



Reducing the Community Impact of Landslides

**AUSTRALIAN EMERGENCY
MANUALS SERIES**

PART III
Emergency Management Practice
Volume 3 – Guidelines

Guide 8

**REDUCING THE COMMUNITY IMPACT
OF LANDSLIDES**

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THE AUSTRALIAN EMERGENCY MANUALS SERIES

The first publication in the original AEM Series of mainly skills reference manuals was produced in 1989. In August 1996, on advice from the National Emergency Management Principles and Practice Advisory Group, EMA agreed to expand the AEM Series to include a more comprehensive range of emergency management principles and practice reference publications. The Series is now structured in five parts as set out below.

Parts I to III are issued as bound booklets to State and Territory emergency management organisations and appropriate government departments for further dissemination to approved users including local government. Parts IV and V (skills and training management topics) are issued in loose-leaf (amendable) form to all relevant State agencies through each State and Territory Emergency Service who maintain State distribution/amendment registers. All private and commercial enquires are referred to EMA as noted at the end of the Foreword on page v.

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Key to status: A = Available A/R = original version Available/under Review
D = under Development; P= Planned; R = under Review/Revision

FOREWORD

The purpose of this Guide is to provide a national reference for general guidelines on emergency planning for landslide. It has been developed for use by all stakeholders involved in managing landslide.

Details of the development of this Guide and other related publications in the Australian Emergency Manuals Series are noted in the Preface. This Guide was sponsored by Emergency Management Australia.

Proposed changes to this Guide should be forwarded to the Director General, Emergency Management Australia, at the address shown below, through the relevant State/Territory emergency management organisation.

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PREFACE

The community and emergency management agencies have obligations to be prepared for emergencies arising from landslides. These guidelines have been prepared by a team of experienced people from around Australia who are currently involved in landslide and emergency management. These guidelines provide best practice principles concerning current knowledge and understanding as to how best to undertake planning for the management of landslides and the emergency response and recovery following landslide.

The aim of this document is to provide national generic guidelines that can be used by those agencies that have a specific role to play in the management of landslides. These include emergency managers, local government, members of the affected community, and other government departments involved in technical and engineering services.

CHAPTER 1

INTRODUCTION

PURPOSE

1. These guidelines are designed to assist with the awareness and management of landslide risk, defining the treat and developing a planning framework to achieve effective implementation of landslide preparedness and mitigation measures.
2. It is not intended for these guidelines to be prescriptive. However, they do outline a range of procedures which individuals or organisations responsible for developing community landslide plans can utilise. The application of these guidelines will ensure that best available management techniques have been considered in developing a landslide plan.
3. These guidelines will not replace any of the existing emergency management processes associated with landslide preparedness, but will help ensure that there is an integrated and coordinated approach to management by all stakeholders.

SCOPE

4. These guidelines are a generic set of procedures for coordinating management planning for landslide. They cover the aspects of:
 - risk treatment strategies;
 - responsibilities of stakeholders, the community and emergency managers; and
 - emergency risk management.

WHY USE THESE GUIDELINES

5. The impact of landslide on communities can be greatly reduced if the risk is defined beforehand and appropriate management strategies are put in place. In order to assist with the protection of life and property from landslide, it is necessary to have:
 - an aware, informed and prepared stakeholder and emergency management team;
 - an aware, informed and prepared community;
 - cooperation between emergency management agencies, state and local government and the community;
 - a coordinated approach to the use of resources;
 - an understanding of the hazard and consequences associated with landslide;

- programs to reduce the risks associated with landslide;
- a clear definition of those responsible for emergency management and safety;
and
- arrangements to enable communities to respond to and recover from landslide.

WHO SHOULD USE THESE GUIDELINES

6. These guidelines should be used by:

- land use planners;
- emergency managers;
- government at all levels;
- government authorities;
- business;
- the community;
- the insurance industry; and
- others as appropriate.

