CHARACTERISTICS AND ENVIRONMENTAL IMPACTS OF COMMUNAL SOLID WASTE HANDLING IN HAJDÚ-BIHAR COUNTY

Preliminaries, objectives

At the Department of Applied Regional Geography, University of Debrecen since 1994 we have been dealing with environmental loading originating from depositing of communal solid waste. From 1996 our more limited research area – in a joint programme with the Karl Franzens University's Department of Applied Geography at Graz – has been examination of the handling of waste from communities in Hajdú-Bihar county and the environmental problems arising from this.

Our objectives in the course of this research, were:

- To evaluate the real practise and problems of waste management at the Hajdú-Bihar county's communities.
- To examine the most important processes – from the point of view of their effect on the environment – taking place at the waste tips.
- To study the re-naturalisation processes at the abandoned waste tips.
- To examine the pollution of strata close to the surface underneath the waste tip and of the groundwater, and the environmental geology conditions of the sites.
- To discover those environmental characteristics, the role of which could be of particular importance in moderating the environmental loading caused by water leakage.
- To develop a method by which the sub-surface pollution-sensitivity originating from the waste tip can be classified.
- To compile a thematic pollution-sensitivity map of the county.
- To evaluate and classify the characteristics of county waste tips from environmental and hydrogeological, nature and landscape protection, together with community health points of view. And following this, to set up an order of environmental protection focused re-cultivation priority for the waste tips in the county.
- To prepare a cadastre of the county's communal waste tips.

Methods applied

In the course of the work, the following examinations were carried out in the field and laboratory:

- So that we can give a more accurate picture of the domestic situation concerning solid communal waste handling, in numerous places we have supplemented Central Statistics Office data with our own. The source of our data was a questionnaire type survey in the Mayor's Offices, and field inspections of waste tips at 250 East Hungarian communities.
- In the spring of 2001, we carried out a 1000 element questionnaire type population-environment protection survey in Hajdú-Bihar county. Our quota-based probability sampling represented the inhabitants of both sexes over 15 years old in Hajdú-Bihar county.
- We gained knowledge of the community waste management in Hajdú-Bihar county, in the course of questionnaire type data collection at the mayor's offices in 82 communities, and field inspections carried out at 79 communal waste tips in the county.
- We examined the development of pollution and toxic material in water leakage and the temperature of soil covering the waste material at the communal waste tip of Debrecen, together with checking regularly once a month the composition of biogas produced. Further similar emission examinations were carried out at the communal waste tips of Földes and Hajdúhadház.
- Four three years, with cenological examinations we studied the re-naturalisation processes of abandoned (with or without soil covering), and operating waste tips in eight sample areas. On

the basis of species stock composition we carried out the studies of Simon's naturality factors and the Raunkiaer's life form analyses. The habitat ecological indexes were established with the plant species related Zólyomi's and the Borhidi's relative ecological indicator numbers.

- We made 3 drillings down to the groundwater in each of 20 waste depository sites, and their surroundings (their control areas) of differing environmental geological characteristics, but similar from the point of view of waste type, quantity, composition and time of depositing (that is to say, presumably producing similar quantities and qualities of water leakage). We carried out 50 drillings each at the sites of three further waste tips, according to the above viewpoints. Following this we analysed, the pollution and heavy metal content of the soil and groundwater samples collected from the waste depository sites, together with the environmental geology parameters (mechanical composition, the pH, the adsorption capacity, the organic material content, $CaCO_3$-content, the hydraulic conductivity, the sub-soil water depth, and the waste tip's morphological type) from drillings on the same sites.
- We carried out statistical analyses of the pollution and heavy metal content of groundwater samples taken from the waste depository sites, and between the environmental geology parameters of drillings from the same sites, and between the water leakage composition of the Debrecen waste depository and the actual climatic water balance.
- Following laboratory analysis of samples (taken at every 10 cm) from at least one drilling deepened until the groundwater table at each of 79 communal waste tips in Hajdú-Bihar county, we carried out evaluation of the strata close to the surface at the waste disposal sites, from a pollution-sensitivity point of view.
- We carried out classification of the county's waste depositories, with geoinformation methods, based on the order of priority in Government decree 33/2000 (III.17.) serving for quality protection of groundwaters.
- The nature protection classification of waste disposal sites in Hajdú-Bihar county was determined making use of the database of the Hortobágy National Park. We classified the county waste depositories from landscape protection and landscape aesthetics points of view, according to our own evaluation method.
- For human health protection classification of the waste depositories we carried out the following tasks. With geoinformation measurements we calculated the distance of the waste depository, from the nearest community, from the inner area of the community and from the nearest water drawing well. We examined the site situation in relation to wind conditions, together with the more important parameters from the human-health protection point of view.
- From the material of our waste handling examinations carried out over six years, we compiled a data-base entitled Cadastre of Hajdú-Bihar county's communal solid waste depository sites in 2002. This contains the more important data - according to provisions in the Ministerial decree 12/1996. (VII.4.) KTM – of 79 communal solid waste tips situated in the administrational area of the county's 82 communities. The cadastre is also accessible in electronic form, with web-sheet user interface.
- For examining the sensitivity to pollution originating from the waste disposal of the small regions in Hajdú-Bihar county, we deepened 200 drillings down to the groundwater table throughout the county, and from these, we collected soil samples at every 10 cm. Following examination of the determinant environmental geology parameters (mechanical composition, pH, adsorption capacity, humus content, $CaCO_3$-content, hydraulic conduction and groundwater depth), with the help of our self-constructed classification method, we compiled a thematic pollution sensitivity map of the county.
- By mapping analysis we examined the sensitivity to waste disposal of the small regions in Hajdú-Bihar county.

