

A CRITICAL EVALUATION OF THE STRATEGY PROJECT

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The STRATEGY project (sustainable restoration and long-term management of contaminated rural, urban and industrial ecosystems; www.strategy-ec.org.uk) addressed the need for a holistic decision framework for the selection of optimal remediation strategies for long-term sustainable management of contaminated areas in Western Europe. The project considered both technical and social aspects of implementing restoration strategies for urban and rural environments. The importance of considering socially relevant objectives in addition to the dose reduction was emphasised. A critical evaluation was carried out on 101 selected countermeasures, (including rural waste disposal options), a model was developed to aid optimising countermeasure strategies and a method of carrying out participatory decision-making suggested. The outputs of the project are described and critically evaluated.

INTRODUCTION

Urban (including industrial), agricultural and semi-natural environments may be contaminated for many years following a nuclear accident. To sustain acceptable living and working conditions, a capability to implement robust and effective restoration strategies is required. Experience after the Chernobyl accident has shown that many different issues impact on the long-term sustainability of radioactively contaminated areas. The STRATEGY project had the overall objective of establishing a holistic decision framework for the selection of optimal remediation strategies for long-term sustainable management of contaminated areas in Western Europe.

In this paper, we provide a critical evaluation of some of the approaches and outputs of STRATEGY. The evaluation draws on the experience of the participants and also of end-users (including regulators at a national level and a local emergency officer).

OBJECTIVES OF RESTORATION

An assessment of potential countermeasures should consider not only technical issues but also social and ethical considerations such as distribution of

dose, cost and benefit across the relevant populations; stakeholder involvement; self-help; environmental consequences and indirect costs. In optimising restoration strategies, decision-makers should aim to achieve a wide range of objectives:

- reducing individual and/or collective dose while minimising other health risk factors;
- meeting legal limitations regarding environmental protection, dose limits and intervention limits;
- optimising cost-effectiveness;
- maintaining and/or creating economic activity;
- providing public reassurance and maintaining a sense of well-being;
- minimising social and cultural disruption and environmental damage;
- maximising institutional, public and scientific learning;
- enhancing participatory dialogue.

In practice, some of the objectives may conflict. For example, the goals of public reassurance and economic activity might only be achieved at the cost of social disruption. Therefore, decision-making criteria will need to be established to balance cost-effectiveness with social, ethical and environmental considerations.

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OUTPUTS

Datasheets on countermeasures for mid-to long-term restoration

Approach

The approach adopted has been to extend the criteria against which countermeasures are evaluated from effectiveness and radiological protection criteria to a more integrated, holistic approach which addresses the wider range of objectives listed above. Specifically, the aspects used to assess available countermeasures were: (i) can measures be practically applied (e.g. are the required resources likely to exist or do some environmental characteristics limit the applicability of the measure); (ii) do they incur considerable direct or indirect (side effect) costs; (iii) do they have significant environmental effects; (iv) are wastes generated as a consequence of the measure and, if so, what are the appropriate disposal methods; (v) what doses will be received by people implementing the countermeasure. To achieve this, a critical evaluation was carried out on a range of countermeasures and waste disposal options. A template was devised which provided a means of carrying out a comprehensive and wide-ranging evaluation of different countermeasures. A review of mid-to long-term countermeasures was carried out and countermeasures were divided into those considered worth evaluating, those which were rejected as being unlikely to be of use, and those with potential but requiring further development. For those measures fully evaluated, a datasheet based on the template was completed. Overall, datasheets were produced for 101 countermeasures, comprising 35 methods for urban/industrial environments, 29 methods for agricultural and semi-natural environments plus 12 waste disposal options, 3 methods for forest environments, 7 methods for aquatic environments and 15 methods on social issues. The main output was a comprehensive, documented, critical evaluation of countermeasures relevant for off-site nuclear emergency management in the mid- to long-term. The datasheets were peer reviewed by independent experts and are available as a CD-ROM⁽¹⁾. Documents on a range of issues including social and legal aspects, dose estimation methodologies and cost effectiveness are hyperlinked to the datasheets.

Population of the datasheets was dependent on available relevant information. In some cases, this required the derivation of novel data, for instance, implementation doses to operatives carrying out the measures (rural datasheets). For some aspects considered, there was a dependence on the particular scenarios and area affected so only general statements could be made.

Evaluation

The information in the datasheets was intended to be generally applicable for use in different European

countries. Nevertheless, for some information there is a bias towards the originator's country or the regions where methods were tested. Furthermore, countermeasures for foodstuffs from Mediterranean countries were not covered as well as those for northern countries. The datasheets are freely available and could readily be made 'country specific' both in terms of the information they contain and language used. Currently, the rural and waste templates are being taken forward by the joint FAO/IAEA division to be adapted to other climate types and to update Handbook 363⁽²⁾, and they have been provided to various EC projects.

