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Assessing Community Health Risks: Proactive Vs Reactive Sampling

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Abstract: Problem statement: A considerable number of native birds died in the West Australian coastal town of Esperance and surroundings during late 2006 and early 2007, which raised community concerns about environmental contamination. Forensic investigations of dead birds suggested that lead may have been the causative agent. At the time, lead and nickel, as well as iron ore and other materials, were being exported through the Port of Esperance (port). Government agencies undertook a targeted environmental sampling programme to identify the exposure sources and the extent of contamination. Results of ambient air monitoring, blood lead level investigations and analysis of metals in rainwater tanks suggested widespread contamination of the Esperance town site with lead and nickel. The Department of Environment and Conservation (DEC) retained Golder Associates Pty Ltd., (Golder) to undertake a human health and ecological risk assessment (risk assessment) using the information collected through the investigation of lead and nickel contamination in Esperance. The quantity and quality of exposure data are an important contributor to the uncertainty associated with the outcomes of a risk assessment. **Conclusion:** As the data were collected essentially as part of the emergency response to the events in Esperance, there was some uncertainty about the suitability and completeness of the data for risk assessment. The urgent nature of the emergency response meant that sampling was opportunistic and not necessarily sufficient or suitable for risk assessment from a methodical and scientific perspective. This study demonstrated the need for collecting 'meaningful and reliable' data for assessing risks from environmental contamination.

Key words: Risk assessment, human health, ecological health

INTRODUCTION

The local community in Esperance raised concerns about environmental contamination following the death of a number of native birds during late 2006 and early 2007. Forensic investigations of dead birds suggested that lead may have been the causative agent. Subsequent investigations by government agencies included analyses of lead and nickel concentrations in air, rainwater, soil, dust, swabs, plants, birds and human blood.

There was concern in the Esperance community about the potential impacts of the contamination on the resident's health. Subsequently, the Department of Environment and Conservation (DEC) retained Golder Associates Pty Ltd., (Golder) to undertake a human health and ecological risk assessment (risk assessment) using the information collected during the investigation of lead and nickel contamination in Esperance. As a first step, Golder undertook a Data Gap Analysis (DGA) to assess the suitability of the available information for the risk assessment. While a large volume of information was available, some was found to be unsuitable for risk assessment for a variety of reasons.

MATERIALS AND METHODS

Golder followed State and National risk assessment guidance[1]. Risk assessment is a systematic process for collecting, evaluating and integrating biological and environmental information comprising a four step process: issue identification, hazard assessment, exposure assessment and risk characterisation. The issue identification stage identifies the issues that can be assessed through risk assessment and clarifies the context for the risk assessment. An important component of issues identification (sometimes referred to as problem formulation) is the development of a Conceptual Site Model (CSM), a tool that can help in identifying sources, exposure pathways and receptors on which to focus a risk assessment.

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Normally environmental sampling and analyses would occur once the CSM has been developed. Contaminant information available for the Esperance risk assessment was collected in response to an apparent pollution incident and it was unclear whether or not the information was suitable or sufficient for assessing health risks to human and environmental values. Thus, Golder considered that a systematic assessment of the information through a Data Gap Analysis (DGA) was necessary to assess its usability in the risk assessment.

The CSM developed for the Esperance town site considered contaminants of concern in food, soil, sediment, water, ambient air and deposited dust; uses of these media by the receptors; and exposure variables such as land uses, human exposure routes, ecological exposure routes and human and ecological receptors.

The information received from DEC comprised 80 reports of data collected by a number of government and non-government organisations, including Esperance residents. The data were ranked according to national guidelines[1] into one of three categories ranging from low (higher uncertainty) to a high confidence level (lower uncertainty) depending on the level of confidence that could be assigned to the outcome of the risk assessment based on the data.

