H. R. WASMER

wastes management as a world problem

INTRODUCTION

Nobody needs to be told that pollution is a world-wide problem. To most people this means that certain pollutants like pesticides have become widely distributed within the natural cycles in water and in the atmosphere; indeed, compounds like DDT are found in the most remote places on earth.

Traditionally, waste management was restricted to the technical, organizational and economic aspects of waste handling. Emphasis was given to wastes from point sources such as effluents, stack emissions or municipal refuse. Thus, most activities and particularly most financial investments were concentrated on the construction of treatment facilities. This so called end-of-pipe approach was successful insofar as the environmental situation would have deteriorated even further without such treatment. However, evaluations of cost/benefit relations were not carried out for alternative approaches to waste management. The question remains open whether we have chosen the optimum solution.

In order to evaluate waste management activities it seems appropriate to clarify terms such as efficiency and effectiveness: The process of policy making leads to the formulation of objectives. In the case of environmental protection, this means a description of the state of the environment to be achieved or maintained. By quantifying these objectives it becomes necessary to work with tolerance levels and to set limits to the residual load on the environment. Setting these limits is based, on the one hand, on our scientific knowledge, and, on the other, on philosophical considerations i.e. our ethics regarding the biosphere. Once such objectives are set, our aim will be to reach these goals by the most effective and economical means. The term efficiency can be applied to the quantification of such endeavors (waste management). However, here again, the important point has to be stressed. It is the residual load on the environment that has to be taken as a reference and not just the amount of pollutants removed.

The limited effectiveness of end-of-pipe measures becomes evident in the face of pollution from non-point sources (lead discharged into the atmosphere by internal combustion engines, freon from spray cans as a threat to the ozone layer in the atmosphere). When dealing with these kinds of pollutants, waste management plays an important role in the initiation of any materials flow, i.e. the design of manufacturing processes, produce specifications, or even in non-technical fields such as legislation, taxation etc.

The aspects of waste management described so far are more or less restricted to the national level. The following attempts demonstrate that waste management plays an important role on the international scene as well and that the traditional approaches to waste management are inadequate for pollution control on a world-wide basis.

Objectives

The objectives of this paper are

- to elaborate parameters that could be used for the description of pollution potentials on a world-wide basis;
- to demonstrate that there exists a transfer of environmental problems even if pollutants are not transported across political boundaries;
- to identify and describe the constraints on waste management and to show the limits of pollution control measures.

GNP/Energy Consumption as a Measure of National Pollution

It has been proposed by Goldberg(1) to use the GNP/area ratio as a measure of the potential pollution of a country. While the gross national product is incontestably related to the flow of materials within a society as a result of its industrial, agricultural and domestic activities, Goldberg's approach has some severe limitations:

a) It does not take into account that only part of the area is cultivated or otherwise used for civilisatory activities;

b) It does not consider the various types of activities that combine to make up the GNP.

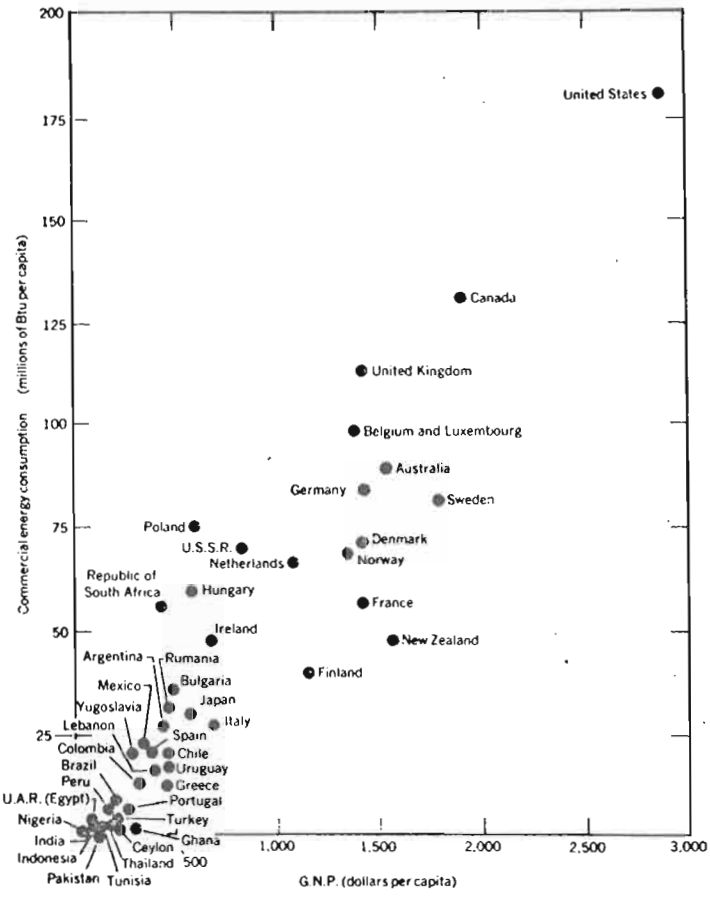
Gambel(2) investigated the relationship between GNP/capita and consumption of fossil fuel energy for different countries. In general, high per capita energy consumption is a prerequisite for high output of goods and services. Figure 1 shows this well known pattern, with the industrialized countries demonstrating peak values while a cluster of points, indicating various developing countries, are situated at the opposite end. The question arose how the distribution pattern of GNP/capita vs energy/capita could be explained. For this purpose more recent data(3) were elaborated and the ratio of GNP/energy consumed determined (i.e. the slope in Gambel's presentation).