Results

1. The situation of communal solid waste handling in Hungary – as reflected by our questionnaire studies

In 2000 approximately 23-24 million m^3 of communal solid waste was produced in Hungary (OHT 2002). About 85% of this, that is, 20.42 million $m^3 \approx 4.1$ million tons went for organised disposal (KSH (Central Statistics Office) 2001). The amount of communal solid waste transported showed a regular increase of 2-5% in the years of the 90's. About 86% of the domestic communities operated organised waste collection and transportation. In 2001 this service extended to cover 3524 million households (KSH 2002). The first national plan in connection with waste handling was established in our country in 2002. The main obstruction to the planning up until now, was the lack of an information system for recording and processing the data.

Since there was no reliable national database available to us in connection with the handling of communal solid waste we carried out field examinations for disclosing the domestic situation. The source of our data was a questionnaire survey in the Mayor's Offices, and field inspection of waste disposal sites at 250 East Hungarian communities, therefore our statistics can be regarded mainly as representative of the Eastern part of the country, and we would only recommend their being taken into account as an estimation in relation to the situation country-wide.

According to our examination, in practise 68-70% of the households make use of the organised waste collection and transportation. Selective waste collection was carried out in 2-3% of the communities in 2000. On the whole, 10-15% of the population indicated that they collect their waste selectively. The illegal dumping of waste represents a constant, serious problem at 40% of the communities. Among the methods for handling communal solid waste in Hungary, the waste depositories are dominant in general. 83% of the communal waste goes to the waste depository sites. 82% of the communities operate legal communal waste depositories – that is having official operation permission –, or in an illegal form. On this basis, in our opinion the actual number of communal waste disposal sites in the country used regularly by the population, is between 2500-2600. Out of these 665 have official operating permission, and about 1800-1900 operate illegally. Out of the latter, 60-65% are reported by their operators as closed and abandoned depositories. The number of large sized desolate depositories utilised by the population countrywide is estimated as 300-400.

In our survey we established that almost half of the operating waste tips are more than 20 years old. The local governments and local government economic organisations operate 85% of the sites. Operation of 15% is of a small regional character.

When establishing the currently operating depositories, the communities for the majority gave preference to economically valueless, mainly deteriorated areas. 45% of the waste depositories can be found in former mining pits. When selecting the site, the environment protection points of view were rather of secondary importance, and with 85% of the waste tips, these were not even examined, or had examined by the local governments. For a large part a consequence of this is that there are regular complaints and reports by the population in connection with one third of the depositories.

The site fundamentals are extremely unfavourable at two thirds of the waste disposal sites, being positioned on particularly pollution sensitive area, where safe waste disposal cannot be carried out. According to the current jural conditions these waste depositories should be closed down as soon as possible. At one quarter of the waste depositories the disposal of waste is carried out on low sensitivity territory with relatively favourable site fundamentals, while 10% of these sites are extremely suitable for disposal with high environmental safety. At the same time, due to the equipment and operating deficiencies, even at the latter a potential risk exists.