CHAPTER 2

THE NEED FOR LANDSLIDE PLANNING

LANDSLIDE THREAT

1. In Australia, landslides cause more problems than are generally recognised. A landslide or landslip is the movement of a mass of rock, earth or debris down a slope. It can vary in size from a single boulder in a rock-fall to tens of millions of cubic metres of material in a debris avalanche.
2. While the Thredbo, NSW, landslide which killed 18 people in July 1997, or the Gracetown, WA, cliff collapse which caused nine fatalities in September 1996, made the World news, many smaller events kill one or two people at a time, and do not receive such extensive media coverage. At the date of publication, in Australia a total of 83 people were known to have been killed by 37 landslides since 1842. It is almost certain at the date of publication, that these statistics are incomplete and that the number of fatal events is much higher. An additional 85 people were known to have been injured.
3. Landslides have caused many instances of damage and disruption to houses, roads, railways, and pipelines. The data is too incomplete to give accurate costs but is estimated to total billions of present-day dollars. Examples include the Wollongong-Sydney-Brisbane railway, where costs associated with landslide damage are estimated to average \$25 million per year during the period 1989-1996; and more than 200 buildings that have been damaged by landslide with many of these being destroyed. Minimum estimated costs of building damage are in the order of \$30 million present-day dollars.

WE CAN PLAN FOR LANDSLIDE

4. Landslides are often a manageable natural hazard in Australia. Planning will help mitigate landslide consequences, thus ensuring that management arrangements and solutions can be devised methodically and with appropriate consultation in an atmosphere free of the stresses which actual events invariably create. Areas susceptible to landslide are often identifiable and there is usually some warning prior to their occurrence. Often it is possible to determine who may be affected and what problems could be encountered. Much is to be gained therefore by predicting potential landslide activity.

Methodologies

5. The potential for landslide activity can be assessed using a number of methodologies. These may include:
 - the monitoring and interpretation of slide movement as a response to rainfall;
 - the defining of areas of potential landslide activity;
 - the estimation of frequency and size of landslides given various triggering scenarios; and
 - estimating the potential run-out distance of debris flows.

6. It is also possible to model landslide scenarios and their impact upon communities. In this way appropriate planning will mitigate the economic and social costs which landslides impose. Planning will reduce the impact to a community by creating an agreed set of arrangements and actions that will improve the community's ability to manage the threat. This will include devising solutions for the many problems which can be foreseen and which would, without the plan, have to be managed in an ad hoc fashion.
7. Landslide planning should be undertaken in any area in which landslides are considered a threat. Some localities have well documented histories of landslide events and impacts and the hazard is well understood. Landslide plans for such areas may well record the landslide management strategies the communities have tried and tested. The landslide plans for these areas may be made available to interested parties.
8. In other areas there is less information concerning the landslide hazard. This may be because they occur rarely and the experience has been forgotten or simply not considered important. In such situations the relevance of landslide planning may not be so obvious. If there is any perceived or actual interaction between landslides and human activity a landslide plan is essential. As well, the landslide management process should be applied in such instances to determine how the impact of a landslide can be reduced. Remedial stabilisation measures may fail during extreme events and hence, effective landslide planning should include expert site assessment and plans for managing the residual risk (see Definitions).
9. Assessments about the level and focus of planning should be made using an emergency risk management approach as shown in figure 2-1. These analyses will need to consider the physical characteristics of landsliding in the area and the nature of the community. By adopting an emergency risk management approach, strategies will be determined as to how landslide-affected communities can identify, analyse and treat their landslide problems and provide solutions (Emergency Management Australia, 1997a and b).