RESULTS

Golder identified a number of receptor groups in the CSM that included human and terrestrial and aquatic ecological receptors. Exposure scenarios considered for human receptors included residential, recreational park users and subsistence users. Terrestrial ecological receptors included terrestrial plants, mammals, birds, other vertebrates and invertebrates. Freshwater ecological receptors were not considered because of the distance to the nearest freshwater body from the Esperance town-site. Marine ecological receptors included marine plants, mammals, birds, fish and benthic species. Receptor exposure pathways included ingestion, inhalation or dermal exposure to soil, dust or rainwater, including food chain pathways.

Following are examples of data to which different degrees of confidence were assigned in the DGA.

Data that provided a higher degree of confidence for inclusion in the risk assessment included the results of rain water analysis. These comprised a large data set of targeted sampling in the Esperance town site that also provided an indication of the distribution of contamination. The rain water was a defined body of water with a relatively stable level of contaminants and the results provided a reasonable basis for estimating exposure by ingestion and dermal contact.

Results of soil sampling and analysis provided a medium degree of confidence for use in the risk assessment. Soil samples were generally collected close to the Port within the Esperance town site and along the railway transport route as part of the response to the pollution incident. The data did not necessarily reflect a spatial distribution of lead and nickel concentrations in soil across the entire town site. This was taken into consideration during the risk assessment by the use of realistic concentration statistics such as the 95% upper confidence limit of the mean.

DISCUSSION

Some data were collected under circumstances where confidentiality agreements did not allow disclosure of sample details to third parties e.g., the identity of donors of blood for blood lead levels analysis. This limited some of the analyses Golder was able to undertake, without modifying the data. However, Golder was able to undertake a co-location analysis of these and other data once the names and residential addresses were codified by appropriately authorised people and hence assess relationships between lead and nickel concentrations and distance from the port in 250 m increments.

Various data supplied were assessed as having a higher level of uncertainty hence a lower level of confidence for use in the risk assessment. Data from swab samples collected inside Esperance residences and ceiling dust samples from roof cavities were supplied. These data were collected for “forensic” rather than risk assessment purposes. Due to the nature of swab or ceiling dust samples, it is difficult to estimate inhalational exposure since the swab samples measure dust loads on surfaces or ceiling spaces and not concentrations in indoor air. Nonetheless, we used a set of conservative assumptions to estimate concentrations of lead and nickel in indoor air that could be used in the risk assessment.

A lower level of confidence was associated with body burden data supplied for lead and nickel in birds. Although the large number of bird deaths reported in Esperance was suggestive of a problem or illness, it was difficult to assess the relationship quantitatively from the limited numbers of dead birds that were available for analysis. In addition, birds are not a static organism and their exposure is difficult to estimate due to anticipated variations in habitat and diet.

The majority of soil and plant samples were collected in residential zones around the town site, as opposed to areas of open space or bushland where wildlife are more likely to live. Body burden data for lead and nickel in mammalian wildlife in the Esperance area were not collected. Subsequently mammalian exposure to lead and nickel could not be directly assessed and was instead evaluated using a food chain modelling approach. Hence, the assessment for land animals was considered to have a lower degree of confidence.

CONCLUSION

The general aim of a risk assessment is to collect data in a systemic manner from environmental media and biological systems and assess the risks to human or ecological health. The development of CSM helps identify the contaminants of interest, sources of contamination, pathways of exposure and receptors of interest, thus facilitating the development of a sampling and analysis plan for the risk assessment (proactive sampling). This approach was not possible in the case of Esperance, since the decision to undertake a risk assessment was taken after the majority of data had already been collected in response to the bird deaths (reactive sampling).

While a considerable proportion of the information available could be used in the risk assessment, the degree of confidence associated with the results was variable and in some cases was lower than may have otherwise been if proactive sampling had been undertaken. Thus conclusions were limited in scope and outcome for some issues that were identified as a concern in the CSM.

Whilst proactive sampling may have resulted in a higher degree of confidence in the result than reactive sampling, the data collected in response to the pollution incident were usable and sufficient to draw conclusions about the potential effects of the contaminants on the residents and ecology of Esperance. These conclusions need to be placed in the context of the degree of confidence in the results obtained.

ACKNOWLEDGMENT

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REFERENCE

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