Evaluating the Actions towards Environmental Health using DPSEEA and Program Logic

Helen Jordan[1], David Dunt[1], Louise Dunn[2], and Glenda Verrinder[3]

[1]Centre for Health Policy, Programs and Economics, University of Melbourne, [2]Swinburne University of Technology, Melbourne & [3]La Trobe University, Bendigo

This paper illustrates the integration of an approach used in program evaluation with an approach used by environmental health practitioners to provide a useful tool for program planning, evaluation and decision making for environmental health practitioners. A program logic approach that focuses on and links the 'actions' designed to improve environmental health with each of the components of the DPSEEA (Driver, Pressure, State, Exposure, Effect and Action) conceptual framework for indicator development is presented. Together, these approaches can be used to facilitate the evaluation of organised actions towards environmental health, and the effectiveness of these actions in attaining the goals that might be associated with any one or more components of the DPSEEA framework. These approaches also highlight the complexities of environmental health problems. They show the need for an interdisciplinary and multidisciplinary range of professionals to assist in addressing these issues. It is important to have an understanding that they are heuristic models, and can alter with improved knowledge of the mechanisms and conditions of the environmental problem and the intervention designed to address it.

Key words: *Environmental Health; Evaluation; Program Logic; Environmental Health Management; Environmental Health Planning*

Tools that can assist environmental health practitioners to evaluate actions towards environmental health need to be promoted. Many evaluation tools and approaches exist and are extensively described in the evaluation literature. Program logic, a systematic way of describing the logic underpinning a program, is one of these tools. It is used in the evaluation of programs across all disciplines from the planning stage to the step of interpreting and communicating the evaluation findings. It is used to illustrate the hypothesised or tested causal linkages between the processes, or organised set of actions, and the outcomes arising from these processes or actions. The United States Environmental Protection Agency (USEPA) promotes the use of program logic in recently developed guidelines for the evaluation of environmental programs (USEPA).

DPSEEA (Driver, Pressure, State, Exposure and Action) is a useful environmental health framework that allows practitioners to describe, heuristically, a logical conceptual sequence of events that leads to an environmental health problem. This framework can be integrated with the program logic approach to facilitate and strengthen evaluation of the actions towards environmental health.

The first section of this paper describes, separately, the DPSEEA framework, and the program logic approach that is often utilised in evaluation planning. The second section illustrates a number of applications in evaluation planning for these complementary frameworks. The paper then concludes by relating the use of these complementary approaches to policy development in environmental health.

DPSEEA Framework

The DPSEEA framework was developed and adopted as the conceptual framework for indicator development by the project HEADLAMP (Health and Environmental Analysis for Decision-Making, Linkage Analysis and Monitoring Project), jointly commissioned by the World Health Organization (WHO), USEPA and the United Nations Environment Programme (UNEP) (Corvalan, Briggs & Kjellstrom 1996). The DPSEEA framework was designed to support decision making in environmental health management, by describing environmental health problems from their proximal and distal causes to their health effects, and identifying areas for intervention (Pruss 2001).

The DPSEEA framework has three key applications within the wider HEADLAMP process described elsewhere by Corvalan and Kjellstrom (1996). First, DPSEEA can provide a framework for defining and validating the wider environmental health problem through the demonstration of known links between an environmental factor and its associated health outcome. Second, it can be used to guide the choice of data and indicators for compilation, assessment and quantification of the problem, and third, it can be a useful decision making tool for the formulation and implementation of policy toward improved environmental health. We propose and describe a fourth application. DPSSEA, when combined with a technique often used in the discipline of program evaluation, can be used as a tool to guide evaluation planning and interpretation, of the actions designed to address the environmental health problem, particularly when merged with the program logic approach.

The DPSEEA framework links the Drivers, Pressures, and State of the environment to Exposure and ultimately Effects on human health. Information on each of the links in the chain can inform decision makers of the mechanisms involving an environmental health problem, and consequently, assist them in choosing the most appropriate Actions or strategies to address the problem.

Within the DPSEEA framework, the D component of the chain refers to the Drivers, or driving forces, that "...motivate and push the environmental processes" that lead to detrimental health effects (Corvalan et al. 1996, p. 32). (See Box 1). The P component of the chain refers to the Pressures exerted on the State of the environment as a result of these Drivers. The Drivers and Pressures often relate directly to human occupation, exploitation or neglect of the environment.

Box 1:

Example 1

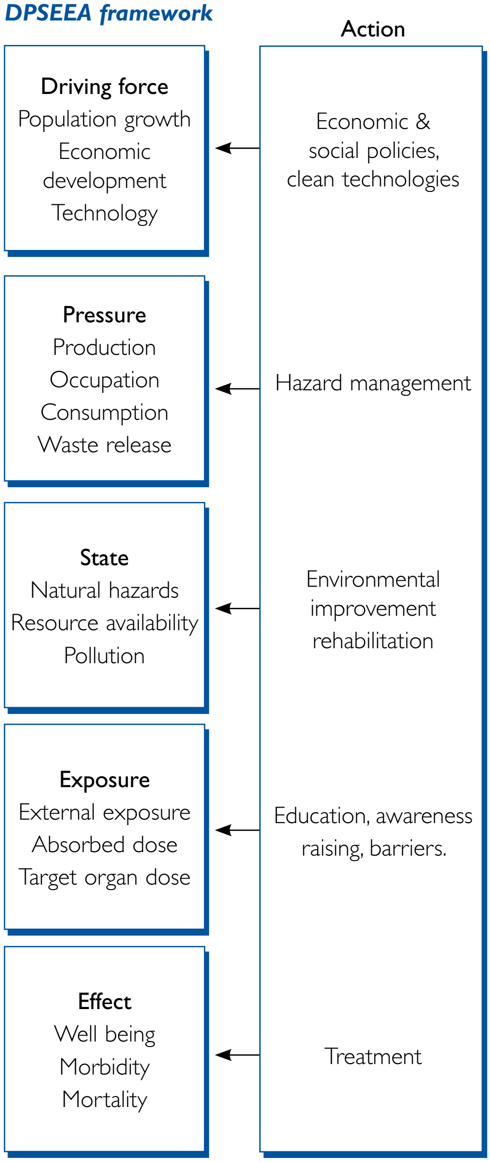
Driver:	Use of coal to produce energy
Pressure:	Emission of greenhouse gases from power generators into the atmosphere.
State:	Increased global temperatures.
Exposure:	Exposure to vector borne diseases, reduced food productivity, weather disasters and extreme events, sea-level rise.
Effects:	Malaria, dengue, schistosomiasis, toxic algae and cholera, malnutrition, asthma, deaths and injuries due to extreme weather conditions, etc.