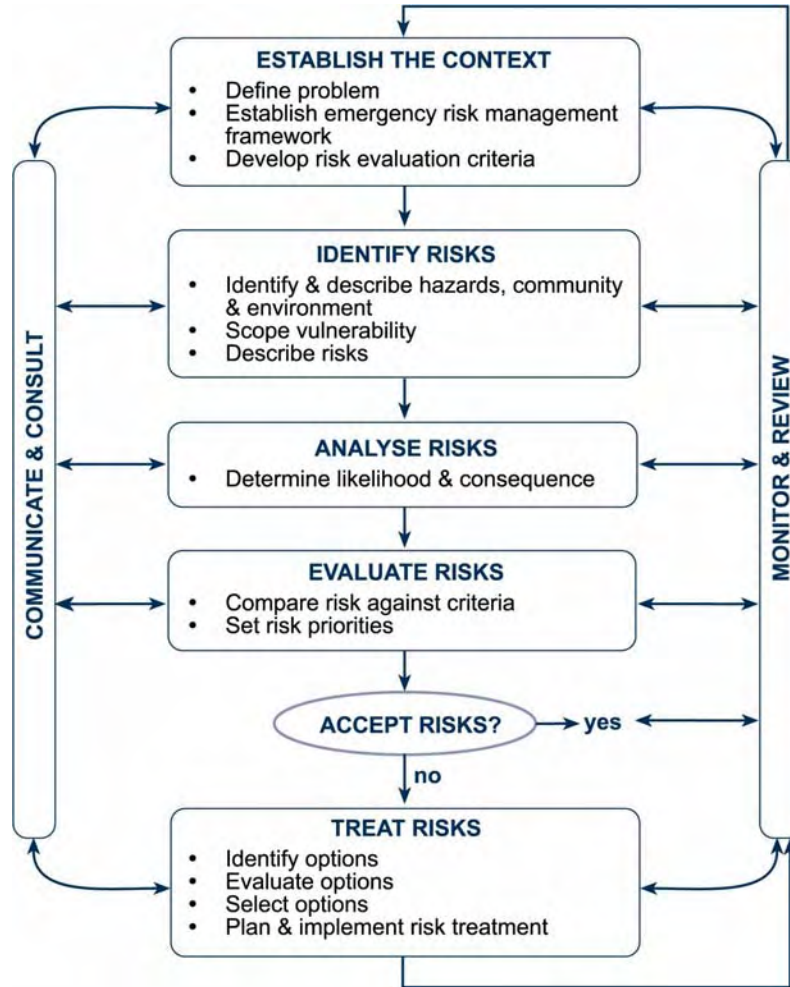


Figure 2-1: Emergency Risk Management Approach to Planning

Plan for All Types

10. It is desirable that the landslide plan for an area takes account of all landslide types that could be experienced. Whatever the nature of the landslide regime the plan should, as far as possible, cover the range from minor or nuisance landslides to extreme events. It must cover the causes, probability and consequences of landsliding.

Fundamental Principle

11. Planning to handle threats is part of making sure community preparedness for those threats is developed and maintained. It is a fundamental principle of emergency management that communities, which have thought about a problem and planned for it beforehand, will be able to cope better than those which have ignored it and hoped it will never occur (Emergency Management Australia, 1993).

CHAPTER 3

LANDSLIDE RISK MANAGEMENT

INTRODUCTION

1. The following landslide risk management strategy is structured in accordance with the Emergency Risk Management process as depicted in Chapter 2, figure 2-1.
2. In developing a landslide risk management program it is important for landslide to be seen in a broad community wide context. The information required for the effective implementation of the risk management process (Chapter 2, figure 1) requires input from a wide range of sources including scientific, cultural, social, legislative and the economic environment in which it is being conducted. For detailed risk management guidelines readers are referred to: AGS Guidelines, AS/NZS 4360:1999 - *Risk Management*, EMA *Emergency Risk Management Applications Guide 2000*, Planners and managers should coordinate the relevant expertise of the various stages of the process thereby ensuring a robust outcome.

WHY USE RISK MANAGEMENT

3. Emergency risk Management provides:
 - a series of tools and processes and a general philosophy which can be used by communities;
 - an accountable and credible means of reducing risk; and
 - a generic format and language for risk management.

ESTABLISH THE CONTEXT

4. Best practice for landslide management occurs within the scope and limitations of established policies and practices. It is therefore essential to:
 - define the scope of the risk management process; and
 - develop risk evaluation criteria.

Both of these matters are discussed in the following paragraphs.

Defining the Problem and Scope of the Risk Management Process

5. A first step in the risk assessment process is to identify and define the scope of the problem and a model in which the work is to be carried out. Risk assessments are an essential component of risk management. Issues to be considered include but are not limited to:
 - scale of the proposed assessment (eg single house or regional assessment);
 - data manipulation, storage and accessibility (eg scale, spread sheets, databases, maps, geographic information systems, tec);
 - the extent of the landslide and/or potential landslide area;

monitoring rates of movement and other conditions (eg pore water pressure, weather conditions);

historical information relating to landslide activity in the area;

human activities influencing slope stability; and

elements at risk and their vulnerability.