This ratio varied considerably as shown in Figure 2. The following conclusions can be drawn from these data:

1. GNP/energy is an indication of the type of activities for which energy is used to produce goods and services.

2. GNP/energy consumption is a criterion for quantifying the specific pollution potential for the overall activities of a country. The absolute pollution potential would then be the produce of specific pollution potential times total GNP. The relevance of such a figure

Figure 1 COMPARISON OF FOSSIL-FUEL CONSUMPTION AND INCOMES FOR DIFFERENT COUNTRIES.



could be further improved if it would be corrected by the factor total land area/cultivated or "used" area.

3. It has been proposed that the costs for pollution control be incorporated as externalities in the price of consumer goods. Even more important, however, is that these externalities be included in the price of primary materials.

4. The international implications of the waste management problem are more far-reaching than we used to believe; national waste management policies (or legislation) should consequently be based on the nature of environmental problems rather than on available pollution control technologies.

The statements made above need further explanation.

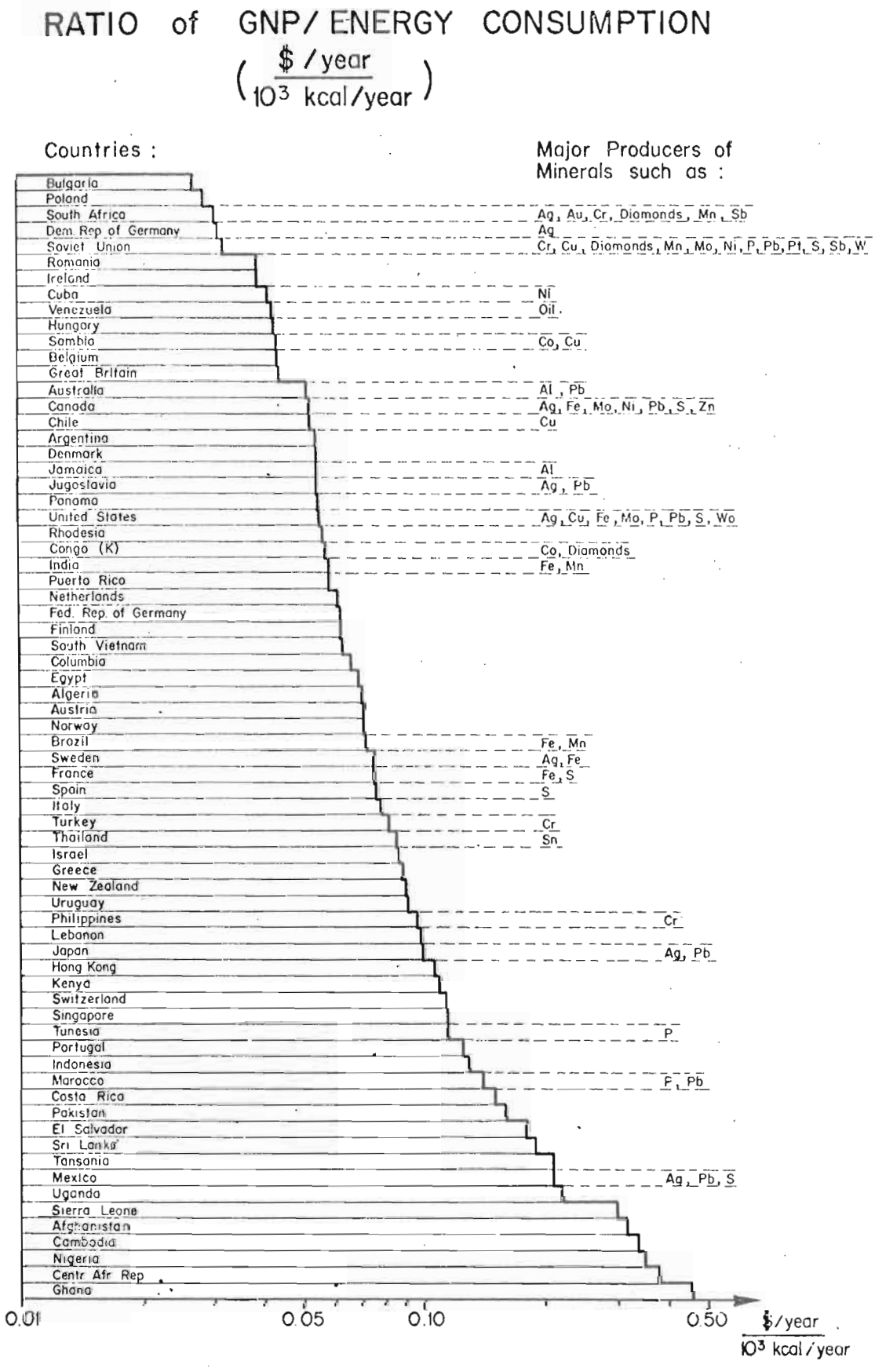
Statement 1 and 2

Several authors(4) have proposed to use the following equation for the description of environmental loadings U :

$$U = \frac{GNP}{Area} (1-\eta)$$

where η is a descriptor for the efficiency of activities.

Figure 2


RATIO of GNP/ ENERGY CONSUMPTION
($/year / 10³ kcal/year)
Countries :
Major Producers of Minerals such as :
Bulgaria
Poland
South Africa
Ag, Au, Cr, Diamonds, Mn, Sb
Dem Rep of Germany
Ag
Soviet Union
Cr, Cu, Diamonds, Mn, Mo, Ni, P, Pb, Pt, S, Sb, W
Romania
Ireland
Cuba
Ni
Venezuela
Oil
Hungary
Sambia
Co, Cu
Belgium
Great Britain
Australia
Al, Pb
Canada
Ag, Fe, Mo, Ni, Pb, S, Zn
Chile
Cu
Argentina
Denmark
Jamaica
Al
Jugoslavia
Ag, Pb
Panama
United States
Ag, Cu, Fe, Mo, P, Pb, S, Wo
Rhodesia
Congo (K)
Co, Diamonds
India
Fe, Mn
Puerto Rico
Netherlands
Fed. Rep. of Germany
