APPLICATION OF THE AUSTRALIAN WASTE DATABASE TO REGIONAL ENVIRONMENTAL MANAGEMENT

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ABSTRACT

The CRC for Waste Management & Pollution Control has established a national waste database for the Environment Protection Agency of Australia over the past three years, with cooperation from State environmental protection authorities. The aim of the Australian Waste Database is to establish an accessible waste generation and disposal information system to be used by a range of organisations for improving the management of waste. The objectives that needed to be accomplished to establish the Database were to establish a uniform classification system, to develop guidelines on the sampling and characterisation of wastes, and to establish a PC based relational database.

This paper outlines the structure and operation of the Australian Waste Database, and then explains how it can be used, along with other tools such as Life Cycle Assessment and Regional Materials Flux Analysis, for improving regional environmental management.

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Ecologically Sustainable Development (ESD) has become a guiding principle for environmental management in Australia. Following the Rio Earth Summit and the production of Agenda 21, Australia formed a series of ESD working groups to analyse the implications for a range of sectors in the economy. These consisted of agriculture, forest use, energy production, energy use, fisheries, manufacturing, mining, tourism, and transport. In addition cross - sectoral issues were addressed. The Council of Australian Governments (Prime Minister, 1992) agreed that ".. future development of policies and programs should take place within the framework of the ESD Strategy ..". New South Wales has included ESD principles in their Environment Protection Act (1992).

While this general agreement on broad principles has been reached, there remains a great deal of work to be done in "operationalising" the principles into practice, where they affect the day to day decisions of regulatory authorities and project proponents. This paper examines the implications of ESD principles for waste management, which is a cross-sectoral area of importance to regional environmental management. In particular the paper addresses two questions :

1. How do ESD principles influence the practice of waste management?

2 What data are required to enable implementation and monitoring of these principles in waste management ?

The paper concludes with an outline of how the Australian Waste Database (AWD) will meet some of these data needs and argues that a move to a more holistic materials accounting is required for successful implementation of ESD principles in regional environmental management.

ESD DERIVED GUIDING PRINCIPLES FOR WASTE MANAGEMENT

Guiding principles for waste management derived from ESD principles are suggested in this section. The data that will be required to enable these principles to be implemented are also described. Each of five major ESD principles; namely, intergenerational equity, intragenerational equity, biodiversity, the precautionary principle and global issues, are dealt with in turn (refer Moore, 1995 for a more detailed treatment).

Intergenerational Equity

ESD Principle : Intergenerational Equity is normally stated as the fundamental definition of ESD, namely that "the current generation should not compromise the ability of future generations to meet their needs in material and non-material terms ".

Application to Waste Management : Application of this ESD principle to waste management would lead to the requirement that all waste produced by this generation be managed in such a way that the next generation (taken as 30 years from now) incurs no liability by way of environmental quality degradation and/or the cost of remediating environmentally degraded assets.

The principle could be extended to state that we should try to leave future generations with potential assets from our waste management processes rather than potential liabilities. In this regard, the establishment of monofils to accept waste treatment residues high in potentially valuable materials, could provide future generations with an asset when markets and technologies change (Brunner and Baccini, 1992). Indeed, recyclables collected now, without an economic market, could be stored in dry cells for future use when scarcity and/or technology make them economically attractive to mine.

Data Requirements : The data requirements of this guiding principle are to compile an inventory of waste repositories, and to report on the composition and state of the materials in each repository, so that statements on liabilities (wastes not yet at final storage quality) and assets (in monofils) could be made.

Intragenerational Equity

ESD Principle : Intragenerational equity requires that the distributional effects of development on the allocation of benefits and costs need to be considered, both in the introduction of economic growth policies and projects, and in policies aimed at other aspects of ESD (such as reducing greenhouse gas emissions by increasing fuel costs).

Application to Waste Management : The principle of intragenerational equity applied to waste management would require the costs and benefits of the waste management system to be equitably shared among individuals in the community.

