

# Thredbo disaster Coroner's Inquest

## Overview

On Wednesday, July 30<sup>th</sup> 1997 at 11.37 p.m. some '10,000 tonnes of soil slid down a Thredbo hill demolishing two ski lodges and killing 18 people' (Newman 1997). 'A whoosh of air, that sounded like a sonic boom and trees cracking, splitting the still, cold night air like gunfire. Alarm bells started ringing across the nation. Calls for help went out to all emergency services. No one could really believe the nature of the appeal; no one ever imagined a catastrophe like this could happen' (Diver and Bouda 1999, 53).

Three years later, on the 29<sup>th</sup> of June 2000, the New South Wales Coroner, Derrick Hand, published an exhaustive exemplary report (Hand 2000) of his inquest into the disaster. His task was to explain why the idyllic tranquility of a part of a most beautiful place had been replaced, almost instantaneously, by one of demolished building rubble. *Figure 1* clearly portrays the Coroner's challenging task. 'The sudden movement of slope material is as instantaneous as any earthquake event causing just as dramatic an impact upon property and lives' (Bryant 1991, 236).

'Until the Thredbo landslide tragedy there had been little public recognition that landslides were a significant threat in Australia. Where landslides occur, their physical impact is typically confined to a few properties or a short length of road or railway, but the effect can be disturbing or disruptive. Insurance policies in Australia do not normally cover landslide, and this can cause anguish to property owners. One landslide blocking a road or railway can cause inconvenience and economic loss' (Michael-Leiba 2000, 32).

The Thredbo tragedy has stimulated renewed interest in the risks associated with landslips (e.g. Landslide Awareness 1997; Landslip Workshop 1999; Ritchie and Hunt 2001; Walker 2001).

Recently, the *Cities Project* (A.G.S.O. 2000) of the Australian Geological Survey has instigated a multi-hazard risk assessments initiative aimed at reducing the risks posed by the range of geohazards in Australian urban communities (Granger 1999). This work is now bearing fruit, with some quantitative risk studies already completed. For example, that of the landslide-prone area of Cairns, about which detailed information is now available (Granger et al. 1999; Michael-Leiba 2000).

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Similar, not so comprehensive, but directly relevant and sufficient, landslide risk data was available for Thredbo. Had the geohazard information that was available been acted upon effectively, there would have been no such major landslide disaster at Thredbo, no untimely deaths, no Thredbo Coroner's inquest, no subsequent Coroner's Report (Shiels and Shiels 1991; Hand 2000).

'In several respects the Inquest into the Thredbo tragedy has no precedent. First, it concerned more deaths than had previously been considered as a result of a landslide in Australian history (Landslide Awareness 1997). Secondly, it was a disaster caused by a geohazard which affected an essentially urban community located in an isolated national park' (Hand 2000, 14).

'The Kosciusko State Park (the "Park") was created pursuant to the Kosciusko State Park Act 1944. The same Act created the Kosciusko State Park Trust (the "Trust"). The Trust had the care, control, and management of the Park. The Trust was given the power (inter alia) to carry out any work in connection with the improvement, development and maintenance of the Park, including the opening of roads, the erection of hostels and other buildings and structures' (Hand 2000, 18).

Nestled at the foot of Australia's high country, the home of the nation's highest mountain, Kosciusko, Thredbo resembles a small European ski village, with lodges, restaurants and shops terraced into the steep hillside facing the ski fields. Through the middle runs the Thredbo River. About 200 kilometres south-west of Canberra, the nation's capital city, Thredbo is popular all year round—snow sports in winter, bushwalking and a range of sports in summer. Its reputation is world-renowned. Some three million people visit Kosciusko National Park

yearly (Diver and Bouda 1999, 53).

The time taken to produce the report into the Thredbo disaster (three years) is a measure of the complexity of the issues and concerns involved and of the consummate thoroughness with which the Coroner executed his task of 'using death in order to save life' (Law Report 2000). The Coroner's Report is destined to become a classic study and should become an essential authoritative source and inspiration for all concerned with hazard mitigation in complex multi-functional modern human settlements set in challenging environments.

The coroner largely blamed government authorities, including the New South Wales National Parks and Wildlife Service (NPWS), for their laxity in failing to ensure that Thredbo Village was structurally stable. Crucially he noted that the NPWS should not have approved the laying of a water main along the unstable Alpine way, the road above the destroyed ski lodges. Damage to the pipe was a factor in the collapse of the road and in the landslide. The coroner noted his concern regarding the NPWS's ability to assess engineering issues, such as slope stability in relation to park roads. He also noted that the NPWS's difficulties were largely not of its own making, 'much being done by responsible government authorities over the years to try and keep the Alpine Way and other poorly constructed roads in the park operational. They had to struggle with problems occasioned by roads not designed for the purpose to which they were later put. The authorities were subject to funding restraints.' The coroner recommended an independent investigation into the NPWS's responsibility for urban communities and road maintenance in national parks such as Kosciusko, which contains Thredbo. Potential litigation and the possibility of millions of dollars of compensation are envisaged (Powell 2000).

A hallmark of the coroner's approach is his overall interrelating systems and sub-systems approach and conceptualisation (Clarke and Crossland 1985; O'Connor and McDermott, 1997), within which the participating individuals and groups carried out their statutory and non-statutory duties and responsibilities. Although the malfunctioning pipeline was found to be the immediate cause of the event, building upon unstable sites



Figure 1: Top – Threbo Village disaster domain before the 30 July 1997 landslide, looking towards Bimbadeen and Carinya Lodges (arrowed). Below – after the landslide.

without full geophysical assessments and fully engineered designs and constructions were also core contributory factors. The singular catastrophic Threbo event on that traumatic night in July 1997 was ultimately seen as a consequence of a long chain of antecedent events starting when the Snowy Mountains Hydro-Electric Authority (SMHEA) commenced construction operations in 1949. Painstakingly, meticulously, and comprehensively, Coroner Hand and his Office teased out and reconstructed the panoply of intertwining activities, dysfunctional decision-making and individual and organisational resource and capability limitations, that lead to the untimely deaths of 18 people.