6. Landslide management must incorporate professional landslide expertise, preferably including local knowledge. Professional landslide experts will be able to identify pertinent geotechnical issues and provide a best practice approach for landslide risk assessment and management. It is expected that this method of assessment and management would follow the Australian Geomechanics Society's Guidelines (AGS) 1985 and/or 2000 approach.

Risk Evaluation Criteria

7. It is important to distinguish between acceptable and tolerable risk. Acceptable risk is a risk that the community accepts, considering existing control measures adequate. Tolerable risk however, is a risk that a community is willing to live with according to its economic situation, in exchange for certain lifestyle benefits (AGS 2000). However, communities may perceive and respond to landslide risk in very different ways.
8. Individual/community attitudes to acceptable or tolerable risk may be affected by:
 - available resources;
 - personal or community economic situation;
 - commitment to property;
 - individual or community memory and experience with risk;
 - ability to transfer risk;
 - government regulations/requirements;
 - whether the risk analysis is believed; or
 - changing community values and expectations.

IDENTIFY, ANALYSE AND EVALUATE LANDSLIDE RISK

9. Identifying risk requires a detailed investigation of the characteristics and interaction of the hazards with the community. Firstly, determination of the hazard requires an understanding of the classification and causes of landslides. To encourage consistency, descriptive landslide terminology should be based on accepted classification systems. Cruden and Vames (1996) have revised a landslide classification system. In summary, this system describes each landslide by:
 - material; rock, debris or earth; and
 - landslide type: falls, topples, slides, spreads and flows.

10. Landslides are one of the natural means by which mountains and other slopes wear away. However, landslide occurrence can be exacerbated by human activity. Factors causing landslides include:
- increased soil water pressure resulting from heavy or prolonged rainfall;
 - reduction in strength of the soil and rock;
 - earthquakes;
 - human activities (vibrations, slope modifications, water leakage, loading etc); and
 - vegetation removal.
11. Secondly, it is also necessary to identify the characteristics of the community and the environment and how they interact with the hazard. The interaction requires the scoping of vulnerability and will identify areas within the community most at risk.
12. The use of a well-structured systematic process is critical to the identification of risk. This step will also provide information about conditions or events that can be managed as part of the risk treatment options (ERM 2000, AGS 2000).

VULNERABILITY

13. Central to the emergency risk management process is the determination of vulnerability. Determination of vulnerability establishes the capability of a community and the environment to anticipate, cope with, and recover from, emergencies. Vulnerability combines the concepts of susceptibility (the degree of exposure) and resilience (the ability to sustain and recover from loss). To profile the vulnerability of a community and the environment it may be necessary to identify appropriate indicators. Studies of vulnerability could involve both quantitative and qualitative methods.

Five Elements at Risk

14. It is necessary to understand elements in the community to fully appreciate the magnitude and implications of community vulnerability and therefore landslide risk. Granger (1999) has defined the elements at risk in a community and refers to these as the “five S’s”. These are as follows:
- **Shelter** – The buildings that provide shelter to the community at home, at work and at play, vary considerably in their vulnerability to different hazards.
 - **Sustenance** – All communities are dependent on a safe and adequate supply of both water and food and to a lesser extent fuel for cooking and warmth.
 - **Security** – Relates to the provision of the greater community with services relevant to health and wealth.
 - **Society** – Relates to the social fabric of society which dictates strongly the resilience or otherwise of the community to disaster.
 - **Setting** – Relates to the physical environment, communications, demographics, etc.

15. Much information is available that not only defines a particular community but, at a more detailed level, also provides an estimate of the relative vulnerability of each element at risk. This information may include maps, population data incorporating census information, land surveys, building data, environmental characteristics etc.

