvoja. Človekove aktivnosti niso obsegale samo preoblikovanja krovne plasti, kot je spreminjanje gozdnih površin v kmetijske, pač pa tudi neposredno poseganje v rečni tok, kar je povzročilo obsežne spremembe v izgledu pokrajine in marsikdaj bistveno spremenilo značilnosti podtalne vode, ki je z reko neposredno povezana.

S prodom nasuta ravnina je naravni vir, ki služi potrebam mesta in njegovega prebivalstva. V zgodovini je privzemala in izgubljala različne vloge, ves čas pa je bila vir pitne vode. Voda je predstavljala tudi grožnjo. Že pred stoletji so jo začeli krotiti, da bi zmanjšali njeno razdiralno moč. S hidromelioracijskimi posegi so med drugim spremenili dinamiko nasipavanja proda, to je drugega vira, povezanega z reko. Prod se je na prodnih ravninah nalagal skozi daljše geološko obdobje in se ne obnavlja kot voda, zato sodi med neobnovljive vire. Tretji naravni vir, prav tako neobnovljiv, je prostor, ki je temeljni predpogoj, da se določena dejavnost sploh lahko izvaja.

V reliefno razgibani Sloveniji so prodne ravnice gospodarsko, prometno in prebivalstveno-poselitveno jedro države. V skladu s tem je pritisk nanje še večji, saj različne dejavnosti iščejo svoj prostor. Še posebej so izpostavljena območja v neposredni bližini mest ali celo znotraj mestnega ozemlja. Zaradi različnih pogledov na naravne vire določenega območja, predvsem pa zaradi poveličevanja ekonomičnosti koriščenja naravnega vira, se ta prostor (preveč) obremenjuje in se pri tem ne upošteva vseh dejavnosti. Pomanjkanje ustreznih pravnih ukrepov ali njihovo neizvajanje ob nizki osveščenosti vpletenih ljudi lahko pripelje do anarhije, ki ruši naravno ravnovesje in manjša njegovo vrednost. Namesto ekološko, ekonomsko in kulturno visoko vrednega odprtega prostora znotraj mestnega ozemlja smo ustvarili degradirano obrečno pokrajino. Ob tem je ogrožena njena prvenstvena funkcija, to je oskrba z vodo in s tem zdravje ljudi in kakovost življenja.

Preučevanje prodnih ravnin zahteva zaradi prepletanja medsebojno izključujočih se dejavnosti, zaradi degradiranosti in funkcijske vpetosti v mestni prostor holističen in interdisciplinarni pristop. Le tako se lahko v prizadetem okolju, soočimo z naravnimi, pokrajinskoekološkimi, gospodarskimi, kulturnimi in socialnimi izzivi (Naveh in Lieberman 1984; Zonneveld 1995; Moss 2000). Za potrebe tega članka bomo sprejeli posplošeno definicijo pokrajinske ekologije, ki pravi, da pokrajina ni le kompleksen pojav, ki se ga da opisati in analizirati z objektivnimi znanstvenimi metodami, ampak tudi subjektiven in izkustveni pojav ter ima zaznavni, estetski in kulturni pomen (Antrop 2000). Opazovalec zaznavno pokrajino analizira, primerja in ocenjuje v skladu s svojim znanjem in predhodnimi izkušnjami. Zato pokrajina ni le nekaj, ampak tudi nekaj predstavlja.

V središču našega zanimanja je Jarški prod, mikropokrajina ob reki Savi znotraj ljubljanskega mestnega ozemlja. Namen članka je prikazati, kako je splet (ne)ugodnih naravnih in družbenih potez povzročil, da je del Ljubljanskega polja, ki bi moral biti zaradi svoje funkcije črpanja vode, strogo zaščiten, postal degradirana pokrajina. Poglavitni vzrok današnjega stanja je odsotnost zrelega odnosa do življenjskega okolja. Jarški prod žal ni našel pravega mesta v vrednostnem sistemu prebivalcev Ljubljane in njene okolice, ki so v njem videli samo naravni vir. Njegovo ekonomsko izkoriščanje, ki je slonelo na egocentričnem odnosu do okolja, je pripeljalo do tega, da je obrečna pokrajina postala manjvreden prostor. Prikazati hočemo, da so spremembe v pokrajini, ki so se zgodile v zadnjega pol stoletja, bolj kot posledica uradnih ukrepov posledica miselnosti v družbi.

Predstavljamo problematiko gramoznic in njihovo povezanost z divjim odlaganjem odpadkov. Odkopavanje gramoza in zasipavanje gramoznic ter odlaganje odpadkov, je tesno povezano z gospodarskim in družbenim razvojem Ljubljane ter z lego znotraj širšega mestnega prostora. Mesto se je razširilo na nekdanja kmetijska zemljišča, v neposredni bližini vodarn potekajo zelo obremenjene ceste, obenem pa je območje, prostor brez vsebine – če odmislimo črpanje vode, ki omogoča divje odlaganje odpadkov. Območje je dobro dostopno, prepredeno s potmi, nedovoljene dejavnosti pa pospešuje tudi mešano in neurejeno lastništvo. Odlaganje odpadkov so pritegnile tudi številne opuščene, nesanirane gramoznice.