Stakeholder participation is an important mechanism to explore these additional benefits or disadvantages to the use of countermeasures, and is an essential step in developing a decision framework which avoids problems previously experienced in emergency management. Close liaison with the FARMING stakeholder network facilitated evaluation of countermeasure templates for rural ecosystems⁽³⁾ whilst for other datasheets stakeholders were consulted in small groups or individually. Stakeholder opinion suggested that some countermeasures were as likely to be rejected on socio-ethical grounds as on technical and economic grounds. Rejection of specific countermeasures can be expected to show site, context and national differences.

The end users felt that uncertainties associated with countermeasures should be more explicit in the datasheets and that although the methods of publication (i.e. CD-ROM, report and the STRATEGY website) are acceptable they could be improved only with the publication of a paper copy. From a wider perspective, they felt that the range of countermeasures covered could easily be extended to include other pollution scenarios and that the datasheets would be a good tool for further education and training of various people involved in emergency preparedness (they have been used successfully in Nordic and IAEA training courses and a recent international workshop; see www.ec-farming.net/wisdom.html). It was felt that the lay user would feel comfortable using the datasheets. Overall, the end users felt that the datasheets were a valuable resource which they all intended to use. However, countermeasure choice would ultimately depend on many factors and may be influenced by responses of neighbouring countries.

Decision support model

Approach⁽⁴⁾

A model-based methodology to assist the identification of optimal medium to long-term countermeasure strategies for radioactively contaminated regions has been successfully developed and parameterised for

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Cs, Sr, Pu and Am. Collective and individual ingestion doses of the region's population are estimated using a spatially variable radionuclide transfer model and a combination of dietary data and information on the geographical sources of foods. External gamma doses, from ^{137}Cs , are derived from kerma rates for a number of surfaces (e.g. walls, roofs, streets and so on) per unit deposition⁽⁵⁾. These are combined with data describing the distribution of daily activity for the population (e.g. time spent indoors, outdoors and so on).

Currently, a limited range of countermeasures are considered within the model: restrictions on the sale of contaminated foods; ploughing of pastures; deep ploughing of pastures, edible and silage crop fields; skim and burial ploughing of pastures, and edible and silage crop fields; application of potassium fertilisers and/or lime to pastures and crops; administration of AFCF to animals; clean feeding of animals; washing of roofs, walls and streets; urban topsoil removal or triple digging; lawn mowing; tree pruning in urban areas; and dietary advice. Various combinations of these countermeasures can be activated within each grid square and the combined effect on dose simulated. Waste disposal options and environmental (physical and 'legal') restrictions have been included within the implementation of countermeasures as appropriate.

The model evaluates the effectiveness of a given countermeasure combination through a cost function which incorporates the benefit obtained through the reduction in dose and the cost of implementing countermeasures. The model then identifies the combination of countermeasures which gives rise to the lowest value of the cost function using a mathematical optimisation procedure⁽⁶⁾. Outputs allow an evaluation of resources required and hence present a starting point for discussion of practicability of suggested remediation strategies.

Evaluation

The major limitations to the model are that, at present, only 22 of the 101 countermeasures considered are simulated, and only a small number of countermeasure side effects are considered.

In addition to the economic and health implications of a restoration strategy, the model allows the indirect side effects of countermeasure implementation to be assessed, which leads to a more holistic approach to the decision making process; some additional social dimensions of countermeasure implementation can also be estimated through the model (e.g. uneven dose distribution). However, whilst the initial intention was to assign numerical values to more social factors to enable their incorporation within the model it soon became obvious that interaction with affected stakeholders would be

required. Therefore, it was decided that further inclusion of social parameters was inappropriate. The model outputs should be used as inputs into decision-making, rather than a substitute for explicit and inclusive decision-making.

The model has been used in two contrasting case study scenarios⁽⁴⁾ and the outputs were tested interactively as part of the decision-making process⁽⁷⁾. The end users felt that the underlying assumptions behind the model, and their implementation were acceptable, but the 'front end' needed further work especially for application to, or by, non-specialists. For some countries, there may be a lack of underlying data but the model can adapt to incorporate further information if it becomes available. The end users thought the model could be used as a starting point within an emergency situation thus providing focus and then, at a later stage, to confirm or refine a previous decision and to inform on aspects such as compensation levels. Demonstrations of what the model is capable of would be required so that the end users would know what to ask for from an expert who would run it and provide feedback (but that they would not use the model, as currently constructed, themselves). The model has recently been successfully used within a large scale emergency exercise although this demonstrated a number of areas for potential improvement, including spatial and temporal scales of implementation. The advantages of the approach need to be compared with other systems such as RODOS⁽⁸⁾ and consideration given to incorporating those elements from the STRATEGY approach which signify advances which can be used to assist decision-making after accidents.