With a sound legacy of prior coronial reports to underpin his Threbo investigation, Hand, has produced another invaluable document, capping a distinguished career dedicated to making communities safer for others. Those who died did not die in vain.

There was one person who survived the Threbo disaster and lived. His name, now familiar to most Australians, is Stuart Diver. For 65 hours after the landslide, he was trapped deep under heavy building slabs and tangled debris, in a compact concrete catacomb, experiencing excruciatingly painful, freezing and wet conditions. Unable to move much, or initially communicate his dire plight, his dead wife lay beside him. After he was discovered, still alive and the sole survivor, 53 hours later, life-preserving aid and rescue took a draining further 12 hours for a very dangerous extraction from his near-death place. The work of the hundreds of emergency management workers was exemplary. Diver's personal observations and perspectives on the event are both insightful and inspirational (Diver and Bouda 1999; George 2000; Mills 2000).

The just cited writings convey a powerful picture of the personal impacts of the Threbo disaster. Diver displayed a very

strong will to survive and exceptional *in situ* survival skills (Kay 1981; Drabek 1986; Leach 1994; Paton and Long 1996). Also most notable was the consummate, unrelenting dedication, and fine emergency management competencies and skills of the many persons involved in his rescue, long after the expectation of human survival was all but exhausted (Dawe 1999, Diver and Bouda 1999; Mills 2000; Hand 2000).

The rest of this paper will record in greater detail the essence and salient features of the Coroner's Report on the Threbo disaster, and of the circumstances leading up to the traumatic event and the implications thereof for making our communities safer places in which to live. To convey best the essentials of the findings, a selection of the Coroner's own words will be used.

### Role of the Coroner's Inquest

'The Inquest plays an important function as a fact-finding exercise, essential to investigate and answer the relatives' and public's need to know the cause of death free from the constraints which bind inter partes litigation. It does not apportion guilt. Although not expressly prohibited by the Act, it is not the function of a Coroner to determine, or appear to determine, any question of civil, let alone criminal, liability. I have made this point more than clear, I hope, from the outset of this Inquest. That said, however, it would be impossible in discharging my duties as Coroner not to analyse the evidence in the course of reaching my conclusions. A Coroner may make findings about any parts of the evidence in the course of the Report. Findings are not limited to those required by the Act. As a former State Coroner Mr. Waller has said, summing up should be universal practice' (Hand 2000, 10).

As it seems reasonable that the relatives, witnesses and public are entitled to know not only the verdict, but also what evidence was accepted and what weight was given to various factors from which the Coroner arrived at his conclusions. The summing up will give [the Coroner] the opportunity of making observations as to safety procedures, recommendations to public bodies, commendations for bravery, and for giving such warnings to the public as appear apt.

To collect the evidence and write the Report was a task of considerable complexity. Over 100 witnesses were called to give evidence. Sixteen bodies, with legal representation, were parties to the inquest; there were four expert

advisers to the Coroner who utilised five administrative staff; other parties and the public made verbal and written submissions. A wide range of government documents and reports covering a span of nearly half a century were assessed. The final Report consists of 206 pages of elegantly expressed, carefully reasoned analysis and assessment of the material, of commentary, and of recommendations, so meeting fully, the comprehensive and necessary public coronial fact-finding and analysis of the circumstances leading to the deaths.

### **The Alpine Way, Thredbo Village, infrastructure, private enterprises and public bodies**

The Coroner's Report is structured into the following sections: introduction; the Alpine Way; Roads and Traffic Authority (RTA) as technical adviser 1991–1996; the development of Thredbo; the water main—construction; the Winterhaus retaining wall—construction; engineering cause; the water main theory; the retaining wall theory; the rescue; acknowledgements; findings; recommendations; and appendices. In the space available here a small sample only of the gist of the report is possible. Those whose mainstream interest is hazard mitigation and disaster prevention should read the report in full, as each section contains much of value. Here we aim to convey the essence of the Coroner's investigation, analysis and decision-making, findings and recommendations, and to elaborate further on the ekistic field of concern—the satisfactory conceptualisation, planning, design, construction, management and maintenance of safe and sustainable human habitats.

In his work the Coroner sought and obtained a comprehensive and objective account of many aspects of the Thredbo landslide. There is no indication that the central picture that has emerged has in any way been distorted by paucity and/or suppression of vital evidence. The common-place fear and trepidation of some witnesses to not be forthcoming, because of the possible attribution of blame, has been systematically overcome by the careful conceptualisation of the key issues and concerns before and during the evidential hearings; and the quality, meticulousness and openness of most witnesses, from whom multiple independent corroboration of all important details were always obtained. The result is evidence-based research, conceptualisation and coherent paradigm building at its best.

The immediate root cause of the Thredbo catastrophe was the failure of the Alpine Highway above Thredbo Village which initiated the calamitous landslide. This came about in spite of the clear and widely appreciated evidence that the road's instability in that location presented a serious ever-present unacceptable risk to lives and properties in the Village. The Alpine Way extends for approximately 1.3 kilometres above Thredbo Village. Throughout the history of the Village prior to the 1997 landslide, and despite comments made by many, that part of the Alpine Way was never reconstructed to improve upon the original construction road standards. Several reports were used by NPWS to obtain funds for road improvements along the Alpine Way, but those funds were not spent on reconstructing the highly unstable road above the Village.

There had been a continuing record of landslides. For instance, the first well-recorded landslide occurred in 1964 adjacent to Winterhaus Lodge in the Thredbo Village. This landslide possessed attributes similar to those that were to prove so fatal at Thredbo in 1997.

The Winterhaus landslide occurred on 2 October 1964. It involved the sudden slump of an outer segment of the fill on the Alpine Way above the Winterhaus Lodge through a vertical distance of about 6 feet. That slump was followed by a further vertical displacement to about 9 feet below the road pavement which occurred slowly over the following three days accompanied by a mudflow down-slope extension at the toe of the landslide. Prior to the landslide occurring, cracks and differential settlement of the pavement of the Alpine Way had developed. They were accompanied by several small isolated water outflows from the fill down-slope of the road.