Gramoznice imajo vodilno vlogo pri degradiranosti pokrajine. Neustrezno ravnanje z njimi in neustrezno ravnanje z omenjenim prostorom je vzrok krhkosti območja vodovarstvenih pasov črpališča Jarški prod. Zaskrbljujoče je dejstvo, da kljub ustrezni zakonodaji učinkovita zaščita v praksi ne zaživi. Prikazati hočemo, da bo območje, ki je v preteklosti nudilo vrsto priložnosti, lahko zelo kmalu postalo ekološko breme. Zaenkrat analize še kažejo na ustreznost vode, vendar je območje zaradi nenadzorovane rabe v preteklosti, ki v zmanjšanem obsegu še traja, tudi grožnja, saj ne vemo, kaj vse se skriva pod površjem. Za celostno in dolgoročno uspešno rešitev problematike samo ureditev površja ne bo zadoščala, ampak je potrebno ponovno vzpostaviti kulturno in socialno vrednost območja in ga umestiti v vrednosten sistem meščanov.

2 Preučevano območje in metode dela

Jarški prod je območje na levem bregu reke Save, južno od črnuške industrijsko-obrtno-servisne cone, ki se od zahoda proti vzhodu razteza med Črnučami in Nadgorico; njegov ožji del je vodovarstveno območje vodarne Jarški prod, ki obsega površino 216,7 ha znotraj meja vodovarstvenih območij 0, I in IIA. Vodarna Jarški prod spada med pomembnejše vodne vire mesta Ljubljane in v prihodnje se bodo količine tu načrpane vode še povečevale.

Jarški prod je, tako kot celotno Ljubljansko polje oblikovala Sava s pritoki. Sava večinoma teče po lastnih prodnih nanosih, v katere vrezuje svojo strugo in odneseno gradivo na drugem mestu odlaga. Območja prodnih nanosov se menjajo s kratkimi odseki, na katerih pride na dan živoskalna osnova. Na morfološki razvoj struge vpliva tudi rečni režim oziroma kolebanje vodnega pretoka prek leta. Za preoblikovanje oziroma prestavljanje rečne struge so najpomembnejše visoke vode, ki lahko v kratkem času povzročijo precejšnje spremembe. Ob poplavah se je rečna struga pogosto prestavila tudi za 100 m. Takrat je Sava nosila velike količine proda in ga je nato odložila, kjer se je ob enem pojavu zmanjšala njena transportna moč. Zaradi odlaganja proda se je del vode razlil. Prestavljanje struge je ob Gameljškem in Tomačevskem zavoju obsegalo približno 430 ha.

Ob Savi so na pleistocenskem in holocenskem karbonatnem produ nastale obrečne slabo razvite plitve prsti z drevesnim in grmovnim rastjem ter travniki. Prsti so nastale na prodiščih, ki so bila aktivna še pred dobrimi 100 leti in so neprimerne za kmetijsko rabo. Ponekod se že tvori humusni horizont v obliki prhlinaste organske snovi, ki se zbira ob koreninah skromnega rastlinja. Na mlajših prodnih terasah so se razvile plitve obrečne rendzine in rjave prsti. Njihova rodovitnost je obratno sorazmerna s količino proda, vendar so za obdelovanje primerne že kmalu po padavinah, ker se voda hitro odcedi (Brečko 1998). Na plitvih prsteh prevladuje gozd belega gabra in gradna (Hrvatin in Perko 2000). Na globljih prsteh, kjer so bili nekoč travniki in njive v kmetijski rabi, se zarašča bodikavo grmovno rastje.

Svojstvene in zelo raznolike možnosti za razvoj prsti nudijo predvsem odlagališča odpadkov. Zaradi biološkega razpada organskega odpada (listje, iglice, vejice) se počasi ustvari tanek sloj preperelíne, ki omogoča rast pionirskim vrstam mahov. Na območju med vodarno in Savo, kjer je bilo intenzivno izkopavanje proda, so gramoznice zasuli z različnim gradivom in vanj posadili drevesa, drugje pa so območje prepustili naravnemu zaraščanju (gramoznica ob vrtičkarskem naselju).

Z vidika samočistilnih sposobnosti podtalnice je velikega pomena debelina vodonosne prodno-konglomeratne plasti, ki na Jarškem produ presega 70 m. Podtalnica je ob visokem vodnem stanju 4–8 m globoko in 8–11 m ob nizkem vodnem stanju (Analiza … 1995). V gramoznicah je zaradi odstranjenih prsti in rastja ter delno odstranjene krovne plasti vodonosnika podtalnica še bližje površju. Zato je stalna nevarnost nenadnega onesnaženja podtalnice.

Za določanje vplivov odlagališč odpadkov v gramoznicah na podtalnico smo geografske metode dopolnili s kemijskimi. Prve temeljijo na odkrivanju in preučevanju gramoznic. Podobno kakor pri geomorfološkem raziskovanju je tudi za preučevanje gramoznic, ki so antropogene geomorfološke oblike, velika ovira gosto grmovno ali gozdno rastje. Najprimernejši čas za delo je od pozne jeseni do zgodnje pomladi, ko drevesa in grmi niso olistani in so divja odlagališča odpadkov dobro vidna. Lego, obliko in veliksot gramoznic smo najprej določili na digitalnem ortofoto posnetku v merilu 1 : 1000. Te lastnosti smo za posamezno gramoznico izmerili tudi s pomočjo GPS-a. Digitalne podatke smo ovrednotili v nadaljnji analizi s pomočjo geografskih informacijskih sistemov in jih primerjali z obstoječimi podatki. V popisni list smo še vpisali poglavitne značilnosti gramoznice. Vse pridobljene popisne podatke o gramoznicah smo združili v interaktivno podatkovno bazo, ki vsebuje petindvajset podatkovnih polj za vsak popisan objekt:

