

ERAPSM: A model for setting priorities for environmental aspects of waterway management

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SUMMARY: The Environmental Risk Assessment and Priority Setting Model (ERAPSM) was developed in response to the need to determine priority waterway management activities in an environment of competing projects and limited resources. The ERAPSM is a data management system that provides a tool for ranking program priorities on the basis of environmental risk. It has been developed as a tool to provide a sound basis for establishing business priorities and for planning and evaluation of expenditure proposals and performance management. It is part of a broader planning framework that:

- supports the setting of strategic objectives and priorities by the Board and senior management; and
- ensures that individual managers have clear responsibility and accountability for delivery of program outputs.

ERAPSM is a TMMicrosoft Access driven computer model that interrogates existing information on waterway condition. Mathematical formulae are used to determine ratings for waterway threat, value, risk and benefit of waterway management activities according to specified rules. Outputs from the model can be exported or dynamically linked (ODBC) to mapping systems for spatial representation and thematic mapping.

ERAPSM was initially developed to demonstrate how environmental risk assessment can be used to assist in setting priorities for waterway management. Even though ERAPSM is in its infancy, it is proving to be a useful decision support tool by assisting in the preparation of annual work programs for waterway management activities in the Melbourne Water area. Further development of the model may make it suitable for adoption by other organisations involved in waterway management.

THE MAIN POINTS OF THIS PAPER

- ERAPSM is a TMMicrosoft Access driven computer model.
- ERAPSM is a data management system that ranks program priorities on the basis of environmental risk.
- ERAPSM was developed as a prototype to demonstrate the application of a risk based approach to the environmental management of waterways.
- Outputs from the model can be dynamically linked to mapping systems for spatial representation and thematic maps.

1. INTRODUCTION

Environmental management is now a mainstream activity for most major Australian businesses. Yet in many organisations, business management systems have not evolved to support the high standards of environmental management performance required. This applies to conservation and natural resource management agencies of government as well as non-government business enterprises (Victorian Auditor General, 1995).

The Melbourne Water Corporation has developed a strategic framework for the environmental management of waterways (Wood *et al.*, 1999). Our mission is to provide healthy stream environments that meet the

community's need for recreation, water supply, drainage and flood protection services.

Programs are in place or being developed to manage the range of threats to waterway health. Figure 1 illustrates that various responses are required to manage a range of threatening processes that will lead to providing our goal of providing healthy waterways. ERAPSM was developed as part of this framework to assist in setting priorities between competing projects (responses) in an environment where resources are always limited. It is a demonstration project designed to test the application of an environmental risk based approach to the management of waterways.

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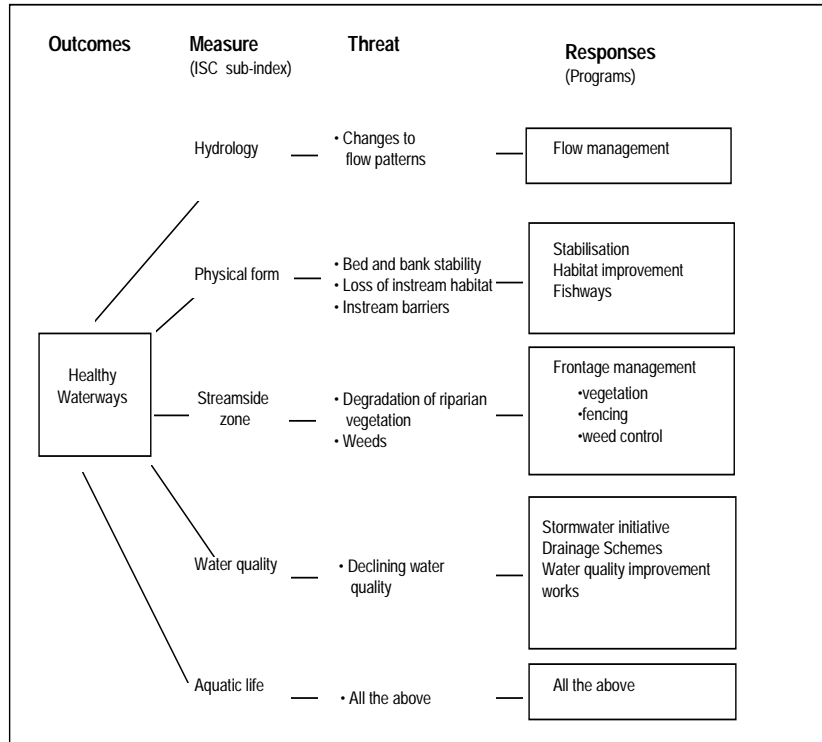