Past poor management of waste by indiscriminate dumping and landfilling has created contaminated sites with local environmental problems of contaminated groundwater, soils and air. This has provided benefits to parts of the community (through artificially low waste disposal costs) and obviously placed very high costs on individuals and small sections of the community affected by the contaminated site.

In regions where a comprehensive waste management system has been introduced, there are still difficulties with the implementation of this principle. Environmental costs may be born by a small number of individuals in the community, and it is this issue which makes the siting of new treatment and disposal facilities so difficult.

If this ESD principle is to be implemented, a means of arriving at a more equitable distribution of the costs needs to be developed. In newly industrialising countries, the principle can be accommodated by having the treatment and possibly the disposal facility for hazardous wastes located within the industrial estate, which is normally separate from the residential areas, thereby enabling the benefits and costs to be born by the one group, with the whole community receiving a benefit. This is more problematic in cities, including most Australian cities, with dispersed industries and a legacy of poor planning that allowed residential areas to be located adjacent to industrial areas. It is also obviously difficult for urban solid waste.

Data Requirements : Data required to enable this principle to be implemented includes information on where waste is being generated and where it is being treated and disposed of.

Conservation of Biodiversity

ESD Principle : Biological diversity encompasses three levels (ESD Working Group Chairs, 1992) :

- genetic diversity - the total range of genetic information contained in the genes of all living things

- species diversity - the variety of species of organisms on earth
- ecosystem diversity - the variety of habitats, biotic communities, and ecological processes and interactions that characterise the biosphere.

Changes in biodiversity have been a feature of geological time frames, as indicated by the geological record. However, when the rate of change can be measured in time frames of decades, there is concern that the natural capacity of ecosystems to respond may be exceeded. If this occurs, then the benefits and values associated with biodiversity may be threatened.

Application to Waste management : Implementation of the biodiversity principle would require that the management of wastes not impact on species and ecosystem diversity. This could require routing of hazardous waste truck movements to avoid sensitive areas within regions, and the establishment of emission standards that would not impact on ecosystems.

Current good practice in treating and disposing of waste requires that emission standards are adhered to. These emission standards are usually based on what Best Available Technology (BAT) can achieve. Conventional risk analysis usually indicates that the risk to human health from these emission levels are very low, and relatively low compared with other similarly calculated risks to health from anthropogenic sources (this should not be interpreted to mean that these risks levels are "acceptable", a relevant and complex issue not dealt with in this paper.) However, ecotoxicology has not yet been able to confidently provide acceptable emission standards for the host of substances contained in waste emissions to the environment (Baccini & Brunner, 1991), and there are consequently limits to the practical implementation of this principle in the area of waste management.

Data Requirements : Data requirements for this principle would include the mapping of ecological resources, and overlay mapping of emissions from waste management and other anthropogenic processes in order to enable assessment of the potential for adverse impact on biodiversity. This is a complex and difficult area, and our science is not sufficiently developed to a stage where we can rely on ecotoxicological risk based approaches. More pragmatic materials flux analysis (Brunner and Baccini, 1992) may be an appropriate interim solution.

The Precautionary Principle

ESD Principles : There are a number of definitions of the precautionary principle, and it is perhaps the most poorly developed of the ESD principles. A conference (Institute of Environmental Studies, 1993) on the precautionary principle highlighted the current developing nature of this principle, with a range of perspectives provided in the Proceedings. The definition now commonly adopted in Australia is that agreed to in the InterGovernmental Agreement on the Environment (1992):

"Where there are threats of serious or irreversible environmental damage, lack of full scientific knowledge should not be used as a reason for postponing measures to prevent environmental degradation.

In the application of the precautionary principle public and private decisions should be guided by :

- careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and
- an assessment of the risk weighted consequences of various options."

Application to Waste Management and Data Requirements : There will be difficulties in operationalising the precautionary principle in the waste management (and other) fields, because of the political judgements required in the determination of what is a 'serious' threat, and problems of identifying irreversible damage in advance. Data on waste quantities and characteristics will at least reduce some of the sources of uncertainty in dealing with this class of problems in waste management, where the precautionary principle may have to be introduced.