- ime in priimek popisovalca;
- datum popisa;
- ura popisa;
- identifikacijska številka gramoznice;
- koordinata y;
- koordinata x;
- nadmorska višina gramoznice (m);
- katastrska občina gramoznice;
- parcelna številka gramoznice;
- ime in priimek lastnika zemljišča;
- naslov lastnika zemljišča;
- hišna številka lastnika zemljišča;
- dodatek k hišni številki;
- vodovarstveno območje, na katerem je gramoznica;
- oddaljenost gramoznice od vvo 0 (m);
- oddaljenost gramoznice od najbližje asfaltne ali makadamske poti (m);
- vrsta dostopa do gramoznice;
- dolžina gramoznice (m);
- širina gramoznice (m);
- globina gramoznice (m);
- vrsta gramoznice;
- delež zasutega dna pri sveže izkopani gramoznici (%);
- debelina nasutine nad ravnijo površja (m);
- fotografija gramoznice;
- opombe.

Ker je velika količina odpadkov v gramoznicah ali ob njih, je pomembno vprašanje starih opuščenih gramoznic in odpadkov v njih. Stara ekološka bremena neznane vsebine so potencialna nevarnost za podtalnico, zato je njihovo odkrivanje ključnega pomena za ohranjanje vodnih virov. Podatke o legi in velikosti starih gramoznic smo pridobili z analizo letalskih posnetkov za obdobje 1959–2003. Uporabili smo letalske posnetke iz let 1959, 1964, 1970, 1975, 1979, 1985, 1989 in 1995. Na starejših posnetkih večjih gramoznic ni bilo, zaznali smo le intenzivno zaraščanje prodišč.

Letalske posnetke smo najprej pretvorili v digitalno obliko in uskladili s koordinatnim sistemom digitalnega ortofoto načrta v merilu 1 : 1000 iz leta 2002, na katerega se opirajo lokacije leta 2004 popisanih odlagališč in gramoznic. Ta del poteka v programskem paketu *ArcGIS* (Petek in Fridl 2004).

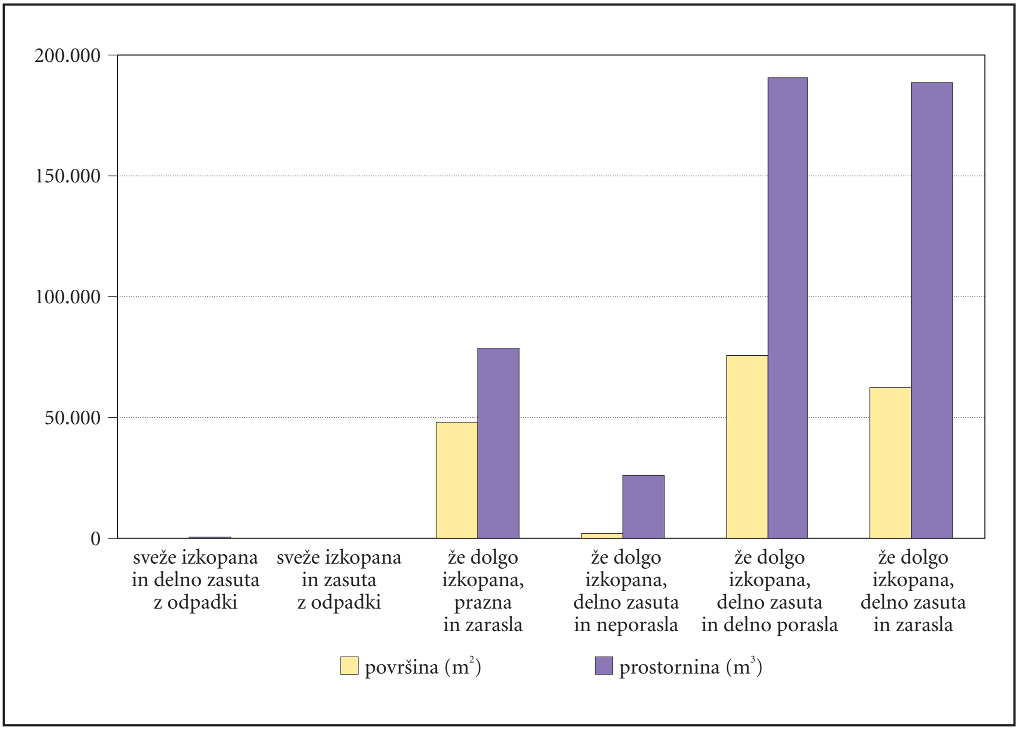
3 Gramoznice in odlagališča odpadkov kot prvina (degradirane) pokrajine

Temeljni problem prodnih ravnin v zvezi s površinskim izkoriščanjem proda je neustrezna sanacija gramoznic, saj se zelo pogosto spremenijo v divja odlagališča odpadkov. Okoljevarstvena problematika gramoznic pri nas ni nova. Najprej so jih obravnavali strokovnjaki s področja tehničnih ved, in sicer v zvezi z reševanjem individualnih primerov oziroma možnostmi pridobivanja gramoza. Celostno so gramoznice obravnavali Jakič (1995), Hanjže (2001) in Konjar (2001), z vidika divjega odlaganja odpadkov pa je gramoznice podrobno obravnaval Kosmač (1988). Divjemu odlaganju odpadkov se je posvetil Šebenik (1994a; 1994b) in ugotavljal vpliv glede na pokrajinski tip. Da so se problema začeli resno zavedati tudi odgovorni, dokazuje dejstvo, da je bilo v zadnjih letih naročenih in izdelanih nekaj projektov s tega področja (Berden Zrimec in sodelavci 2004; Špeh 2001; Smrekar in sodelavci 2005).

