The need of changing the wastewater treatment and monitoring strategies to prevent chemical pollution

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Abstract. The quality of the water worldwide mainly depends on wastewater treatment and management. Wastewater discharges are important sources of pathogenic microorganisms, nutrients and emerging pollutants, which are major causes of water quality deterioration. Not only drinking water sources are affected but, the whole ecosystem, preventing it to provide food and other services. Wastewater treatment paradigm in the recent years has been based on removal of organic load and disinfection. This is not sufficient anymore. A change in this paradigm is urgent and it is mandatory that we start to develop affordable treatment technologies and monitoring tools to warrant the required quality of the wastewater based on the desired level of protection. Each region or country needs to establish their own list of priority contaminants as well their water quality criteria for each different use of the water. Chemical analysis of inorganics and organics, sometimes with very low detection limits, and biotests are key tools to monitor the wastewater and receiving water bodies but an effort still need to done to implement them in monitoring programs and regulatory system. As promising tools we can highlight environmental sensors and chemical indicators such as caffeine, which can simplify and lower the cost of the monitoring activities, although more studies to their validation are needed. A worldwide effort of the academia, government and non-government organizations need to be done to come up with affordable treatment and monitoring technologies that can be applied to all nations and protect one of the most valuable resources in the world: the water.

Keywords: wastewater treatment, wastewater monitoring, biotests, effluent quality criteria

1. INTRODUCTION

The quality of the water worldwide mainly depends on wastewater treatment and management. Wastewater can be generated point and diffuse sources. Point sources can be theoretically divided in domestic and industrial but in reality they are mixed because there is a tendency of the wastewater treatment companies to collect both effluents types and treat them in high volume wastewater treatment plant (WWTP). Diffuse sources are mainly agricultural and urban runoff, which are more difficult to treat but there are several measurements that can be done to prevent the contamination of water resources. The choices of effluent treatment and abatement options will depend on the desired level of protection. In the past we believed that reduction of organic load followed by an efficient disinfection would be sufficient to protect human health. Pathogenic microorganisms were the major treat. Indeed in several parts of the world where this type of treatment was implemented a reduction of waterborne diseases, like children mortality, was observed. But we started to observe that only this approach was not sufficient as the water quality was deteriorating year by year. Then realized that nutrients and chemical substances were also main treats. Eutrophication in water resources increased all around the world allowing heavily growth of macrophytes and cyanobacteria especially with the increase in water temperatures and scarcity. Entire lakes and reservoirs became heavily polluted impairing not only water abstraction for human consumption [1] but also livestock, irrigation and energy production activities. Then, emergent pollutants arises, showing that exposure to pharmaceuticals, pesticides and hormones in very low levels, depending on the human or animal development stage could decrease the capacity of reproduction, cause cancer among other effects [2].

Not only drinking water sources are affected but the whole ecosystem, preventing it to provide food and other important services. The main source of nutrients and emerging contaminants are the wastewater discharges highlighting that if we want to protect our water resources it is mandatory to pay special attention on wastewater treatment and monitoring. The challenge is how to appropriately treat the wastewater and verify its quality to accomplish the desired levels of protection of the receiving waters, all around the world.

2. OBJECTIVE

The objective of this work is to show new insights of what can be done to improve the wastewater managing system including chemical analyzes and biotest as monitoring tools to allow the required protection of the receiving waters.

3. RESULTS AND DISCUSSIONS

Europe recognized that the best way to protect their drinking water sources and allow aquatic ecosystem services was to pursuit the “water good ecological status” [3]. This is a new paradigm that includes the protection of the aquatic life and protection of the water for other uses. Indeed there are several other important uses of water besides the drinking water abstraction that must be considered: irrigation, livestock, recreational, energy use, aquaculture and others. For each of this individual uses there are water quality criteria. For decades the main focus was that wastewaters should have its organic load and pathogens removed before being discharged in the receiving waters. Obvious treatment technologies options were aerated lagoons, low in cost but requiring large areas or activated sludge plants, which required more energy but less space. Those technologies are still being used in several countries but although still a dream for several regions, without any treatment option, can’t be considered sufficient anymore. It is necessary to complement them with other technologies to remove nutrients and chemical pollutants at lower levels [4]. There are several options but still there is a need to reduce their costs to allow their use worldwide. But not only development of technologies is important but also monitoring tools.

Effluent emission standards are usually technological based and its compliance does not necessarily protect the receiving water. This will depend on the dilution factor (effluent/receiving water) and the required level of protection based on the intended uses of the water. In the Brazilian norm [5] an effluent to be released must be in compliance with the emission standard and quality standard of the receiving water [6]. This norm presents a classification system that includes different water protection levels, e.g. class 1 and 2 are the most protected including drinking water, recreational, livestock, irrigation, aquaculture and aquatic life protection. This approach leads to the necessity f the establishment of water quality criteria for each use of the water.

