

Water quality

Prevalence of contaminants and metals in aquatic ecosystems in Durban area

A completed Water Research Commission (WRC) undertook a reconnaissance survey in a highly industrialised and urbanised area (Durban) for an extensive suite of persistent organic pollutants in aquatic ecosystems.

Background

Organic chemicals, including polycyclic aromatic hydrocarbons, pesticides, and polychlorinated biphenyls are routinely analysed in water, sediment and biological tissue for ecological and human health risk assessment purposes in many regions of the world.

This is because these chemicals pose significant risks to ecological and human receptors when present at elevated concentrations. Many of these chemicals have a high bioaccumulation potential and, unlike metals (some organic forms excluded), also a high biomagnification potential.

An important pathway of exposure to these chemicals for humans is dietary, with the consumption of fish and shellfish one of the most significant of the dietary pathways. Many organic chemicals, such as polychlorinated biphenyls, are also persistent in the environment, meaning that they retain their chemical form and have long half-lives.

Because of their persistence and their toxicity the production and use of some organic chemicals has been banned or restricted under conditions of the Stockholm Convention on Persistent Organic Pollutants, to which South Africa is a signatory. Despite their banning, because of their persistence many of these chemicals continue to pose ecological and human health risks.

For example, the production and use of polychlorinated biphenyls was banned in the late 1970s, yet in many parts of the world these chemicals remain a major ecological and human health concern.

In recent years there has been a significant increase in research on the prevalence and potential ecological and human health risks posed by organic chemicals in South African aquatic ecosystems. The level of attention is nevertheless far lower than in many parts of the world. For example, there are no local or national aquatic monitoring programmes that consistently monitor for chemicals such as polychlorinated biphenyls.

There appear to be a number of reasons for this low level of attention in South Africa, including significant technical and human capacity constraints for organic chemical analysis and the high cost of analyses that is often considered prohibitive by public funding organisations. Also, many government agencies appear not to appreciate the significant risks that these chemicals pose to ecological and human receptors and consequently rarely stipulate the need for their monitoring.

The majority of attention on organic chemicals in South Africa was historically and still is focused on freshwater ecosystems. South African coastal ecosystems have received comparatively little attention. There was a very strong focus on coastal pollution in the 1970s and 1980s, albeit that the focus was predominantly on metals in sediment.

However, funding constraints in the late 1980s and early 1990s led to the virtual collapse of coastal pollution research and in particular research on organic chemicals. It should come as no surprise that our understanding on whether organic chemicals are widespread and significant contaminants of water, sediment and biological tissue in coastal ecosystems and whether they are cause for ecological and human health concern is virtually non-existent.

Although there has been a significant increase in research on these chemicals in coastal ecosystems in the last 5-10 years, our understanding of their significance as contaminants of water, sediment and biological tissue in coastal ecosystems remains poor.

This lack of understanding has important implications since coastal ecosystems, especially sheltered estuaries and embayments, are ecologically highly productive and provide numerous ecological goods and services to the benefit of the South African population.

Sheltered estuaries and embayments are, however, well-known depositional zones susceptible to contaminant accumulation. Because of their use by humans for various purposes, including as a source of food (e.g. fish) and for recreation, exposure to contaminants accumulating in these systems represents a potentially significant source of risk to the health of human users.

Description of WRC study

The overarching objective of this study was to improve our understanding on whether organic chemicals are widespread and significant contaminants of aquatic ecosystems in the eThekweni area of KwaZulu-Natal in South Africa, and, if so, to determine whether they are cause for concern from an ecological and human health risk perspective.

The eThekweni area was identified as a case study for other coastal cities in South Africa, under the assumption that contamination trends evident in this city may be replicated in other coastal cities. Thus, the findings and recommendations arising from this study may be applicable to other coastal cities in South Africa. Several aims were identified to address the overarching objective.

Conclusions

The findings showed that polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and DDT and metabolites were widespread and at times significant contaminants of sediment in rivers, estuaries and canals in the eThekweni area. Chlordanes were less frequent, but often significant contaminants of sediment in the survey performed in 2012.

At numerous stations, specifically in catchments that are urbanised and industrialised, the magnitude of contamination was sufficient to suspect these chemicals were posing an acute toxic risk to sediment-dwelling organisms. This

conclusion was through the comparison of contaminant concentrations to sediment quality guidelines.

Although toxicity testing using the H4IIE cell bioassay confirmed toxicity in some sediment samples, there was often only a weak correlation between contaminant concentrations and toxicity. Confirmation of the potential toxic risk posed by the organic chemicals, but particularly polychlorinated biphenyl, was provided by the analysis of contaminant concentrations in the tissue of fish caught and mussels collected in Durban Bay and in the uMngeni and Isipingo River estuaries.

This showed that contaminant concentrations in many fish species and in mussels were high enough to pose a potential chronic and carcinogenic health risk to human consumers (and by implication other organisms).

This finding has important implications in that it calls for the more frequent monitoring of contaminant monitoring in fish and shellfish and the communication of the findings to recreational and subsistence fishers. Commissioning such monitoring and communicating the findings will largely be the responsibility of local municipalities and/or provincial government departments, and budgets need to be allocated for this purpose.

The findings of this study motivate for similar studies in other coastal cities. Of particular concern in the eThekweni area was the widespread and at times significant contamination of sediment by polychlorinated biphenyls and the accumulation of these chemicals in the tissue of fish and mussels.

Polychlorinated biphenyls are highly toxic and pose significant ecological and human health risks. Based on this finding, in the eThekweni area at least there is need for the routine monitoring of these contaminants in aquatic monitoring programmes.

This study has provided evidence for significant sources of organic and metal contaminants to aquatic ecosystems in the Durban Bay catchment. Inflows from the Amanzimnyama River, Island View Canal, Bayhead Canal, and numerous stormwater outfalls are important vectors for the introduction of contaminants to Durban Bay. There is also evidence that certain port activities are significant sources of contaminants to the Bay.

The sources of contaminants need to be identified, controlled and reduced if there is to be any improvement in water and sediment quality in Durban Bay. This will reduce the uptake of contaminants by fish, shellfish and other biota,

and thereby reduce potential health risks posed by contaminants in fish and shellfish to human consumers.

An Estuarine Management Plan for Durban Bay has been formulated and is in the process of being updated. The plan recognises the need for a catchment scale approach to the sustainable management of the Bay. The findings of this study can be incorporated into the Estuarine Management Plan and used to identify and prioritise areas of the catchment where contaminant source identification, reduction and control procedures should be implemented.

Further reading:

To order the report, *Prevalence and significance of organic contaminants and metals in aquatic ecosystems in the Ethekekwini area of Kwazulu-Natal* (**Report No. 1977/1/15**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.