Figure 1: Strategic framework for environmental management of waterways (Wood et al. 1998).

2. ENVIRONMENTAL RISK

Environmental risk is a function of the extent and severity of environmental threats to a waterway and the values of the waterway (Figure 2); the greater the risk, the greater the potential loss of values due to threatening processes. Priority in protecting or enhancing stream health is therefore given to areas of highest environmental value where the consequence of losing these values is greatest. Figure 2 describes the risk management process for waterway management, where the severity and significance of threats and values are assessed to assist in planning waterway management programs.

Figure 3 demonstrates that ERAPSM is based on an assessment of environmental values and threats, it is a data management system that incorporates semi-quantitative measures of environmental threat and environmental value. ERAPSM also provides the ability to take into account the perceptions of customers and stakeholders, the opportunity to achieve results and the impact of the actions in reducing risk to the business. It provides outputs for other business processes, such as development of activity plans and annual works programs. ERAPSM also allows semi-quantitative targets to be set for program outcomes such as vegetation condition or waterway stability.

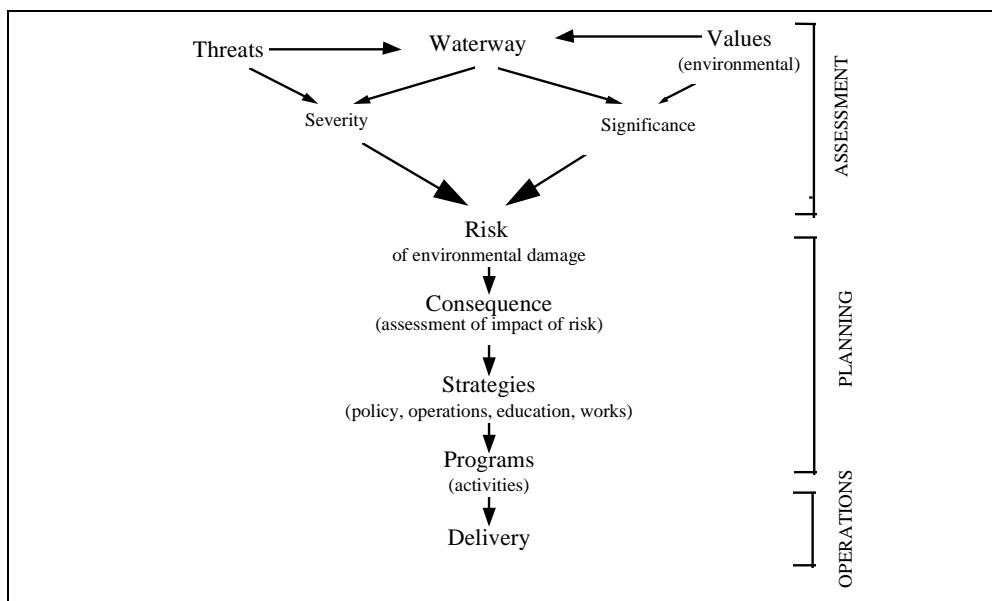


Figure 2: Risk management model for waterway management

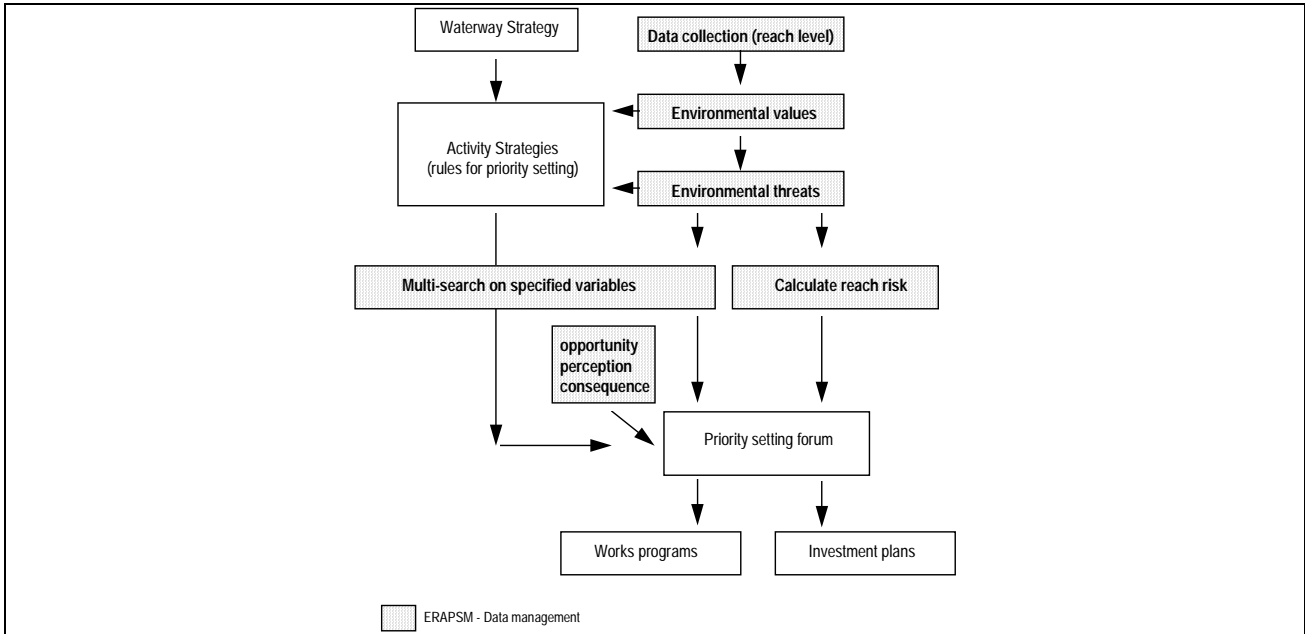


Figure 3: Contribution of ERAPSM to priority setting framework

3. ENVIRONMENTAL RISK ASSESSMENT AND PRIORITY SETTING MODEL

ERAPSM is a TMMicrosoft Access driven computer model developed within Melbourne Water to test the application of an environmental risk based approach to setting waterway management priorities. Mathematical formulae are used to determine waterway ratings for waterway threat, value, risk and benefit of waterway management activities. Outputs from the model can be dynamically linked to mapping systems for spatial representation and thematic mapping.

ERAPSM differs from other environmental assessment procedures (Seymour, 1987; Macmillan and Kunert, 1990; Macmillan, 1990; Heron 1989) because it uses risk management as a basic principle and aims to prioritise waterway management activities. This is not a criticism of these approaches but a recognition that they were developed for different reasons.

3.1 Origin of ERAPSM

The current version of ERAPSM is not the final product. ERAPSM has been developed as a prototype to demonstrate the application of an environmental risk based approach to the management of waterways. Its current form uses limited resources and only readily available environmental data. These limitations constrained the debate about what values and threats should be used but enabled the model to be developed and evaluated over a short period of time. ERAPSM has now been accepted as part of Melbourne Water’s planning framework for waterway management and is undergoing review as part of a second stage of development.