The Alpine Way was built by SMHEA during the construction of the Snowy Mountains Scheme in order to connect Cooma with Khancoban. It was considered essential for the Scheme's development in the Khancoban area. The SMHEA recognised that 'the terrain was extremely difficult for road building and that the road would only ever be used for light vehicle traffic'. According to SMHEA, the Alpine Way was constructed to a 'class A' standard, which was SMHEA's highest standard at the time. However, as SMHEA also points out, a class A standard road was never intended to be a main public highway. It was intended to be used as a construction road, a fact which was readily apparent. The SMHEA roads were

designed with the intention that they last twenty years.

'The fact that the Alpine Way was constructed with a view to being used primarily for a relatively short term purpose in connection with the Snowy Mountains Scheme had long term consequences when the road was later acquired by New South Wales for permanent use as a vehicular thoroughfare' (Hand 2000, 21).

The problems with the Alpine Way were well known and described by commentators throughout its history. Thus, in February 1974, Mr. Shaw, a former Commissioner of Main Roads, wrote of the road:

'The SMHEA construction access requirements necessitated road location on high plateaux and along very steeply sloping mountains and gully sides involving costly side cutting liable to slipping unless placed wholly in the solid. Very little of the latter was done...In many places the (roads) edge is supported against slip down the side slope of the ridge by logs of felled timber which were rolled or dragged into a roughly horizontal position. These logs are now rotting and slips will occur with increasing frequency' (Hand 2000, 21).

On 1 April 1968 the Alpine Way and other roads within the Park constructed by SMHEA became the responsibility of the New South Wales State Government. New South Wales accepted responsibility for maintenance and snow clearing of those roads on the basis that SMHEA was to pay the State an amount in respect of the roads constructed by SMHEA and required by the State for public use as well as being required for operation and maintenance of the Snowy Mountains Scheme. NPWS was responsible for the care and management of roads within the Park. In addition, the DMR agreed to act as agent for NPWS in undertaking snow clearing and maintenance of the roads on a priority basis. The question of providing protection within the Park and general management responsibilities connected with roads remained with NPWS.

The RTA has been responsible for the New South Wales main road system including the Snowy River Shire, throughout the period of the existence of the Alpine Way. It has done this in its various manifestations, first as the Department of Main Roads and then its successor, the Roads and Traffic Authority. At various stages throughout this period it was open to the State Government to proclaim or declare the Alpine Way to be a main road or one or other of a variety of other described roads. The effect of such a

proclamation or declaration would have been to bring the Alpine Way under the control of the RTA and to make it directly responsible for maintenance or construction works. Although this step was not taken prior to the landslide, numerous attempts were made throughout the history of the road to make the RTA directly responsible for it. These steps were unsuccessful (Hand 2000, 23). The RTA and its predecessor the DMR never expressly advised NPWS of the need to reconstruct the road adjacent to the village to avoid the risk of death or injury due to landslide. It is a matter of grave concern to me that a representative of the RTA inspected the Alpine Way, including above the village for a period of some 6 or so years from 1991 until 1996 and never recommended that the road above the village should be reconstructed (Hand 2000, 182).

The construction of some buildings on the extremely difficult site of Thredbo Village was itself seen to be wanting in normal building 'precautionary principles' (Harding and Fisher 1994). Risk analysis showed that, 'at the time of the Thredbo landslide, the risk of death from a mobile landslide at the Carinya-Bimbadeen site was over 2000 times the level suggested by the N.S.W. Department of Planning for tourist developments' (Hand 2000, 180). In spite of this, unsuitable building constructions proceeded in a number of inherently dangerous locations. In one such instance it was reported that 'in approving the site for construction, one person relied on his own engineering judgement. He did not ask for a soil investigation report. That, in his opinion, "was not an appropriate practice at that time", nor was it the practice for him to check the structural design of the building. He presumed that the architect and engineer who designed the lodge would ensure that it was safe and adequate for the site. Whether it was consistent with accepted hillside design and practice at that time was "up to the applicant" and a matter for NPWS. A number of buildings were actually completed and occupied before formal approval was ever given for them to commence' (Hand 2000, 81).

A similarly cavalier approach to the construction of an essential public utility was also in evidence:

'The water main was constructed in April-June 1984 through the uncompacted fill which comprised part of the Alpine Way. It was constructed of AC pipes with Supertite joints. The slope in which and above which it was constructed was subject to vertical and horizontal movement.

Supertite joints were not designed to resist pull-out forces. There are no extant design drawings or construction drawings for the water main. There are no 'as built' drawings. Construction commenced in 1984 before any approval was given. A stop work order was issued by NPWS. It is not known for how long the pipeline had been under construction or the extent of the construction before the stop-work order was issued. Approval was subsequently given by NPWS and construction proceeded. A drawing is extant showing the pipeline as having an approximate 90 degree bend near to the Schuss-Carinya boundary. The installation of an AC water main with Supertite joints in ground that was subject of movement meant that there was a risk that joints could separate and/or the pipe could break leading to leakage of water into the surrounding ground. The slope along the Alpine Way was marginally stable. Its continued stability depended on it being kept well drained. The construction of the water main jeopardised that marginal stability by introducing a potential source of continuous water flow in the event of leakage' (Hand 2000, 93).

The above samples of the very carefully gleaned and detailed evidence, highlights the woeful contemporary human settlement legacy pertaining at Thredbo Village leading up to July 1997.

In summary, the historical records and the evidence of witnesses disclose that in Thredbo Village:

- areas were being classified as 'slip areas/zones'.
- areas of the ground had slipped, or had the potential to slip, and were classified as posing a risk to the Village.
- at one time the lot on which Carinya was constructed was classified as a 'so-called unbuildable slip site'.
- officers of NPWS contemplated the possibility of a landslide of a magnitude of at least 200 metres in length occurring above the Village.
- a subdivision development was rejected on the basis the Alpine Way had to be reconstructed before it could proceed.

'Despite this, there appears to have been no awareness that any works should be undertaken to remove the risk from the Alpine Way or to undertake a systematic review of potential slip zones within the Village' (Hand 2000, 89).

### Findings

In the Coroner's own words (Hand 2000, 5):

'A mass of evidence was led before me which established clearly that throughout

that period the Alpine Way fill embankment which ran for approximately 1.3 kilometres above Thredbo Village was in a marginally stable state and extremely vulnerable to collapse if saturated by water.

