The Australian and New Zealand Experience of Terrestrial Ecological Risk Assessment and Potential Methods to Address Current Limitations

Michael Warne[1], Rebecca Hamon[1], Mike McLaughlin[1], Kathryn O'Halloran[2], Helen Davies[3], Elvin Wong[3], John Chapman[3], Rai Kookana[1], Carine Saison[1]

[1]CSIRO Land & Water, PMB 2 Glen Osmond, SA 5064, Australia (michael.warne@csiro.au)
[2]Landcare Research, PO Box 69, Lincoln 8152, New Zealand
[3]NSW Dept. of Environment & Conservation, PO Box A290, Sydney Sth, 1232, NSW, Australia

INTRODUCTION

Protection of the Australian and New Zealand environment is recognised at all levels of government as being a crucial element of ecological sustainable development. The National Environment Protection (Assessment of Site Contamination) Measure (1999) (the NEPM) for and the Resource Management Act (1991) (the RMA) are the two major pieces of legislation that govern the assessment and treatment of contaminated sites in Australia and New Zealand respectively. The NEPM has two major components relating to ecological risks. The first is a set of environmental investigation levels (EILs) for soils that are to be used to determine whether a site warrants further investigation. Those sites with concentrations below the EIL do not require further work. If however, they are exceeded then either management action in the form of remediation or site-specific investigation in the form of further chemical analyses and toxicity testing is triggered. Due to a lack of appropriate data only phytotoxicity investigation levels (PILs) with limited application for urban lands (specifically sandy loams with a pH of 6 – 8) could be developed. The second component is a recommended process for conducting ecological risk assessments of contaminated sites for those sites that exceed the EILs. The recommended process is based on the Environment Canada framework. Contaminated site assessments in New Zealand rely upon non-statutory soil criteria available in three industry-based guidelines, or where appropriate soil criteria (including those protective of ecological receptors) are not available overseas soil criteria (such as those in the NEPM) are applied. These 'soil acceptance criteria' trigger action in an equivalent manner to the NEPM investigation levels. Most of the NZ-specific soil criteria have been derived for the protection of human health, although some are, by default, also protective of plant life and livestock health. No detailed methodologies for estimating ecological risks at contaminated sites are available in either country.

SOIL TOXICITY TESTING

Soil toxicity tests are required to assess site-specific impacts as part of the ecological risk assessments and to provide data that are used to derive environmental investigation levels. The development of soil ecotoxicity tests has occurred only relatively recently in Australia and New Zealand (Australasia) and has lagged considerably behind developments in aquatic ecotoxicity testing, both in terms of the number of phyla for which tests have been developed and the quantity of toxicity data available for either native species or introduced species tested under Australasian conditions. Tests using earthworms, collembolan, enchytraeids, isopods, plants and micro-organisms are conducted in Australasia. However, the majority of these use introduced rather than native species. For example, the European compost worms *Eisenia andreii and E. fetida* are predominantly used rather than native species or more suitable true ground dwelling earthworms such as *Aporrectodea caliginosa*

or *Lumbricus terrestris*. Plant phytotoxicity data are also heavily skewed to favour agricultural crops such as wheat and lettuce rather than native (e.g. banksia, grevillea) or even ornamental species (e.g. roses, gladioli). Another limitation is that the majority of Australasian terrestrial toxicity data have been determined not in soils but in aqueous solutions (e.g hydroponic studies). The Australasian ecotoxicity database (Warne *et al*., 1998; Warne and Westbury, 1999; Markich et al., 2002) will be used to illustrate the weaknesses and strengths of the existing terrestrial toxicity data.

Relatively, few terrestrial ecological risk assessments have been conducted within Australasia. This is partly due to the lack of ecotoxicological expertise and partly due to the relative appeal of disposing contaminated soil to landfill at relatively low cost to the site owner. However with increasing pressure to reduce waste to landfill, this practice of 'dig and dump' will not be tolerated in the longer term and will increase the need for more quantitative risk assessments to better delineate high risk areas. A couple of examples of how terrestrial toxicity testing have been utilised in Australasia to assess contaminated sites will be presented.

LIMITATIONS OF THE CURRENT REGULATORY FRAMEWORK

The available EILs in the NEPM were derived mainly using phytotoxicity data. However, these EILs were simply concentrations below which no phytotoxic effects had been reported – they were not calculated using an assessment factor method or a species sensitivity method. An additional limitation of the EILs is that they only cover one type of organism and are most probably not appropriate for all terrestrial species. Moreover the EILs can be both over and under protective depending on the soil factors that modify ecotoxicity (e.g. pH, cation exchange capacity, clay content and organic carbon content). Hence the EILs for soils are considered interim and there is considerable scope for further development of measures in the assessment of contaminated sites.

THE WAY FORWARD

The NEPM will be reviewed in 2005 and this provides an opportunity for many of the existing limitations to be addressed. This presentation will outline one potential way of addressing the existing limitations and propose a method for deriving soil specific or regional EILs. The proposed method will derive EILs that aim to consider toxicity to plants, invertebrates and microorganisms; the concept also integrates species sensitivity data with soil modifying factors to derive the ecological thresholds. Data from international studies for these contaminants will be input into the model to derive generic EILs and these will be normalised to Australasian conditions using data from Australasian studies.

REFERENCES

Markich SJ, Warne MStJ, Westbury A-M, Roberts CJ. 2002. A compilation of toxicity data for chemicals to Australasian species. Part 3: Metals and Metalloids. *Australas. J. Ecotoxicol*. 8, 1-137.

Warne MStJ and Westbury A-M. 1999. A compilation of toxicity data for chemicals to Australasian species. Part II: Organic Chemicals. *Australas. J. Ecotoxicol*., 5, 21 - 85.

Warne MStJ, Westbury A-M, Sunderam R. 1998. A compilation of toxicity data for chemicals to Australasian aquatic species. Part 1: Pesticides. *Australas. J. Ecotoxicol*., 4, 93 -144.