MANAGEMENT FOR ENVIRONMENTAL AND SOCIAL SUSTAINABILITY AT JENOLAN CAVES, N. S. W., AUSTRALIA*

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SUMMARY

Jenolan Caves have been open to the public since the 1850s, and at one time were Australia's premier tourism destination. In about 1993, the administration decided that the continuing increase in visitor numbers represented a significant threat to the environmental quality of the site.

Accordingly, a meeting of karst and tourism professionals was set up to advise on action, and as a result, a continuing program of both environmental and social monitoring was established under the oversight of a supervising committee. This paper will describe the innovative managerial arrangements, which are in place and the processes being utilised. Results to date will be outlined.

THE JENOLAN CAVES

The Jenolan Caves are located in a deep valley in the Western side of the Blue Mountains, and contained in a relatively small area of impounded karst. The karst has an extremely complex geological history, with two periods of major folding, a number of faulting events, at least three periods of palaeokarst deposition, with evidence of hydrothermal activity, and of sulphuric acid erosion. The main cave system comprises over 20 kms. of passages contained within a one km. length of the limestone body, and a complex series of different tourist routes have been provided (*Hamilton-Smith & Osborne 1998*).

The Caves are said to have been discovered in 1838, and in 1866, the Jenolan Caves Reserve was proclaimed. This was one of the first wild-land reservations in Australia, and in 1872 was certainly the first to be placed under conservation regulations. The Reserve quickly became an important tourist destination, and by the end of the 19th century, was probably one of the best known and most often visited attractions in Australia. It was also the site of a remarkable series of innovations. The beauty of the caves was safeguarded by erection of wire screening, visitors were shown the caves by magnesium light (first used at Jenolan, later elsewhere in Australia, but not generally 'm other countries), the first use of electric lighting in caves anywhere in the world (1880), and Australia's first hydro-electric generating system (1889).

The reserve was, for many years, managed by various government departments, an in 1988 the first formal plan of management was prepared and formally approved in 1989. Following this, the Jenolan Caves Reserve Trust was established as a corporation under the provisions of the Crown Lands Act and regulations with specific responsibility for the management of Jenolan, and now three other caves reserves in New South Wales. As visitor numbers increased, so the location within a deep and precipitous valley served to generate considerable problems in both visitor access and maintenance of environmental quality.

Accordingly, the Trust became concerned about the potential impacts of increasing visitor numbers, particularly after undertaking a study of future development options, and in 1994 commissioned a further study by Manidis Roberts Consultants (1995) into how the 'carrying capacity' of the reserve might best be determined. This study involved a three-day workshop, comprising experts in karst research, cave management and visitor management. A program for action, based in the *Visitor Impact Management* process (*Graefe et al 1990*) was proposed. This proposal was adopted and immediately implemented by the Trust. Then in due course the Social and Environmental Monitoring (SEM) Committee was appointed by the trust to maintain an oversight of this program and first met in May 1996.

STRUCTURAL ARRANGEMENTS

The Board of the Trust has a number of smaller sub-committees, and of these, the conservation sub-committee provides for oversight of and liaison with the SEM Committee. The SEM Committee itself includes both persons with long experience and knowledge of caves and karst management and those without such experience but considerable other relevant expertise. These structural arrangements are summarised in *Fig. 1*.

The Committee meets twice in each year, and one or more members of the Conservation Sub-committee always attend at least part of each meeting. Two staff members, the karst resources manager and assistant, who have the responsibility for actual operation of the research program, also attend each meeting.

The role of the committee is to:

- maintain a program of evaluating both the quality of visitor experience and the quality of the environment
- maintain a continuing review of the quality of the resulting research and of any other submitted reports
- produce an annual independent *State of the Environment* Report
- identify implications for management and budgetary decision-making

The transparency and accessibility of the evaluation process is maintained in a number of ways. The annual *State of the Environment* Report is published in the statutory annual report of the Trust, and in effect, constitutes an audit of both the quality of the bio-physical environment and the visitor experience. A quarterly newsletter is published and regular 'fact sheets' reporting progress are made readily available, particularly to staff. Members of the committee and the two staff concerned also have close liaison with staff and other stakeholders, and two stakeholder workshops have been held.

This degree of structural integration and the continuing openness of communication both serve to enhance understanding and implementation to an unusual degree. However, there is another less explicit but important integration process. The level of expertise represented amongst the members of the SEM Committee means that any research or monitoring is soundly based from both conceptual-theoretical and practical-methodological perspectives. Members of the committee are also in a position to alert all concerned of the implications of other research throughout the world.