The most serious site and operating problems:

- One third of the waste depositories lie on waterlogged areas and areas having high groundwater level.
- More than one half of the waste depositories operate with landfill technology.
- One third of the waste depositories are positioned on sand and on gravel.
- One tenth of the waste depositories are positioned on nature protection areas.
- One third of the waste depositories are positioned in places unfavourable from human health protection points of view.
- At two thirds of the waste depositories regular compacting or earth covering is omitted.
- At one quarter of the waste depositories the operator applies neutralisation by incineration.

Scarcely 5-10% of the waste tips in operation satisfy the higher level technical operating specifications.

2. The communal solid waste handling situation in Hajdú-Bihar county

In Hajdú-Bihar county close to 1-million m^3 communal solid waste is produced each year. Within the framework of organised collection 885.6 thousand m^3, that is, 210.8 thousand tons was removed in 2001 (KSH 2002).

The change in the amount of communal waste removed displays a trend similar to that nationally.

In 2001 there was organised collection and removal of waste in 76.8% of the communities in Hajdú-Bihar county. The number of households in the county making use of the non-selective, organised collection and removal of household waste, was 177774, which represents a ratio of 83.9% (KSH 2002).

According to data from our household questionnaire, 67.81% of the households in the county actually make use of the service. 30-40% of the Hajdú-Bihar county's population – only taking the readiness of the population into account – could be included in selective collection of communal waste.

The communal solid waste produced in the 82 communities in Hajdú-Bihar county is placed in 79 depositories. 94% of the county communities operate waste depositories in legal or illegal – not having environment protection permission, but to the knowledge of the environment protection authority – form. One half of the waste depositories operating in the county do not have permission from the environment protection authority competent for the area. One quarter of the county waste depositories are positioned in mud pits, one fifth in clay pits, while 85% are positioned in sand pits.

95% of the communal waste depositories operating in the county do not satisfy the obligatory specifications relating to equipment and operation. As a result of the deficiencies, the environmental loading, beyond the composition and quantity of the waste, are mainly determined by the natural characteristics of the communities. Those natural characteristics, which for the majority did not receive sufficient attention when the disposal sites were selected.

3. Evaluation of the environmental effect of processes taking place in the waste depositories

The biogas and the heat production are of outstanding significance, mainly due to their effect on vegetation of waste depositories re-naturalising in a spontaneous manner or re-cultivated in a planned manner, while the water leakage is important because of its role in pollution of soils, surface and groundwater, together with its effect on the vegetation.

3.1. Results of the biogas examination

The gas composition at the waste depositories in Debrecen represents decomposition processes taking place in strongly compacted and regularly covered waste. Although aerobic and

anaerobic decomposition take place beside each other in the waste depository, the latter process is the dominant. The main components of the biogas produced, are methane, carbon dioxide and nitrogen. The methane and carbon dioxide ratio is 64 : 36. As opposed to this, at the disorderly, open waste depository at Hajdúhadház, we found extremely moderate gas production compared to the amount of waste deposited. The composition of gas produced indicates that the waste is less compacted and does not receive regular covering, thus the gas production is not intensive. In the central, more compacted sections of the waste depository, production of methane has commenced. There the ratio of methane and carbon dioxide was 58 : 42, while in the less compacted sections this was 45 : 55. In other sections ventilation of the waste is general, thus here the aerobic decomposition is dominant, mainly resulting in carbon dioxide.

3.2. Results of the heat production examination

In the course of examining soil temperature at the waste depository at Debrecen covered with an earth layer, we established that the temperature of the soil's main rooting zone (a depth of 30-50 cm) was 8-12°C higher in the winter season, while in summer was 12-19°C higher than the surrounding area. A further difference was that the soil temperature of the waste depository was less uniform, showing a greater seasonal fluctuation than the surroundings. In the main rooting zone of the waste depository it is 10.5-11.7 °C warmer than in winter, while in the surroundings the soil temperature in summer only exceeds the winter temperature by 3.7-7.7°C. That is to say, the seasonal fluctuation of soil temperature is one and a half to two times greater in the waste tip area than in the surroundings.
Serious environmental stress is caused to the vegetation of a re-cultivated depository, by having to accommodate to a 10-20°C positive soil temperature anomaly, and a greater seasonal fluctuation than the surroundings.

3.3. Results of the water leakage examination

According to the maximum concentration of the examined heavy metals, the water leakage from the waste disposal sites proved to be strongly polluted. The water leakage of the examined waste tips were similarly classified as strongly polluted on the basis of average values of their oxygen balance (BOI_5, KOI, TOC), their ammonium content and their specific conductivity. Since the pH of the water leakage moves between 7.82 and 8.42 during the entire year, the examined water leakage behaved less as an aggressive solvent, as compared to that described in the early stages of the anaerobic decomposition process. Thus the concentration of contaminating materials did not display extremely high values.