Odlagališča v opuščenih kopih so najpogostejša na ravninah na robu urbanih naselij, kjer so tudi največja. V njih se običajno odlaga gradbeni material. Največkrat gradbena podjetja in posamezniki, ki so izkopavali in uporabljali gramoz in pesek iz gramoznic (velikokrat brez dovoljenja), po končanem izkoriščanju vanje navozijo odpadni gradbeni material in druge odpadke. Ker se ti odpadki odlagajo nenadzorovano, v različnih oblikah in v neznanih količinah, so njihovi učinki na podtalnico nepredvidljivi, lahko celo izjemni. Gradbeni material namreč sestavljajo tudi nevarni odpadki (asfalt, različna plastika, ostanki barv, lakov, azbest). Prodišča na Jarškem produ so zahodno in vzhodno od mestne vpadnice prepredena z gramoznicami. Jeseni 2004 smo s terenskim delom odkrili 22 gramoznic. Njihova površina je med 25 in 65.000 m^2, prostornina od 50 do 130.000 m^3, globina do 6 m, v enem primeru celo več kot 10 m. Povprečna gramoznica tako meri 8550 m^2 in ima prostornino 22.042 m^3.

Zadnja faza v procesu izkopavanja mineralnih surovin je sanacija. Poteka lahko po naravni poti ali antropogeno, tako da gramoznice zasujejo in zasadijo z drevjem ali pa se rastje naravno obnovi. Ker je bila prepuščena posameznikom in podjetjem, je v večini primerov neustrezna in nenadzorovana. Glede na obdobje sanacije ali zaraščanja, lahko sklepamo o starosti odloženega materiala ter ločimo staro in novo ekološko breme.

Slika 1: Dinamika spreminjanja površin gramoznic (Smrekar in sodelavci 2005).
Glej angleški del prispevka.

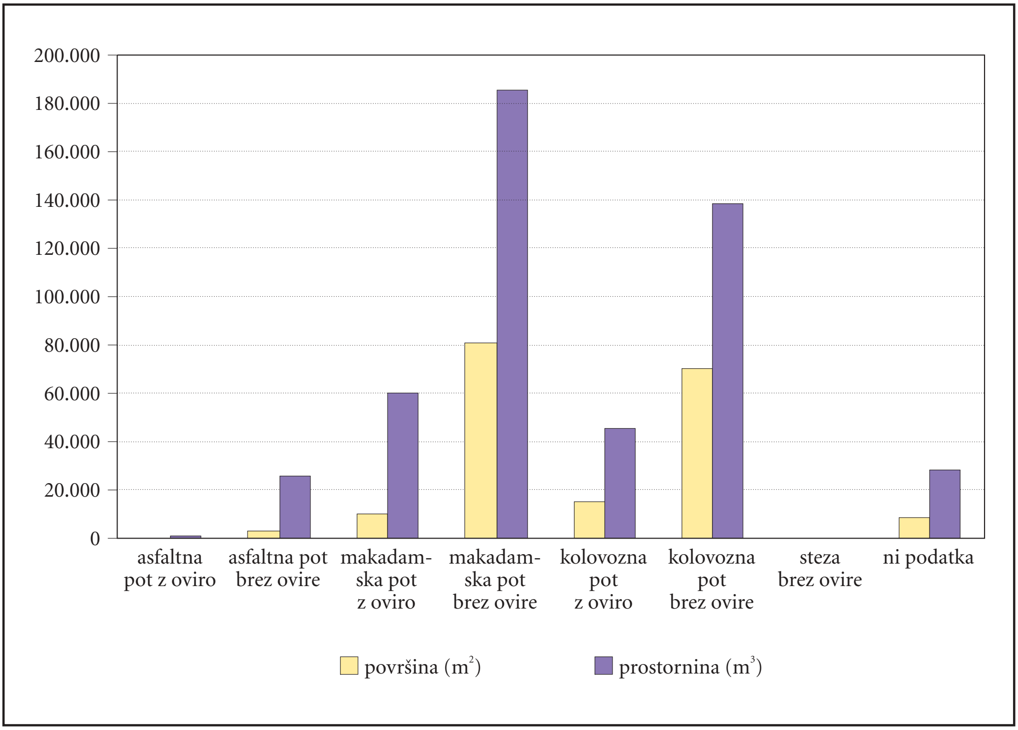


Slika 2: Površina in prostornina gramoznic glede na njihovo stanje (Smrekar in sodelavci 2005).

