Assessment of waste for use on agricultural land

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Abstract

The disposal of waste to agricultural land requires a systematic and transparent assessment procedure to ensure environmental and production sustainability. A hybrid model of risk assessment used in the general risk, environmental management and the mining industries was developed and tested using the waste from a yeast factory. The model is systematic and cybernetic and develops a succession of decisions that have the capacity to focus the environmental and agronomic considerations down to individual crops, land and management systems. The process directly links environmental risk assessment and development of management plans to agronomic development of the use waste products.

Media summary

An assessment procedure to develop environmental risk and agricultural management plans is described. The procedure was tested on waste from a yeast factory and resulted in the successful dispersal of the material to surrounding agricultural land.

Key words

waste, environmental risk assessment, land disposal of waste, dunder, yeast.

Introduction

The agricultural sector and its productive land is the focus for the reuse and/or disposal of water and organic based wasted (for instance QEPA sustainable industries program). The characteristics of these wastes are extremely variable and may range from class B sewage effluent (suitable for vegetable production) to high biochemical oxygen demand or nutrient laden waste. The sources are also variable, and include domestic sewage treatment plants, food processing factories and intensive animal feedlots.

The essential issue facing the waste use in agricultural activities and the communities associated with them, is the assessment of the waste and its characteristics and the agricultural systems into which they may be placed. It is essential they be compatible and that an appropriate environmental risk management plan acceptable to the community is developed. To address these issues a systematic and transparent procedure is essential. Such a procedure would need to be underpinned by seven environmental principles for sustainable land disposal, namely:

- the waste characteristics must be matched to the land use requirements similar to the assessment of land use potential (FAO 1983);
- the application of the material should result in no significant net change in the environment beyond acceptable limits (Gardner 1995);

- waste is applied to the extent of its most limiting factor (Crites *et al.* 2000);
- mass balance approach be used to decide nutrient and salt additions to the site (Loehr *et al.* 1979)
- hydraulic loads not exceed irrigation "best practice" (Beavers 1996).
- development should be ecologically sustainable (Anon 1992) by water resources being not contaminated (Gardner 1995), off site movement of waste or it products is controlled and isolated (Qld Environmental Protection Act 1994), land use production system is stable (Gardner 1995), land is not excluded from future land uses; and there is no nuisance to adjacent landusers; and
- public health is protected (Beavers 1996)

In addition to the environmental principles an overriding political and legal concept that guides the assessment process is the "precautionary principle" (Deville and Harding 1997). This principle was established in law in Australia in May 1992 by an inter-governmental agreement. The precautionary principle dictates that action must be taken to protect the environment ahead of any scientific evidence of environmental harm. The adoption of this principle has shifted the onus of proof during allegations of environmental harm from the accuser to the accused or instigator of any activity.

There are several examples of risk assessment and management, for instance general risk management (AS/NZS 1999), environmental risk management (Beer and Zoilkowski 1996; Pritchard 2000) and mine risk management (EA 1999). However, the limitations in applying these approaches range from the monotonic and sequential logic to broad systems approaches that lack the focus on agricultural use of wastes. Suffice, parts of all these systems have application and a hybrid model of the existing risk assessment and management models gives a comprehensive and simple approach. This concept was applied to a case study that developed and land disposal and reuse scheme for a yeast factory dunder.

Assessment procedure

The hybrid model (Matthew 2003) for the assessment of the waste reuse and development of an environmental risk management plan is shown in Figure 1. The essential features are:

- cybernetic and iterative nature;
- assessment of both high accidental over application of waste and the low level repeated applications which may be done sequentially or in parallel; and
- the review process which may be considered a sensitivity analysis of the judgements where specific experimentation or research is conducted to validate the outcomes.

The first step is the limiting factor analysis. To undertake the limiting factor analysis there must be a match of the waste characteristics to the land attributes and land use requirements (using a full description of both). The quantity of waste and its chemical and physical characteristics may be described easily. Crites *et al*. (2000) lists the main effluent characteristics that may affect land application of high strength industrial wastes as: high carbon content; total suspended solids; total salts; sodium

concentration; nutrient concentration (mainly of nitrogen and phosphorus); pH; metals; and colour.

The land use requirements are more difficult to portray and consist primarily of:

- land attributes such as climate, soils, water resources, and terrain and vegetation are used too identify the waste conditioning or assimilative potential of a site and thus the total area required to use the waste;
- land use management which in a natural system are ecological cycles and in agricultural systems are factors such as rotation of crops and pastures, cropping cycle and its timing, nutrient cycles and cultural practices including water availability, irrigation, pest control and physical layout of the system; and
- socio-economic influences such as land tenure and the community understanding or acceptance of a land based waste disposal and/or reuse system (Morwood 2000).

From this point in the flow chart each level for the high and low application of waste corresponds to a similar assessment process. The objectives or context of the assessments are governed by the seven principles in the previous section. The hazards and constraints are identified next. The hazards relate to the environmental limiting factors. The constraints may be environmental pollution; incorporation of dunder into an agricultural system; the agronomic or production outcomes of using dunder; environmental indicators; and availability of suitable application technologies.