The composition of the water leakage varied considerably during the year, and its quality moved between the good and strongly polluted categories. Our statistical analysis displayed a significant relation between the water leakage's volatile acid content and the metal concentrations. The volatile sebacic acids originating from the activity of fermentative and acid producing bacteria, in reaction with the metals, form water solvent compounds, and make leaching easier. The development of climatic water balance determined the nitrogen balance and the organic material content in 25-40%. While in the case of the majority of metals, the water leakage composition developed according to the climatic water balance in 10-15% cases. The water leakage was most strongly polluted in those periods when the small amount of rain was accompanied by high evaporation value, that is, the water balance was negative.

4. Effects on re-naturalisation and re-cultivation by the processes taking place in the depositories

A variable ecotope mosaic could form in a re-cultivated waste tip, which mainly created by significant territorial differences in water supply and nitrogen content. The lack of water, the

formation of biogas and the production of heat reduce the re-cultivation's success. The one-year-old plants are rather more adaptable to the extremely fluctuating water supply and the soil temperature differing from the surroundings. Matching into the landscape will be unsuccessful in the long term if the re-cultivation does not include earth covering. It is unfavourable if the earth covering material is mainly building rubble, or if it is spread mixed highly with rubbish. If the re-cultivation is levelling and compacting without earth covering, - independent of the differing landscape characteristics – it will result in degraded vegetation similar to each other but strikingly deviating from the surroundings. The vegetation of an abandoned depository without earth covering, even 8 years later will deviate strikingly from its surroundings. The species indicating degradation are in the majority in both the operating and the re-cultivated waste depositories. However while exclusively these are present at the operating waste depositories, at former waste depositories re-naturalising without earth covering the ratio of species in the vegetation indicating naturality is 6%, and in the re-cultivated waste depositories with earth covering this is 8%. That ratio of species enduring disturbance and pioneer species grows in a similar manner. In vegetation on waste depositories re-cultivated with earth covering, the rate of adventive species is 20% less than at operating waste depositories, and 12% less than with re-cultivation without earth covering.

From the vegetation point of view matching into the landscape is significantly simpler on dry areas than in a wet habitat environment. On the former implantation of more valuable vegetation characteristic of the natural state is successful in even a spontaneous manner, while it is not in the latter case.

5. The role of the waste depositories' environmental geology characteristics in the pollution of groundwater

In the course of our examinations we experienced that the degree of groundwater pollution under the individual depositories can deviate significantly due to the differing environmental geology characteristics. The clayey texture strata close to the surface in general bound 40-70% more contaminating material as compared to the sandy texture strata. It was also obvious from the values of contaminating and toxic materials loading the groundwater that landfills load the sub-surface environment more than the waste-heaps. We experienced particularly high pollution in the groundwater underneath waste depositories where the landfill is deeper than the groundwater table and the waste material is lying in water.

On the basis of heavy metal content, the groundwater underneath the examined waste depositories, for the most part could be listed in the tolerable and polluted water categories. In the case of heavy metals, in some cases the groundwater of sand pit and clay pit landfills was placed in the strongly polluted category. The sub-soil loading compared to the limiting values of natural origin, were the highest in sandpit and clay pit landfills in every case of measured heavy metal. The concentration of toxic materials in the groundwater below this kind of depositories was on average twice-three times – but in some cases even six-seven times – higher than that in the groundwater outside their area of effect.

On the basis of effect on groundwater, the worst types of depository in Hajdú-Bihar county were the following:

- Depression in sandy areas (sand pit), in which the groundwater level is less than 1.5 m deep, calculated from the landfill bottom surface.
- Depressions in clayey areas (clay pit) with the landfill deepening below the groundwater table, in which the permanent presence of water leakage (groundwater, precipitation, etc.) causes intensive leaching in the waste.
- Waste-heaps on flat sandy areas, where the maximum level of groundwater always remains more than 1.5 m.
- Landfills in loess areas (former sun-dried brick making pits).

The least amount of pollution was measured underneath waste-heaps in loess areas and waste-heaps in clayey-silty areas.

