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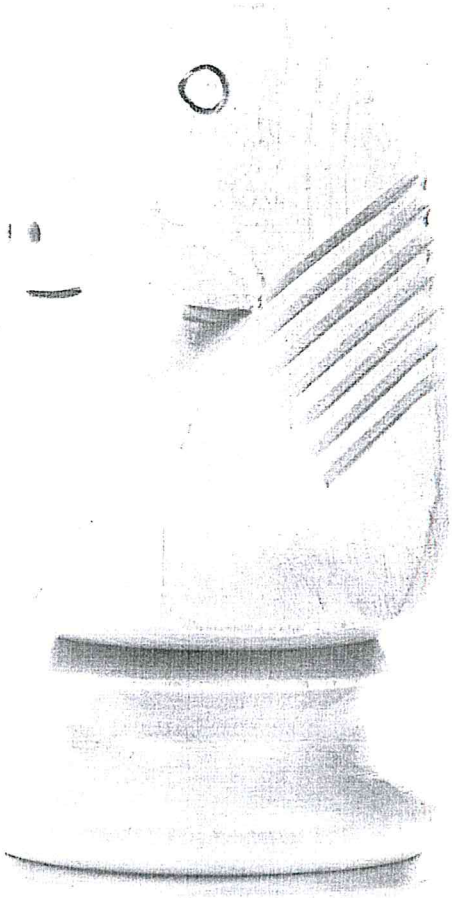

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Assessing and managing the water quality risk – a way to attend sustainability

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Abstract

The paper presents different aspects of interest found during hazards pre-assessments of priority dangerous substances discharged in sewage system by different economic agents and the way their discharges should be regulated. The used methodology is based on sustainable development approach principles such are: "polluter pays principle", "precautionary principle", and "intergenerational equity principle". It is designed as a site examination of activities, raw materials, products and services and analytical test reports of the sewage-discharged wastewaters. The obtained results are used to evaluate hazards. An expert value judgment multi-criteria approach substantiates the evaluating process. In those screenings, we found heavy metals in ranges of tens of μg/L. We compared the obtained values with the stated limits in different legal regulatory documents and critically discussed some challenges in applying the law for permit purposes in order to find a possible optimal course of action in managing the risk of water bodies of not having the required quality. The new methodology is of practical use being successfully tested at different economic agents discharging in a municipal sewage system.

Key words: *risk, methodology, management*

Introduction

The way economic agents are treating pollution either as an undesirable or as a normal output result of their activities can influence the cost estimates and prices of pollution abatement at the point of discharge at the municipal sewage. This has an impact on the entire polluters' community discharging in a certain sewage area and finally on the water body. Since we live in a finite world, any economic development in long term should be environmentally and socially sustainable. In this respect polluters should adjust their profits by sharing their maintenance sewage and decontamination costs for preserving the good potential for water quality having essentially two options to decide which one is more appropriate. These options are: 1) they can treat pollution as an undesirable output which has as a result their profit abatement or 2) they can treat pollution as a normal input in the production process but this time they are forced to modify the price of products and their competitiveness on the market. The last approach is usually dictated by the type of market they are involved in and their position on this market. Priority dangerous substances are subject of international, European and national legislation being toxic, persistent and bio cumulative. They are classified in three categories as volatiles, semi volatiles and metals. They are regulated in different legal documents. (Governmental Decision nr. 352/2002; Governmental Decision nr. 458/2002; Governmental Decision nr. 351/2005; Governmental Order nr. 31/2006; Governmental Decision nr. 1038/2010). The limits for their discharge are set according to current growing evidences about their detrimental effects for aquatic environment and finally for human health.