Finland
South Vietnam
Columbia
Egypt
Algeria
Austria
Norway
Brazil
Fe, Mn
Sweden
Ag, Fe
France
Fe, S
Spain
S
Italy
Turkey
Cr
Thailand
Sn
Israel
Greece
New Zealand
Uruguay
Philippines
Cr
Lebanon
Japan
Ag, Pb
Hong Kong
Kenya
Switzerland
Singapore
Tunesia
P
Portugal
Indonesia
Marocco
P, Pb
Costa Rica
Pakistan
El Salvador
Sri Lanka
Tansania
Mexico
Ag, Pb, S
Uganda
Sierra Leone
Afghanistan
Cambodia
Nigeria
Centr Afr Rep
Ghana
0.01
0.05
0.10
0.50
$/year
10³ kcal/year

Could the differences in the GNP/energy ratio be explained by the efficiency by which energy is used?

The variation in the ratio of GNP/energy consumption can only be partially explained by the efficiency of energy use. Figure 2 does not take into account the various forms of energy; i.e. no distinction is made between electricity produced in hydromechanical plants and electricity produced by the combustion of fossil fuels.

The geographical distribution of the various countries shows that the more "efficient" energy users are located in warm climates. Conversely, the "inefficient" energy users need considerable amounts of energy for heating which does not directly contribute to the growth of the GNP.

Figure 2 shows some very interesting facts that should consequently be considered in the definition of waste management policies. Countries with an economy based on the production of primary raw materials will undoubtedly have a lower ratio of GNP/energy used. The ratio per se is given by thermodynamics. To illustrate the importance of primary production, the major producers of metals are also listed in figure 2. Countries that are active mainly in the tertiary sector (i.e. no heavy industry but raw material imports and high quality goods production, with emphasis on services, tourism etc.) show relatively high ratios.

Although "efficiency" should not be used as a qualifying term, it nevertheless indicates that low GNP/energy ratios are due to energy intensive activities. Metal ores mining and processing are examples of energy intensive activities (for one ton of copper about 600 tons of waste materials are produced).