'The stability and geotechnical problems with the Carinya site were recognised and understood before any development of the Village in this area. At some later time, probably in the early to late 1960s, this knowledge was either lost, ignored or forgotten.

'I have found in this report that the landslide was triggered when water from a leaking water main saturated the south-west corner of the landslide in the fill embankment of the Alpine Way setting off the first stage of the landslide. The first stage impacted upon the eastern wing of Carinya Lodge. Simultaneously the first stage removed the support of the land to its east causing that, too, to collapse onto the lodges below.

'The causes of the tragic deaths which occurred as a result of that landslide are complex. I have found in this report that those causes are:

- the failure of any government authority responsible for the care, control and management of the Kosciusko National Park and the maintenance of the Alpine Way to take any steps throughout a c. 40-year period to ensure that the Village was rendered safe from exposure to that marginally stable embankment
- the approval and construction of a water main constructed of materials which could not withstand the movement which was taking place in the marginally stable Alpine Way embankment into which it was laid
- leakage from the water main leading to the saturation of the marginally stable Alpine Way fill embankment
- the Alpine Way fill embankment was in a marginally stable state because of the way in which it was originally constructed by the Snowy Mountain Hydro-Electric Authority for the limited purpose of use in connection with the Snowy Mountains Hydro-Electric Scheme

'My examination of the history of the road has left me with no choice but to come to the conclusion that the propensity of the Alpine Way to landsliding which could lead to destruction of lodges and serious injury to persons within them was known to those authorities throughout the relevant period. Despite this, no specific recommendation was ever made by those directly responsible for the road that would have led to the reconstruction of the road above the Village.

‘I have been unable to resolve satisfactorily in my mind how the above hazardous situation was allowed to develop and continue for so long.’

The Coroner also found ‘that, in my opinion, the Rescue Services performed an excellent rescue in all the circumstances which confronted them in July and August 1997. I do note, however, that neither the District and Local Disaster Plans (‘DISPLANS’) recognised the potential hazard of landslide in the Alpine area’ (Hand 2000, 184).

### Recommendations

The primary purpose of the Thredbo coronial inquiry was to ascertain an accurate account of the circumstances leading up to the 18 early unnatural deaths and make recommendations for the minimisation of similar events in the future. The Coroner made a number of pertinent recommendations. The following edited (for stand-alone clarity) abstracts convey the essence of these:

I recommend that the Minister for the Environment consider appointing an appropriate independent committee (to inquire into the responsibilities of NPWS) which I would expect would include, at least, representatives of Local Government, Road Authorities and the Planning and Engineering communities to undertake that review.

I recommend that the RTA examines its system of assessment of slope stability in the light of the lessons I would hope it has learned from this landslide.

I request that urgent consideration be given by NPWS to take account of Kosciusko Thredbo Pty Ltd (the head leasees) request concerning the removal of Alpine Way fill from above the western portion of the Village. If possible, it should provide a detailed explanation of what, if any, risk it sees arising from leaving that fill *in situ*.

I recommend that the Alpine Way and other Park roads inherited from the Snowy Mountains Hydro-Electric Authority which suffer from the same poor construction which affected the Alpine Way be monitored by appropriate experts in order to detect any areas of instability in the manner monitoring is now being undertaken above Thredbo Village.

I also recommend that the Alpine Way along its length, and the other like roads under the jurisdiction of NPWS, be subjected to regular and

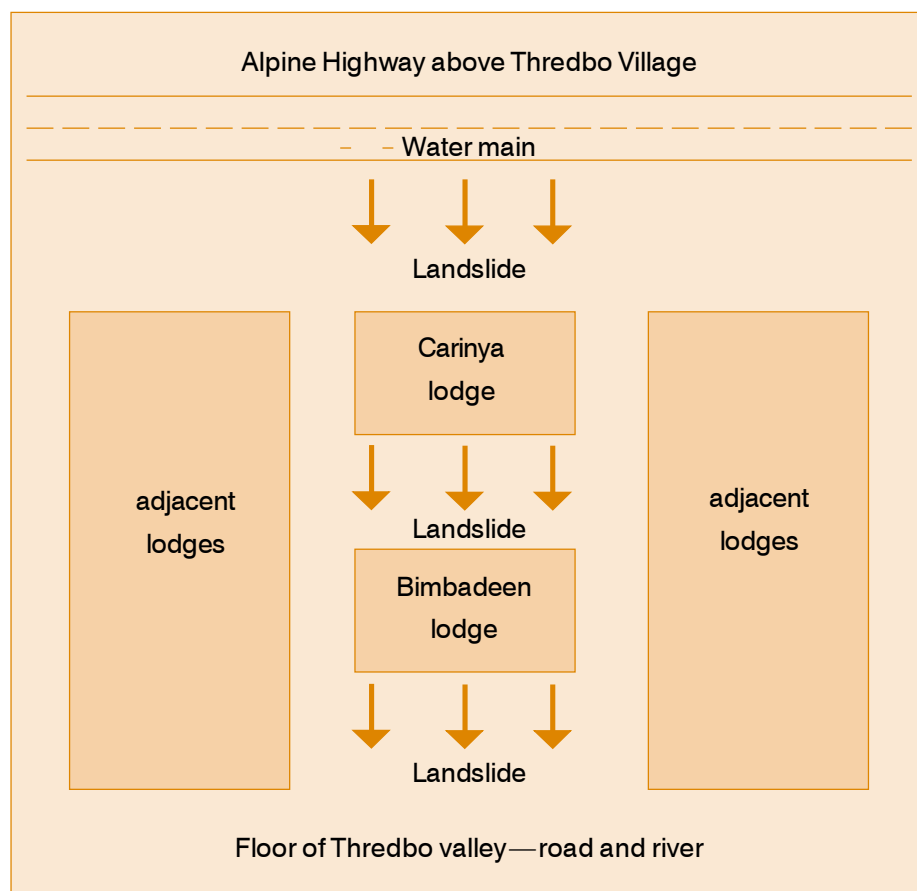


Figure 2: Schematic diagram of the Thredbo landslide. Water from the faulty leaking water main located in the unstable Alpine Way above Thredbo Village was the immediate cause of the disaster, depicts the Coroner’s, immediate-cause of the disaster, findings.

expert geo-technical assessment.

