MULTI CRITERIA EVALUATION OF REGIONAL SEWAGE SLUDGE RECYCLING PLAN IN HUNGARY

Prof. dr. János Tamás DSc[1] – Dr. János Fehér[2] – Dr. Sándor Nagy PhD[3] – Prof. dr. Béla Baranyi DSc[4]

[1]Head of Water and Environmental Management Institute, University of Debrecen;
[2]Hon.Associate Prof. Water and Environmental Management Institute, University of Debrecen;

[3]Chairman of the Supervisory Board of Debrecen Water Works;

[4]University Professor, University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management

1. Introduction

The worldwide problem of sludge disposing is representative to Hungary as well as its neighbouring regions. In order to plan possibilities of disposing of the produced amount of sludge, a National Sewerage and Waste Water Treatment Strategy (NSWWTS) was elaborated by the Ministry of Environment and Water in 2006. The EC Nitrate Directive and Urban Waste Water Treatment Directive (UWWTD) propose that the environmentally sound sludge disposing on agricultural land has to be fostered (EEA Report, 2005). The simple deposition cannot be considered as proper long term solution, merely a constrained placement solution, when there is no good utilization solution. The NSWWTS will lead to substantial increase in the amount of sludge requiring disposal in Hungary, yet economic pressures still require low-cost solutions as well (KVvM, 2008).

At the same time, besides the qualitative and quantitative problems, the water management sector has to deal with other conflicts in relation to sludge deposal, such as: (a) quality problem of groundwater (b) Low quality operation of water works and water supply networks in small settlements could be the reason of secondary chemical and biological pollutions; (c) Some waste water treatment (wwt) solutions are neglecting the optimal local disposal opportunities and the newly built wwt plants will increase significantly the tariffs for the population with the additional investment and operation costs; (d) Profit oriented wwt plant managements are not interested in cooperation at watershed level, which decreases the efficiency of regional solutions. Sludge disposing represents a salient problem among these issues.

The European Union (EU) supports the solutions of water management problems with significant financial resources, but setting such conditions which could not be met by the settlements in most cases, thus these conditions and the lack of capacity harmonization led to over- or under scaling of solutions (European Environmental Agency, 2005).

Costs of operation and depreciation of the new investment projects will increase the tariffs by 3-4 times in the next 5 years, resulting in 8-10 times differences in tariffs in the country. This situation would generate serious social problems in the near future and actual political regime recognised this social risk and start to mitigate by reorganising cost/benefit ratio of wwt. In near future wwt can operate only non-profit form. In view of these developments, there is need for more consistent policy in relation to regulation of sludge application on agricultural land so that authorities would be able to implement secure and cost-effective disposal strategies. However, agricultural recycling of sewage sludge is highly sensitive to the effects of adverse publicity on sludge application operations and the population could not demand it in lack of information. The disposal of sludge on agricultural land is getting more and more difficult because of more strict food safety agricultural policy of the EU (Smith, 1996).

It is constrained to apply it on lowlands which are frequently affected by water management problems such as inland excess waters, drought, increased runoff and floods. In this water policy situation both the national government and municipal self-governments are looking for solutions that could be supported with a complex spatially and temporally optimized decision support process. In such process, besides the environmental-hydrological view points, technical and social aspects should be taken into account (Juhasz, 2003).

To find solution for the above listed problems we have investigated the provisions of the NSWWTS. A GIS based spatial decision supporting system (SDSS) was developed, by which we could make multi-criteria re-evaluation of the planned wwt developments (Tamás, 2004). With the help of the developed SDSS many wwt and sludge treatment technologies could be designed in better way. This would lead to significant cost savings for the country.

2. Methods

During the elaboration of the NSWWTS concept the prospective developments were taking into account. In Hungary at the beginning of the socio-economic transition period (1990) the length of water supply networks was about 48 500 km, while the length of sewer networks was about 15 000 km. The daily drinking water production capacity was 5,2 million m^3/d, and the hydraulic treatment capacity of waste water treatment plants was 1,5 million m^3/d. In the 3 135 settlements out of 4.1 million homes 74% was supplied with drinking water, but only 42,5% was connected to sewer network. As a result of very significant development 93.4% of the homes have been connected to sewer network by 2003. In compliance with EU regulations in all settlements having waste water load higher than 2000 PE separated type sewer networks were built, though in most of the larger cities where these networks were built earlier these are combined types. In the eastern part of the country which is less developed the ration of the connected homes is lower and does not reach 60%. In 2004 still only 66.5% of the collected waste water was treated biologically (KvVM, 2008).