TREATMENT OF LANDSLIDE RISK

16. There are a number of ways in which risk can be treated. Options include the following:

- **Accept the Risk** – Plan to manage any consequences.
- **Avoid the Risk** – This may be achieved by:
 - abandoning or revising project/activity; or
 - acquisition/re-zoning land.
- **Reduce the Hazard** – Introduce stabilisation measures to control the landslide. After implementation of these stabilisation measures risks should be acceptable or tolerable. Examples include:
 - retaining walls – gabions;
 - subsurface drainage systems;
 - rock bolts;
 - draping areas with plastic and other general surface water diversion techniques; and
 - appropriate vegetation.
- **Reduce the Consequences** – Implementation of defensive measures or adapt the element at risk. Examples include:
 - levees to deflect small debris flows;
 - construction of debris flow channels;
 - compatible house designs;
 - evacuation plans;
 - berms; and
 - wire mesh fences.
- **Monitor Landslide Activity** – Examples include:
 - appearance of tension cracks and other forms of surface disruption;
 - movement sensors – ground surveys, inclinometers etc; and
 - forecasts of heavy rainfall.
- **Transfer the Risk** – Requiring another to accept or compensate for the risk. Examples include:
 - insurance; and
 - acquisition of land.
- **Postpone the Decision** – Pending further investigation and evaluation, and re-assessment of the situation.

CHAPTER 4

DEVELOPING THE PLAN FOR RESIDUAL RISK

INTRODUCTION

1. Residual risk is the remaining level of risk after the risk treatment measures have been taken. Occasionally measures to reduce the probability or consequences of landslide activity fail, so an emergency plan should be in place. Landslide plans are “records of intended proceedings” which are designed to achieve an end – in this case reduction of potential loss of life and destruction posed to the elements of a community. Preparation of such plans requires systematic ordering of the steps to be taken in the event of a landslide developing in an area. These steps or actions will be a combination of generic and site specific approaches; that is they will recognise the general principles of emergency management as they apply to landsliding but will also recognise matters which are unique in local circumstances.

INTEGRATED PLANNING APPROACH

2. The very nature of emergency risk management implies that landslide risks can be prioritised and appropriate treatment determined through assessment and evaluation of options.

LEGISLATIVE RESPONSIBILITIES

3. Governments within Australia have legislative responsibilities for public safety. This is implemented in various ways by different governments. Relevant authorities should be consulted for guidance in referring to appropriate legislation.

WHEN TO PLAN

4. Prioritisation of planning for landslide emergencies may be influenced by:
 - condition of the slope and the degree, if any, of deficiency;
 - population at risk and community vulnerability;
 - a range of probability and consequence situations; and
 - stakeholder perceptions and expectations.
5. Planning needs and priorities should be jointly reviewed as and when further relevant information comes to hand.

STAKEHOLDERS

6. It is of paramount importance that all relevant stakeholders are identified and may include governments at all levels, property owners and lessees, emergency managers and communities at risk as well as those who may be affected by, or perceive themselves to be affected by the emergency risk management process

A PLANNING FRAMEWORK

7. Developing the plan for residual risk involves producing response and recovery plans. These must reflect the State and or Territory emergency management arrangements.
8. The following steps are deemed to be critical elements for both a response and recovery plan. Further information can be found by referring to the Australian Emergency Manual – *Community Emergency Planning* and Australian Emergency Manual – *Disaster Recovery*.

Determine Authority to Plan

9. Authorisation of a plan gives it not only credibility but also acceptance by those who will have to use it. In most instances the authority to plan is established under State and Territory emergency management legislation or arrangements.

Aim of Plan

10. The aim of the plan should be clearly defined and in accordance with State and or Territory emergency management legislation or arrangements.

Establish Planning Committee

11. In some States or Territories membership of the planning committee may be determined by legislation or emergency management arrangements. It is paramount, however, that the membership represents the interests of all stakeholders.

Roles and Responsibilities

12. Negotiating and establishing clear, unambiguous roles and responsibilities is recognised as an essential task of successful planning. In most instances these will be in accordance with State and Territory emergency management arrangements.
13. Examples of the various divisions of responsibility when planning for landslide are shown below.

Property Owners at Risk

14. Property Owners at risk of landslide need to:
 - be aware of the risk;
 - seek expert advice if appropriate;
 - establish liaison with emergency management agencies if appropriate;
 - participate in planning and awareness programs; and
 - develop their own emergency plan.