Obdobja trajanja – življenja določene gramoznice so zelo različna. Pri nekaterih se je celoten morfološki ciklus od izkopa do zasutja ali zaraščanja obrnil v nekaj letih. Del preučevanega območja jugovzhodno od vodarne (slika 1) ima še posebej dinamično zgodovino izkopavanj in je nazoren primer nesaniranega ekološkega bremena iz preteklosti. Prve manjše gramoznice so se na tem območju pojavile leta 1959, uporabljali so jih do leta 1975. Njihova povprečna površina je bila do 5000 m^2. V sedemdesetih pa se posamezne gramoznice združijo v obsežno območje izkoriščanja na površini 75.000 m^2. Gramoznica je bila aktivna do leta 1985. Popisovalci so konec leta 2004 na območju te gramoznice popisali največja odlagališča odpadkov, velika do 5000 m^2. Gramoznico so v osemdesetih letih 20. stoletja začeli zasipavati, pozneje pa se je osrednji del zasadil z drevesi (iglavci). Znotraj gramoznice se je do danes ohranilo omrežje makadamskih poti, po katerih se je v obdobju izkopavanja odvažalo velike količine gramoza, pozneje pa so bile ključne za dovažanje odpadkov (Smrekar in sodelavci 2005). Dostopnost je eden ključnih dejavnikov za nastanek odlagališč odpadkov v gramoznicah. Čeprav so na nekaterih dostopnih poteh postavljene ovire, jih je praviloma mogoče obiti in tako do gramoznic neovirano pripeljati odpadno gradivo. Leta 1995 sta bili znotraj opisanega območja še dve manjši gramoznici, leta 2004 pa le ena. Na območju gramoznice so odloženi različni odpadki neznane sestave in so nenehna grožnja podtalnici zaradi možnosti izpiranja snovi iz odlagališč odpadkov v podtalnico. Na površju prevladujejo gradbeni odpadki, ki so povečini nenevarni za podtalnico. Toda material je heterogen in ponekod neznane sestave, zato je kljub analizi še vedno možno onesnaženje podtalnice.

Slika 3: Vrste gramoznic (Smrekar in sodelavci 2005).
Glej angleški del prispevka.

Slika 4: Površina in prostornina gramoznic glede na vodovarstveno območje (Smrekar in sodelavci 2005).
Glej angleški del prispevka.



Slika 5: Površina in prostornina gramoznic glede na dostopnost (Smrekar in sodelavci 2005).

4 Gramoznice in vpliv odlagališč na obremenjevanje podtalnice

Redne meritve kakovosti podtalnice kažejo relativno ugodno stanje, kljub številnim divjim odlagališčem odpadkov v ožjem vplivnem območju vodarne. Ker smo na številnih odlagališčih odkrili nevarne odpadke, katerih razpadni produkti bi lahko ogrozili kakovost podzemne pitne vode, smo dodatno preverjali sestavo odpadkov na kritičnih odlagališčih in ugotavljali posledice izcejanja v podtalnico. Izbrali smo tri z odpadki onesnažene gramoznice na pritočni in na odtočni strani vodarne in odvzeli vzorce prodne podlage pod odlagališčem na enajstih vzorčevalnih mestih. Glede na obdobje odlaganja in aktivnost odlagališč smo ločili staro in novo ekološko breme. Analizirali smo snovi, ki so lahko posledica izpiranja iz odlagališč odpadkov in so zdravju nevarnem, če presegajo mejne vrednosti: težke kovine, kloridi, sulfati, policiklični aromatski ogljikovodiki-PAO, adsorbljivi organski halogeni-AOX, lahkohlapni aromatski ogljikovodiki-BTX, poliklorirani bifenili-PCB. Analize je izdelal Kemijski inštitut.

Slika 6: Vzorčevalna mesta (Smrekar in sodelavci 2005).
Glej angleški del prispevka.

Gramoznica 1 (V1; slika 6) je že dolgo izkopana, delno zasuta in porasla. Zaradi gostega grmovja drevesnega rastja in neizrazitega roba je na terenu težje določljiva. Je na dotočni strani v neposredni bližini vodarne in 260 m oddaljena od vodovarstvenega območja 0. Na robu in znotraj gramoznice so na različnih mestih odloženi in večinoma prekriti različni odpadki. Na površju prevladujejo gradbeni odpadki, med katere so pomešani nevarni odpadki (kovinski sodi z barvo in laki, asfalt, salonitne plošče). Odlaganje odpadkov je potekalo v različnih obdobjih, povečini pa gre za staro ekološko breme.

V katastrskem načrtu je na območju gramoznice velika podolgovata parcela, ki spominja na rečno strugo in katere katastrska raba je označena kot družbena lastnina v skupni rabi. Z analizo letalskih posnetkov in digitalnih ortofoto načrtov za obdobje 1959–2003 smo ugotovili, da je gramoznica nastala že v začetku šestdesetih let. Največji obseg je imela leta 1964, ko je merila približno 80 krat 100 m. V obdobju 1970–1975 je merila še 30 krat 50 m, leta 1979 pa se je že zaraščala.

Preglednica 1: Vzorčevalna mesta na območju gramoznice V1.

vzorčevalno mesto	opis vzorčevalnih mest
V1/1	Na površini je pet kovinskih 200-litrskih sodov, v katerih so odpadne barve in laki. Pod sodi je povprečno od 10 do 15 cm prsti. Sode smo začasno odstranili in odvzeli vzorec prsti in proda do globine 2 metrov. V podlagi je avtohton prod.
V1/2	Vzorčevalno mesto V1/2 je 50 m severozahodno od vzorčevalnega mesta V1/1. Na površini do globine 0,5 m je prst, pripeljana od drugod, do globine 2 m je avtohton prod. Vzorec smo odvzeli v celotnem izkopanem prerezu proda.
V1/3	Vzorčevalno mesto V1/3 je 30 m severozahodno od vzorčevalnega mesta V1/2. Na površini je približno 10 cm debela plast azbestnih plošč, pod ploščami je avtohton prod. Vzorec smo odvzeli v celotnem izkopanem prerezu proda pod ploščami.
V1/4	Vzorčevalno mesto V1/4 je blizu vzorčevalnega mesta V1/3. Obremenjeno je z raznovrstnimi odpadki. Na površini je do globine 0,5 m približno 3 m^3 zdrobljenega asfalta. Pod asfaltom je avtohton prod. Vzorec smo odvzeli v celotnem izkopanem prerezu proda do globine približno 2,5 m.