The S component of the chain refers to the State of the environment with respect to a physical or natural environmental hazardous situation, for example, floods, soil erosion, the presence of vectors, environmental pollution, or the availability and quality of natural resources (Corvalan et al. 1996).

The first E in the DPSEEA framework refers to Exposure. Exposure is "the intersection between humans and the hazards inherent in the environment" (Corvalan et al. 1996, p. 33). The second E in the chain refers to the health effects that result from the exposure to a hazard in the environment.

The A component of DPSEEA refers to the Actions. Actions depict those operations, services, or programs that attempt to address any one or more of the five elements of the DPSEEA framework, which together define the environmental health problem. See Figure 1 for examples of actions and their relationship to the rest of the elements of the framework.

Figure 1: The linking of actions within the DPSEEA framework



Source: Modified from Corvalan et al. 1996. (Permission provided by World Health Organization 2007)

An action might directly address the Effects link in the chain, for example, the treatment of people who might be displaying the effects of arsenic exposure. Alternatively, an action or strategy might directly focus on the Exposure link in the chain, for example, by informing those living in areas with high soil arsenic concentrations to adopt behaviours to reduce their risk of exposure.

In most cases, it is expected that an impact on any link in the Driver, Pressure, State, Exposure or Effects elements of the chain will in turn impact on all successive linkages. For instance, an action that acts directly on the Driver, for example, Action 1, Figure 2, is also expected to impact on the Pressure, State, Exposure and subsequent Effect of the chain. While an action that directly addresses the Exposure link in the chain, for example, Action 2, Figure 2, is expected to impact on the Exposure and Effect.

Program Logic

According to Bickman (1987), the program logic, sometimes referred to as the program theory, is a "plausible and sensible model of how a program is supposed to work" , and is a description of the inputs, activities, and causal pathways that justify and describe the efforts put towards achieving a strategic outcome, and can include the conditions or factors necessary for those pathways to progress.

An outcome hierarchy is a component of the logic model that focuses on the outcomes expected to arise from the actions. Suchman (1967), Patton (1997) and Funnel (1997) along with other evaluation practitioners and theorists, promote the use of outcome or objective hierarchies as tools in evaluation.

To construct an outcome hierarchy, outcomes are described by their expected order of manifestation. By illustrating them in a hierarchical manner according to their means-end causative linkages, it becomes clear which are the proximal and which are the distal outcomes in relation to the program activities, and their expected order of manifestation in relation to each other, as illustrated in Figure 3.

Figure 2: An example of an action flow on the Driver, Pressure, Exposure, Effect pathway

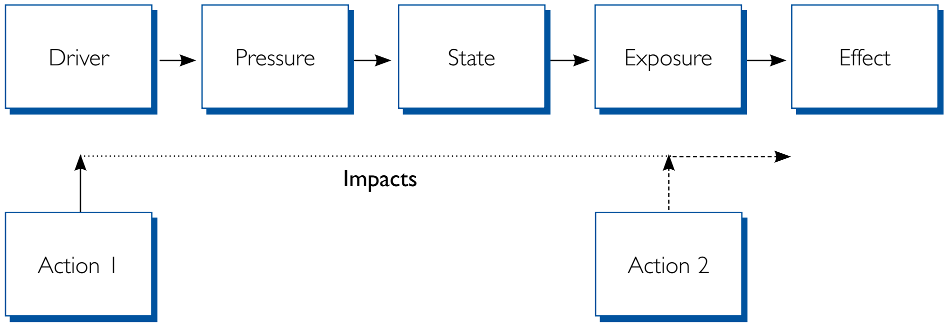


Figure 3: An outcome hierarchy for a service or program of actions aimed at reducing the transmission of blood borne diseases through unhygienic tattooing practices