6. Evaluation of community characteristics from environmental geology points of view – pollution-sensitivity

In the course of statistical analysis, of contaminating material and heavy metal content of groundwater samples collected from the waste depository sites, and between environmental geology parameters of drillings on the same sites, the role of five environmental geology variables proved to be determinant in the development of groundwater pollution. On the basis of the statistical relations we worked out a site classification method which, besides evaluation of the site's morphological characteristics, also takes account of the following: mechanical composition (Importance factor: 15), clay mineral content (Importance factor: 35), humus content (Importance factor: 6.5), pH value (Importance factor: 13.5), unsaturated stratum thickness (Importance factor: 30). The point values of our classification system were established and included in the evaluation tables following statistical analysis of data obtained in the course of laboratory examinations.
Only those environmental geology parameters appear in our evaluation system, which we met with at the waste depositories in Hajdú-Bihar county. Thus our evaluation method is suitable for classification of our communal waste depositories positioned on areas filled with stream deposits.

7. Classification of the communal waste disposal sites in Hajdú-Bihar county

7.1. Environmental and hydrogeology classification of the county's waste depositories

The pollution-sensitivity of strata close to the surface at communal waste depositories in Hajdú-Bihar county (according to our own classification system) have been expressed by a number between 0-1000. The lower the number of points received by a site, the greater the pollution-sensitivity against water leakage **(Figure 1.).**
In the county the environmental geology characteristics of the Tiszacsege waste depository proved to be the most unfavourable from the pollution-sensitivity point of view.
35.4% of the county waste depositories are positioned on strongly sensitive (between 200-400 points) sites. More than half of these can be found in the South-Nyírség, while 17.8% in the Borsod floodplain. Those waste depositories were placed in this category, which for one part are positioned on areas with high hydraulic conductivity (sandy texture), and/or are positioned in artificial or natural depressions exposed to permanent effects of water.
53% of the waste depositories in Hajdú-Bihar county lie on sites with medium sensitive (between 400-600 points) characteristics. Mainly waste depositories on the Hortobágy, the Great-Sárrét and the Bihar plains were placed in this category, where the waste is deposited on loam areas and loess silt areas and/or the waste could come under permanent effect of water. More than half of these kinds of tips are endangered by inland water.
Only 6.3% of the waste depositories are positioned on areas with moderately sensitive (between 600-800 points) environmental geology characteristics. Some waste-heaps are found on the South-Hajdúság, the Great-Sárrét and the Bihar-plain, where clayey loess silt and meadow clay can be found, and have no problems with either groundwater or inland water.
In the course of our examinations we also established that one third of the county's depositories are endangered by inland water, while more than half are positioned on territory with high groundwater table. While 7.6% of the depositories can be found within a 200 metres band taken from the banks of rivers.