Slika 7: Vzorčevalno mesto V1/3 (fotografija: Mateja Breg).
Glej angleški del prispevka.

Sestava odpadkov, ki je razvidna v prerezih izkopov območja V1, je odraz na površju odloženih odpadkov, kjer prevladuje odpadni gradbeni material. Rezultati analize ne izražajo prekoračitve mejnih vrednosti za posamezne škodljive snovi, so pa vrednosti višje kot na vzorčnih mestih V2 in V3.

Gramoznica 2 (V2; slika 6) je na jugovzhodnem robu najožjega varstvenega pasu v odtočni smeri vodarne, kjer pa obstaja nevarnost onesnaženja pitne vode zaradi depresijskega lijaka. Je delno zasuta in delno porasla. Na južnem robu, kjer je bila nedavno ponovno izkopana, je trenutno nezasuta. V tej gramoznici so največja odlagališča odpadkov, v katerih prevladuje gradbeni material. Vzorčili smo na treh odlagališčih, ki so med seboj oddaljena 50 m. na enem odlagališču smo vzorčili dvakrat. Na največjem odlagališču smo vzorčili dvakrat. Zgodovina izkopavanj v tej gramoznici sega v leto 1959, ko so na tem območju že vidni večji ločeni izkopi, ki so do leta 1975 združeni dosegli največjo površino, 75.000 m^2.

Preglednica 2: Vzorčevalna mesta na območju gramoznice V2.

vzorčevalno mesto	opis vzorčevalnih mest
V2/1	Na površini so večji kosi asfalta in razbite betonske cevi. Pod ploščami in betonskimi cevmi je avtohtoni prod. Vzorec smo odvzeli po celotnem izkopanem prerezu proda do globine približno 3 m, vendar brez kosov asfalta in betona.
V2/2	Vzorčevalno mesto V2/2 je 50 m zahodno od vzorčevalnega mesta V2/1. Na površini do globine približno 0,5 m najdemo različne odpadke (opeka, beton, pločevina, salonitne plošče, kosi asfalta, žica, les in podobno). Pod temi odpadki do globine 1,5 m sta nakopičena prst in kamenje. Naprej do globine 4 m je avtohton prod. Vzorec drobne frakcije velikosti pod 5 cm smo odvzeli po celotni globini izkopanega prereza proda do globine približno 4 m.
V2/3	Vzorčevalno mesto V2/3 je 228 m severno od vzorčevalnega mesta V2/2. Na površini do globine 2,5 m najdemo gradbeni material (opeka, beton, kamen, prst in podobno). Pod njim od globine 2,5 m do 4 m je avtohton prod. Vzorec drobne frakcije proda smo odvzeli po celotni globini izkopanega prereza do 4 m.
V2/4	Vzorčevalno mesto V2/4 je 212 m severovzhodno od vzorčevalnega mesta V2/2 in 149 m jugovzhodno od V2/3. Na površini in do globine 2 m je gradbeni material (opeka, beton, kamen, kosi asfalta, prst in podobno). Pod gradbenim materialom od globine 2 m je avtohton prod. Vzorec smo odvzeli po celotni globini izkopanega prereza.

Prerez izkopov je pokazal heterogeno sestavo gradbenih odpadkov, predvsem betonskih blokov, železa, jalovine, salonitne plošče itd. Rezultati kemijske analize niso pri nobenem od parametrov presegli mejnih vrednosti.

Gramoznica 3 (V3; slika 6) je že dolgo izkopana, delno zasuta in porasla. Leži med vodarno in reko Savo. Zaradi popolne zaraščenosti z grmovnim in drevesnim rastjem, je dostop v gramoznico otežen. V gramoznici in na njenem robu so pod rastjem različno veliki kupi gradiva neznane sestave, ki smo ga opredelili kot staro ekološko breme. Izkopavanje gramoza sega v leto 1970 (70 m krat 70 m), med letoma 1975 in 1979 se je gramoznica zaradi zasipavanja že zmanjšala, leta 1985 pa je bila že zaraščena.

Preglednica 3: Vzorčevalna mesta na območju gramoznice V3.

vzorčevalno mesto	opis vzorčevalnih mest
V3/1	Na površini do globine 0,5 metra je alohtona prst. Pod prstjo do globine 3 m je avtohton prod. Vzorec je odvzet v izkopanem prerezu do globine 3 m.
V3/2	Vzorčevalno mesto V3/2 je le 7 m južno od vzorčevalnega mesta V3/1. Na površini do globine pol metra je alohtona prst, pod njo pa je avtohtoni prod. Vzorec smo odvzeli v izkopanem prerezu proda do globine 4 m.
V3/3	Vzorčevalno mesto V3/3 je 57 m severovzhodno od vzorčevalnega mesta V3/2. Na površini do globine 0,7 m se mešata alohtona prst in gradbeni material. Pod njima je od globine 0,7 m do treh metrov avtohtoni prod. Vzorec smo odvzeli v izkopanem prerezu proda do globine do 3 m.