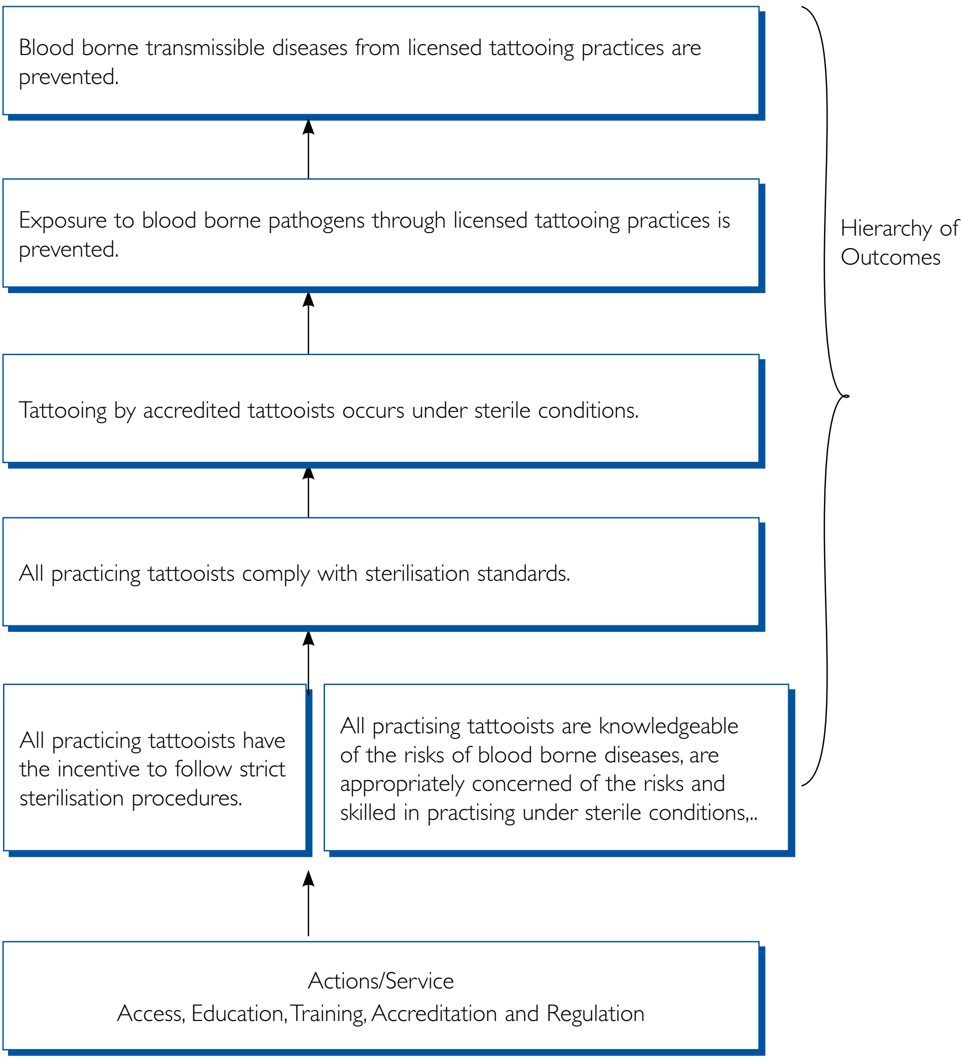
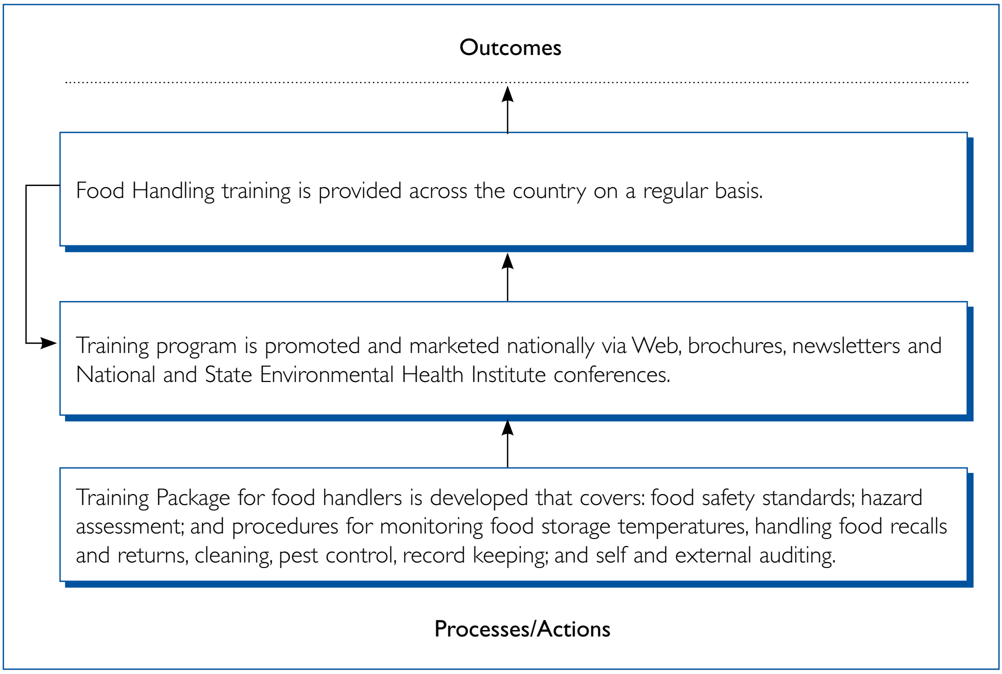


Figure 4: Pathway diagram illustrating the processes of a food safety training program and their linkages



The outcome hierarchy depicted in Figure 3 is unilinear, although programs often have a number of goals and associated streams of objectives or expected outcomes, and might have alternative causal pathways (Rogers 2008) or feedback loops as described below. In these cases, a multi-linear and multi-directional flow diagram could be used to illustrate the various arms of outcomes and how they may interact with each other.

In addition to outcomes, a program logic can illustrate the processes or actions as depicted in Figure 4.