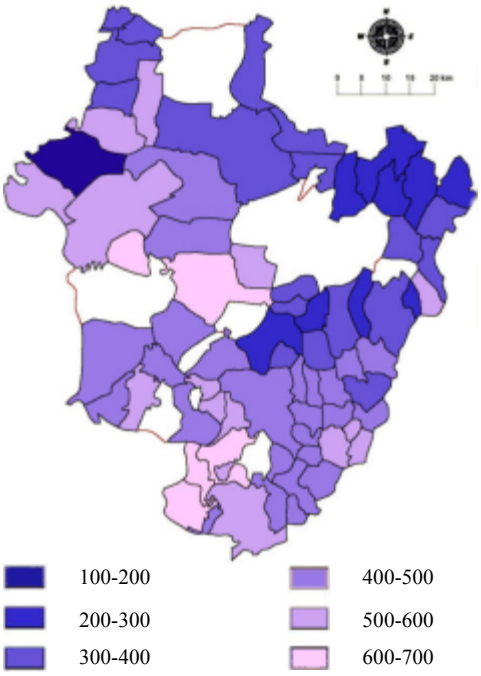

Fig. 1. The sensitivity points of depository sites in steps of 100

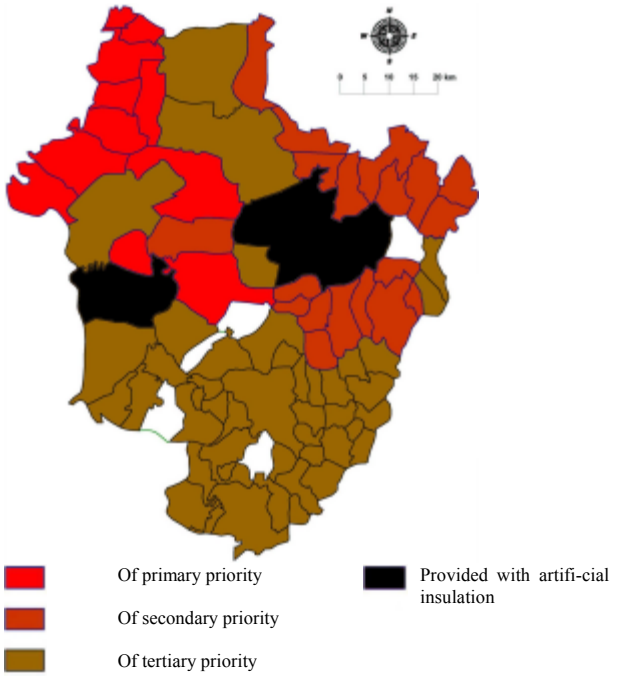

Fig. 2. Order of re-cultivation priority for the county waste depositories from environmental geology and water conservation points of view

Evaluating the county waste disposal sites according to the categories of Government decree 33/2000 (III.17.) serving for protection of sub-surface water, the depositories at Tiszacsege, Tiszagyulaháza and Egyek proved the most unfavourable. These sites are positioned on highly sensitive ("A") areas and at the same time lie on specially or outstandingly sensitive, sub-surface water conservation areas.

With combined evaluation of the sites' environmental geology and water conservation characteristics, we came to the conclusion that further depositing of waste should not be continued at 13.9% of the waste disposal sites in Hajdú-Bihar county, that is, re-cultivation is of primary priority. Re-cultivation is of secondary priority at 25.3% of the county waste depositories, because at these, according to water conservation classification, the depositing of waste is carried out on sites of sensitive characteristics, while according to our own environmental geology classification, on sites of strongly sensitive characteristics.

At 58.2% of the county's communal waste depositories – compared to the foregoing -, the environmental geology characteristics of the sites are more favourable. Only two waste depositories (Debrecen, Nádudvar) operate in the county, where the site and operating conditions satisfy the specifications, and where the artificial insulation guarantees the safety of the surroundings **(Fig. 2.)**.

7.2. Nature and landscape conservation classification of the county waste depositories

12.6% of the Hajdú-Bihar county waste depositories are positioned in areas under nature protection patronage. We can find 25.3% of the waste depository sites in unprotected nature areas.

We classified the effect of the waste depositories on the landscape, according to the appearance and visibility of the sites. 8.8% waste disposal sites were placed in the most unfavourable category of our landscape aesthetics evaluation. These waste depositories are plainly visible from the public road and residential buildings, and are positioned close to areas in near-natural state, where their appearance is disturbing from the landscape protection point of view.

Following combined nature and landscape protection evaluation of the waste depositories, based on these, we worked out six priority groups **(Fig. 3.)**. In this, those waste depositories

positioned on protected nature areas were given primary re-cultivation priority. 20.2% of the waste disposal sites received secondary priority, which were positioned in natural areas, and – according to our landscape aesthetics evaluation – were positioned in a manner least matching into the landscape.

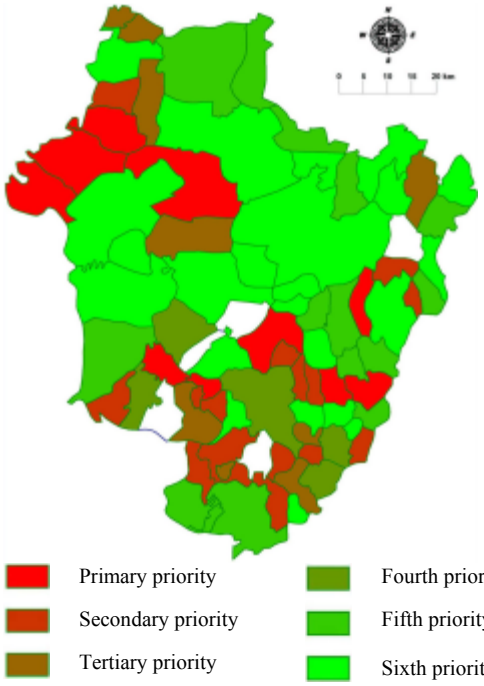

Fig. 3. Order of re-cultivation priority for the county waste depositories, from nature and landscape protection points of view

