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SPATIAL PLANNING AND PROTECTION MEASURES FOR KARST AREAS

PROSTORSKO NAČRTOVANJE IN UKREPI ZAŠČITE NA KRAŠKIH OBMOČJIH

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Elery Hamilton-Smith: Spatial planning and protection measures for Karst areas

This paper presents a brief review of the values and vulnerability of karst systems, and specifically examines issues of water balance, physical destruction, sedimentation and pollution. It then outlines key issues in the protection of karst and the need for continuing vigilance.

Keywords: karst, management, groundwater balance, vulnerability, protection.

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Elery Hamilton-Smith: Prostorsko načrtovanje in ukrepi zaščite na kraških območjih

Članek prestavi kratek pregled vrednot in ranljivosti kraških sistemov. Posebej se osredotoči na vprašanja vodnega ravnotežja, fizičnega uničevanja, sedimentacije in onesnaževanja. Predstavi temeljne probleme pri zaščiti krasa in opozori na potrebo po budnem spremljanju posegov v kras.

Ključne besede: kras, upravljanje, ravnotežje podzemne vode, ranljivost, zaščita.

INTRODUCTION

. . . a karst system incorporating component landforms as well as life, energy, water, gases, soils and bedrock . . . (Eberhard 1994: 8.)

Any discussion of karst protection must commence with the basic understanding that karst is a complex, dynamic and interactive system. An overall view of karst must engage with that complexity, and so call upon a wide range of insights from a diversity of disciplines. It calls for application of what is usually termed *integrated systems analysis.* This was probably first well recognised in the karst literature by Yuan Daoxian (1988) in his keynote address to the Congress of the International Association of Hydrology.

My own experience over many years has been based in this approach – which is now generally accepted, although some scholars still maintain a narrow disciplinary perspective. In this paper, I will focus particularly upon protective management but this first demands an introductory perspective on the values and vulnerability of karst.

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COMMENTING UPON KARST VALUES

Many karst systems are places of striking, even sublime beauty (Burke 1756). In turn this is coupled, for many people, with a genuine sense of spirituality. Most such landscapes thus have extremely important cultural values that may even have persisted continually since the Neolithic.

Fig. 1: The famous towerkarst of Guilin in China is famed for its beauty

In turn, cultural values are linked with a great diversity of scientific values in the common claim that *Caves are the Books in the Library of the History of the Earth,* even though we are still striving to fully understand the languages of those books. The very way in which evidence of the past is interwoven within karst echoes both the complexity and integration of the karst system itself, and in so doing, potentially adds a further layer of integration to our understandings. So, karst provides a unique store of knowledge with many features not found in other earth systems.

Finally, there is a wondrous range of economic assets in karst, of which the most significant must be the groundwater reservoirs, which probably provide for the water needs of at least 25% of the World population. Regrettably, the importance of maintaining the quality and quantity of groundwater is all

too often overlooked in the greed for more highly priced and spectacular commodities such as the limestone itself or even the swiftlet nests of Southeast Asia. (Watson *et al.,* 1997)

AND UPON VULNERABILITY

The same complexity and integration of karst, in itself, underlies the vulnerability of the system. A change in any of the major components of the system will inevitably impact upon others. Given that water is the most basic yet most variable of the major components, it is the one most likely to be subject to either changes in volume or to pollution of various kinds. Thus, it is also the most important element in almost any protective management program.

However, the very attractiveness of karst brings with it the impact of human developments with dams, roads, bridges and other constructions. Then the quality of many karst soils or other products of economic value brings both extractive or developmental industries and urbanization, so as a result, both destruction of the rock Itself and often the introduction of pollutants, either as waste products or in the name of chemical management practices, e.g., fertilizers and pesticides.

So, we know we must look towards sustainability, but in practice this may be very difficult and very slow to develop. The Shui people of China have published a text on sustainability over a thousand years ago, and have managed their forest and karst lands at Maolan for at least that long. But more generally, the dominance of simplistic economic thinking (and greed) often defeats the demand for sustainability. Contemporary modernism in resource management was initiated by March (1864) in his rightly famous *Man and Nature*. But far too much of his wisdom still awaits full expression (e.g., Goldie *et al.,* 2005).

MAINTAINING THE WATER BALANCE

The centrality of water as a major determinant of the character and integrity of karst has already been emphasised. Natural variations in water as a result of flooding, increased rainfall, or drought may all arise, and are largely self-balancing over time. But because the cycles of nature may well be gradual in change, we often neglect the potential of permanent change. The process of desertification has adequately demonstrated its capacity

Fig. 2: Temple of Baal, Jenolan Caves, New South Wales

for permanency, and although there is no question that it can be reversed and so restoration may be possible, it is all too rarely attempted. The widespread karst deserts of China are well known, but current research is furthering our understanding of the processes at work, including the formerly neglected role of microbiota.