Governmental Decisions nr. 351/2005 and nr. 1038/2010 are two legal documents including actions to be taken for the progressive reduction and elimination of priority dangerous substances from water body discharges in Romania. To be able to take appropriate risk control actions, a hazards pre-assessment of those substances when exceeding the law requirements limits, should be carried out. In the Governmental Order nr. 31/2006, the required hazards pre-assessment is called screening and it is view as an analysis based on good and reliable criteria for assessing the hazards and vulnerabilities. The legislation requires discharges of those substances to be regulated by permits. This way, the pollution of water body where the sewage used waters are discharged either through a municipal treatment plant or without one is supposed to be under control, each polluter being forced to pay the de-pollution costs in order to reach the required legal limits.

Theoretical Bases

Following up a number of economic agents' applications a number of screenings have been carried out at each polluter' sites during September 2010 and April 2011. Those screenings are required in order to obtain the discharge permits. For this purpose we designed a methodology based on sustainable development approach principles such are "polluter pays principle", "precautionary principle", and "inter-generational equity principle".

The methodology uses specific designed procedures in order to collect and evaluate evidences to be used in those pre-assessments. Through these procedures we collected analytical evidences about the quality of the discharged wastewaters in a point before entering the sewage system. In this respect a set of analytical tests have been performed on samples taken from this point. We collected also evidences about site activities, products and services. In this respect a comprehensive examination has been performed during a site audit. Finally we analysed if used waters discharges pose a risk through the presence of priority dangerous substances both on the sewage system and further on the water body and if their presence is a constant one.

If a dangerous substance is found present in the sewage used waters discharges and its concentration value - reported as a maximal admissible concentration - is greater than the environmental standard limit for the corresponding water resource use[1], then the sewage system can be considered to be put under a pollution stress. In this situation the hazard is real but we should check also if the yearly average concentration value exceeds the stated limits in Governmental Decision nr. 1038/2010. If the dangerous substance is not found present in the sewage used waters discharges or if its concentration value - reported as a maximal admissible concentration - doesn't exceed the environmental standard limit for the water resource use, then the sewage system cannot be considered to be put under a pollution stress. In this situation there is no real hazard.

The sewage eco-system is not exposed and the monthly monitoring requirements necessary for checking if yearly average concentration value exceeds the stated limits can be applied only in a special contextual sewage area - low flow rates, other economic agents discharging in the area large amounts of substances stated in Governmental Decision nr. 1038/2010 or other substances that can interact with those ones.

The Governmental Decision nr. 352/2005 in conjunction with Governmental Decisions nr. 351/2005 updated by 1038/2010 are prescribing environmental limits for the dangerous priority substances according to the use of water resources. In the case of the sewage used waters the limits are stated for two situations: when the used waters are directly discharged into the water flow and when they are discharged through a wastewater treatment plant. When they are discharged directly into the water body the different hazardous substances concentrations should be in ranges that don't expose the eco-system for maintaining the potential good quality of water for human consumption.

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[1] in this paper, water resource use is sewage wastewater (see the limits stated in Governmental Decision nr. 352/2005)

Besides the performed analytical tests at the economic agent point of discharge, a site audit is carried out to investigate the existence of dangerous priority substances in used raw materials in connection with activities, products and services as well as the possibilities of those substances to reach the sewage system and further the water body in normal or emergency situations. A major source of information is represented by safety materials data-sheets. With the gathered evidences from site audit and analytical tests, a technical document is presented for the hazards pre-assessment.

In this technical type report the possibilities and probabilities of those substances to be a constant and consistent presence in concentration ranges exceeding the stated limits - causing this way significant pollution with consequences of different severities - are analysed and critically discussed. It is based on experts' value judgements using the following criteria types:

1. environmental technical criteria – exceeding or not the limits, technical decontamination possibilities etc;
2. economic criteria related to the de-pollution costs involved in reaching the required limits;
3. socio-acceptability criteria related to the way the local citizens groups are affected by the pollution taking into account the latest findings in relation to eco-toxicological effects of those substances and also
4. political acceptability criteria related to the way the decision makers find the proposed regulatory measures acceptable for their short and long term economic development.

