

# GROUNDWATER POLLUTION IMPACT ON THE RURAL AREAS

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## ABSTRACT

This paper presents the impact of groundwater pollution on the land around irregular deposits on bordering rural communities. Rural area has the ability to preserve and restore the natural environment due to reduced anthropogenic pressure, associated with the type of economic exploitation and general development level of productive forces. Environmental quality of rural life has important antistress effects and therefore it is considered a heritage of humanity and should be kept. The paper is particularly important because we have taken into account that aquifer is an important source of water. Pollution is a serious problem affecting the environment and human health, in this case we want to present the study on pollution spreading. Historical pollution site has not been seen to be dangerous, till now. The purpose of this paper is to highlight the influence of pollution on rural areas in the neighborhood of inappropriate landfills and dumps storing waste or byproducts from various industries. In this paper we show the evolution of the pollutant plume from the landfill Șag-Parța and a slag and ash dump Utvin, Timiș county. Both deposits are located near the town of Timișoara. The models presented in this paper were performed using MODFLOW software.

**Keywords:** rural area, pollution plume, groundwater, dump, environmental protection.

## INTRODUCTION

### Rural areas

Etymologically, the word "rural" comes from the Latin "rurs, ruris", and refers at culture, fields, occupied territory, inhabited, arranged and worked by man. The rural is land area which is dominated by forests, crops and green spaces that rely on a predominantly agricultural society.

Rural area has the ability to preserve and restore the natural environment following to reduced anthropogenic pressure, associated with the type of economic exploitation and general development level of productive forces. Extensive fields of culture, the absence of the main ways of communication, the insular presence of framework built of smaller dimensions and herds of animals, betrays the present of rural areas.

The problem of development and rural arrangement is one of the most complex contemporary themes, because, in his essence, means achieving a balance between conservation requirement of rural areas in terms of economic, ecological and socio-cultural, on the one hand, and tendency to modernize rural life, on the other. (BOLD, 2003)

A rural area is: agricultural land - used for crop and livestock - and non-agricultural land - used for housing, small industry, services and other human activities - seen as a whole. Rural area is defined as "the inner and coastal area which includes villages and small towns where the bulk of the land is used for agriculture and forestry, arrangement of mountain areas for leisure, natural reserves, for habitation, for activities crafts and for services or industrial activities." (HANCU, 2004)

In Europe from the years 1987-1988 began a new process more pronounced of

appreciation of the rural. During this period took place European Campaign for the Rural World, organized by the Council of Europe, campaign comprises a series of events and conference on various topics, which were largely at the origin of publication of Swiss Charter for Development of Rural World, adopted by the National Committee of Rural Areas on 16 December 1987.

The first project of the European Charter of Rural Area was presented Parliamentary Assembly on July 28, 1995, in Strasbourg. Final form of the Charter was obtained at ordinary session of the Parliamentary Assembly of Council of Europe on 23 April 1996 as the 1296 Recommendation regarding the European Charter of Rural Area. (MAN, 2007)

### **Characteristics of the rural areas:**

- \* The most important branch of activity in rural area is agriculture;
- \* In some areas, particular importance has forestry and wood processing industry;
- \* There are mountainous areas or areas of delta in which agro-tourism has a large and growing importance;
- \* In rural areas primary economic sectors have the highest proportion;
- \* The main occupations of those in rural areas are: crafts, practice or in primary manufacturing industry, requiring many qualifications (obviously aren't missing highly skilled professions: education, culture, etc.);
- \* Most common form of ownership is private property, family; there are also state properties but more restricted, as research stations, reserves and national parks, areas covered by way of communications, etc.
- \* Population density and area of the locality in rural areas are smaller but from socially point of view human relationships are much closer;
- \* Environmental quality of rural life has an important relaxing effect and therefore it is regarded as a heritage of humanity;
- \* The true value and dimension of the rural area is given by lifestyle and popular culture;
- \* Economic development based primarily on agriculture and forestry, shall be designed so that agricultural raw materials to be processed as close to where they were produced; (HANCU, 2004)

### **Groundwater**

To describe and characterize the flow it is necessary first to define the term "aquifer" and then to discuss the movement of groundwater in this environment. Definition of aquifer term can be done as:

*Aquifer is an underground area of permeable rocks that have capabilities to store significant amounts of water and allow water flow to wells.*

Aquifers can be classified into two distinct groups:

- \* Unconfined aquifers, which are bounded only below by an impermeable layer and
- \* Confined aquifers or under pressure, which is between two impermeable layers.