I recommend that NPWS establish and maintain in a central location a record setting out a detailed history of incidents of instability and the like on the Alpine Way and other like roads under its jurisdiction which should include regular reports of problem areas and remedial action taken. I suggest that they be brought to the attention of NPWS with a view to any concerns in this respect being allayed as soon as possible.

I recommend that the Building Code of Australia and any local code dealing with planning, development and building approval procedures, be reviewed and, if necessary, amended to include directions which require relevant consent authorities to take into account and to consider the application of proper hillside building practices and geo-technical considerations when assessing and planning urban communities in hillside environments.

I further recommend that the report *Landslide Risk Management Concepts and Guidelines* (A.G.S. 2000) be taken into account in undertaking this exercise.

I recommend that both the District

and Local Counter Disaster Plans be revised taking into account the risk of landslides in the Alpine area and their management.

Having regard to ... the increasing likelihood of slope instability as development in hilly areas increases, I commend to the authorities revision of all emergency plans to ensure they reflect appropriately the risk of landslides in the relevant area.

The above wide-ranging recommendations, when acted upon, have the potential to substantially reduce the landslide risk factors in Thredbo and similar locations. Such desirable changes are not easy to implement and their timely and effective applications are by no means assured. However, notwithstanding any beneficial changes that may stem from the Coroner’s findings and recommendations, considerable work has been completed overseas (Maybury 1986; Wilson 1991; Smith 1992; Blaikie et al. 1994; IDNDR 1995; Munasinghe and Clarke 1995; Burby 1998; Elms 1998; Godschalk et al. 1999; Ingleton 1999; Mileti 1999) and in Australia, to formulate and implement much-improved guidelines for risk management (Standards Australia 1995, Zamecka and Buchanan 1999), sound land usage (Graham 1998) and building

and infrastructure construction (Wilson 2000), at locations posing evident concerns over endemic geo-hazards (Granger 1999). The Hazard Mitigation Working Group of Emergency Management Australia is at the forefront of work in this area (HMWG 2000).

### Critical Issues Exposed by the Report

*'Great blunders are often made, like large ropes, of a multitude of fibres'*  
(Victor Hugo 1862).

As part of his findings, the Coroner (Hand 2000,184) stated that he had been unable to resolve satisfactorily in his mind how the extremely hazardous propensity-for-landslide-disaster situation at Thredbo Village had been allowed to develop, and continue without rectification, for so long.

Walker (2001), on behalf of the NSW Government, has already made recommendations concerning improving arrangements for government management of remote urban communities and the maintenance of their access and connecting roads. And the emergency management responses and recovery processes have been the subject of several detailed examinations (State debrief 1997; Westaway et al. 1997; Dawe 1999).

Here we will, *inter alia*, explore the Coroner's core concerns and findings further, seeking to shed light upon, and further clarify, the intricate web of pre-disaster-contributing critical issues.

The Thredbo Coroners Report (Hand 2000) highlights many important factors impacting upon the design and management of human settlements in complex contemporary societies (Cutter 1993; Dumas 1999; Eisenberg 2000; Friedman and Friedman 1985; Higgins,1980; Laver 1981;McConnell 1988; Mishan 1967; Perrow 1984; and Stein 1985). These factors embrace the endemic difficulties of inertial and resource-stretched modern governments, and public and private bureaucracies and organisations, faced as they are with managing complex technological and other systems and sub-systems (Skertchly 1968; Hall 1972; Skertchly 1977; Clarke and Crossland 1985; O'Connor 1997; Zeffane 2000b), particularly in the fast-changing, 'economically rational', profit-seeking, capitalist world (Mishan 1967; Soros 1988; Shutt 1998; Shiel 2000).

In general, the greater the magnitude of death, injury and destruction the greater the psychosocial impact. Although natural disasters, such as cyclones, can create greater levels of destruction and loss of life, their psychological impact is often less than technological events (e.g.

structural failure, mechanical breakdown) or human-induced events (e.g. human error or deliberate sabotage) because the latter are believed to be more preventable.

Technological or human-induced events on the other hand trigger heightened feelings of anger and focus attention on the attribution of blame to those perceived to be responsible. Their period of impact may be prolonged as a result of legal proceedings, the apportionment of blame or responsibility and compensation issues. Consequently, people may find themselves facing constant reminders of the event and their role, prolonging the period of impact and slowing the recovery process (Paton and Long 1996,115).

### The Thredbo disaster was a human-induced event directly attributable to multiple human mistakes

There is an extensive technical literature upon land instability as an important geohazard (Sharpe 1975; Crozier 1986) and the characteristics of slopes (Young 1972; Chowdhury 1978; Finlayson and Statham 1980). This literature was available for use by the NPWS, RTA, SMHEA and Kosciuszko Thredbo Pty Ltd, the 'head lease' developers and land users, well before 1997.

The quality of human settlement in Thredbo Village over the past forty years has been adversely impacted by unclear determining, planning and consent authorities; lax building designs, approvals, constructions and maintenance; frequent lack-lustre engineering, hydrological and geo-technical advice; a lack of community awareness of the real levels of environmental risks; and a lack of well-informed, trained and prepared emergency capabilities and rescue resources for possible landslide and other catastrophes.

From time to time voices were heard from some well-informed engineers, planners, and geo-technical experts. For example, Bright, James, Huggett, Lloyd, Moye and Sinclair Knight and Partners, all gave corroborated evidence appreciating the real risks involved in living in Thredbo Village (Hand 2000).

Such initiatives may today be assisted by sophisticated modelling of geohazards (Granger et al. 1999; Michael-Leiba 2000; Smith 2000). McEntire (2000, 58, 61) too, champions the cause of minimising human settlement vulnerabilities by adopting a pro-active hazard and risk reduction planning ethos. He affirms that 'invulnerable development is development pursued in such a manner as to address vulnerabilities, and thereby

decrease the probability that social, political and economic progress will be set back by disaster... what is needed is a form of development that reduces disaster vulnerabilities in order to avert the reversal of social, political and economic progress'. Such an approach, which should be mandatory, requires that appropriately qualified and skilled technocrats, working in well-resourced technocracies, are both enabled to perform their duties with integrity, and also empowered to cause the implementation of their outputs and findings, where these are evidentially well-founded in accordance with established planning and precautionary principles.