Finally, the proposed regulatory measures represent money economic agents should pay either for enforcing their pollutants monitoring process for demonstrating they stay within the required limits or for the construction of de-pollution facilities in order to reach them. In each case the two alternatives available for the economic agents should be balanced according to the findings and local area pollution context.

The criteria can be ranked using a MCDA (English acronym for Multiple Criteria Decision Analysis) methods or algorithms. One of those methods/algorithms that we propose to be used in order to reach permitting decision following the screening conclusions is AHP (Analytical Hierarchy Method) which is based on pair wise comparison of criteria/alternatives.

The data from this report – the relevant priority/priority dangerous substances inventory - can be used further to assess the risk for water body quality.

Experimental Data

In the following discussions we present as a relevant example heavy metals. The Governmental Decision nr. 352/2005 regulates those metals in the order of hundreds and thousands of μg/L /litter. In order to detect those metals in sewage used waters discharges the used analytical techniques should have:

1) good detection limit – the LOD – (English acronym for Limit of Detection) - the used method detection limit should be lower than the permitted content in the sample by at least one order of magnitude;
2) high sensitivity in the range of interest and good robustness;
3) an adequate acceptable uncertainty. (Zhengzhi, Li 2002).

Listed metals in the Table 1 have been found with higher prevalence in sewage discharges from economic agents involved in a variety of industrial activities and service such as: metals processing, building and construction materials, paintings, coatings, chemicals production etc. In the performed screenings they have been detected in the range of tens of μg/L using ICP-OES – Inductively Coupled Plasma – Optical Emission Spectrometry.

Table 1 presents a comparison among concentrations limits for priority dangerous substances stated in three legal documents: Governmental Decisions nr. 351/2005 updated with nr. 1038/2010 and nr. 352/2005 the last one being specific for used waters discharged in the sewage

system. The updated limits from Governmental Decision nr. 1038/2010 shows a stricter approach. Why are the limits so strict? Which is the context when the decision of applying stricter limits should be taken? Those are questions that we are trying to respond.

Table 1 - Required limits for waters of different use

CAS Nr. (Chemical Abstract Service Nr)	Substance Name	Required limits for used waters discharged into a sewage system according to Governmental Decision nr. 352/2005	Required limits for used waters discharged directly into a water body coming or not from an upstream treatment plant according to Governmental Decision nr. 352/2005	Required limits for potable water according to Governmental Decision nr. 458/2002	Required limits for priority/priority dangerous substances according to Governmental Decision nr. 1038/2010	Prior required limits for priority/priority dangerous substances according to Governmental Decision nr. 351/2005
		<in μg/L> (momentarily value)	<in μg/L> (momentarily value)	<in μg/L> (momentarily value)	<in μg/L.> (annual average)	<in μg/L.> (annual average)
1	2	3	4	5	6	7
7440-50-8	Cu	200	100	100/2000 [1]	1.3	1300
7440-66-6	Zn	1000.00	500.00	5000	100.00	-
7440-02-0	Ni	1000.00	500.00	20	20.00	1300.00
7439-98-7	Mo	-	100.00	-	3.60	3600.00
7440-48-4	Co	-	1000.00	-	0.70	700.00
7440-47-3	Cr	1500.00	1000.00	50	2.50	2500.00
7440-39-3	As	-	100.00	-	7.20	7200.00
7439-92-1	Hg	-	50.00	1	8.05	1000.00
7439-92-1	Pb	500.00	200.00	-	7.20	400.00

[1] when elements of water distribution network system are made of copper

Results and discussions

The tightening of the discharged limits for the priority dangerous substances is supported by the growing evidences about their cell metabolic toxicity. With reference to heavy metals though, it should be noted that some of them in certain trace amounts are required as micro-functional elements for the cell health. Their toxicity starts only from certain concentration levels that are different among species.