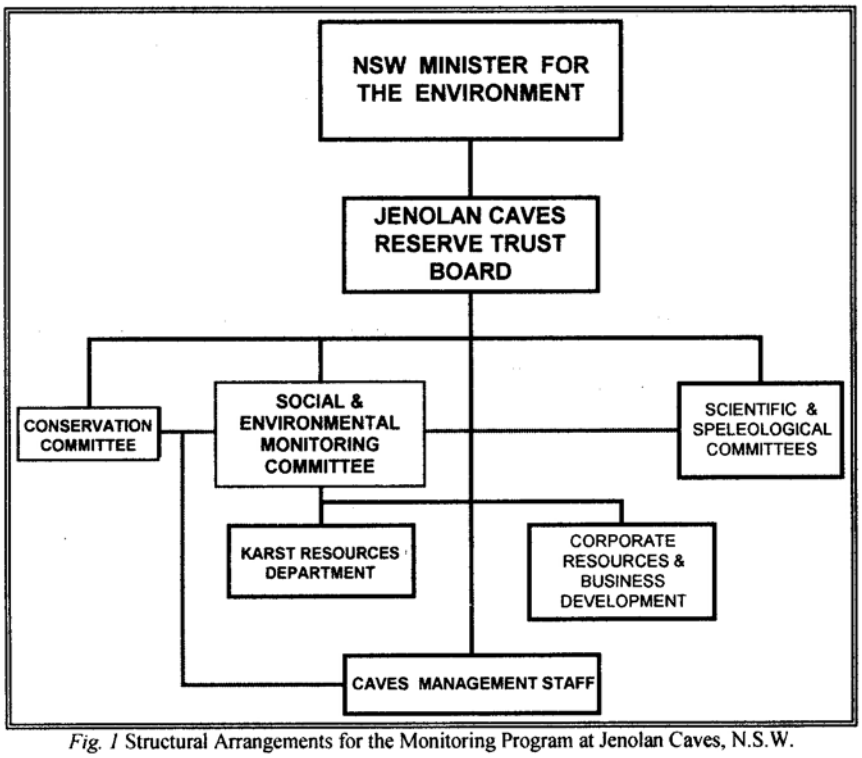

Fig. 1 Structural Arrangements for the Monitoring Program at Jenolan Caves, N.S.W.

The actual work program has evolved as a shared responsibility with broad involvement. The core-monitoring role rests with the staff of the Karst Resources Department. However, some members of the committee also make a significant contribution to the work program, either in, conjunction with staff or through their personal research activities. As a number are from universities, they have been able to enlist post-graduate students to pursue topics of concern to the evaluation program.

THE WORK PROGRAM

VIM, and indeed all of the quality maintenance models, assumes that the major issue in sustainability is one of visitor impacts. Our experience has led us to the broader conclusion that we must consider any processes that threaten the quality of the environment and/or the visitor experience. Thus in looking at the ecology of the surface environment at Jenolan Caves, probably the most damaging threats are due to invasive species (weeds, pathogens and feral animals) together with the impact of the old-time pathways which were inappropriately located and built with poor design and construction techniques.

So this wider view of the task, which arises out of sustainability concepts, is one way in which the Jenolan process has evolved to be holistic rather than fragmented.

The key elements of the VIM process include:

- the establishment of precise objectives for management of both the environment and visitor experience
- identification of indicators which serve to measure the extent to which objectives are being achieved
- measurement of these indicators
- development of appropriate managerial responses to revealed problems

The VIM framework (and that of other similar models) also appears to assume that it is a relatively easy task to define specific and precise objectives. In fact, this can only be done effectively with a good understanding of the social and natural systems, and at least in Australia, we often lack an adequate basis for doing this.

Some environmental properties can be clearly defined and readily measured. At Jenolan Caves these include, for instance, the composition of the air within the caves, the quality of the water, evaporation rates within the cave and the deposition of dust within the cave. However in endeavouring to capture, for instance, the less tangible characteristics of the recreational experience and to recognise the role of the recreating person in individually shaping that experience, while maintaining fidelity to the reality of experience, an insistence on precise definition of objectives may prove truly troublesome. A similar problem arises in a number of environmental issues, for instance, endeavouring to establish the desired ecological balance in an already badly damaged vegetation community.