But whatever the quality of sound earlier advice on the vulnerability to disaster of the Thredbo settlement, the sporadic Thredbo warning voices were generally much muted, often to the point of extinction, by the indifference and/or inabilities of influential others, who possessed the authority and power, to remedy the situation (Higgins 1980; Friedman and Friedman 1983; Hand 2000).

Within many organisations the most competent technical people may not readily be able to have their well-founded views taken up and acted upon. Many technocrats work in organisations where the best plans are not necessarily the ones that are operationalised. Another factor is the cultural and value system pertaining within many private corporations and public bodies where, for example, 'up to 30% of contemporary workers in a representative sample of Australian organisations do not trust their bosses' (Zeffane 2000a, Zeffane 2000b). Also, 'some people in bureaucracies may deliberately edit out information or data that would highlight their errors or failures of judgement' (Dumas 1999).

So, where there have been would-be whistleblowers, it has generally been very difficult for them to act in the interests of the community. Had this been possible, some landslide risk-aware people may have been listened to and their advice acted upon, so averting the tragedy of Thredbo 1997 (Shiels and Shiels 1991). Today, too, much-improved know-how concerning persuasive and optimally effective counter-disaster alerting and preventative advocacy communications and procedures, is available to support such initiatives (Martin 1999; Vinten 2000).

Over the last half century, as the Coroner's detailed examination of the Thredbo Disaster has revealed, there has been an appalling continuing history of unacceptable administrative and engineering practice, and inappropriate land

Goal confusion	At no stage was there ever a clear conceptualisation of the detailed nature of ultimate Thredbo Village and its essential services and critical infrastructure needs. At the outset, the authorities were concerned only with basic temporary construction camps accessed by temporary roads and communications. This ethos continued.
Institutional Peter Principle	The various agencies were expected to perform tasks beyond their levels of competencies and resources. There was never available adequate professional land usage and township planning expertise; the Alpine Way was never designed, constructed and maintained for the purposes it was later required to perform; and the design, construction and monitoring of the watermain was seriously deficient.
Insufficient human technocratic competencies for necessary tasks	The competencies of available field staff over some four decades varied widely. As well, some of these key staff sometimes did not have either the time, or access to suitable resources, to perform the duties adequately.
Lack-lustre administrative and managerial staff	There was an absence of high-calibre, capable and responsible leadership in lead agencies. Institutional inertia, lack of openness and trust, and under-resourcing, contributed to suppressing safety issues.
Lack of accountable, responsible and prudent, public and private sector management	Both the public and private sector organisations evidenced serious levels of disregard and haphazardness over executing their work in ways which would meet sound contemporary standards.
Disregard for technocratic staff advice	Where sound assessment and performance advice on current and future hazards was produced by field workers it was not ever sufficiently operationalised by the authorities to reduce the risks associated with the evident hazards to acceptable levels.
Non-observance of laws and regulations	Even where they existed, in many instances little or no attempt was made to comply with extant legalities. There were cases of dubious post-hoc construction and building approvals.
Linked public and private sector culpabilities	Public bodies worked aberrantly as excessively closed and technically under-resourced entities; private corporations displayed disdainful disregard for due process compliance.
'Out-of-sight, out-of-mind'	The small Thredbo Village and its activities were located in a relatively remote bushland area and were of direct concern to but an elite few, some of whom were not overly regulation-bound. The State was pre-occupied with major development issues elsewhere. Thredbo human settlement safety was not an evident priority.

Figure 3: Antecedent institutional causes of the Thredbo landslide disaster.

usage associated with Thredbo Village. These have included unsafe utility installation, inappropriate road usage, insufficient road maintenance, building upon unstable sites, inappropriate building designs, and building without authorisations.

Sound contemporary planning, construction and human settlement management regimes, have often not been adhered to. Hand (2000) details many such instances in his Report, some of which have already been cited. Where suitable regulations did exist, they were often disregarded and/or simply not enforced; unfounded assumptions were made as to the efficacy of existing plans and procedures; and where sound advice was forthcoming, it was generally ignored or not sufficiently, or ever, acted upon. For much of the pertinent time the Coroner found evidence of inappropriate land zoning and observance of building regulations including that 'there were no requirements for engineering reports in relation to building work' (Hand 2000, 85). From the outset, the Thredbo community did not possess an orderly and carefully orchestrated approach to safe and sus-

tainable human settlement. Although the Coroner reports gradual improvements in planning and development arrangements, these came too late to mitigate the Thredbo catastrophe.

The ultimately death-dealing, in part dysfunctional, human settlement development value system and operational malaise was evident in parts of both the public, Kosiusco National Park Thredbo development managements and involved public bodies. The leaking pipe along Alpine Way need not necessarily have led to the disaster, had pertinent other aspects of the Thredbo settlement's plans, designs, construction and approvals regime been adequate.

The serious geo-hazard know-how and action deficiencies revealed by Thredbo, are being even more exacerbated in many public bodies today, by deliberate government policies of 'right-sizing' and outsourcing and 'doing more with less' (Bell and Head 1994; Brain 1999, Hancock 1998; Sheil 2000; Sturgess 1996; Yates 2000a; Yates 2000b). This is of vital concern in private enterprises and public bodies whose optimum functioning and decision-making requires high levels of advanced engineering and technical expertise (Yates

2000a; Yates 2000b). When, as has happened over the past decade, public utilities have had their engineering and other in-house capabilities progressively reduced, the potential for much-enhanced hazard generation leading to increased risks concerning vital human safety issues has caused (and continues to cause) considerable individual and public disquiet (Dumas 1999; McEntire 2000; Sheil 2000; Stein 1985 and Perrow 1984; Yates 2000a; Yates 2000b).