3.2 Waterway data

Melbourne Water has been collecting data on the condition of waterways since 1988 (Melbourne Parks and Waterways, 1995). Waterway condition data has been collected on a reach basis for 1076 individual reaches which equates to 3100 km of waterways. Data collection has relied heavily upon collection of information on waterway threats, with less emphasis on waterway values. The values and threats incorporated into the current version of ERAPSM are provided in Tables 1 and 2. The values and threats selected are based on existing information and are currently being reviewed. It is acknowledged that these are not necessarily the most appropriate criteria for the risk assessment model but they have been used to evaluate its application.

3.3 Risk analysis

Rules are applied to each of the values and threats to determine a threat rating score and value rating score for a waterway reach (Tables 1 and 2). A risk score is then calculated for each reach based on the following formula:

$$\text{Reach risk} = (\text{sum all values}) \times (\text{sum all threats})$$

The higher the score, the higher the risk of losing environmental values and hence the higher priority for managing the threatening process. Risk calculations are one of the features ERAPSM provides to assist in setting priorities for waterway management. The risk rating can be used to illustrate relative risk to the business if the threatening process is not managed. Because information is collected at the reach level, risk can be calculated at various scales eg. reach, waterway or catchment. Figure 4 illustrates risk ratings calculated by ERAPSM for some sub-catchments.