At the same time, there has also been a long debate about the appropriateness or otherwise of insisting upon clearly defined objectives. *Wholey et al* (1975) and many others argue that evaluation is impossible without clearly defined and measurable objectives; *Nienaber and Wildavsky* (1973: 11) present a powerful critique of the objective-based approach. They argue that:
.....objectives are not just out there, like ripe fruit waiting to be pluce; they are man-made, artificial, imposed on a recalcitrant world. Inevitably they do violence to reality by emphasising certain activities (and hence organisational elements) over others.

Scriven (1972, 1993) presents a similar argument, together with a clearly defined conceptual approach to goal-free evaluation, which has since been further developed by many others.

The approach at Jenolan has therefore been that, where necessary, rather than striving to delineate precise objectives (which are all too likely to be flawed), issues for concern are defined, the state of these issues is identified and monitored (which in itself may assist to develop an adequate understanding for the definition of objectives) and at the same time, students and others are encouraged to undertake basic research upon the issue concerned.

There is a special problem in the social arena, where managers only define their objectives for visitor experience in terms of providing opportunities and all too rarely define even the range of opportunities in clear terms. Although there is an available and well-developed technology for defining 'customer satisfaction' and other characteristics of the visitor experience, this is only useful at the broad level, and makes only a limited contribution to the kind of understanding of visitor experience that is desirable. The committee continues to pursue the investigation of this area.

ASPECTS OF THE WORK PROGRAM

Air quality and vehicle pollution

One of the concerns which attracted considerable attention at the beginning of the program, and was assumed to be potentially extremely damaging, was the impact of exhaust and dust emissions from motor vehicles. Research and monitoring showed that although there were high pollution levels in the Grand Arch (an immense cave passage through which all traffic passes) even these are short lived due to the winds which clear the air constantly, but see below re traffic access. The exhaust fumes and dust (from tires and brake pads) only penetrated a short distance into the other cave passages, and were deemed not to present a major threat.

However, this research led to two other important findings. The first was that there was a relatively stable thermocline and associated change in humidity at the furthest point to which external dust and fumes entered the cave. Temperature differences as high as 4^{o} C has been recorded on either side of the thermocline. This appears to protect the cave from external pollutants (James at al 1998). Monitoring of the thermocline has now commenced in order to more fully understand its dynamics, and to assess the impact of visitor parties passing through it.

The second was that there were a number of locations in the cave with high concentrations of zinc and cadmium resulting from both leeching of galvanised metal structures, and even more strongly from the former practice of in-cave fabrication of handrail systems. Cadmium, a virtually ubiquitous impurity in zinc, has a highly toxic impact on micro-biota and hence upon the integrity of the cave environment. For this and other reasons, in-cave fabrication is now avoided and the galvanised structures will be progressively replaced with stainless steel.

Vehicular traffic

Although pollution as a result of the heavy vehicular traffic proved to be less important than anticipated, a comprehensive assessment of the traffic situation showed that the geological instability of the current major traffic route to the caves dictates that the road should be replaced at the earliest feasible date. Further, the impact of motor vehicles within the tightly constrained space of the pedestrian precinct at the caves offices is such as to adversely affect the visitor experience. Finally, the current impacts upon the Grand Arch and its fauna are certainly undesirable, and should be eliminated. It has therefore been decided to proceed with the development of an alternative access means, probably by a cable car system.

Cave climatic conditions

Climatic conditions within the cave areas visited by tourists have been regularly monitored, and a major research study of the total climatic systems of the cave completed by *Michie* (1997). Although the results of monitoring still demand further analysis, it appears that although each visitor party causes a rise in cave temperature, this does not exceed 0.5^{o} C and so falls within the normal range of seasonal variation. A similar variation occurs in carbon dioxide levels, and again, *given the current size and timing of visitor parties*, does not seem to be a cause for alarm. However, a full integration of the measurements of carbon dioxide, temperature and humidity is required before the effects of climatic variation can be fully assessed.

However, the problem of dust is a very different matter. Although there are some natural sources of dust, the great majority is borne into the cave on visitor's footwear and clothing, shed as lint from clothing and skin flakes from visitors. It has a marked negative impact upon the quality of speleothems appearance, causing surface dulling and discoloration. It also changes the bio-ecology of the cave, providing food input to both Collembola and other small invertebrates and to microbiota, and hence having significant chemical effects.