Yates (2000a, 2000b) has recently analysed and directly confirmed the above engineering/technological skill deficiency concerns in the Australian environment. In a troubling statement (Yates 2000a, 5), he observes that:

'Over the last decade, government bodies have been reduced considerably in size. This has resulted in a corresponding decrease in the number of specialists, including engineers, where there has been a 20% to 40% reduction in the Commonwealth, State and Local government public sectors. The loss of technical expertise in Australian governments increases the risk that contracts for engineering, information technology and other technical goods and

services, will not achieve government or taxpayer expectations. Since the departure of many technical specialists, the focus on improving contracting skills has overlooked the growing problem of a decline in technical expertise. Consequently, governments need to adopt new approaches to ensure that they have access to the technical expertise required to be an informed buyer of technology.' And apropos of Thredbo, facilitate the building of safer communities.

Yates thus provides additional broad confirmation of the accuracy of the Coroner's portrayal of the causes of the Thredbo catastrophe and of an important societal malaise that needs to be addressed.

It is evident that in the increasingly intricate, interdependent, technological societies in which we live, there will be on-going complex catastrophes of many kinds to contend with (Dumas 1999; Perrow 1984). Hopefully, many others will ultimately benefit, after able coroners like Derrick Hand, in their quintessential risk-preventative roles, determine the causes of unnecessarily high-risk early deaths (Hand 2000). And leading-edge technocrats, within adequately funded, managed and resourced, competent, 'world best practice' organisations (Linstone and Mitroff 1994; Linstone 1999; Mayo-Smith

and Ruther 1986; Pirages and Sharpe 1996; Stephens 1998 and Svieby 1997), will operationalise, with alacrity, coronial recommendations for societal improvements (Elms 1998; Heath 1998). The great challenge ahead is to construct and manage sustainable human settlements that are as safe as possible (Cutter 1993; Henderson 1999; Marien, M. 1996; Pirages and Sharp 1996).

Figure 3 summarises the main historical constituent causes of the catastrophe, so elucidating the Coroner's earlier expressed concerns.

A note of caution is also pertinent. All human/technical systems are unavoidably subject to failure. Design errors, flaws in manufacturing, mistakes in maintenance, and the complexity of modern technological systems conspire to make them less than perfectly reliable...yet there is often a 'good-news syndrome' confirming a psychological bias toward wanting to believe that there is a higher degree of predictability (and safety) in situations than actually exists' (Dumas 1999). Safer human settlement futures entails accommodating such complex matters as have been outlined in this paper, better.

Table 1 summarises the overall Thredbo problematic and possible remedies. The principal source of the key issues is, of

course, Coroner Hand's Thredbo Report.

Table 2 provides some core guidelines to facilitate the design, construction and management of human communities at acceptable current and future levels of acceptable risk for their users and residents. Many important policy, planning and operational changes are needed (Dumas 1999; Elms 1998; Hardy and Fisher 1994; Marien 1996; Pirages and Sharpe 1996). There is currently much 'safety in human settlements know-how' available that is not utilised appropriately and optimally. The task of bringing about significantly improved human-safety-directed regimes in contemporary multi-faceted and pluralistic human societies and settlements is clearly an important and challenging one.

In conclusion, we affirm that dysfunctional human experiences are often the mother of beneficial invention (Reed 1996). It is from such experiences that enlightened, motivated, and resource-adequate, communities, can plan and practice more effective hazard identification and hazard mitigation, and thus risk reduction, so facilitating enhanced quality-of-life-maintenance and/or enhancement, for all concerned (Silverstein 1992; IDNDR 1995 1999; Elms 1998; Heath 1998; Ingleton 1999; Skertchly and Skertchly 2000).

Factor	Dimensions	Issue	Remedy
Human inertia	Complacency	Lack of response to evident need for safe action	Accountable openness to necessary change
Human incompetence	Unsound knowledge and skilling	Inability to understand and suitably act	Monitoring of 'acceptable-only' performances
Not using best available advice/know-how	Ignoring the best available advice/know-how	Not acting upon the best available advice/know-how	Championing/rewarding superior technocrats
Whistleblowers	Vital warnings	Facilitate usage	Officially utilise
Dangerous management of technical complexity	Lack of ability to understand contemporary socio-technical work systems	Incompetent technical leaders managers and decision-makers; political policies	Rigorous initial selection and on-going relevant skilling/renewal training programs
Human skills under-resourcing	Absent/over-stretched resources	Unavailability of required competencies	Adequate human competencies to match needs
Physical resource deficiencies	Absent and/or obsolescent equipment	Work tools insufficient for sound work	Sound work equipment to match work needs
Disregarding established planning guidelines	Disregarding proven planning building and land-use criteria	Not conforming to established sound policies and practices	Instigating modern operational procedures
Disregarding coronial recommendations	Ignoring well-founded coronial advice	Using well-founded coronial advice	Responding to coronial findings with alacrity
Absence of application of the 'Precautionary Principle'	Prudent pro-active, realistic situation audits/actions	Non-application of sound plans and operations	Building a 'safer communities culture' for less vulnerable futures

Table 1: Thredbo Disaster – key issues and solutions.



Feature	Characteristics	Authorities
Land lot(s) info including all known potentially serious hazardous features and risks details	Obtain two corroborating independent-expert detailed land data sets: specific locational and contiguous land history current and futures profiles	Australian Geological Survey; State and Territory Lands, Planning and Environment bodies
Hazard analysis: entity disruption, severe property damage, human injury & death risks	Specific formulation of the like-lihood (probability) of impact of serious hazards: e.g. 1) annual risk of major structural damage, 2) annual risk of death	Recognized geo-hazard agencies and technocratic (engineering and techno- logical) specialists with current competencies
Safe design of the fabricated human infrastructure: roads utilities, buildings etc in urban, rural and remote settlements, matched to locations	Only commission designers of proven integrity, competence and performance record; have all core human safety design features independently confirmed by equally competent technocratic professionals	Government/expert body mandated and licensed experts with established and up-to-date records of leading edge (world best practice) designs (and subsequent constructions)
Construction: the progressive safe fabrication, to design specification, of human settlement artifacts and entities	Verify and certify all vital construction features to comply with all design plans, statutes, regulations and contemporary benchmarks; confirm core safety with another assessor	Licensed, reputable, competent, independent construction assessors and inspectors, overseen by an adequately staffed official monitoring body
Human-safe settlement management: Sustainable, safe, affordable, on-going settlement viability; working to attain community-approved safety benchmarks through progressive improvements	Institute on-going, open, accountable, monitoring and informing, on all core human safety aspects and hazards/risks of the natural and built environments. Incorporate human safety considerations and standards as essential components of all settlements using current and emergent knowledge and understanding	Open, accountable (with F.O.I.), competent governments and public bodies e.g. Emergency Management Australia and Counter Disaster agencies; State Territory and Local Governments and community leaders; adults, owners, operators, shareholders, managers

Table 2: Application of 'The Precautionary Principle' to maximize human settlement safety in environments with known hazard propensities.

