Finding Emerging Contaminants in Water

By
Cecilia Mazza, PhD
Waters Corporation, 34 Maple Street, Milford, MA 01757
Cecilia_mazza@waters.com

Water is a key ingredient for our daily living and water quality is at the center of attention of a growing number of countries around the globe. Depending on the specifications a body of water meets, the resource will be allocated for areas such as farming, human consumption, manufacturing, recreation. Maintaining or improving water quality assures its usage and value. The clean up of the Charles River in Massachusetts is a perfect example where the aim is to make the river available for swimming year round increasing the recreational potential of this body of water. (http://www.charlesriverconservancy.org/projects/swimming/index.html). On the other hand, when water quality degrades, its usage becomes limiting. A case in point is the recent report in the Chinese media on the concern farmers have in Xian Xiang-China over their irrigation water being polluted with discharge from untreated wastewater from local drug manufacturers (http://www.chinadaily.com.cn/china/2008-10/30/content_7158786.htm). Water quality is determined by esthetics, physical and chemical parameters, biological and radioactive content and regulatory agencies presently issue acceptable levels for these. Nowadays, there is an increased focus in organic compounds in water referred to as emerging contaminants (http://toxics.usgs.gov/regional/emc/index.html). These emerging contaminants are present in trace amounts; they are encountered in the environment and are believed to pose risks but research studies are on going to determine to which extent these compounds are harmful (http://www.ecos.org/files/2527_file_EC_Survey_response_summary.pdf)

Emerging contaminants have gained notoriety not only because of the potential environmental impact, wildlife and human physiological effects of chronic chemical exposure but also because we can now detect many of these compounds at parts per trillion (ppt) levels using today's state of the art technology such as liquid chromatography coupled to mass spectrometers (LC/MS/MS). Emerging contaminants sources are personal care products, consumer goods and prescription drugs, just to name a few. Examples of emerging contaminants are endocrine disruptors, pain killers, anti-depressants, anti-fungals and drugs of abuse. These compounds are not regulated in drinking, ground or surface water, nether in wastewater. Universities, government regulating agencies, businesses and non-for profit organizations are turning their attention to many common emerging contaminants and trying to determine their levels in, for example, drinking and surface water, wastewater and aquatic life (Heringa, M.B., van der Linden, S. and Stocks, P. "Effect Monitoring for Endocrine disrupting substances in the Rhine River, NWQMC, Sixth National Monitoring Conference, May 18-22, 2008, Atlantic City, NJ, USA; Cahill, J.D., Furlong, E. T., Burkhardt, M.R.m Koplin, D. and Anderson, L.G., "Determination of pharmaceutical compounds in surface- and ground-water samples by solid-phase extraction and high-performance liquid chromatography–electrospray ionization mass spectrometry", Journal of Chromatography A, 2004; Smyth , S.A., Lishman, L., Kleywegt, S., Svoboda, M.L., Lee, H.-B., Seto, P., "Pharmaceuticals and Personal Care Products in Canadian Municipal Wastewater", Weftec 2008, Chicago, IL, USA; Stahl, L and Wathen J., EPA Pilot Study of Pharmaceuticals and Personal Care Products in Fish Tissue", NWQMC, Sixth National Monitoring Conference, May 18-22, 2008, Atlantic City, NJ, USA, Barber, L.., Lee, K.E., Swackhamer, D.L., Schoenfuss, H.L., "Reproductive responses of male fathead minnows exposed to wastewater treatment plant effluent, effluent treated with XAD8 resin, and an environmentally relevant mixture of alkylphenol compounds", Aquatic Toxicology, V 82, 1, 2007, p. 36-46). An initial research on ten sources of potable water included town, well and bottled water; the study showed the presence of 19.6ppt of an antifungal in one of the sources and 16.3ppt of a anti-convulsant in another source (Mallet, C., "Analysis of Emerging Contaminants in Drinking Water by ON-line SPE/LC/MS/MS", ASMS 2008, Denver, CO). Further, the public has become acutely aware of the presence of some emerging contaminants such as anti-depressants and hormones in drinking water sources accessed by more than 41 million Americans since the extensive Associated Press report came to light (http://www.usatoday.com/news/nation/2008-03-10-drugs-tap-water_N.htm). However, these findings have ramifications worldwide because people around the globe consume similar pharmaceuticals, excrete them or their metabolites through wastewater that potentially makes it back to drinking and surface water sources and dispose of old, expired prescriptions in varying ways depending on customs or per local government guidelines including flushing them in the toilet.(http://www.fda.gov/consumer/updates/drug_disposal062308.html). There are examples of places taking back pharmaceuticals or in countries such as The Netherlands, residents can dispose of their unwanted medications as part of their household recycling program decreasing the exposure to these drugs.

We may ask, what is the acceptable concentration for each of the emerging contaminants in water sources? While yet to be regulated, there is a method issued by the United States Environmental Protection Agency to screen pharmaceuticals and personal care products in water, soil, sediments and biosolids (http://www.epa.gov/waterscience/methods/method/files/1694.pdf). So what is next? A clear assessment of the situation in a wider number of sources using spatial and temporal sampling with fast analytical turnaround times for sound decision making are necessary. This increased focus on emerging contaminants by the public as well as regulatory agencies should inevitably lead us to an increased sampling of all water sources. This coupled with the fact that as the emerging contaminants list expands, scientists and managers handling large number of samples are beginning to see their instrument capabilities and labor resources stretched to keep up with demand. With an increased workload and tightening budgets, laboratory personnel and their decision makers are looking for ways to simplify the workflow in their facilities. As the workload increases there is a lager chance for human errors, especially for the labor intensive steps of sample preparation prior to analysis by LC/MS/MS. Just like the car industry adopted robotics to address costs, reduce manufacturing variability and minimize turnaround times, the impact of automation is clear in laboratories with large volumes of samples. Minimal human intervention will be required, to minimize manual sample preparation, which in case of waste water treatment has rendered such relative standard deviations as high as 50% that do not allow the user to make sound decisions in terms of water treatment. Being that zero levels are not realistic for regulations, as laboratories adopt automation for the analysis of emerging contaminants, we will be able to determine faster the concentration of these compounds in water sources and understand to what extent they impact the environment, wildlife and human health. This faster approach to laboratory studies we will be able to help regulatory agencies to establish acceptable upper level limits in the various sources of water. Ultimately these findings will allow for appropriate control of effluents into water ways, have better approaches to recycling and improve manufacturing monitoring.