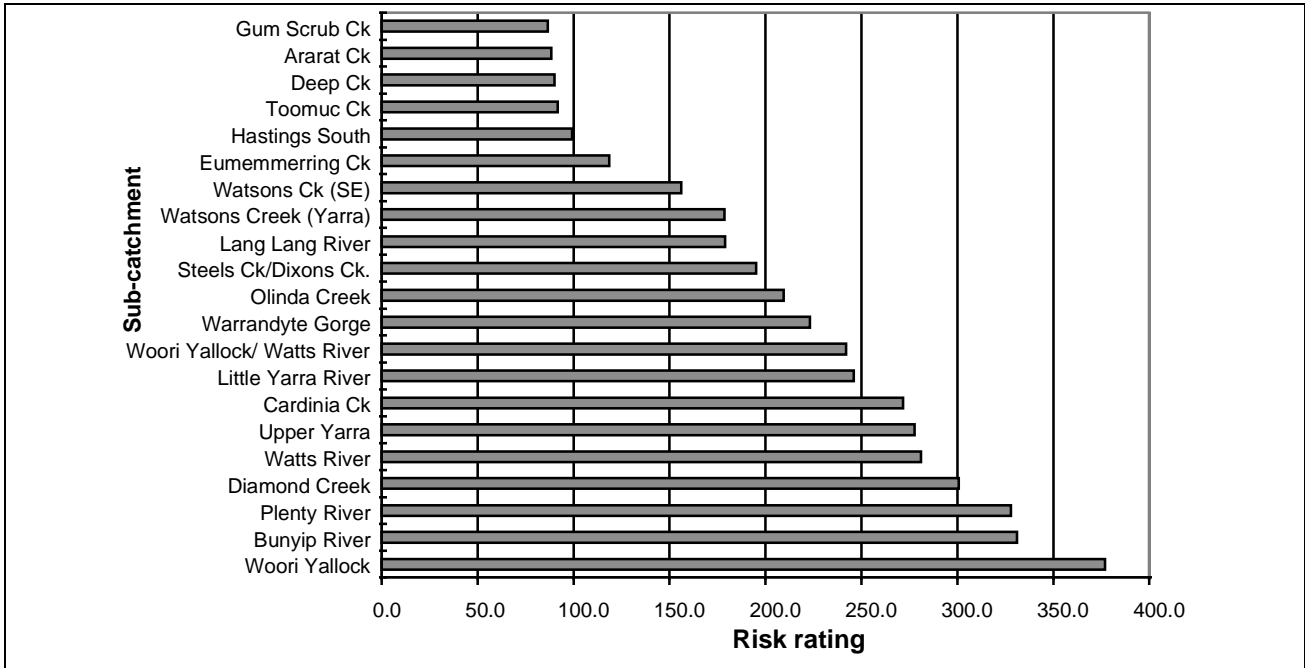


Figure 4: Risk rating on selected sub-catchments

Table 1: Rules for determining value rating

Rating	Very low	Low	Moderate	High	Very high
Value Score	1	2	3	4	5
VROT ⁴				1-3 present	>3 listed
Bank vegetation	Native understorey and/or overstorey almost non-existent. Significant regeneration of exotics or cleared. Mainly introduced grasses.	Remnants of native overstorey. Understorey dominated by exotics. Ground cover mainly introduced grasses.	Significant presence of understorey exotics mixed with remnant natives. Native overstorey generally remaining with some cleared grassed areas. One side cleared with other virtually undisturbed.	Slightly modified, natives present on both banks along with possibly some grassed areas.	Virtually undisturbed, representative of natural vegetation in excellent condition.
Verge vegetation	Both sides cleared with introduced groundcover.	Very narrow corridor of native or exotic vegetation (<5 m wide).	Wide corridor of mixed natives and exotics, on one side cleared with the other reasonably undisturbed and >30 m wide.	Mainly undisturbed native vegetation, <30m wide, or some exotics or reduced cover of natives in wider corridor. Minor areas of disturbance with possibly some small areas of introduced grasses.	Virtually undisturbed native vegetation in excellent condition, > 30m wide.
Platypus	Absent (0 score)	Not surveyed, likely to be absent.	Not surveyed.	Marginal habitat.	Platypus inhabit reach and known to breed.

Table 2: Rules for determining threat rating

Rating	Very Low	Low	Moderate	High	Very High
Threat Score	1	2	3	4	5
Bank stability	Excellent	Good	Moderate	Poor	Very Poor
Bank vegetation	Virtually undisturbed, representative of natural vegetation in excellent condition.	Slightly modified, natives present on both banks along with possibly some grassed areas.	Significant presence of understorey exotics mixed with remnant natives. Native overstorey generally remaining with some cleared grassed areas. One side cleared with other virtually undisturbed.	Remnants of native overstorey. Understorey dominated by exotics. Ground cover mainly introduced grasses.	Native understorey and/or overstorey almost non-existent. Significant regeneration of exotics or cleared. Mainly introduced grasses.
Verge vegetation	Virtually undisturbed native vegetation in excellent condition, > 30m wide.	Mainly undisturbed native vegetation, <30m wide, or some exotics or reduced cover of natives in wider corridor. Minor areas of disturbance with possibly some small areas of introduced grasses.	Wide corridor of mixed natives and exotics, on one side cleared with the other reasonably undisturbed and >30 m wide.	Very narrow corridor of native or exotic vegetation (<5 m wide).	Both sides cleared with introduced groundcover.
Naturalness of channel	Natural	Natural with some modification (minor de-snagging or straightening)	Natural with extensive modification (major de-snagging, straightening, channel enlargement).	Constructed un-lined.	Constructed - lined
Barriers	1	2-5	6-9	10-15	>16
Noxious weeds	Nil infestation.	Few isolated patches on banks and verges (<10 % occurrence).	More frequent patches (10 % - 40 % occurrence).	Significant areas of banks and verges (40 % - 80 %).	Most of streamzone infested (> 80 %).

⁴ Victorian Rare or Threatened Species

4. ACTIVITY PLANNING

ERAPSM provides many data sorting and selection tools that can be activity specific. The 'multi-search' function searches for user specified threats and/or values. This function can assist greatly when determining priority areas for waterway works of a specific type, as the user can search for a specific value and then find where threats are impacting upon this value. For example, areas where bank vegetation value is high and weed threat rating is high. These areas may be targeted for weed control works. This makes ERAPSM a useful tool when formulating works programs.

4.1 Weed Management Works Program

ERAPSM has been used to assist in developing weed management work programs. Figure 3 illustrates the process adopted.

Priority setting rules were established as part of an 'Activity Strategy' for weeds. The rules required that the:

- highest proportion of funding should be given to waterways that exhibited high value vegetation and moderate weed threat; and,
- some funding should be provided to waterways that exhibited high value vegetation and low weed threat.