Some species can be tolerant of larger amounts than others. With respect to the municipal wastewater treatment this is of great interest. The tolerance can be used to make municipal sludge biomass adapted to metals content inputs fluctuations when those used waters are discharged into the water body through a treatment plant.

However, it should be noted that biological treatment has some limitations when it comes to degrade different wastewater types with very high heavy metals content. (Ufuk Alkan et al., 2008) The metals become toxic and the growth of the microbial biomass is affected and thus the efficiency of the treatment. (Principi, Villa, 2006). Therefore, the abatement of metal content at source of discharge should be always the strategy of choice.

When used waters are discharged into the water body not through a treatment plant but directly, the things are getting complicated because the limits should be established in order to preserve

the entire water body eco-system from being damaged as we have already mentioned. In this case the limits are based on eco-toxicity studies.

In column 4 -Table 1 are presented some examples of metals limits as they are stated in Governmental Decision 352/2005 for the wastewaters discharged directly into a water flow. Comparing the limits from column 4 with those from column 3 of the same Table 1 we see a difference of one order of magnitude between them. The limits for used waters discharged into the sewage system are less strict because they usually go into a municipal wastewater treatment plant and thus is supposed that the stricter limits stated from column 4 can be reached.

However, there are situations when this is not happening because of a high metal content of the discharged sewage wastewaters. When stated limits in columns 3 and 4 are supposed to be insufficient to reach the safe limits for the water body, depending on local area context of wastewaters discharges, stricter limits can be enforced in order to prevent shock inputs that can stress the municipal biological treatment stage compromising its nominal decontamination capacity.

To prevent this situation, the first step is to regulate the sewage discharges at each polluter by periodically revising their discharge permit enforcing "polluter pays" and "precautionary" principles in order to be cost effective in the reduction and elimination of priority dangerous substances. That means each economic agent should take necessary measures including building local wastewater treatment plant to ease the load of the downstream municipal treatment plant when over one year, constantly, the stated limits have been exceeded.

When there is a suspicion that Water Directive objectives cannot be met, the regulatory body is allowed to enforce the law requirements. The restrictions can reach up to the stated limits in column 6 that are extremely low. The challenge here is that BAT (English acronym for Best Available Techniques) are not all the time capable to reach the required limits that are in the range of 1-10 μg/L.

In addition, when comparing legal present limits for potable water, column 5, with the new limits that might be applied when the regulatory body found insufficient the current standards, column 6, we reach the paradoxical situation when the regulator cannot require a state of the art technique in order to reach the recommended enforced permit limits because that technique will be, from the very beginning, cost prohibitive for any economic agent all over the world.

As the law is made to accommodate a large range of situations and to create the necessary frame to solve all possible conceivable cases, the established limits should be applied contextually and in a flexible manner when the receiving water flow is a potable one.

For other type of water flows only a well sustained documentation made by experts in the field can justify stricter limits than those corresponding to the water resource use.

Conclusions

The process of stating environmental limits is a complex one. As going by known definitions, in a society/economy, the public good is non-rivalry and non-excludable.

If in the past, goods such are air or water were free goods, now they become scarce goods. As anything in shortage, they can become a source of trade in a society and they can have a market value.

To have a sustainable development the environmental costs should be taking into consideration in order to avoid water management crisis.

The process of hazards' assessment and the permitting issue process are challenging from both scientifically and economically perspectives.

Scientifically because a lot of uncertainty is involved in the evaluation process and economically because a sustainable development approach should be applied in order to reach a democratic and modern consensus in order to protect our water resources.

The efforts for improving the legal framework with realistically stated and applied limits should be made in order to meet Water Directive objectives and gain social and political acceptance for the costs of decontamination.

In this respect the designed methodology is an instrument to be applied for water assessing the risk of hazardous substances. This will facilitate the development of an inventory of those substances as is require by the national and European in order to evaluate the risk of water bodies where those substances are discharged.

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