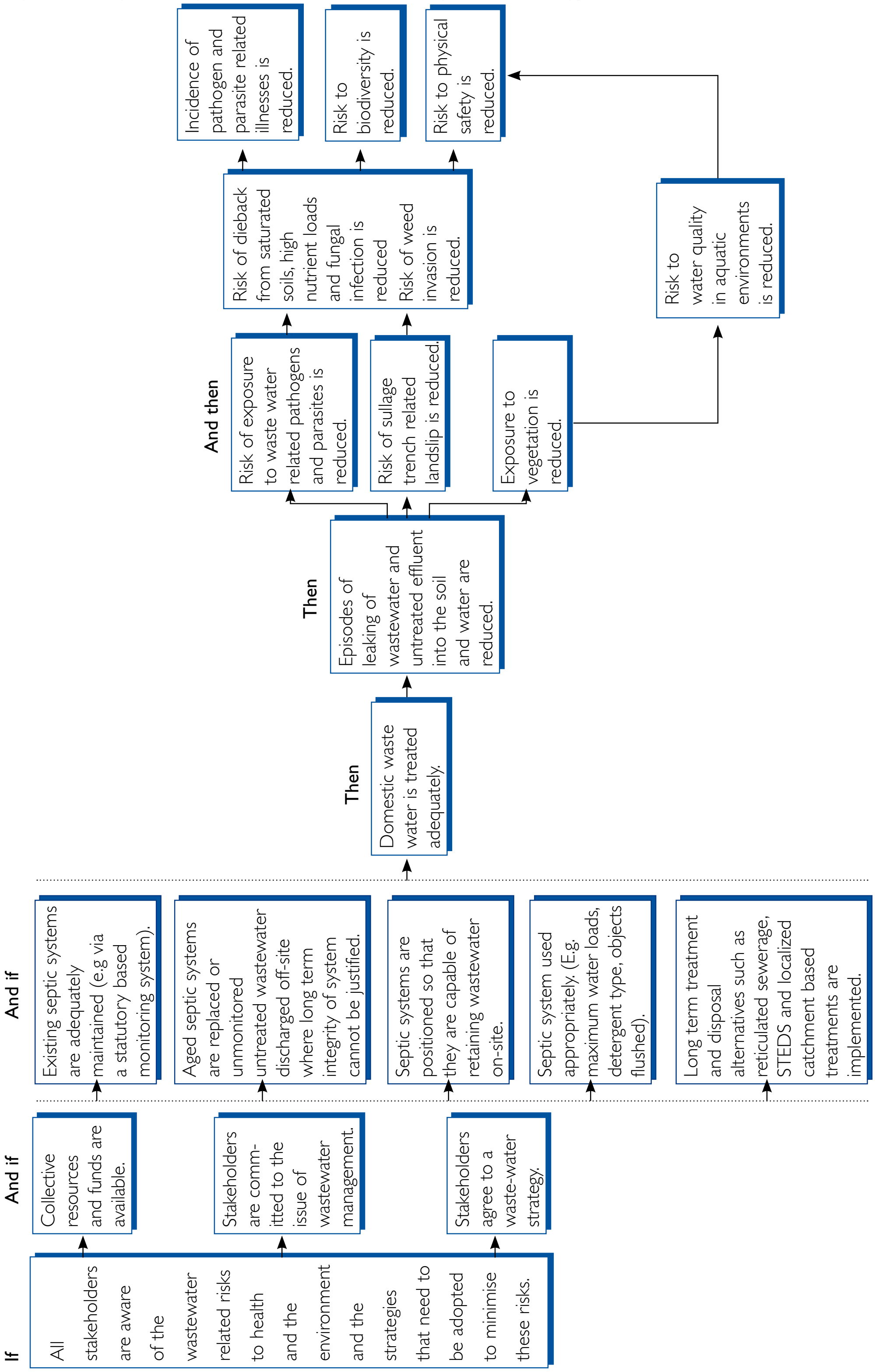
On their own, Figures 3 and 4 are only pathway diagrams. "Pathway diagrams [typically] do not include the operational detail that a logic model has...they usually start with program activities or outputs, rather than with antecedent conditions [e.g. inputs/resources]" (Cooksy, Gill & Kelly 2001 p. 120).

These pathway diagrams can be expanded to illustrate the wider elements of program logic, for example, prerequisites for implementation such as the necessary resources, skills, and support structures. The 'if' and 'then' approach utilised by Smith and described by Owen (2006), allows for the inclusion of those conditions that are necessary for the actions to be implemented according to plan and for the desired outcomes to be achieved, for example, if X conditions are met, and Y activities are undertaken, then Z outcomes are expected to occur. See Figure 5 for an example.

Program logic and DPSEEA

The program logic approach is partly implicit in the DPSEEA framework. The DPSEEA framework represents the linkages between particular environmental health issues and health, thus providing a clearer understanding of the nature of the environmental health problem. However, this approach can be further utilised to illustrate more fully the nature of the environmental health actions, and how these actions are anticipated to

Figure 5: Program Logic of a waste water management strategy



affect the environmental health problem. Clear information on the nature of the action(s) and the goals that are expected to be realised (i.e. goals that relate to any one or more of the DPSEE components) will be necessary in order to evaluate the implementation of the actions and their effectiveness in attaining the goals.

More specifically and functionally, a program logic incorporating each of the DPSEEA elements can be used to identify, to communicate and to test assumptions underpinning each of the causal linkages. It can also identify and negotiate the evaluation questions and variables, and show where in the sequence of linkages problems might lie.

Implicit in the program logic or pathway diagrams illustrated in Figures 3 and 5 of environmental health actions and/or their intended effects towards addressing an environmental health problem, is the concept of drivers and pressures leading to a state and subsequent human exposure and health effect. These linkages could be made more explicit. See Figure 6 for an example illustrating the linking actions to intended outcomes and the eventual goals associated with the DPSEEA chain for a program designed to reduce the incidence of smog related asthma.

Figure 6 outlines the key actions adopted to address particular DPSEE elements and links the 'Actions' to these using an outcome hierarchy. 'If' and 'then' statements are implicit within the outcome hierarchy. In the example above, the intermediate outcomes: 'accessing message', 'acknowledging message', 'knowledge and attitudinal change', are expected to occur before behaviour change is to be observed. Behaviour change is expected to occur before any of the DPSEE associated outcomes are achieved. That is, the community adopts different forms of transport and reduces outdoor activities on high smog alert days before any impact on the elements of DPSEE are to be observed. Though this is not always the case, behaviour change can occur before knowledge and attitudinal change, particularly where regulation and punitive action is the incentive for behaviour change.