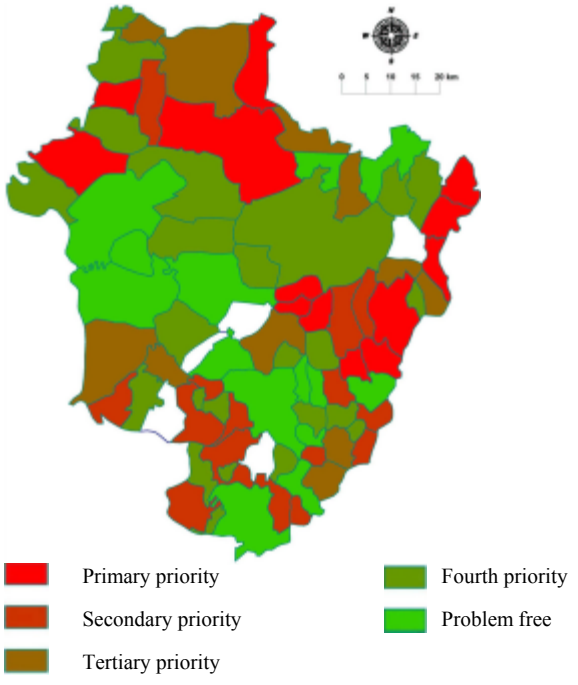

Fig. 4. Order of re-cultivation priority for the county waste depositories, from the human-health protection point of view

7.3. Human health protection classification of the county waste depositories

In the course of our examination we experienced that 78.5% of the waste depositories did not keep the 1000 metres public health protective distance between the waste depository and the nearest residential building. At 38% of the communities the distance between the waste depository and the nearest residential building was not even 200 metres. 12.7% of the county's waste depositories are positioned in an unfavourable place from the point of view of wind conditions. The bad operational practise of the sites, with combined unfavourable wind conditions and insufficient protective distance, represented a hazard at 22.7% of the county's depositories. On the basis of data on the water drawing wells of the TIVIZIG (East Hungarian Water Conservation Authority), we established that 12.6% of the county waste depositories are within 200 metres of the nearest drinking water well, and one third are at a distance of between 200-500 metres.

On the basis of all this we determined four re-cultivation priority groups from the human health-protection point of view **(Fig. 4.)**. We classified 17.7% of the Hajdú-Bihar county waste depositories, for primary re-cultivation from the human-health point of view. Drilled drinking water wells can be found near the waste depositories, and the strata close to the surface are sensitive to toxic and polluting materials. At 19% of the waste disposal sites we consider the environmental safety hazard to be higher, due to the operating deficiencies and the insufficient protective distance (the waste depository is less than 200 metres from the nearest residential building). We evaluated these waste disposal sites as of secondary re-cultivation priority. The further order of priority was determined according to the distance of the waste depositories from residential buildings and drinking water wells, since more serious deficiencies in connection with operation were not observed at these sites. 19% of the waste depositories operating in the county, we considered to be free from problems from the human health protection point of view.

8. Pollution sensitivity mapping of the territory of Hajdú-Bihar county, and classification of its small regions for pollution originating from disposal of waste

In the course of the examinations we sunk 200 drillings down to the groundwater, and took soil samples from these every 10 cm. Following examination of the determinant environmental geology parameters, with the help of our classification tables, we gave a sensitivity value for every drilling point, which was expressed in five stages, shown by sensitivity points (0-1000) in steps of 200. **(Fig. 5.)**. Following this we established the territorial ratios for each small region of the various sensitivity categories, then obtained sensitivity points from the product of the sensitivity categories and the related regional ratios. On the basis of these, the South-Nyírség proved the small region most sensitive to waste depository pollution, while the Great-Sárrét proved the least sensitive.

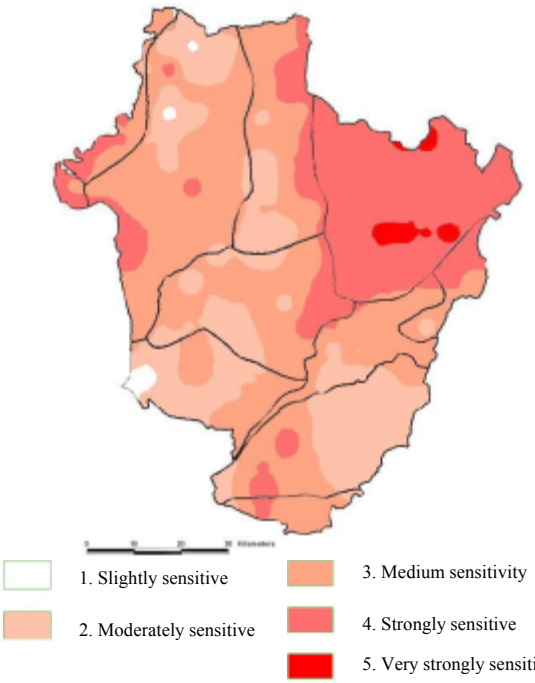

Fig. 5. Pollution-sensitivity of Hajdú-Bihar county's small regions to depositing of waste