Currently there are 555 waste water treatment plants (wwtp), which have operational licence and represent 2.19 million m^3/d built in hydraulic capacity. Out of this total capacity 68% (1.24 million m^3/d) has biological treatment stage, and 29% (0,58 million m^3/d) from the total capacity provides nutrient removal, as well. The NSWWTS predicts that the total waste water load of all agglomerations in the country will reach 14.18 million PE by 2015 and this value will be increased upto 14.89 million PE if those industrial loads are taken into account which is not connected to public sewer networks. The degree of sewer network supply will go up to 89.3% for agglomerations with > 2000 PE, while in case of agglomerations with < 2000 PE this ration will remain at low 3.7% level. According to the prediction of the NSWWTS 93% of the waste water load will be treated at least by biological stage by the end of 2015 (TESZIR WEB, 2013).

During the 2003–2015 period the pollution load entering into the sewer networks will increase by 4.454 million PE, while the treatment capacity will increase by 7.308 million PE with upgrading of mechanical and biological treatment stages. Thus, the total treatment capacity of the country will increase upto 13.366 million PE. The currently exiting 27 100 km long sewer network – with the planned 17 300 km new developments – will be extended to 44 400 km.

The growing public concern about the agricultural utilization of sludge is known in Hungary too, which situation directs the technical solutions towards sludge incineration. However, because of the significant costs, this solution has not gained expanded applications in the country. A rather strict governmental regulation about the sludge utilization on agricultural lands exists, which is based on EU directives.

In our investigations the followings were taken into account. There were 458 wwtp where some degree of sludge processing exited. From these wwtp-s 221.450 t dry material/y sludge was produced. Out of this total amount 43.5% was utilized on agricultural land, 47.2% was deposited on dumping sites, while the rest 9,3% went to unknown places. By 2015 the total amount of produced sludge will go up to 390,549 t dry material/y according to the plans, and 65% would go to agricultural utilization, and 35% to dumping sites. Incineration was not taken into account in the plan because of financial reasons. The national standard prohibits the agricultural utilization of untreated sludge. The treated sludge - by definition – means that it went through biological, chemical and heat treatment or long term storage or other convenient procedure by which its fermenting capacity and related health risks were significantly reduced.

In case of smaller settlements, 6-8% dry material content “partially” stabilized thickened sludge is applied on arable land outside of vegetation period using injection technology putting the sludge 20-40 cm deep into soil. In case of larger settlements – sometime together with sludge transported from other neighbouring settlements – compost is produced utilizing dry materials (straw, chaff, etc.) from the agriculture, which after control analyses carried to agricultural land. For effective treatment and process the so called waste water collection agglomerations were created by the relevant settlements.

The waste water collection agglomeration means that such areas where the population and/or industrial activities are in sufficient concentration to set up sewer network for collecting waste water, and conduct waste water to treatment plant or final effluent point. The waste water collection agglomeration can consist of a single (administratively independent) settlement or a group of settlements. The sludge agglomeration is based on the same principle. The most critical part of the NSWWTS is that it did not investigate the options of the 2-4 times increased amount of sludge production utilization on agricultural territorial placement.

Our GIS based research which beyond the tasks of sludge placement methodological and spatial decision supports investigated how the unity of data collection for geographical information system, data integration and interpretation could be solved (Tamás, et al. 2006). Planning of sludge processing and placement was carried out at regional and settlement scale. We compared the locations of sludge agglomerations with the locations of agricultural areas potentially suitable for sludge placement. We investigated how the economically manageable sludge agglomeration and their operable sizes (transportation distances, size of suburban zone etc) can be determined. It was necessary to make a survey about waste water loads coming from the industrial plants to sewer networks in order to judge the usefulness of produced sludge. Data were collected from the relevant environmental protection and water management authorities. Three main groups of data were used such as natural resources, built environment and societal environment.

Performing the spatial analysis of the data listed in the above table, first, those areas were excluded which were associated with some type of risks in connection with sludge disposal. Following that, as part of the revision of the NSWWTS applied agglomeration structure, we determined those agricultural areas, which were suitable for sludge disposal. Afterward the suitable areas were allocated into new agglomerations.