Statement 3 and 4

Countries whose activities lie mainly in the tertiary sector are actually living at the expense of those countries that produce primary materials. There is a hidden trade of waste management problems, since the countries importing primary materials are exporting pollution problems to the primary producers. The extreme case would be a country that imports all primary materials including food and energy and exports high quality goods and services. This country does not have to deal with any of those waste management problems that are related to the production of the imported raw materials.

Bound by more stringent pollution control legislation, producers in industrialized countries can no longer consider the quality of air, water and soil a free and unlimited resource. Expenditures for pollution control are included in costing and are ultimately passed on to the consumer.

It seems obvious that such considerations should not be limited to the manufacturing level but should include the level of primary production as well.

It is beyond the scope of this paper to discuss the various implications for the international trade of primary products if the cost of pollution control were included in the price of primary products. To reach international agreement will not be an easy task, but world-wide concern for the state of our environment gives reason to believe that the common interest of mankind will be respected.

Some comments on legislation: All legislation on pollution control mentions as one of the objectives the state of the environment that should be maintained. In the case of water pollution control legislation, the only workable basis is to set up criteria for the condition of the

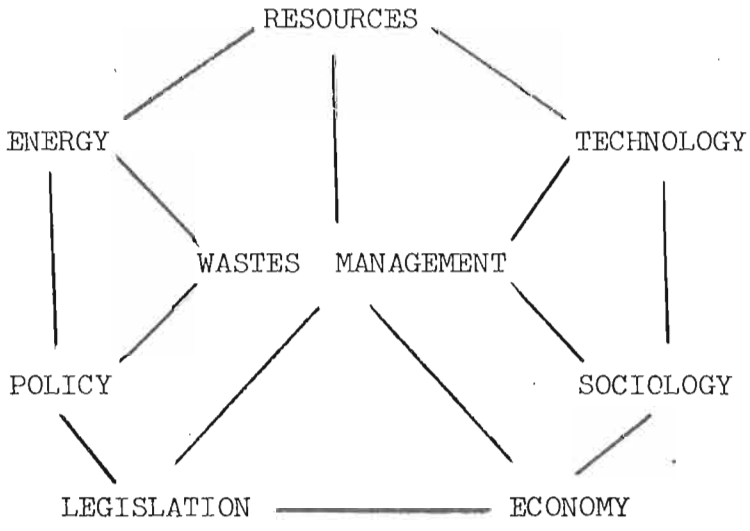
receiving water bodies. Quite often such standards are taken over from other countries' legislation. Such practices can lead to situations where the ultimate goal, protection of the environment, is only partially achieved because the boundary conditions were not duly taken into account. It would certainly be most unfortunate if a country active mainly in the tertiary sector (services) would adopt the same criteria as another country that produces mostly primary materials.

It also shows the inherent fallacy of the philosophy that the extent of pollution control should be determined by technological fixes, i.e. "the most practicable means", or "best available technology". This end-of-pipe approach leads to a series of standard technical solutions for most waste management problems. One could agree that there is too much emphasis on technology transfer with regard to waste management compared to the transfer of problem analysis.

Constraints and Limits to Waste Management

The various aspects of resource conservation, pollution control and environment cannot be considered out of context. The complex interactions within the materials cycle, the direct correlation between energy and minerals production, the effects on industry and the consumer, and the inter-relationships of national and international policy all need to be taken into account for the formulation of objectives. Figure 3 shows these inter-relationships in a schematic form.

Figure 3 INTER-RELATIONSHIPS IN WASTES MANAGEMENT



The following paragraphs are an attempt to describe the technological limits to waste management. The non-technical (socio-economic) aspects will not be discussed further because this would go beyond the scope of this paper.

The lack of available waste treatment technology is not the principal barrier to pollution control. The basic technology is known for the control of most problems, although engineering applications may not, as yet, be developed enough to meet the demands of practice. Waste management is primarily an economic and political problem that was left with the engineers. While technology can do much towards conserving resources it cannot do everything. Those who argue that technology has always come up with an answer tend to ignore that the so called "solved" problems have always had their social, environmental or economic costs.

The limits to technical measures for waste management can easily be shown by a mathematical model.

CONCLUSIONS

As the use of resources continues the world trend towards inter-dependence will become more pronounced. There will be occasional fluctuations like the recent oil crisis. The long range goal of countries should, however, not go in the direction of independence with regard to raw material supplies; this would be impossible. Policy-making at all levels should recognize inter-dependence within the materials cycle among nations and among the various users of resources. "Above all we should adopt a conservation ethic that is determined to avoid wastage, make more efficient use of materials and practice waste management on a rational basis."(6)

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