In developing countries such as Brazil and others, it is common to use criteria defined by developed countries or those from international agencies which have differences in climate, type of water and soil, treatment and analytical capabilities and public management policies [7]. There is an urgent need for training of people of the developing countries in this scientific area because before implementing new approaches for monitoring wastewater it is important to set the appropriate cut off values.

For toxic chemical monitoring there are mainly two approaches that are in use. Chemical analyzes and biotests. The main difficulty with the chemical analysis approach is the selection of priority compounds, which will be specific to each region or country and respective analytical method. Usually chemical analysis both for inorganics and organics of toxicological interest requires sophisticated and high cost equipment, especially if emerging contaminants are included. The demand for lower quantification limits is considered a challenge for environmental monitoring of several substances [8]. Biotests were the promise of the 90s and a lot of group from the academia and regulatory agencies in developing countries started to implement toxicity, mutagenicity and estrogenicity tests. Although some of them are quite cheap several shortcomings were observed related to the reproducibility and interpretation of the results and the definition of standards based on a biotest result. In Brazil there is a good example of the introduction of toxicity and mutagenicity tests in the regulatory norm of Rio Grande do Sul [9] but its implementation has not been easy. Another difficulty is to define which assays are relevant to each intended use of water. Would it be appropriate to rely on a plant bioassay for human health protection? Waters that are appropriate for human consumption are safe for aquatic life protection? It is necessary to properly understand meaning of each bioassay to make a good use of them.

One very promising area is the use of chemical sensors for pesticides and other compounds and chemical indicators such as caffeine [10]. They can simplify and lower the cost of the monitoring activities, although more studies to validate those techniques are still needed.

Because of the increase in population all around the world and events of water scarcity reuse is an important measure and efforts should be done in this direction, but this activity must be accompanied by a clear definition for what is being reused for. For each use specific quality criteria must be derived. A point that deserves our attention is the direct reuse of wastewater for drinking water purposes. Although technological feasible, it ignores the crucial importance of returning the water to the ecosystem to warrant not only drinking water supply but also food and other relevant services that will be not warrant if the wastewater is directly used as tap water.

4. CONCLUSIONS

There is an urgent need to change the wastewater treatment and monitoring strategies in developing countries, although some of them have still not implemented basic sanitation technologies. But to warrant the protection of their water resources and to allow their social and economic development and welfare it will be necessary to move forward and use the best available technology to treat and monitor their wastewaters and receiving waters. This is still a challenge in modern world because the relative high costs of those new technologies and associated high level of training required. A worldwide effort of the academia, government and non-government organizations need to be done to come up with affordable treatment and monitoring technologies that can be applied to all nations and protect one of the most valuable resources in the world: the water.

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REFERENCES:

[1] Funari, E & Testai, E. Human health risk assessment related to cyanotoxins exposure. Crit. Rev. Toxicol. 38(2), 97-125 (2008); doi: 10.1080/10408440701749454

[2]WHO/UNEP. State of the science of endocrine disrupting chemicals, 296p. (2012) (http://www.who.int/ceh/publications/endocrine/en/), accessed on June 3rd, 2015.

[3] European Comission. Introduction to the new EU Water Framework Directive http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm, accessed on June, 3rd, 2015.

[4] Gadipelly, C. et al. Pharmaceutical industry wastewater: Review of the tehcnologies for water treatment and reuse. Ind. Eng. Chem. Res. 53 (29), 11571-11592 (2014): doi: 10.1021/ie501210j.

[5] Brasil. Conselho Nacional do Meio ambiente—CONAMA. Resolução 430 (2011) http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=646 accessed on June, 2nd. 2015.

[6] Brasil. Conselho Nacional do Meio Ambiete – CONAMA. Resolução 357 (2005); (http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=459) accessed on June 2nd, 2015.

[7] Umbuzeiro, G. The need of scientific based regulations of chemicals in water: A proposal for Brazil. Applied Research in Toxicology. 1(1) 48-49 (2015)

[8] Lepom et al Needs for reliable analytical methods for monitoring chemical pollutants in surface water under the European Water Framework Directive. J. Chromatogr. A 1216, 302–315 (2009) doi:10.1016/j.chroma.2008.06.017

[9] Rio Grande do Sul. Conselho Estadual do Meio Ambiente – CONSEMA. Resolução 129 (2006). http://www.sema.rs.gov.br/upload/Resolu%C3%A7%C3%A3o%20CONSEMA%20n%C2%BA%20129_2006%20-%20Dispo e%20sobre%20a%20defini%C3%A7%C3%A3o%20crit%20e%20padroes%20emissao%20toxic%20efluent %20liqu%20lan% C3%A7ados%20nas%20aguas%20superf%20RS.pdf accessed on June 1st, 2015.

[10] MONTAGNER, C.C. et al. Caffeine as an indicator of estrogenic activity in source waters. Environmental Science: Processes & Impacts, v. 16, p. 1866-1869 (2014); DOI: 10.1039/c4em00058g