The flow rate of water in a saturated zone, is regulated by three key factors:

### **Hydraulic gradient**

$$i = \frac{Q}{k \cdot A}$$

i- hydraulic gradient

Q – flow rate

k – hydraulic conductivity

A – cross sectional of flow area

**Hydraulic conductivity** is the ability of rock or sediment to transmit fluid, in other words the speed of water flow under a hydraulic gradient.

**Rock porosity** is the relationship between pore volume and total volume of solid particles of the rock. Porosity depends on geological material and can be determined by field tests or laboratory tests.

## MATERIAL AND METHOD

### Description of the region

The studied area is located SW of the city Timișoara, is bounded to the north of Bega river and south of the Timiș river. In the area bounded by the two rivers are two pollution sources, namely: landfill Parța-Șag and slag and ash dump Utvin.

**Parta-Sag Landfill** was opened in 1973, with a projected area of 16.6 ha and a capacity of 1,800,000 m<sup>3</sup> with the owner on the City Council of Timisoara. The authorized operator is S.C. Retim S.A. Timisoara. As technical data we can say that the deposit has a volume of waste stored of 1.8 million m<sup>3</sup>, with a free capacity of 100,000 m<sup>3</sup> and an annually stored volume of 103.80 thousand m<sup>3</sup>. The landfill is located at a distance of 10 km from Timisoara, 3 km from Sag, 7 km from Parta and 4 km of the river Timis (nearest surface water source). Parta-Sag landfill is a inappropriate deposit located on a former clay quarry. Because the leachate resulted from leakage from landfill pollutes aquifer, the European Union forced Romania to close the landfill. Thus, in 31.XII.2008 Parta- Sag landfill was closed permanently, but still continues to pollute.

**Utvin slag and ash dump** is a deposit of lowland, which occupies an area of 150 hectares. The dump has a trapezoidal form with the large base of 1100 m, the lower base of 900 m and the trapezoidal height of 500 m. The dump began operating in 1988 and is open till today.

Dump is located at: 1,5 km SW of Utvin Village and about 4 km west of Timișoara City. The dump is located at approx. 2 km SE of Bega river and is located near the Nivelda creek, which passing approximately 500m south of the deposit. The deposit is designed for a total capacity of 4 821 000 m<sup>3</sup>.

### Waterproofing system

According to the hydrogeological survey, slag and ash dump Utvin is located on a clay layer of 3,5 to 6,5 m thick, which has an average permeability of  $k = 0,05 \text{ m / day}$  ( $k = 5 \times 10^{-5} \text{ cm/s}$ ). The permeability of soil and dams is  $k = 5 - 5,7 \times 10^{-5} \text{ cm/s}$ , seismic degree is 7. (MMDD, 2008)

### Modelling software

The forecast of pollutant plume was performed using software MODLOW. MODFLOW is a simulation system for modeling groundwater flow and pollution. This software allows modeling of flow in the aquifer and it's made also to present the pollutant plume in space and time.