3. Results

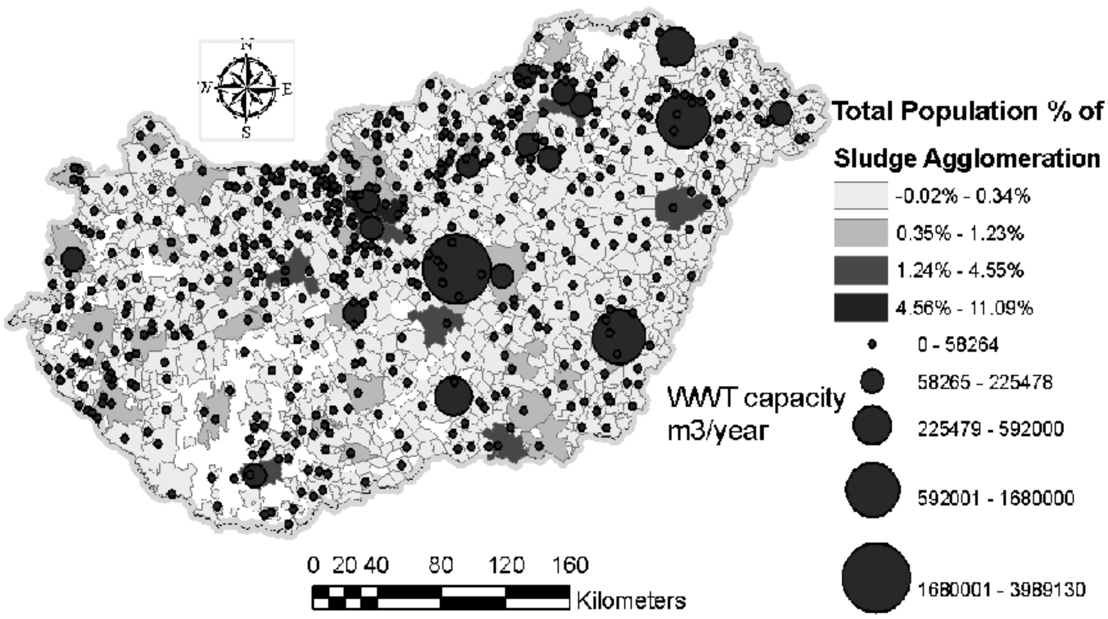
For completion of planning works the knowledge of produced amount of sludge, its quality, the available technologies as well as the feasible alternative placement options is absolutely indispensable. In our investigations we used the records of the operators of the wwtp-s about the amount of produced sludge and operational data. The PE values used in the EU practices were applied for the calculation of the nominal pollution load of sludge allocation agglomerations, assuming that 1 PE was equal with 60 g BOI_5 per person per day load. This figure was increased if additional pollution sources, such as industrial and/or public institutions were identified on the area in concern taking into account the seasonal fluctuations of them as well. The load figures were further modified in the function of existing waste water treatment and sludge treatment technologies.

For the formation of sludge placement agglomerations the settlement structures had to be investigated as well. In the settlement structure of Hungary the ratio of the less than 2000 PE settlements is high (75,3 %), but only 16.9% of the total population concentrates in these settlements. There is relatively few number of larger population cities in the country. Besides Budapest, the capital of the country, there are altogether 10 cities where the daily waste water load is higher then 150 000 PE (Fig. 1).

Figure 1 shows that the administrative areas of 2 436 settlements obliged for waste water treatment covers 86% of the country territory, and out of that 4 548 km^2 is built in area. There are 1 023 waste water treatment agglomerations, and thus in average, 2.4 settlements are in agglomerations which have - in average - 78.9 km^2 areas, though this number has high standard variation (sd = 87.9). In our investigation the agglomeration allocation of the year 2006 was used.

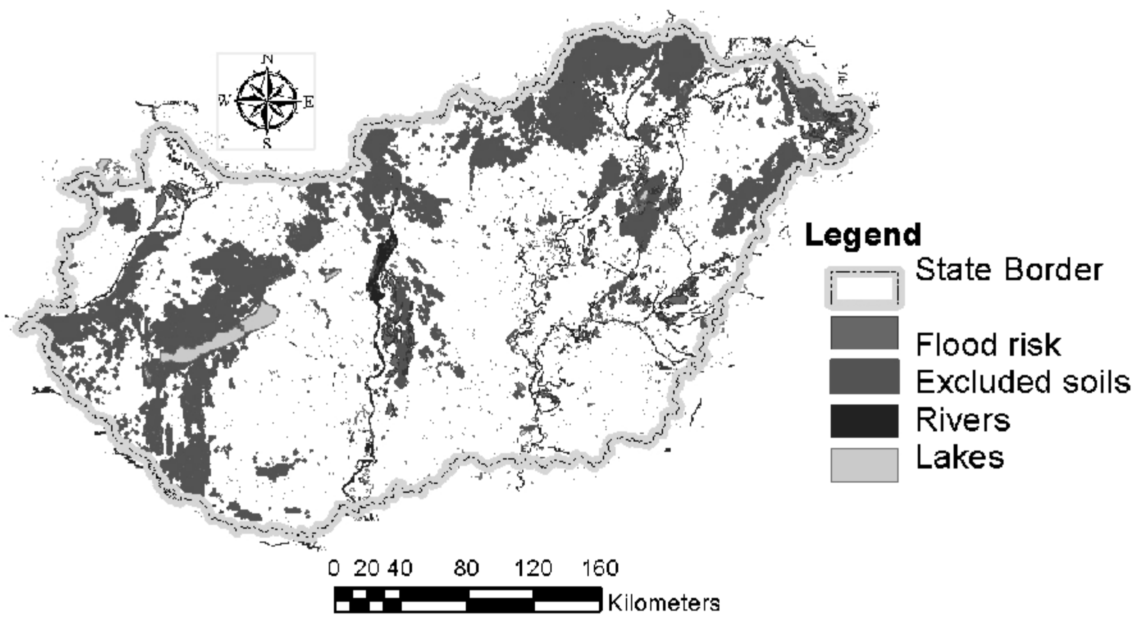
The applied decision making method takes into account the hydrological, relief, land use and geological parameters as well as vulnerable areas of subsurface waters, nature protection areas, and other ecological restrictions. These areas are shown in Figure 2.