Z izkopavanjem smo ugotovili, da v odloženem gradivu prevladuje jalovina (odpadni material iz gradbenih izkopov, prst). Ker je jalovina primerna za prekritje odpadkov, je obstajal sum, da so pod njo nevarni odpadki. Toda v prerezih izkopov, ki so segali v avtohtono prodno podlago, jih nismo odkrili. Tudi rezultati kemijskih analiz prodne podlage niso pokazali preseganja dovoljenih vrednosti škodljivih snovi. Sklepamo, da je gramoznico izkopavalo gradbeno podjetje, ki jo je verjetno tudi zasipavalo z odpadno jalovino.

V preglednici 4 so prikazani le nekateri parametri analize vzorčenj, iz katerih so razvidne razlike v koncentracijah posameznih snovi po posameznih vzorčnih območjih. Najvišje vrednosti so na vzorčnem območju V1, nekoliko manjše na območju V2 in najmanjše na območju V3.

Rezultati odsevajo vrsto odloženih odpadkov, saj so v prerezih na območju V1 odloženi nevarni odpadki (sodi z barvo, asfalt), na območju V2 heterogeni gradbeni odpadki in na območju V3 jalovina. Primerjava

Preglednica 4: Rezultati preskusov reprezentativnih vzorcev odpadkov z izbranih divjih odlagališč odpadkov v gramoznicah.

parameter	enota	V1 (izlužek po SIST EN 12457-4)	V2 (izlužek po SIST EN 12457-4)	V3 (izlužek po SIST EN 12457-4)
Kloridi	mg/kg suhe snovi	17	6,5	5,8
Sulfati	mg/kg suhe snovi	33,7	9,0	6,8
PAO (policiklični aromatski ogljikovodiki)	mg/l	< 0,001	–	–
AOX (adsorbljivi organski halogeni)	mg/l	0,02	–	–
BTX (lahkohlapni aromatski ogljikovodiki)	mg/l	< 0,01	–	–
PCB (poliklorirani bifenili)	mg/l	0,0005	–	–
pH	°C	8,1 (22,7 °C)	7,3 (21,5 °C)	7,1 (21,4 °C)

pH vrednosti kaže precejšnje razlike od skoraj nevtralne na V3 in V2 do rahlo bazične na V1. Različne vrednosti parametrov so tudi posledica intenzitete izpiranja snovi v podtalnico, ki je odvisna tudi od razdalje med gladino podtalnice in dnom gramoznice.

Ugotavljanje vplivov izcednih voda iz odlagališč odpadkov v gramoznicah na kakovost podtalnice, z vzorčenjem samo v treh gramoznicah (od 22 odkritih v letu 2004) je statistično premajhen vzorec, da bi dobili celostno sliko stanja. Zato bo potrebno ugotovitve dopolniti z novimi raziskavami. Če so nevarni odpadki odloženi drugje, je samo vprašanje časa, hitrosti razpadanja odpadkov in samočistilnih sposobnosti območja, kdaj in kako se bo to pokazalo v pitni vodi.

Dobri rezultati raziskave na vzorčnih mestih so pomirjujoči. Toda razlog za nizke izmerjene vrednosti je tudi dolgo obdobje odlaganja odpadkov. Veliko njihovih razpadnih produktov se je tako že odcedilo s površinsko vodo v podtalnico. Toda zaradi velike količine odpadkov, ki so odloženi v gramoznicah ali zunaj njih, obstaja potencialna nevarnost za onesnaženje vira pitne vode.

5 Sanacija gramoznic

Približno 40.000 m^2 odpadkov, odloženih na 216 ha površine, ki je namenjena varovanju in zaščiti perspektivnega vodnega vira, nesporno zahteva premišljene in učinkovite sanacijske posege skupaj s preventivnimi posegi, ki vključujejo predvsem ozaveščanje, obveščanje in izobraževanje prebivalcev o ravnanju z odpadki in celostni zaščiti vodnih virov.

Gospodarjenje z gramoznicami ureja Zakon o rudarstvu, kjer je zapisano, da mora po pridobitvi dovoljenja za opustitev izkoriščanja mineralnih surovin, nosilec rudarske pravice izvesti dokončno sanacijo okolja in odpraviti posledice, ki so nastale pri izvajanju rudarskih del. Na območjih, kjer posledic ni mogoče v celoti sanirati oziroma odpraviti, je izvajalec dolžan izvesti ukrepe zavarovanja, da se izključi nevarnost za zdravje ali življenje ljudi in živali ter možni povzročitelji onesnaževanja okolja oziroma predvidljive škode na objektih in okolju (Zakon o rudarstvu, 60. člen).