Global Issues

ESD Principles : The Brundtland report (WCED, 1991) had a particular focus on the relationship between underdevelopment and threats to global environmental sustainability, concluding that without growth and development, environmental problems in underdeveloped countries, which have global implications, could not be addressed. The Chairs of the ESD Working Groups refer to the need for Australia to address this nexus in its overseas aid program, and then concentrate their discussion on two aspects of global issues :

- International agreements and obligations in the environmental area as well as the influence of trade agreements on global environmental issues.
- the global and cross-border dimension of some environmental problems, particularly greenhouse gas emissions , ozone depleting substances, biodiversity (rainforest destruction) and some emerging issues in waste management.

While Australia often contributes a relatively small total contribution to environmental problems with a global dimension, the per capita contribution is often high (for instance greenhouse gas emissions), because of the structure of the Australian economy.

Application to Waste Management : The implications of complying with ESD principles aimed at minimising global environmental degradation, in the waste management field include:

- Complying with international agreements on the transport of hazardous waste across borders, such as the Basel Convention.
- Treating hazardous organic wastes in such a way as to minimise greenhouse gas emissions in a region.
- Ozone depleting substances such as CFCs and halons being taken out of service should be considered waste, and be treated appropriately.
- The acceptability of achieving hazardous waste management goals by moving chemical processes that produce the waste to another region or country, needs to be considered in the context of global issues; in some cases a nett deterioration may result.

Data Requirements : Implementation of the above principles requires the monitoring of interstate and international waste movements in Australia; and recording the contribution of waste management processes to greenhouse emissions. Relocation of waste producing industries to other regions could be tracked by monitoring waste types produced by industry sectors by region; however, more comprehensive materials accounting (including raw materials and products) is likely to yield a better understanding of this final aspect.

IMPLEMENTATION OF GUIDING PRINCIPLES FOR WASTE MANAGEMENT

The previous section has indicated how ESD principles could be applied to derive a set of guiding principles for waste management, and has also indicated what data would be needed to be able to monitor the success of the implementation of these principles. However, this leaves unanswered the question of " how can these principles be implemented ?", i.e. what are the *means* to achieve the desired goals ? This section briefly reviews some means which may be appropriate in enabling these ESD derived waste management principles to be implemented. The means themselves will also have data requirements, and these are briefly described.

The means have been grouped into the areas of : Materials minimisation; Cleaner Production; Waste Minimisation (or Pollution Prevention); Waste Treatment and Disposal. There are overlaps between these areas and there are no generally accepted clearly defined boundaries : each area can be thought of as belonging to a continuum of environmental and waste management means or tools.

Materials Minimisation

There is increasing agreement that it is our use/misuse of materials (and associated energy) to support our style of living that is the root of our environmental problems, and also the source of some potential solutions (Brunner and Baccini, 1994). If we can redesign our economy to support the same or enhanced functions that our society needs and desires, with reduced materials consumption, then this alone would be consistent with the ESD derived guiding principles for waste management. A number of materials accounting techniques have been developed to measure whether a particular economy is moving in this preferred direction, including :

- **Material Intensity Per Service Unit (MIPS)**, developed by the Wuppertal Institute (Lehmann and Schmidt - Bleek, 1993), measures the weighted total mass of all materials (including an allowance for energy) consumed in providing a unit of service.

- **Sustainable Process Index (SPI)**, developed by Narodoslawsky from TU Graz (Narodoslawsky et al, 1994), computes the total area to embed a process into a region in a sustainable way.

- **Materials Flux Analysis (MFA)**, developed by Baccini and Brunner (1991), measures the flux of materials in goods through a region over time. Identification of the sources and stocks of materials in the " anthroposphere " can lead to prediction of future waste streams and enable anticipatory environmental management policies to be developed. Unsustainable waste emissions can be identified by comparison of anthropogenic emissions with natural geogenic "emissions".

In each of these materials accounting approaches, waste data is an important (but not sufficient) data requirement. Additional information on materials and energy balances of important processes in regions is required in order to complete the analysis.