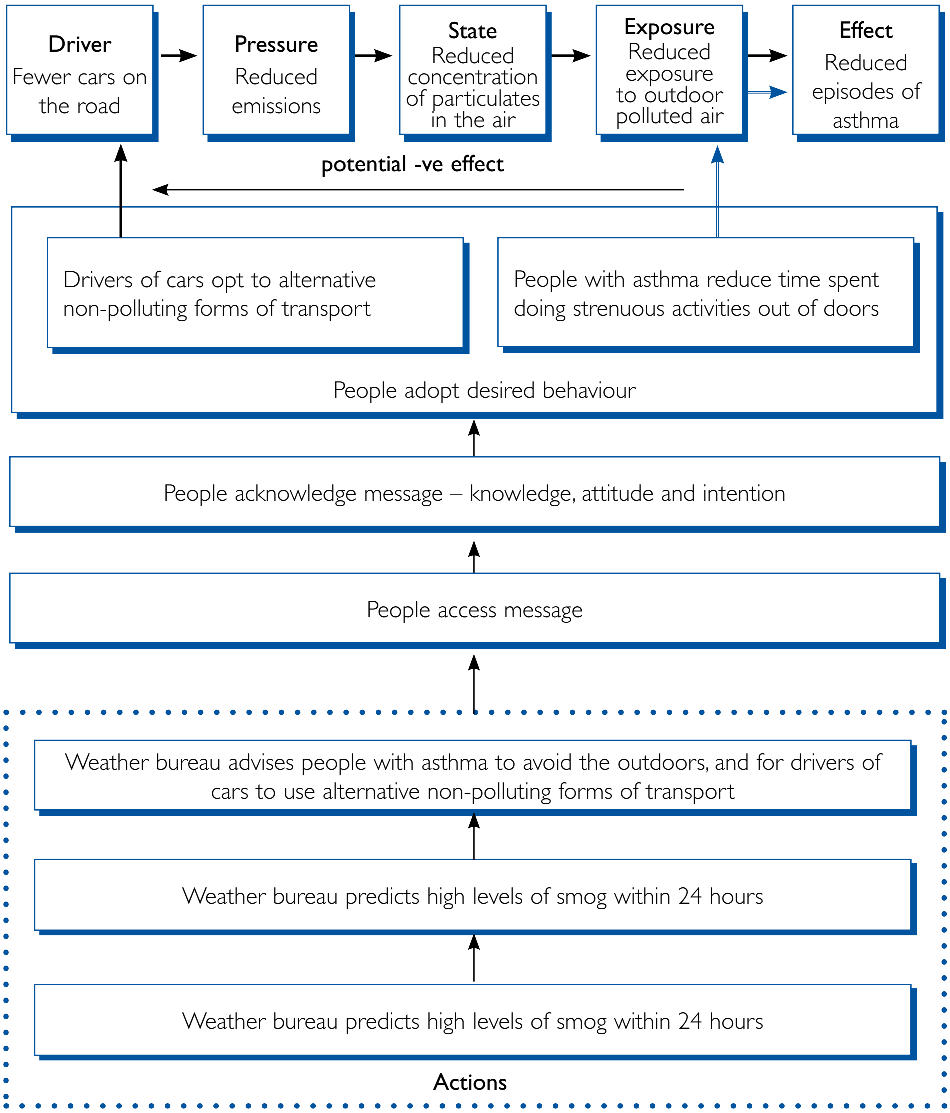
According to the example in Figure 6, the action that involves alerting the community to high smog days, and advising people to use alternative non-polluting forms of transport is expected to have an impact on the Driver and subsequently, the Pressure (e.g. cars emitting particulates), State (e.g. high air concentrations of particulates), Exposure to particulates and Effects (e.g. episodes of asthmatic attacks). Similarly, the action that involves advising people with asthma to avoid the outdoors is expected to have an impact on Exposure to air pollution and the Effects of air pollution.

This diagram (Figure 6) can be a useful tool to question and subsequently test the assumptions underpinning the program. For example, it might be possible that some people adopt the desired behaviours on the knowledge that it is to be a high smog day and nothing else. This alternative logic can be tested by evaluation and revised depending on the findings of the evaluation.

A means-ends causal pathway, such as that depicted in Figure 6, and which focuses on both the actions and the wider problem, allows planners and evaluators to articulate clearly those aspects of the environmental health problem that the action or strategy is attempting to control and any other potential influences or gaps. It also allows a probability model to be applied, and to question all elements using available evidence or the collection of new evidence supporting or refuting the linkages illustrated.

Another example of a program logic that utilises the DPSEEA framework is provided in Figure 7. This diagram illustrates an abridged program logic of a mosquito control program, one of a number developed during a short course group exercise facilitated by one of the authors, and attended by public health and environmental health practitioners. The program depicted, is a multi-strategy