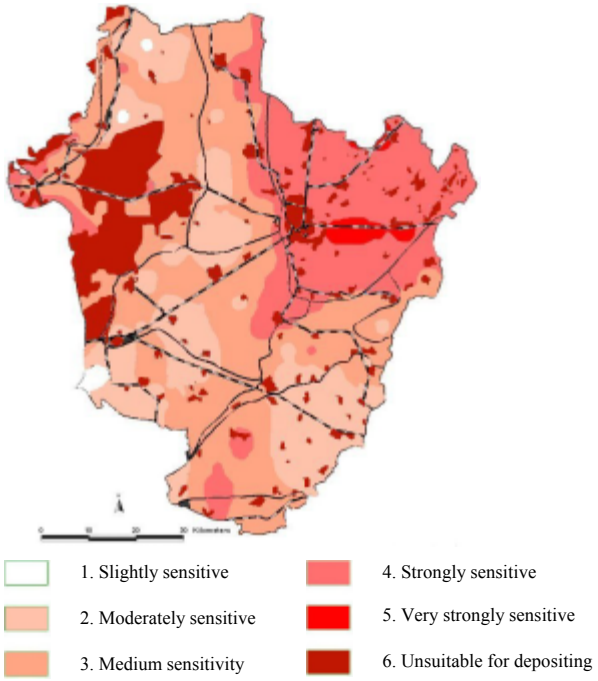

Fig. 6. Sensitivity of Hajdú-Bihar county's small regions to depositing of waste

Following this the water conservation, nature and landscape protection, together with the human health protection points of view were included in the regional sensitivity examination. We compiled a sensitivity map, on which besides the five former sensitivity categories, those areas were also shown, where, from the above listed points of view, waste disposal is forbidden. We consider that these sensitivity points take account of the landscape's loading capacity in a much more complex manner, for to be sure, they not only record the regional sensitivity from environmental geology sensitivity to water leakage, but also include water conservation, nature and landscape protection, together with human health protection points of view. **(Fig. 6.)**.

From this point of view, the South-Nyírség and the Hortobágy proved to be the particularly sensitive regions. In the former case the environmental geology characteristics, while in the latter the nature protection characteristics were the dominant. More than half the county waste depositories with strongly sensitive site characteristics can be found in the South-Nyírség. Here, 41% of the waste is placed in depressions between sand-hills where at times the depth of groundwater is 0.4-1 metre, and the tip surface is medium and coarse sand. While 59% of the waste is positioned in former mine pits formed in blown sand hills.

Further five small regions of the county proved to be medium sensitive (Érmellék loess ridge, Borsod floodplain, Hajdúhát, inter Berettyó-Kálló, South Hajdúság). In these the environmental characteristics are more favourable for waste disposal. However, we observed that in spite of these more favourable possibilities, the characteristics of the sites selected were frequently much

worse than the characteristics offered by the landscape. On the Hajdúhát built up dominantly by loess 22% of the waste, and in the similarly loess dominated Érmellék 65% of the waste are deposited on sandy surfaces. Instead of the mainly silty-clayey surface of the South-Hajdúság and the Borsod flood area, in the former 21% and in the latter 85% of the waste are disposed on sandy areas.

The Bihar-plain and the Great-Sárrét – with their mainly silty, flood area loess surfaces – proved to be the least sensitive areas of Hajdú-Bihar county. According to their environmental geology classification, the proportion of moderately sensitive territories is over 50% in both of them. 94% of the Bihar-plain, and 96.5% of the Great-Sárrét come within the lowest sensitivity category as specified in Government decree 33/2000. However, the landscape characteristics, favourable from the point of view of waste disposal, are completely neglected by the incorrectly chosen depositing technology. On the Bihar-plain the waste for the large part is deposited in loam pits with high groundwater table, while in the Great-Sárrét 81% is deposited in clay pits, where frequently the depositing basin is entirely filled with water leakage.