## RESULTS

Because both waste deposits (the Parța-Șag dump and the Utvin ash and slug dump) are

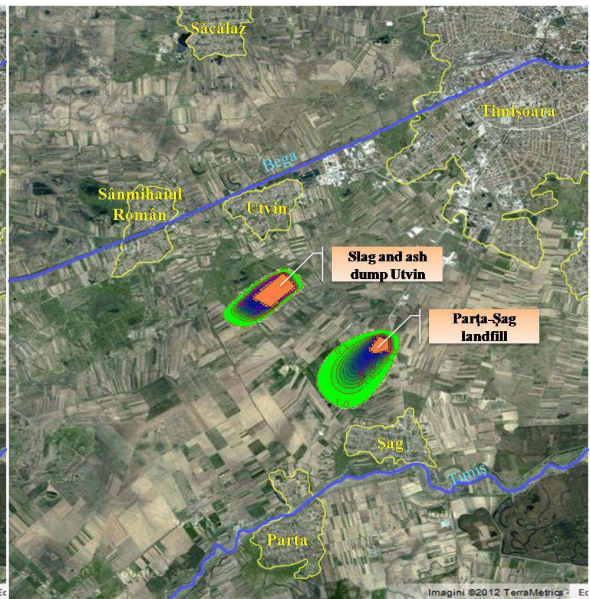
not isolated very good, the leachate infiltrated the aquifer affecting the groundwater for the entire area.

The study followed the evolution of the pollution plume in the aquifer between 1993-2013 and continued with the forecast until 2033, in the case that no measures of prevention are taken. The mathematical models used to determine the evolution of the pollution plume where performed using the MODFLOW software.

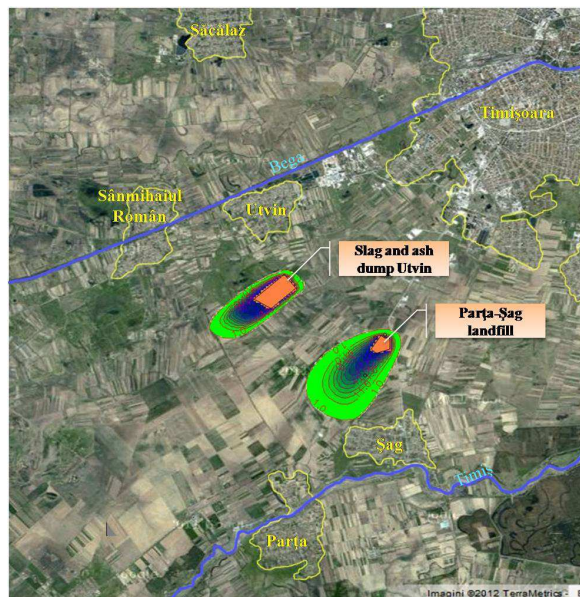
The spreading of the pollutant towards the rural areas can be highlighted using the following models:



**Figure 1. Pollution plum 1993 (5 years slag and ash dump Utvin; 20 years Parța-Șag landfill)**

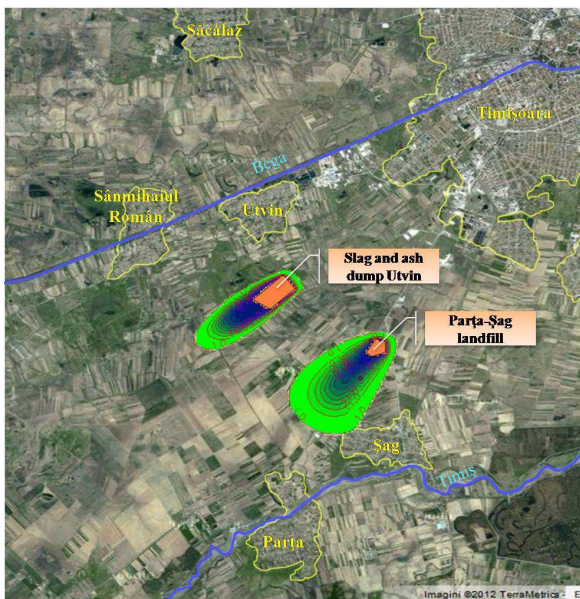


**Figure 2. Pollution plum 2003 (15 years slag and ash dump Utvin; 30 years Parța-Șag landfill)**

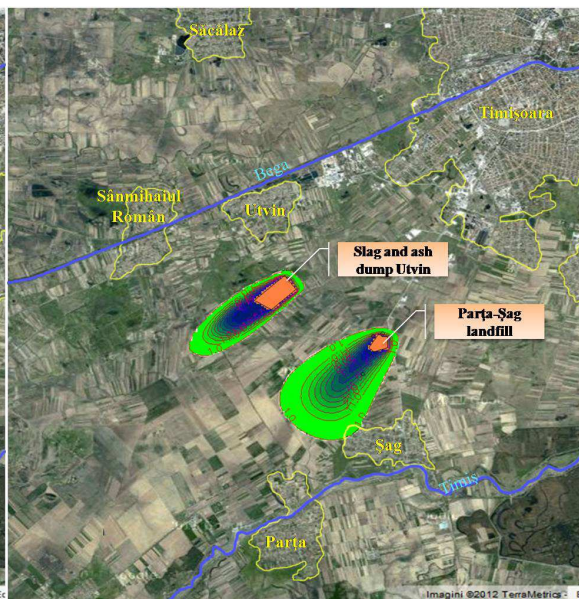


**Figure 3. Pollution plum 2013 (25 years slag and ash dump Utvin; 40 years Parța-Șag landfill)**





**Figure 4. Pollution plum 2023 (35 years slag and ash dump Utvin; 50 years Parța-Șag landfill)**



**Figure 5. Pollution plum 2033 (45 years slag and ash dump Utvin; 60 years Parța-Șag landfill)**

All ready from the year 1993, at 20 respectively 5 years of functioning (*fig.1*), the spreading of the pollutant in the aquifer can be highlighted. After 10 years, 2003 (*fig.2*), there is a visible impact on the soil, also a shifting of the pollutant towards the rural areas can be observed, in this case Șag and Parța.

In the year 2013 (*fig. 3*), 40 years from the opening of the Șag-Parța landfill and 25 years from the opening of the Utvin dump, this representing the current situation, the pollution plume is moving closer and closer towards Șag, endangering the fountains situated at the outskirts of the village.

If no measures of prevention and treatment are taken in the near future, between 2022 (*fig. 4*) and 2033 (*fig. 5*) the pollutant will contaminate the groundwater of the entire Șag village and will head for the village of Parța and finally the Timiș river.

## CONCLUSIONS

A balance between man and the natural environment is need in order to have a more authentic and natural rural area. Anthropic actions should have very little effect on the natural environment in order for it to have the power purify and conserve it's self.

Development of rural areas, regardless of geographic area, ways of development and needs of local people, must be made according to certain rules considering the limiting factors, only in this case can we talk about sustainable development.

The pollution of the aquifer has negative effects on the groundwater, agriculture and the overall development of the area. Because the pollutant shifts alongside the aquifer, the noxious substances (heavy metals, nitrates, nitrites, etc.) infiltrate the soil affecting the quantity and the quality of the crops.

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## REFERENCES

MINISTERUL MEDIULUI SI DEZVOLTARII DURABILE (2008): Agenția Națională pentru Protecția Mediului: Autorizație integrată de mediu nr. 21 din 04. 02. 2008, pp 12-13

DAVID I. ET AL. (2007): Final Report "Research Contract - Development and Consultancy", between: University Polytechnica Timisoara, Faculty of Hydrotechnics and Grontmij Nederland

CORNELIU DAN HANCU (2004): Dezvoltare rurala, editura Matrix Rom, Bucuresti; pp 8-14

MAN TEODOR EUGEN, MATEOC-SIRB NICOLETA (2007): Dezvoltare rurala si Regionala Durabila a satului romanesc, editura Politehnica, Timisoara 2007 pp 8-12

I. BOLD, E. BUCIUMAN, M. DRAGHICI (2003): Spatiul Rural. Definire. Organizare. Dezvoltare, editura Mirton, Timisoara pp 15-63;