Social issues and stakeholder participation

Approach

Embedded in the use of all countermeasures and countermeasure strategies are a set of assumptions about the ways in which the social world works. These assumptions need to be recognised, and their validity assessed in the socially and culturally variable range of contexts in which countermeasure strategies may be implemented. In general, participation in decision-making enables greater compliance and acceptability, leading to more appropriate choices in strategies and greater focus on the dimensions of primary importance to affected groups. As such, there has been an emphasis on the inclusion of social and ethical considerations within restoration strategies.

Any decision on countermeasure implementation will have to take into account a large amount of information on the benefits, risks and costs of the restoration strategy and its alternatives. The actual selection of a strategy will require trade-offs and

Table 1. Excerpt of a template value matrix developed for countermeasure evaluation.

Stakeholder	Example	Well-being	Integrity	Justice
Owners/employers	Farmer	Doses to humans	Self-help	Possibility for conflict between different industries or projects
	House dweller	Change in income	Consent	
	Hotel owner	Property damage	Property rights	
	Business proprietor			
Users/community	Tourists	Access	Respect for public heritage Community sense	Potential conflict of age/sex/cultural minorities
	Public amenity user	Aesthetics		
	Local community	Empathy		
		Community values Tourism		
Animals/environment	Farm animals	Animal welfare	Endangered species Habitat loss	Potential conflict between farm & wild animals
	Other biota			

The full matrix can be found in Oughton *et al.*⁽⁹⁾ and includes a broader spectrum of stakeholders and values.

value judgements, and almost certainly some lack of agreement within society on what is practical or acceptable. If such a selection is going to be ethically defensible, decision-makers require advice on what criteria are important to consider and why, and also a methodology to ensure a transparent and publicly justifiable procedure for balancing these criteria. As a procedure for ensuring a systematic consideration of ethical issues, and as guidance for stakeholder participation processes, we suggested the use of a value matrix⁽⁹⁾ (Table 1).

A value matrix is a tool to ensure that all relevant concerns are being taken into consideration and to clarify the ethical basis upon which eventual decisions are made. The matrix approach we proposed takes its starting point in three fundamental principles, namely

- (1) to promote well-being and minimise health risks, welfare burdens and other detriments to affected stakeholders;
- (2) to respect the integrity of affected stakeholders;
- (3) to recognise the norm of justice and aim to treat everybody fairly and ensure an equitable distribution of goods among affected stakeholders.

In practice, a matrix can aid a decision-making group by giving an overall picture of the issue at stake, thereby making the ethical dimension of decision-making more transparent. Different countermeasures can affect different groups in different ways, and the matrix can be used to help identify the relevant information required for decision-making (i.e. the facts, values and stakeholders affected). In this way, a bias towards certain kinds of values may be avoided, and the matrix can be used to address conflicts between values in a systematic way, without, necessarily, having to invoke full-fledged theories. A further advantage of the matrix is that it is well suited to use within a participatory process with stakeholder representatives of affected parties.

Evaluation

The matrix developed in STRATEGY has been tested with the end-user group as part of a case study exercise. The exercise demonstrated that the matrix was useful in mapping the concerns of various stakeholders and helpful in weighting the importance of those values⁽⁷⁾. Although the primary objective of the end-user exercise was to test the value matrix as a decision-making aid, the matrix approach in STRATEGY was specifically designed for use in conjunction with the other STRATEGY outputs. Thus the exercise also provided an opportunity to explore the other tools (in this case, the model and countermeasure datasheets) and, specifically, a demonstration of the practical benefits of the interaction between the model and the value matrix in decision-making. On the whole, the group evaluated the exercise positively, thought it would be worthwhile as decision-makers to be trained in, and have further demonstrations of the matrix approach.

CONCLUSION AND RECOMMENDATIONS

The project set itself a considerable challenge in trying to provide methods for a holistic, integrated approach to decision-making regarding off-site remediation after accidents. The importance of considering a wide range of issues, and integrating technical information and approaches with social issues is clear. The mechanisms by which such integration can be achieved need careful consideration. Socially related objectives need to be given due weight and not subsumed by issues connected to dose reduction. Whilst early involvement of the local and wider community of stakeholders within participatory decision-making would be beneficial, the mechanism for doing so needs to be considered. The best mechanism for using the STRATEGY datasheets

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and model needs careful consideration and the value matrix approach developed in STRATEGY is one means of doing this, although the matrix is not a substitute for ethical judgement.

We conclude that the project has provided useful input into the process of making decisions for off-site remediation. In part, this is due to the inclusion of varied expertise from different disciplines to address the wide range of relevant issues, and to liaison with potential end users. Nevertheless, closer contact between expertise involved in STRATEGY, including radioecologists, sociologists, agriculturalists, ethicists, economists and modellers with programmers and users would greatly enhance the usefulness of such work and ensure that the outputs are transferable to decision-making tools.

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