Figure 6: Smog Advisory Service Logic Diagram

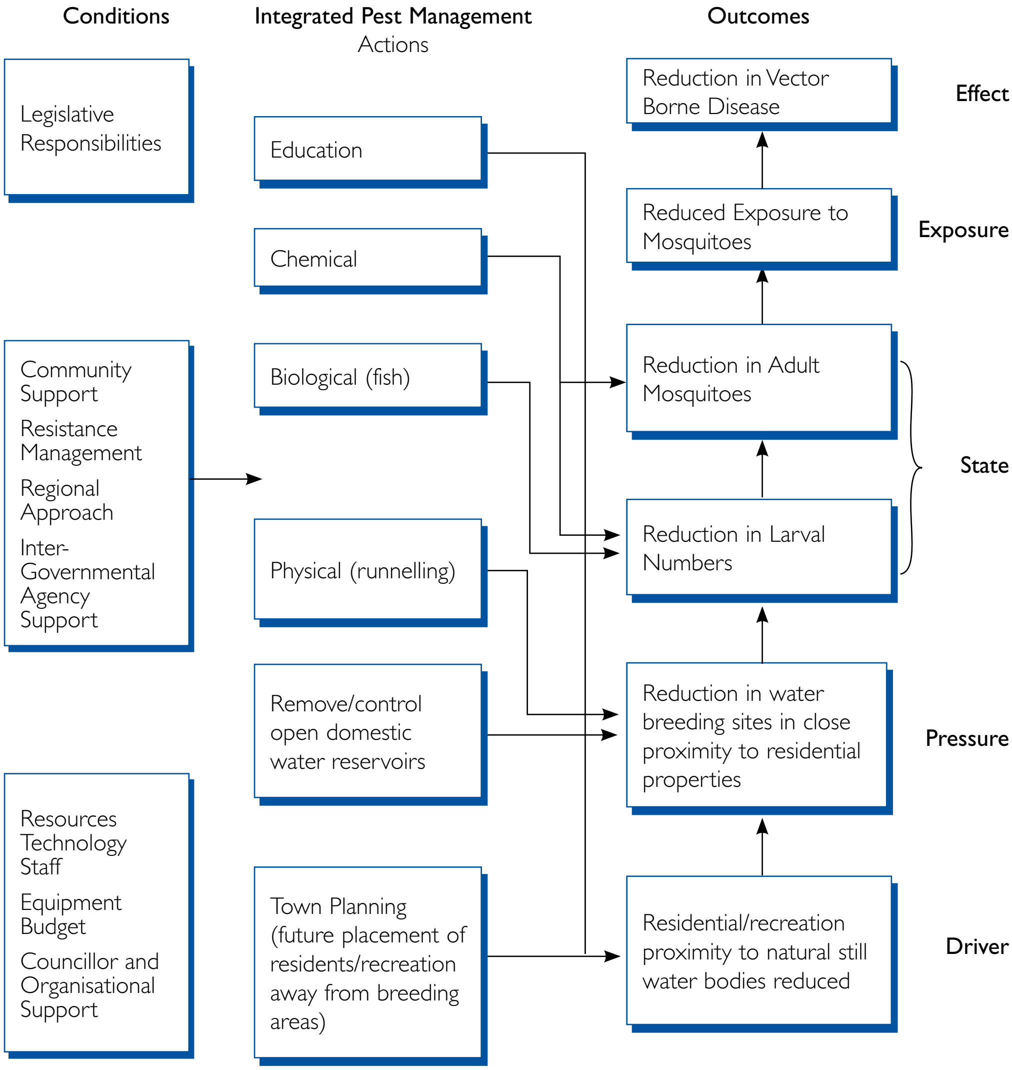


program with actions that ultimately contributed towards the goal of reduced exposure to mosquitoes and mosquito-borne illnesses and inconvenience. This diagram can be used to communicate the rationale for the strategy, to prioritise elements of the strategy and/or to identify gaps and question the evidence supporting the various linkages illustrated. Multi-disciplinary input is useful to question particular 'assumptions' underpinning the logic.

The complexity in the system

DPSEEA and program logic, alone or combined, are useful tools for describing environmental health programs, however, it is important that they embrace complexity in the system rather than simplify it. Models or frameworks such as these tend to be treated as 'closed systems', but this can be avoided by being aware of the potential for multi-directional cause-effect interactions, unintended outcomes, potential wider influences and timing and threshold

Figure 7: Program Logic of a mosquito control program



effects as described below. A recent article by Rogers (2008) provides additional guidelines for using program logic when evaluating complicated and complex aspects of interventions.

Multi-directional interactions

DPSEEA and outcome hierarchies might imply a linear uni-directional flow. However, users of such an approach should not assume that this is always the case. It is possible that impacts further along the chain impact upon previous elements, by amplifying or dampening down the initial changes or effects. In cases where this is foreseeable, bi-directional arrows could be used to illustrate these mechanisms in the logic diagrams. If evaluating the impacts of a program, it is prudent to consider the potential two-way interactive effects of the program being evaluated.

Examples might include: i. programs addressing the exposure to an existing hazard. For instance, teaching parents strategies to reduce children's exposure to lead in soil might reduce the perceived need for action by those contributing to the hazard (e.g.

industry) if they know that the risk of exposure to the hazard is minimised. ii. concerns about exposure to risks of smog, raised by smog alerts, reduce people's willingness to let their children walk to school, thereby increasing car traffic and having an amplifying effect on the problem. This is illustrated by the negative loop in Figure 6.

Rogers (2008) refers to the potential for 'recursive' causality, where the success of an intervention depends on the activation of a 'virtuous cycle' within an intervention as opposed to a unidirectional 'one pass' through the intervention.

Intended and unintended outcomes

DPSEEA and program logic diagrams, tend to include only those outcomes for which the initiative was designed to address. As well as the intended outcomes, a range of unintended outcomes or consequences might arise from the intervention. These outcomes could be positive (i.e. beneficial or adverse). Figure 7 above outlines the intended outcomes of a mosquito control program, but what negative effects are likely to occur with the use of runnelling (building shallow channels to improve linkage of marshes with tidal water) and chemical control methods?

The unintended outcome could be independent or related to those outcomes for which the intervention was designed to achieve. An intervention that decreases vehicle usage for the intended purpose of reducing air particulate emissions is also likely to have a number of added benefits, for example, reduced noise, increased physical activity, improved visibility, fewer emissions of other pollutants including CO_2, less impact on the ecological environment, and reduced fuel costs.

Negative outcomes might include crowded public transport. An intended outcome might have a negative or positive feedback loop effect on itself, thus exerting an inhibitory or promoting effect on its own progression as described further below.

Wider Influences

Potential influencing factors can play across all levels of the DPSEEA and wider program logic framework. A range of drivers and pressures, apart from those being directly addressed for instance, could lead or contribute to an exposure and subsequent

Table 1: Tabulation of wider influencing factors and unintended outcomes

Outcome	Factors that could influence the successful attainment of the outcome	Other consequences
1. Increase in the proportion of people in the high risk group who are aware of the smog alert message. 2. Increase in the proportion of people in the high risk group who reduce strenuous activity out of doors during days of smog alerts. 3. Reduced exposure to smog.	Time of day message relayed Media type Language/clarity, relevance of message Flexibility of workplace, and schools Attitudes and intentions of high risk people Frequency of smog days Ventilation of home/office	Anxiety Reduced physical activity Isolation Work/school days lost Stress If large number of smog alerts then unlikely to act on messages in the future Increase use of vehicles to avoid walking People with asthma move to areas with low smog levels

environmental health problem. These should be considered when planning strategies to address an environmental health problem. For example, lead exposure could be the result of lead paint dust generated through home renovations, lead in petrol and thus surrounding soil, and/or industry. At some point it is the role of decision makers to decide which of these drivers and pressures to address and how to address them, for example, by acting directly on the driver, pressure, state, exposure or effect. At the same time, the potential impact of any initiative on the range of other 'drivers' or 'pressures' should be noted, as these are likely to also impact on exposure and subsequent health effects, and be of interest to an evaluation of program outcomes. While designing and evaluating actions designed to address an environmental problem, it would be useful to identify the full range of 'drivers' that contribute to the problem, not just those which are being targeted.