The risk and impediment identification addresses the question of - "what can happen?" Receptor identification looks at the environment such as soil water flora fauna and people. Agricultural systems suitable for use as waste receivers usually have; high biomass and nutrient removal rates, consistent production, reasonable independence from climatic extremes, well established crop and environmental management systems and established use of nutrients or water. These characteristics describe viable systems for the integration of waste as part of the production cycle.

Consequences are similar to the standard environmental risk assessment. The five factors that affect the impact of the high application are; mobility, degradation rates, waste component accumulation rates and short and long term effects on the environment. The implications for the production system are not as generic and needs to focus on specific crops and their farming systems, for instance, production, mechanisation, and the agronomic and environmental management of the crop and site. At this point the actual areas needed for disposal must be assessed to ensure factory production levels.

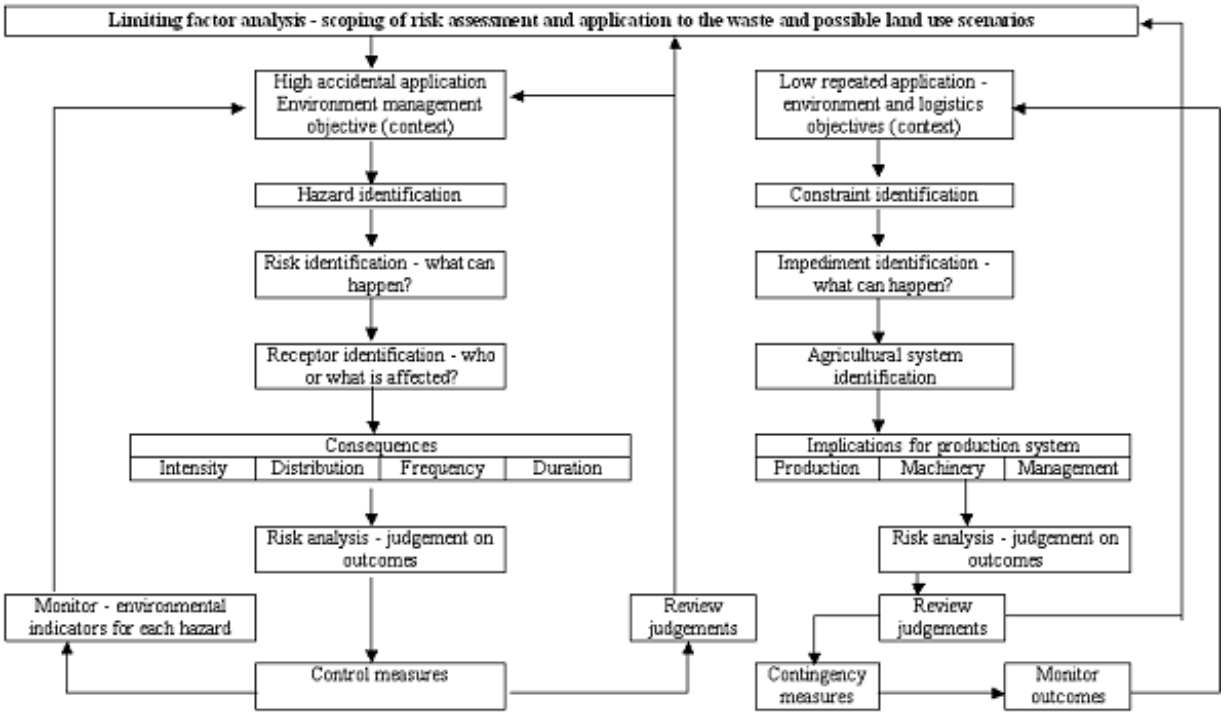

Figure 1Hybrid risk assessment and management model for a waste land disposal scheme (AS/NZS 4360 1999, Beer and Ziokowski 1995, EA 1999, Deville and Harding 1997, Pritchard 2000, Matthew 2003)

The risk analysis for both high and low application rates is a judgement on the environmental and agricultural outcomes of waste use. The review or sensitivity analysis of the judgements represents the research, experimentation and final validation of the process. High application rate experiments investigate the environmental impact of an extreme or repeated overdose of waste in plant soil and water terms. Low application experiments would normally focus on specific crops and management systems and use the waste as an adjunct to the existing agronomic practices. Based on the analysis and experiments, control and contingency measures can be designed and implemented. Following implementation, monitoring is a standard practice for all environmental and agricultural systems.

Discussion

The procedure is systematic and cybernetic which means that wherever the assessment process is started, all the components of the assessment are activated eventually. Repeating the cycles develops a succession of decisions which have the capacity to focus the environmental and agronomic considerations down to individual crops, land and management systems. The method directly links environmental risk assessment and development of management plans to agronomic development of waste products.

The method has been tested once at a full scale waste dispersal for a large food processing factory. The result was a rapid assessment and development of dispersal plans that has been operating without environmental or agricultural mishaps for some three years. The method demonstrates good environmental assessment and

management is good agronomy, and conversely good agronomy is good environmental management.

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