The Thredbo Report of Coroner Derrick Hand (Hand 2000) is highly commended to all politicians and planners; engineers and technocrats; hazard mitigators and counter-disaster and emergency practitioners; and people generally, who seek to improve the safety and well-being of contemporary and future human settlements. Prudent proactive hazard mitigation saves lives.

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For the 'valuable contributions to building safer communities' the authors were recipients of the Inaugural and 2001 Safer Communities Awards conducted by Emergency Management Australia.

**This article has been refereed**

## Book Review

### Human Error—by Design?

by Simon Bennett, Director of the Distance Learning Msc in Risk, Crisis and Disaster Management at the Scarman Centre, University of Leicester.

Published by Perpetuity Press  
53pp, ISBN 1 899287 72 8

Reviewed by Macarthur Job,  
Air Safety Consultant and Author

Almost from the dawn of aviation, so-called 'pilot error' has been an all-too-glib ascription of cause in the investigation of aircraft accidents.

In this little volume, Dr Bennett, a British sociologist specialising in risk, crisis and disaster management, examines the view that while an error of judgement on the part of an aircraft crew might often be the final link in a chain of unfortunate or ill-timed incidents that lead inexorably to an accident, the whole cause process is far more complex.

Factors such as operational requirements, crew training and discipline, crew relationships, air traffic control considerations, aircraft maintenance, aircraft design, and airline management can all impinge on circumstances that bring about an accident. Thus, while the final act that precipitates the accident may be one of crew reaction, the underlying causes may lie far back in the accident process and be quite beyond the control or influence of the pilots.

The book is divided into three sections. In the lengthy introduction, which occupies almost half the book, the author presents his case, continually backing his detailed argument with references and quotations from other writers and authorities on the subject of air safety, all of whom are listed alphabetically with their work, at the end of the book.

The second section, Case Studies, then seeks to reinforce the points made in the Introduction by examining one military and five civil aviation accident situations, all of them well known in past years, which illustrate 'the potentially complex and unpredictable aetiology of aviation accidents and disasters'. The book ends with a Discussion and Conclusion section in which the findings of the six case studies are analysed, again with

frequent reference to the comments of other world authorities — and conclusions are drawn.

Overall, the author presents a convincing argument which could well make 'a positive contribution to air safety at a time of rapid growth and development', as he puts it in outlining his objective in the opening paragraph of the book (his words were of course written before the world-changing events of 11 September).

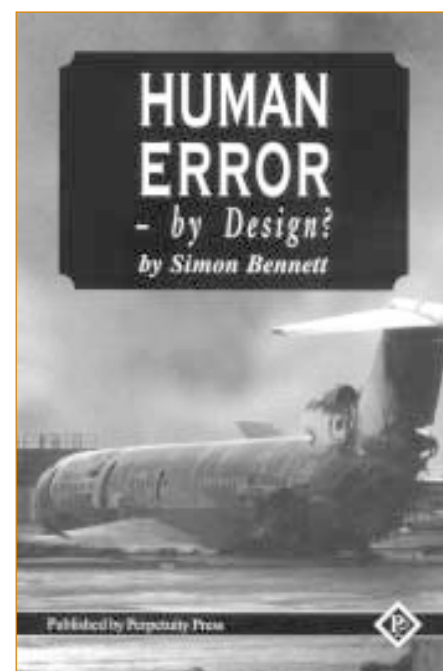
However, all the accident histories considered in the book are more than 30 years old and, in the case of two of the studies, go back to the 1950s. One wonders why the author has not considered the circumstances of more recent accident investigations to illustrate his points even more effectively. The Air Ontario F-28 accident at Dryden in Canada in March 1989, would have been a particularly good example. The background to this accident was so complex that the Privy Council of Canada appointed a special judicial Commission to inquire into its 'contributing factors and causes...', the final report after hearings extending over more than six months, running into four volumes.

Nevertheless, in the field of 'human factors' as they apply to catastrophe management, Dr Bennett undoubtedly achieves his stated goal. Indeed, if widely read and heeded, this work could also do much to counter the all too predictable tendency on the part of the general public and the media to jump to the conclusion of 'pilot error' in the majority of aircraft accidents.

But for a book which is presumably intended for the aviation industry as a whole, it seems a great pity that the style in which it is written will have little appeal. Despite the words of the blurb on the back cover, the text gives the impression of being more a scientific paper than a book.

The language will be unfamiliar to those unaccustomed to academic papers, and the frequent references (some of them unnecessarily pedantic) which appear in parenthesis throughout the text, continual break up the flow of the argument, in effect playing havoc with its readability. This is regrettable, for the content is important, and would otherwise be of interest, both to the aviation industry, as well as to a much wider public audience.

At the same time, from the point of view of the informed industry reader, some of the aviation



terms used will raise eyebrows. The author's habitual use of the hackneyed newspaper jargon 'plane' when he means 'aircraft' seems hardly appropriate to a serious aviation industry publication, and his choice of the word 'velocity' in some places instead of the clearly meant 'airspeed' is technically incorrect.

In a few places also, there are irritating 'explanations' in parenthesis which 'talk down' to the reader, eg.: 'An aircraft stalls when it is flying so slowly that the wings cease to provide adequate lift. A stalled aircraft will fall from the sky. Recovery is not always possible.' One would hope that most industry readers would be familiar enough with so basic an aerodynamic phenomenon as not to require this elementary lesson.

This reviewer believes strongly that, in any written work, readability and ease of comprehension should be a first priority. As one magazine editor would constantly remind his writers: 'No matter how good the story, if no one's going to read it, you might as well not begin.'

For book orders contact the Perpetuity Website at <http://www.perpetuitypress.com>.