As well as other potential 'drivers', a number of factors could influence or contribute to a particular 'driver'. For example, vehicle usage might be the 'driver' of interest but a number of factors are known to influence vehicle usage, for example, access to public transport, the state of walking paths, proximity of schools and shops, or cost of petrol among others. These factors might contribute to the level of vehicle usage, independently of any action adopted to address it.

The 'pressure' (e.g. vehicle emissions) that is influenced by a 'driver' (e.g. vehicle usage) might be further influenced by traffic congestion resulting in higher emissions, inefficient maintenance of equipment, age of vehicles or machinery, efficiency of operations, raw material selection and, fuel quality. Thus, vehicle usage alone might not explain the quantity of air particulates emitted.

Once the pollutants are released a range of factors might influence the concentration of pollutants in the air - the 'State'. For example, meteorological and topographical conditions influence the movement of pollutants and the conversion of gases to smog and ozone.

Spatial and temporal complexity, such as the rapid rates of change that occur in urban environments and the spatial variations in environmental and sociodemographic conditions need also to be considered when developing indicators to evaluate effectiveness of environmental health actions (Briggs & Field 2000).

These factors could be included in the logic diagram, or to avoid too much information, they could be tabulated. Table 1 is linked to the DPSEEA diagram in Figure 6.

'Pressures' and 'State' are generally more complex, particularly for those that are influenced by environmental and chemical interactions. Quantification of the range of factors influencing the system might be needed to be able to predict the impact of an intervention on these elements and to be able to evaluate it and to attribute effect.

To avoid 'closed system' logic diagrams, a number of questions could be asked during the logic clarification stage:

1) What effects other than those for which the actions were designed to achieve need to be included? These may relate to any element within the logic diagram e.g. the inputs, actions or outcomes of the initiative.

2) How could events later in the logic impact on events earlier in the logic? Could there be negative or positive feedback loops?

3) What factors could influence the anticipated or potential outcomes and possibly provide an alternative explanation for the outcomes observed or not observed?

4) When are effects expected to arise? Are there latency effects or thresholds that need to be reached, before a response occurs?

5) Is the response, at any point in the chain, likely to be short or long-lived? Could this impact on the magnitude and duration of the exposure or health effect?

6) What are the uncertainties for each of the linkages illustrated in the program logic? Can we be sure each link will do what is hypothesised? What evidence is available to support these linkages? What are the risks if the assumptions underpinning the logic are not correct?

A program logic can be used to assist a risk analysis by highlighting the assumptions underpinning an initiative. The risk analysis can involve questioning the evidence supporting each of the assumptions depicted, and any risk implications, if they are incorrect.

Evaluation of the Actions

The two complementary approaches, DPSEEA and program logic, allow evaluation planners to focus on and link the 'actions' designed to improve environmental health with each of the DPSEE elements of the framework.

In doing so they allow the evaluators to identify, communicate and test the assumptions underpinning the causal linkages, either in theory or practice, as described above. They can be used as a tool for the evaluator to choose the evaluation variables of interest; or recognise changes in program implementation that might affect the model depicted in the logic or "where in the chain of events the sequence breaks down". (Cooksy, Gill & Kelly 2001, p. 120). They and Weiss (1972) describe these and other benefits in relation to program logic.

Identify, communicate and test assumptions

A logic diagram that encompasses the DPSEEA framework can be used to illustrate the assumptions underpinning the causal linkages, and facilitate testing of these assumptions, either in theory or practice. It can be used to guide the examination of the appropriateness and feasibility of the actions, both with regard to their implementation and the likelihood of their translation into the desired outcomes, in the context of existing or anticipated resources and supports.

Owen (2006) outlines a number of forms of evaluation, one of which is 'clarification evaluation'. During this form of evaluation, the logic diagram can be used as a communication tool to question and adjust the logic in negotiation with key experts and stakeholders.

Choose the evaluation variables of interest

The logic diagram can be used to scope the evaluation and program monitoring activities, that is, to identify the evaluation questions and indicators for measurement. These can focus on the outcomes associated with the DPSEE associated goals, the quality or extent of implementation of the actions designed to attain the goals, and the feasibility and assumptions underpinning the actions.

Recognise problems in implementation or logic

These complementary approaches can be further utilised as tools for the evaluation of environmental health management. They can facilitate evaluations that focus on the nature and implementation of the actions leading towards environmental health, and the effectiveness of these actions in attaining the goals that might be associated with any one or more components of the DPSEEA framework.

A logic incorporating the DPSSEA elements, could assist the evaluator to recognise changes in implementation, either negatively or positively, or where in the causal pathway the sequence fails. For instance, a breakdown occurring anywhere along the causal pathway might explain why a DPSEE associated outcome was not demonstrated. A crucial action might not have been implemented as planned. Alternatively, a preceding outcome might not have been attained, precluding any impacts further along the chain.

There might be barriers to implementation (e.g. inadequate resources, supports, skills or commitment) facilitating the need to examine the wider program logic. Alternatively, the actions implemented might be more feasible than the planned actions. Understanding these changes and the reason for them, could inform future policy development.