But the major threat comes from human action. Excessive drawdown of groundwater for agriculture, mining or other industrial activities is all too common. Urbanisation and other forms of construction may well cause major changes in groundwater re-charge. Forests may both impede recharge and increase drawdown through transpiration.

Planning to reduce damage to water balance is vital, and should always be based in accurate delineation of total catchments. It has been recognised for many years that subterranean divides may not coincide with surface catchments. But many protected areas suffer from boundaries that were established in ignorance or neglect of this understanding. Even when the problem is recognised, the political considerations in boundary change may well demand many years of negotiation, and may well prevent re-definition.

Regrettably, even conservation activists may well lack proper understanding of the character and behavior of groundwater. One striking example from this region

Fig. 3: Groundwater is of great value, but often adds to the beauty of caves: Weebubbie Cave, Nullarbor Plain, Western Australia (Photograph Normal Poulter, OAM)

occurred when Croatia first proposed a change of boundary of the Plitvice Lakes World Heritage area in order to encompass (and hence control) the upper section of the catchment area. Many of the referees who were consulted totally failed to recognise the importance of this and argued that the World Heritage Committee should reject the proposal because "it did not add to the biodiversity of

Fig. 4: Khayon Cave, near Mawlamyine, Myanmar (once known as Farm Cave and an important biological site) is a fine example of the religious use of caves

the site" Fortunately, the Committee recognised and accepted the total validity of the proposal that after all was simply putting the case for total catchment management – now a widely accepted principle in karst management.

Another recent development is taking place in Indonesia where the special province of Yogyakarta is undertaking the revegetation and restoration of the Gunung Sewu - one of the world's great tropical karst areas which has been devastated by both total denudation through logging and by uncontrolled limestone quarrying. Research by Professor Suhardi to develop optimal sequencing and timing of re-vegetation and his leadership in implemen-

tation are achieving remarkable results, unprecedented in tropical karsts. Further, his work is now providing a model for other countries with similar problems, albeit often on a less scale, now using his strategies to achieve their own successes

So, in summary, we must strive for total catchment management and on-going monitoring of recharge or of drawdown. The importance of deliberative environmental restoration is at last being recognised, even though Marsh argued back in 1864 that forests destroyed by human action need human action to ensure their recovery.

Fig. 5: One of the examples of sublime majesty: the Xiaozhai Tiankeng of China

Fig. 6: Another majestic sight: Nare Doline (over 300 m. deep) on the Nakanai Plateau, Papua New Guinea

PREVENTING DESTRUCTION

The establishment of protected areas is the most obvious and best-known strategy for protecting natural or cultural resources. These are often established under relevant legislation with such names as national parks, nature reserves, etc. The IUCN has established a standard classification of these (IUCN 1994, Bishop et al 2004) according to the nature and extent of protection that is afforded. Others may exist by long-standing tradition for as long as many thousands of years; still others are established and managed under private commercial ownership.

The underlying assumptions and managerial styles in protected areas have been undergoing a continuing evolutionary development and adaptation. The famous "Yellowstone Model", was long promoted by the United States as the ideal model for protected area management, but has come under massive challenge by alternative models from Eastern Europe, other cultural traditions and in particular from many new countries. Adrian Phillips (2003) at the Durban Parks Congress provided a magnificent summary of the patterns of change and Hamilton-Smith (2005) provided a further overview which incorporated and commented upon Phillips' summary of changes.

Another important contribution from the Durban Congress was a magnificent discussion paper on governance principles for protected areas prepared by the Canadian Institute of Governance (Graham et al 2003).

More vexed questions arise in respect to areas that are not accorded protected area status. Often, politicians, and other public officials, exercising Bierce's (1911: 243) definition of politics as "the conduct of public affairs for private advantage" will hand over major areas for destructive exploitation. In some countries there is little legislative infrastructure to provide a degree of control over the use of either public or private.

Even where there is, conservationists may find themselves forced to appeal against decisions already made – and this can be a difficult and often costly process. A further mechanism that seeks to provide for safer decision-making is the Precautionary Principle (Cooney 2004, Cooney et al 2004), enunciated clearly in the decisions of the 1992 Rio Declaration:

Where there are threats of serious or irreversible damage, lack of full scientific certainly shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

I am glad to say that after two days in the witness box in the course of challenging an application for mining on a particularly important karst area, the judge not only upheld the appeal, but also wrote the precautionary principle into his judgment.