Površja, ki je bilo izpostavljeno izkopavanju mineralnih surovin, ni mogoče v celoti vrniti v njegovo naravno stanje, obstajajo pa mnogi načini, da se naravnemu (sonaravnemu) stanju čim bolj približamo. Dilema se pojavi pri iskanju sonaravnega načina sanacije določene gramoznice, saj različni strokovnjaki zagovarjajo različne posege v degradirano pokrajino. Sanacija se lahko izvede antropogeno ali poteka po naravni poti. V slednjem primeru se gramoznica preoblikuje v sekundarni habitat, tako da jo preraste rastje. Na robovih se oblikujejo pobočja, ki se zarastejo, v prostoru pa še vedno lahko zaznamo kotanjasto obliko. Vsekakor je ugodna in sonaravna sanacija površinskih kopov po končanem izkoriščanju v območja nadomestnih biotopov z možnostjo razvoja pasivne rekreacije, kajti površinski kopi, še posebej takšni, ki jih je zalila podzemna voda, so območja največje biotske pestrosti v agrarni in urbani pokrajini (Globevnik 2003). Takšen način sanacije pa ni učinkovit pri degradiranih gramoznicah, saj so zaradi odloženih odpadkov življenjske razmere za živa bitja povečini neprimerne. V takem primeru je potrebna načrtovana sanacija, ki jo določimo glede na stopnjo nevarnosti odloženih odpadkov. Pri antropogeni sanaciji gramoznico lahko samo zasujemo in/ali zasadimo z drevjem, nevarne odpadke pa moramo odstraniti. Glede na ugodne rezultate kemijskih analiz, opravljenih na podlagi vzorčenja prodne plasti pod odpadki v gramoznicah Jarškega proda, bi posamezne z odpadki zasute gramoznice lahko sanirali že z izravnavo materiala in zatravljenjem. S takšnim pristopom bi sanacijo gramoznic pospešili, hkrati pa bi zagotovili varno oskrbo s pitno vodo in sonaravni trajnostni razvoj pokrajine na Jarškem produ. Nadaljnje nedovoljeno odlaganje odpadkov, v gramoznicah in v prostoru nasploh, bi preprečili z namestitvijo neprehodnih ovir na dovoznih poteh. Na podlagi celostne analize vodovarstvenega območja Jarškega proda, ob upoštevanju izdelane stopnje prednostne sanacije posameznega odlagališča in značilnosti omrežja prehodnih poti smo določili lokacije samo treh funkcionalnih ovir, s katerimi bi lahko zaustavili vse vrste dostavnih vozil (kamion, osebni avtomobil), ki dovažajo odpadke. Ovire so postavljene na mesta, kjer ni možnosti obvoza (npr. gosto drevje ob cesti, gramoznica) oziroma vključujejo nasipe, ki onemogočijo obvoz ob oviri, kar je pri že obstoječih ovirah pogost pojav. Upoštevati je potrebno tudi dejstvo, da parcele, na katerih bodo postavljene ovire, niso problematične za pridobitev ustreznih dovoljenj za poseg v prostor (strinjanje lastnikov), kar bi lahko izničilo rezultate prizadevanja.

6 Sklep

»… *Družba razlaga svoje okolje glede na način gospodarjenja z njim in z okoljem gospodari glede na način, kako ga razlaga* …« (Berque in sodelavci 1994). Omenjena trditev nakazuje, kako pomembno je dojemanje ljudi in njihov odnos do okolja, v katerem živijo. V nadaljevanju Berque in kolegi (1984) svojo trditev nadgradijo, da razumevanje pokrajine ni samo poznavanje morfologije okolja ali fiziologije človekovega dojemanja, ampak tudi vedenje o kulturnih, socialnih, zgodovinskih vzrokih tega dojemanja, torej o tistem, kar ustvarja človekovo realnost. V tej perspektivi se Jarški prod pojavlja kot ‘ekosimbol’, ki je tako ekološka kot tudi simbolna enota. Jarški prod se mora kot pokrajina izoblikovati in zaživeti. To se zgodi, ko vrsta predstav da tej simbolni enoti točno določeno estetsko shemo, ki je cenjena in jo zato ljudje vzamejo za svojo (Décamps 2001). Drugače povedano, Jarški prod bo postal cenjena in vredna pokrajina, v kateri bodo vsi ukrepi uglašeni z načeli vzdržnega gospodarjenja, takrat, ko bo postala del ljudi. Dokler smotrno gospodarjenje in varovanje ne najde pravega mesta v zavesti ljudi, so vsi formalni ukrepi omejeno učinkoviti.

Zaenkrat je Jarški prod za tiste, ki se zavedajo nevarnosti, breme in grožnja, simbol neustreznega ravnanja s prostorom. Lahko pa bi postal priložnost. V občinskem Prostorskem planu (2002) je zapisano: »… *Prioritetna naloga Mestne občine Ljubljana je varna oskrba s pitno vodo, zato je treba prostorski razvoj prilagajati potrebam ohranitve virov pitne vode* …« Funkcija črpanja vode, ki je na prvem mestu in njej morajo biti podrejene vse druge dejavnosti, bi bila lahko nadgrajena z rekreacijsko in vzgojno dejavnostjo. Nujno bi bilo potrebno uravnovesiti koriščenje vseh naravnih virov, ki jih območje nudi. Pitna voda ima seveda prvenstveno vlogo in zato, da bi jo zaščitili, bi morali popolnoma prekiniti tradicijo izkoriščanja proda in nedovoljenega odlaganja odpadkov.

Treba bi bilo poudariti vlogo in pomen tretjega vira, to je prostora. Območje, ki leži znotraj mestnega ozemlja, bi moralo dobiti novo vlogo. S tem ko bi postalo neke vrste naravni park v urbani pokrajini, bi dobilo novo vsebino, kjer ne bi bilo mesta za odlaganje odpadkov. Na tak način bi prebivalci dobili odprt prostor, dostopen vsakomur in obenem bi z njegovim vključevanjem v svoj stil življenja preprečevali neustrezno ravnanje z njim.

7 Literatura

Glej angleški del prispevka.