Cleaner Production

UNEP defines Cleaner Production as " ...the continuous application of an integrated preventative environmental strategy to processes and products so as to reduce risks to humans and the environment. For processes, this means conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes before they leave a process. For products, cleaner production means to reduce impacts along the entire product life cycle, from raw material extraction to disposal. Cleaner production is achieved by applying know-how, by improving technology, and/or by changing management attitudes. " (reported in Scaife, 1992). Reducing the amount and toxicity of emissions from all life cycle stages of products will certainly move the economy towards ESD.

Life Cycle Assessment (LCA) is the primary tool for implementation of Cleaner Production by the means described in this definition. LCA requires compilation of raw materials and energy used, and emissions produced in order to design improvements in existing processes or to compare options for new processes and products. The use of LCA in Cleaner Production is similar to the use of MIPS, SPI and MFA for regional environmental management. The difference is one of scale. Logically, the micro scale LCAs of all products and processes in a region could be summed to yield the macro scale MFA for a material in a region. Practically, this is not possible and the two approaches are likely to be developed separately to answer the questions they were designed for. They can be considered as complementary, in that the macro materials accounting approaches identify the particular materials, goods and processes in a region that are important for regional environmental management; LCA and Cleaner Production can then optimise the environmental design of these target goods and the industrial processes that create them.

LCA requires information on waste emissions from a series of generic unit processes, either at a region specific or a general level, so that inventories of emissions for a particular product made by a process composed of a number of sub-processes can be derived.

Waste Minimisation

In accordance with OECD practice, waste minimisation is taken to include waste avoidance/elimination, waste reduction (quantity and/or toxicity), reuse and recycling. It focuses on the production of goods in a particular industrial process, without the attention to upstream and downstream effects that is encompassed by Cleaner Production. Waste minimisation can therefore be seen as a sub-set of Cleaner Production. More recently the concept has also been applied to wastes arising from the process household. Waste minimisation is consistent with ESD principles (see Moore, 1995, for a detailed treatment of this), but it does not provide guidance on the most efficient path to ESD, nor does it provide confidence that waste emissions are not simply being transferred to another region or media.

Means to achieve waste minimisation include reuse and recycling of waste materials within and between processes; and source reduction techniques of material substitution, product redesign, and process efficiency improvement.

Monitoring of the effectiveness of various waste minimisation policies and techniques at the regional and facility level require measurement and reporting of waste streams. An appropriate reporting system for waste minimisation has yet to be developed and receive wide acceptance.

Waste Treatment and Disposal

Because of the existing stock of goods in the anthroposphere (Brunner and Baccini, 1992) and because of entropy considerations, it will always be necessary to use waste treatment and disposal in regional waste and environmental management systems, although the "size" of the contribution from this system element may decline over time as goods designed for recylability reach the end of their life. Waste treatment and disposal can be compatible with ESD provided the emissions from these and other processes (transport etc) do not exceed the sustainable regional loads for various materials. It is not easy to determine what these loads are, and until risk based ecotoxicological approaches become more refined, geogenic reference values may provide a pragmatic alternative.

Measurement of waste stream amounts and their composition is important if waste treatment and disposal processes are to be designed to ensure final emissions to the environment do not exceed these acceptable levels. Examination of the above complementary approaches to waste and regional environmental management indicates that, once tools like Materials Flux Analysis and Life Cycle Assessment are introduced, waste streams can be characterised by a combination of direct sampling and analysis and indirect materials balance approaches. Some level of direct waste measurement and reporting will be required.

AUSTRALIAN RESPONSES

The finalisation of the work of the ESD working groups, its application to waste management, and the development of the National Waste Minimisation and Recycling Strategy created a clear need to establish data collection and reporting systems, so that the achievement of targets defined in these strategies could be monitored. A series of related programs have been initiated to address these information needs, including :

- ERIN (the Environmental Resource Information Network) is an Internet site for the distribution of information on a range of Australian environmental issues. The ERIN home page is at the URL http://kaos.erin.gov.au:80/erin.html.