It is a matter for very serious concern, and Jenolan initiated regular washing as one response to this problem (*Bonwick & Ellis* 1985). Recent assessment by *Spate & Moses* (1994) has demonstrated that this in itself has an impact upon the surface of speleothems, and so, although it may be necessary, it should be carefully controlled and minimised. Techniques have now been developed for simple monitoring of dust and lint deposition, and it is planned to establish controlled experiments on means to minimise the problem.

Integrity of the surface environment

Threats to the integrity of the surface environment involve a number of issues, including the impact of invasive species, land stability problems resulting from the long period of human interference, and impacts upon water quality as a result of increased sedimentation and both chemical and biological pollution.

The three current major projects of the monitoring program involve the establishment of a comprehensive water quality monitoring program, the development of an environmental risk management strategy, and the development of a detailed land system analysis as a basis for land management initiatives (*Gillieson & Thurgate*, this meeting).

Quality of visitor experience

Two preliminary studies of the quality of visitor experience have been carried out. *Veldman* (1997) concentrated upon bus tour parties, and found a reasonably high level of self-reported satisfaction

amongst visitors. However, the study also revealed a significant number of problems in visitor service from both bus operators and the caves experience. *Campbell* (1998) examined a random sample of visitors, most of whom were independent travellers who had arrived in private cars. This study provided a preliminary identification and analysis of the psychological components of the visitor experience, demonstrated that many visitors felt too crowded and were most dissatisfied with local food services, and pointed to a need for greater diversity of tour experiences. A recent stakeholder meeting identified further monitoring of visitor experience as a high priority for action.

SUMMARISING THE CURRENT PROCESS

In conclusion, we can now summarise the overall process that, has been developed at Jenolan, and which although it has evolved from the VIM process described above, has adapted it to the Jenolan situation.

It now consists of seven steps. The first of these consists of preliminary investigation of apparent issues or threats, and in the example above of assessing the impact of motor vehicle emissions, the preliminary investigation indicated that although there was clearly a heavy environmental impact upon the Grand Arch, that resolution of this problem could only be resolved as part of a wider traffic access problem. On the other hand investigation of cave climate led to the conclusion that the most critical immediate issue was that of dust, although other issues (temperature, carbon dioxide levels and humidity) require continuing monitoring to ensure that they remain within an acceptable range.

From that point, each of the critical threats that have been identified is monitored in the most effective way, the results of monitoring analysed, and ultimately, proposals for action are presented to the Trust Board. The on-site research and monitoring is supported by appropriate theoretical and conceptual insights and knowledge of other relevant research elsewhere in the world that is provided by the SEM Committee. The total process is summarised in *Fig. 2*.

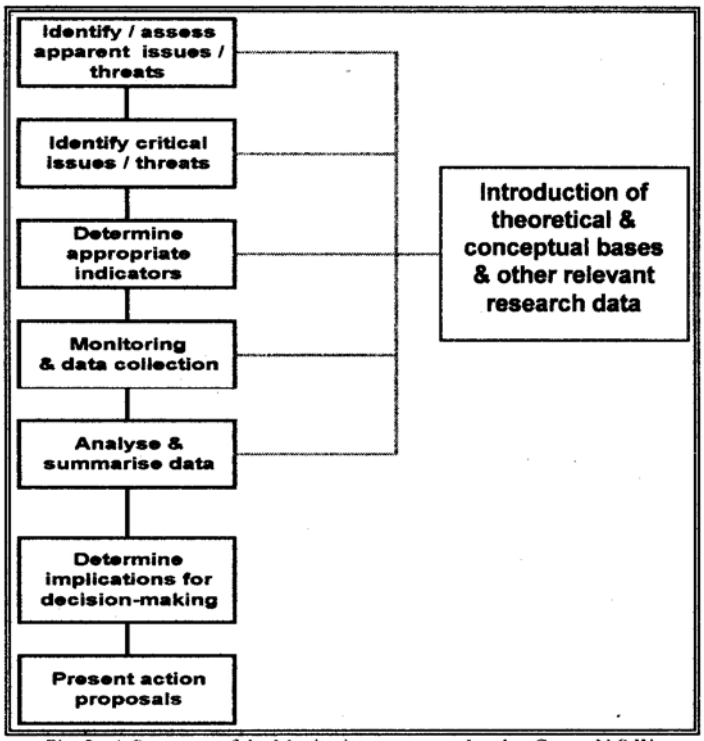

Fig. 2 : A Summary of the Monitoring process at Jenolan Caves, N.S.W.

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