ERAPSM provided the data sorting tools to find the waterways (or reaches within waterways) that conformed with these rules. Output was provided in the form of maps and tables.

A group of Melbourne Water staff involved with weed management then:

- ground checked maps;
- considered public perception (e.g. high profile areas); and,
- discussed other important information such as land ownership and techniques for dealing with particular weed species.

Priorities were then set for weed management activities for the next 12 months. Decisions were defensible as they were based on a systematic risk assessment procedure.

5. OTHER FUNCTIONS OF ERAPSM

ERAPSM has other functions that are not described in Figure 3. These other features are discussed below.

5.1 Investment planning

ERAPSM can be used to assist with investment planning and prioritising waterway management projects. It can store information on costs (average or user specified) for different waterway management activities. This information can be used to help calculate costs of management programs such as revegetation or stabilisation.

ERAPSM contains a project management function where works proposals can be sorted and given priority ranking according to:

- calculating index of benefit (IOB);
- calculating best value for dollar (BFB index); and,
- sorting projects according to risk, threat and/or value.

The progress of projects can also be tracked using ERAPSM which defines project status as:

- completed;
- not started;
- pending more information;
- started not on target; and,
- started on target.

5.1 Gaming

Gaming is carried out by predicting the outcome of management programs on the waterway value score and the waterway threat score. ERAPSM allows the user to record the predictions and illustrates the impact on risk ratings. For example ERAPSM can measure changes in vegetation condition ratings resulting from revegetation programs. Gaming can also be used to examine the impact of increasing or decreasing expenditures on management outcomes. Costs can also be varied during the gaming exercise with ERAPSM.

5.2 Index of Benefit

The Index of Benefit (IOB) gives a rating that measures the expected benefit from a project. It assumes that some projects are going to impact on many threats and many values. For example, outputs of a revegetation project may improve the value score for bank vegetation, verge vegetation, and could improve the value score for platypus; it will reduce the threat scores for bank vegetation, verge vegetation and weeds. The IOB measures the difference between the expected value and the current value and the expected threat and the current threat. Using the formula provided below, scores for different projects can be compared with formula provide below, scores can be compared to each other and it can assist in setting priorities between projects.

$$IOB = \frac{(\text{exp value} - \text{cur value}) + (\text{cur threat} - \text{exp threat})}{(\text{current value} + \text{current threat})} \times \text{cur risk}$$

exp = expected
cur = current

5.3 Value for dollar

The 'bang for buck' index (BFB index) is also useful for setting project priorities. This is calculated by dividing the Index of Benefit score by the total cost of the project. The lower the cost and higher the Index of Benefit Score the higher the BFB Index.

$$BFB = \text{Index of benefit} / \text{Cost of Project}$$

While the IOB and BFB indices are useful in prioritising projects, they should not be used as the sole basis for decision making. They are however useful when comparing one project to another.

5.4 Targets

ERAPSM also assists in setting targets for and reporting outputs from waterway management activities. Expected outputs can be recorded in ERAPSM and reports generated that record targets and achievement. For example, a project may specify that bank vegetation will be improved from value 2 to value 4, this target is recorded and can be measured.

6. FURTHER DEVELOPMENT

ERAPSM has been a useful tool for assisting in priority setting and planning waterway management activities. However, its development is not complete. The ground rules established at the beginning of the development of ERAPSM constrained important debate on the most appropriate values and threats to be used for risk assessment. A review is underway to determine the most appropriate environmental values and threatening processes that should be used by ERAPSM. Potential users of the model and a range of technical 'experts' from various disciplines are being consulted to assist in the ERAPSM review. Outcomes of the review will influence and direct the next version of the ERAPSM.

7. CONCLUSION

The Environmental Risk Assessment and Priority Setting Model provides some useful tools for data management and data analysis which contributes to a priority setting process. It also has many other features that assist in day to day management of waterways. However, it is important to continue refining and

developing ERAPSM even though it has proved its usefulness from turning data and planning into prioritised works programs and on ground activities.

8. REFERENCES

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