Figure 1: Capacities of waste water treatment plants in agglomeration break down



Source: own edited

Figure 2: Areas excluded from potential sludge disposal by flood risks or inadequate soil characteristics



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The larges area excluded from the original agglomeration plan came from the application of the EU Nitrate Directive restriction, which declared 42 985 km^2 areas of 1488 settlements nitrate sensitive. As the result of the investigation of the potentially suitable 23.749 km^2 areas there are 657 settlements with 4 416 km^2 territory, which were able to adopt the produced amount of sludge with quantitative restrictions. With the optimization of the transportation distances it was determined that from the suitable areas there were 3 625 km^2 where the transportation distance exceeded 10 km.

The shape and size of the agricultural areas potentially suitable for sludge placement not always appropriate. The total size of those areas which have less then 10 ha size is 252,42 km^2 where the placement costs will be higher that at the larger units. The investigation method was applied and run in a ESRI ArcGIS macro model. The sludge capacities of waste water treatment plants allocated to areas suitable for sludge placement were allocated based on Voronoi interpolation method.

It can be stated that the 80.780 km^2 total area of wwt agglomerations identified in the NSWWTS was reduced to 20.072 km^2 when the potential suitability of sludge disposal is taken into consideration. 80% of the wwt plants with the capacity over 150.000 PE do not possess enough sludge disposal areas. These wwt plants should consider sludge incineration or much higher operation costs in the future. On the other hand, for wwt plants having treatment capacity between 15.000 and 50.000 PE and located in the South-East region effective alternative solutions could be the injection of liquid sludge into agricultural soils or the composting.

4. Summary

The centralized collection and treatment of waste water produces significant amount of residual sludge requiring environmental sound and economic disposal. The most critical part of the National Sewerage and Waste Water Treatment Strategy is that it has not examined the future opportunities how to dispose of the predicted 2-4 times increased amount of sludge on the agricultural areas.

The presented GIS based decision support model an investigation was carried out to identify the potentially suitable agricultural areas for sludge disposal. After suitable areas were identified an allocation strategy was elaborated taking into consideration of the amount of sludge calculated from the treatment capacities of the wwt plants and thus new sludge disposal agglomerations were determined. It was concluded that only 25% of agglomerations indentified in the Strategy has actually enough agricultural land for sludge utilization. This fact would influence the investment and upgrading programmes of the waste water treatment plants in the future.

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ENSURING SUSTAINABILITY- A GLOBAL CHALLENGE FOR TOURISM

Ivett Gálicz Vargáné, PhD. Student
Szent István University, Faculty of Economy and Social Studies
Enyedi György Doctors' Training of Regional Studies

1. Introduction

Tourism has several positive and negative effects, which are due mainly to the boom of the branch. It is in concord with the increase in production and world population, which generate the basis of global issues. As a result, the entire biosphere is undergoing changes, and influences both the whole of mankind and all the branches of the economy. Global issues occur as environmental and ecological ones, this way, influencing the branch of tourism as well, as it has a serious effect on the environment and local population: the traditional landscape becomes destroyed, the environmental pollution increases, moreover, local culture gets damaged. These problems impose a challenge especially on areas in which tourism has undergone a significant change in a short period of time. At the same time, among the advantages of tourism we can mention the fact that in provides employment facilities for the local population, furthermore, it ensures economic growth. Reception are for tourists provides experience and new information, which satiates their demand and later results in their return, this way, guarantees the strengthening of the economy.

All in all, tourism simultaneously utilises and endangers the values of nature and the economy. It plays an important role in both global and regional development, at economic and social level as well. During the development of tourism, a well-grounded, proactive and sustainable planning is required, however, we need to pay attention to prevent the damage of natural values, landscape,