The feasibility of the actions at producing the desired outcomes might need to be questioned, facilitating the modification of the program logic or a complete change in strategy. New measures of success might be required if the logic is changed, or an increased knowledge of the intervention highlights more important implementation, contextual or outcome indicators. Rogers (2008) emphasised the need for flexibility in logic development and use for complex adaptive systems and emerging interventions - when specific outcomes, and the means to achieve them, emerge during implementation of an intervention. Program logic models are heuristic in nature. Any or all aspects of the logic might alter with new knowledge, gained informally through implementation or more formal research and evaluation practices. They should not be perceived to be 'fixed' models.

The Wider Contribution to Environmental Health

Australia's National Environmental Health Strategy (enHealth 1999) recognises that "environmental health is a wide ranging multidisciplinary field", highlighting the need to improve Australia's capacity to manage and respond to new and emerging environmental health issues. The integration and application of the two approaches also highlights the complexities of environmental health issues, providing the need and opportunity for the cooperation and collaboration of discipline areas, policy makers and the broader community, to address effectively and improve the approaches to environmental health problems. In doing so, it also provides the opportunity to identify areas of further research required to support evidence based practice in this field.

Conclusion

This paper shares one of the central aims of HEADLAMP - to facilitate protection against environmentally related disease and the promotion of a healthy environment (Corvalan & Kjellstrom 1996), by focusing on the actions adopted to address the defined environmental health problem and their evaluation. It pays particular attention to the 'Action' or 'A' component of the DPSEEA chain, the nature of its link with the other components of the chain and the evaluation of actions by using a simple visual systems-based approach that requires the use of logic diagrams. These diagrams provide detailed information concerning the assumptions underlying a program into a format that is clear and easy to communicate (Cooksy, Gill & Kelly 2001).

The paper not only illustrates that program logic is implicit or intrinsic within the DPSEEA framework, but also how it can be further utilised to advance the evaluation of the actions designed to address environmental health issues. Effective environmental health management requires a number of important steps that include defining the environmental health problem; addressing the problem through planned actions; and evaluating the nature and implementation of the actions and the effectiveness of these actions at attaining the goals. The DPSEEA framework can be a useful tool for each of these activities, particularly when merged with a wider program logic model.

While the DPSEEA framework and program logic models have the tendency to be treated as 'closed or fixed systems', it is important, when using these approaches, not to assume unilinearity in the system and ignore the potential for feedback loops or two-way interactions; not to limit problem and program logic assumptions to single 'Drivers' or 'Pressures', 'States', 'Exposures' and 'Effects'; or restrict the focus to intended outcomes only. Users of such approaches need to consider the contextual and influencing factors of the problem and intervention, and revisit the logic model as new evidence arises. If used with these conditions in mind, these frameworks, together, have the potential to contribute to our understanding of problem identification, validation, and management in environmental health.

DPSEEA has provided policy makers with a tool to identify, choose, gather and link information on local and national health impacts with information on the drivers, pressures and state of the environment, but when merged with a program logic model has the potential to do more.

Acknowledgments

We wish to acknowledge David Briggs, Carlos Corvalan and colleagues at the Centre for Health Policy, Programs and Economics for their constructive feedback on an early draft of the paper. Similarly, thanks are due to the many environmental health practitioners who contributed to the program logic diagrams.

References

Bickman, L. 1987, 'The functions of program theory', in *New Directions for Program Evaluation*, ed. L. Bickman, vol. 33, Jossey-Bass, San Fancisco.

Briggs, D.J. & Field, K. 2000, 'Informing environmental health policy in urban areas: The HEADLAMP approach', *Reviews on Environmental Health*, vol. 15, no. 1-2, pp. 169-86.

Cooksy, L.J., Gill, P. & Kelly, P.A. 2001, 'The program logic model as an integrative framework for a multimethod evaluation', *Journal of Evaluation and Program Planning*, vol. 24, pp. 119-28.

Corvalan, C., Briggs, D. & Kjellstrom, T. 1996, 'Development of environmental health indicators', in *Linkage Methods for Environment and Health Analysis: General Guidelines*, eds D. Briggs, C. Corvalan & M. Nurminen, Office of Global and Integrated Environmental Health, World Health Organization, Geneva.

Corvalan, C. & Kjellström T. 1996, 'Health and environmental analysis for decision-making', in *Linkage Methods for Environment and Health Analysis: General Guidelines*, eds D. Briggs, C. Corvalan, M. Nurminen, Office of Global and Integrated Environmental Health, World Health Organization, Geneva.

enHealth 1999, *The National Environmental Health Strategy*, Department of Health and Aged Care, Canberra.

Funnell, S. 1997, 'Program logic: An adaptable tool for designing and evaluating programs', *Evaluation News and Comment*, vol. 6, no. 1, pp. 5-17.

Owen J. 2006, *Program Evaluation: Forms and Approaches*, 3rd edn, Allen & Unwin, Sydney.

Patton, M.Q. 1997, 'The program's theory of action: Conceptualising causal linkages', in *Utilization Focused Evaluation: The New Century Text*, 3rd edn. Sage, Thousand Oaks, CA.

Pruss, A., Corvalan, C.F., Pastides, H. & de Hollander, A.E.M. 2001, 'Methodologic considerations in estimating burden of disease from environmental risk factors at national and global levels', *International Journal of Occupational Environmental Health*, vol. 7, no. 1, pp. 58-67.

Rogers, P.J. 2008, 'Using programme theory to evaluate complicated and complex aspects of interventions', *Evaluation*, vol. 14, no. 1, pp. 29-48.

Suchman, E.A. 1967, *Evaluative Research: Principles and Practice in Public Service and Social Action Programs*, Russell Sage Foundation, New York.

US Environmental Protection Agency 2008, '*Innovation analysis modules*', <http://www.epa.gov/evaluate/modules/> 4 April 2008.

Weiss, C.H. 1972, 'Excerpts from evaluation research: Methods of assessing program effectiveness', *Evaluation Practice* vol. 17 no. 2, pp. 173-75.

Correspondence to:
Helen Jordan
Centre for Health Policy, Programs and Economics
The University of Melbourne
AUSTRALIA
Email: h.jordan@unimelb.edu.au

Back to TOC