There is also the potential for adoption of minimal impact codes of practice. Speleologists have used such codes in various forms, e.g., the Honour Code of the Swiss Speleological Society and the Minimum Impact Code of the Australian Speleological Federation. At the other extreme of scale there is an excellent example in the Cement Sustainability Initiative (WBCSD 2002).

Fig. 7: One page from the Library of the History of the Earth: Victoria Fossil Cave, Naracoorte Caves WHA, Australia

Fig. 8: Gouldens Hole - One of the Cenotes in the Limestone Coast region, South Australia: both a beautiful place and a point of access to an immense groundwater reservoir through both the nineteenth century excavated ramp and the modern pumping station (Photograph Ken Grimes)

Fig. 10: The terraces on the Northern side of the Huon Peninsula, Papua New Guinea are a wondrous source of geo-climatic history

Fig. 9: The bat flight from Deer Cave, Gunung Mulu WHA, Malaysia

Fig. 11: Buchan Caves, Victoria, preserved as a National Park, now Caves Reserve. (1938 photograph made available by Park Manager D. Calnin)

POLLUTION AND SEDIMENTATION

Both pollution and sedimentation share the characteristic that they can spread over an immense area, sometimes reaching locations that may be hundreds of miles from the point of origin. They may result from ignorance, laziness, cost cutting, genuine accident, unforeseen consequences, and inappropriate use of agricultural or other chemicals. Pollution may well be invisible as when excessive organic wastes are discharged and enter the groundwater, creating a high level of nitrates that may be fatal to infants or young children.

Sedimentation can result from any form of soil erosion or mobilization. In New Zealand, the Waitomo Glowworm cave was threatened when a farmer cleared a hillside some 25 miles upstream of the cave. The resulting muddy run-off entered the river and progressively settled, killing the Chironomid and other larvae which were growing all along the river and which normally provide the food source of the glowworms. In Vietnam, a clumsy road construction mobilized immense amounts of mud into several underground rivers and from there to the major surface streams draining the karst.

Fig. 12: The wonderful Maolan forest of China, managed on a basis of sustainability by the Shui people

Fig. 13: The Havalu Forest of Niue managed as a "National Park" since the original inhabitants first arrived over 1,000 years ago.

Fig. 14: The main pathway through Jeita Cave, suspended well above the floor on pillars, and with all electric fittings concealed under the pathway

Most examples of both pollution and sedimentation can be prevented or remedied but it is much less costly to prevent either or both occurring. It may be useful to note here that the South-east Asian grass *Vetiver zizanioides* provides a remarkable tool in controlling water run-off and in stabilising disturbed soils (Whitten et al 1997: 144-146).

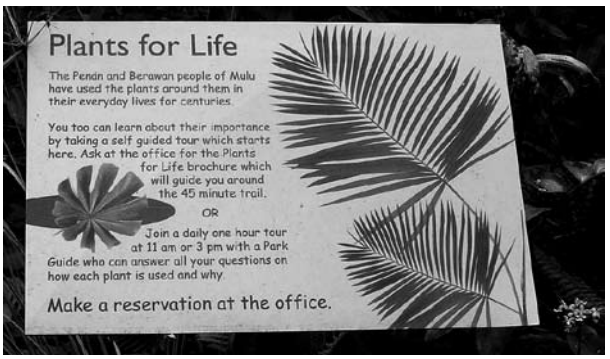

Fig. 15: The commencement of the medical plants trail at Gunung Mulu WHA, Malaysia

Fig. 16: The beauty of the Plitvice Lakes WHA, Croatia

CONTINUING VIGILANCE

It is absolutely vital that land managers do not become complacent, and rather maintain continuing vigilance, as there will always be stupidity, greed and irresponsibility.

But there are two other special hazards:

• The introduction of new and hence little known chemicals or other technology. My personal experience in discovering (by accident) that Metamidophos was being used as a mass pesticide in an Australian karst area is one frightening example.

• Then there are time bombs that will one day explode. The worst example of which I am aware is the massive water storage built when gold mining commenced in South Africa over 100 years ago. When it was built on dolomite, everybody knew that dolomite was insoluble in water. More recently a few geologists started to sound a warning – they were ignored. Then about three or four years ago, the water escaped into the underlying limestones, and then arose through the abandoned mine shafts, bringing an unbelievably dangerous chemical soup to the surface. At present, the government vacillates between 'it hasn't happened, but if it did, it isn't dangerous and we have it all under control'. The result is that it has proved virtually impossible to get any genuine response in place – not surprising when one thinks of the magnitude of the disaster and the ducking for cover of the government response!

• What others might be awaiting attention elsewhere in the world?

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