- A proposal for a National Pollutant Inventory (NPI) is being developed to provide a comprehensive report on the sources and composition of emissions from industrial, transport and household processes in regions. The Australian Waste Database, covering urban solid waste and manifested hazardous waste will form two of a possible six moduled NPI. (CEPA, 1994)

- A system of State of the Environment reports is being established, reporting on waste generation and other environmental issues.

The remainder of this paper describes the development of the Australian Waste Database, an integral part of this suite of responses to Australia's environmental information needs. It has been designed to satisfy the data needs of the ESD waste management principles, and the data needs of the means of implementing those principles (cleaner production etc.) described in preceding sections of this paper.

THE AUSTRALIAN WASTE DATABASE

The Database will consist of three modules; namely, solid waste streams, recyclable material recovery rates, and manifested hazardous waste (Moore et al, 1994).

Solid Waste Streams and Composition :

This is a record of the monthly arisings of Municipal Waste, Commercial and Industrial Waste, and Building and Demolition Waste streams, as recorded by gatehouses at waste facilities, and reported to the State EPAs as required by various regulations. Waste arisings from these sources will be aggregated by region and waste disposal facility type. A variety of reports by region, waste type, generation rate, and disposal route will be produced by the Database. At various times, samples are taken from each of the streams and subjected to material type, and physical and chemical analysis. Data from these analyses will be reported in this module of the Database. At present there are no regulatory requirements for the conduct of such composition studies, and the Database will be reliant on voluntary submission of data from those conducting the studies.

Recyclable Material Recovery Rates

Data on recycling rates of various materials will be reported in this module of the Database.

Manifested Hazardous Waste Streams

Aggregated summaries, by industry type and region, of each type of manifested hazardous waste will be recorded in this module. Reports on waste type by period, by region, and by industry group are being produced. An example of part of a report is shown in Figure 1.

CONCLUSIONS

This paper has described the waste management principles that can be derived from ESD principles, and has then suggested how these waste management principles could be implemented. Implementation by a range of means, from materials minimisation approaches through cleaner production/waste minimisation to waste treatment and disposal, will require a set of spatial and temporal information on wastes and materials.

The waste information system to be established by the Australian Waste Database is a necessary, but not sufficient, system to meet the information needs of a comprehensive regional waste and environmental management system. The AWD will need to be integrated with a comprehensive materials information system if we are to progress from merely monitoring the impact of waste management policies, towards an anticipatory style of regional environmental management.

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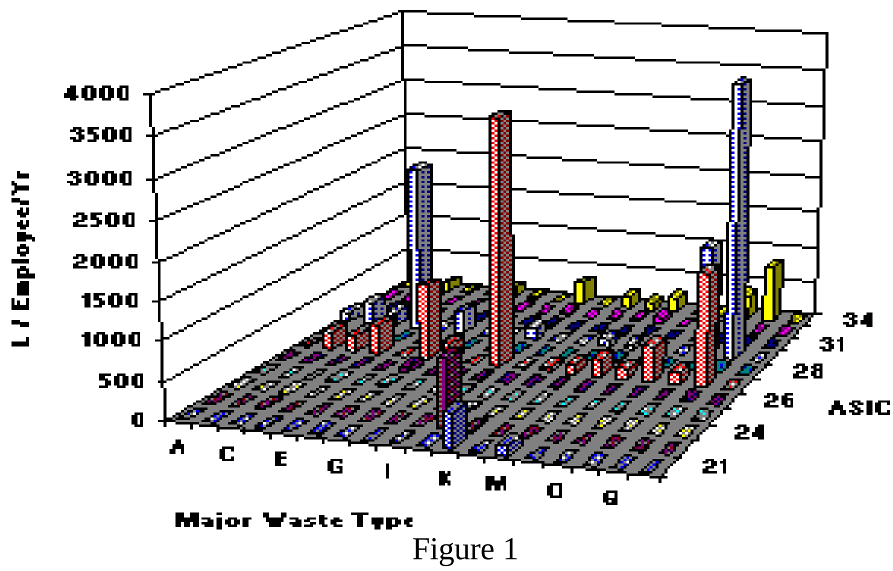

Figure 1

Manifested Hazardous Waste Generation per Employee in the Manufacturing Industries in Melbourne in 1991.