Emergency Managers and Land Management Agencies

15. Emergency managers, land management agencies and governments at all levels need to do as follows:
- Gather all available information needed to develop awareness, response and recovery plans and have this information available during landslide events. The information required includes landslide information, demographics of the population at risk and evacuation strategies.
 - Prepare and maintain an up to date contact list.
 - Arrange for immediate expert geotechnical advice as required.
 - Establish and maintain liaison with all concerned property owners and others at risk.
 - Identify resources to implement response and recovery plans. This includes communication networks, and appropriate public warning systems.
 - Develop community warning systems as needed.

Community

16. The affected community needs:

An understanding of the potential consequences of the landslide and the response required of them in relation to warnings, escape routes and the like;

- opportunities to be involved in and influence the planning process;
- accurate and timely information during emergency events;
- confidence in the emergency arrangement plans; and
- to participate in community awareness and preparedness activities.

ACTIVATION OF THE RESIDUAL EMERGENCY RESPONSE AND RECOVERY PLAN

17. The trigger/s and authority required to activate the plan (either partially or in total) need to be identified and agreed upon during the planning stage. These triggers should be clearly defined within the written plan.

IDENTIFICATION OF RESOURCES

18. The identification of the resources required to manage an emergency event is an essential part of emergency planning. In respect to landslide, the property owner, land management agencies and emergency planners need to identify requirements in terms of physical and human resources. It is important to assess what is needed rather than limit the scope to what is readily available. When the total list of needs is completed, a range of potential sources can be developed.
19. The scale of the impacts from landslide could be so large as to constitute more than a local response and outside resources could be required to support both the response and recovery. The property owner's emergency plan and the community emergency management plans should contain an up-to-date 24 hour contact list of landslide specialists, and suppliers of resources, in addition to emergency management agencies.

EVACUATION

20. Evacuation is a risk management treatment option, which may be used as a means of mitigating the effects of a landslide on a community. It functions by removing people from the risks associated with the event, thus using distance as the protective agent. However, to be effective it must be correctly planned and executed. The process of evacuation is not considered to be complete until the affected community has been returned. Correctly planned and executed it is effective in protecting individuals and communities from the risks associated with landslide.
21. The evacuation procedures will usually be incorporated into the landslide emergency plan and should address:
- evacuation warnings;
 - evacuation routes;
 - traffic management;
 - access control;
 - location of evacuation centres;
 - assembly areas;
 - relief centres;
 - transport resources;
 - special needs; and
 - initiation of recovery.

More information in relation to evacuation planning can be found in Australian Emergency Manual – *Evacuation Planning*.

RECOVERY

22. Disaster recovery is the coordinated process of supporting disaster-affected communities in reconstruction of the physical infrastructure and restoration of emotional, social, economic and physical well being. The physical and social aspects are critical to effective recovery. Recovery is more than the replacement of what was destroyed and the rehabilitation of individuals. It is a complex social process and is best achieved when the affected community exercises a high degree of self-determination. Recovery is a developmental, rather than a remedial process, so the manner in which the physical and social aspects of the process are undertaken will have a critical impact. Activities that are conducted without consultation and recognition of needs and priorities will disrupt and hinder the process.
23. Recovery managers will need to consider landslide remediation and future land-use with the aid of expert geotechnical advice. More information in relation to disaster recovery planning can be found in Australian Emergency Manual - *Disaster Recovery*.

DEBRIEFING

24. In accordance with good emergency management practice a debrief should be convened as soon as practicable after an emergency or exercise. Provided the debrief is conducted correctly, many valuable lessons can be learnt. A written record of the debrief should be taken to assist in assessing the adequacy of the Emergency Management Plan and recommending any changes.

TESTING THE PLAN

25. Once documentation is complete, the response and recovery plans should be tested (exercised) to measure the extent to which the planning objectives have been achieved.

PLAN MAINTENANCE

26. It is important that the plan is regularly reviewed and updated. This can be a result of:
- an actual event;
 - an exercise;
 - a prescribed time frame; or
 - a significant change to the risk assessment, community or environment.

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GLOSSARY

Hazard

A condition with the potential for causing an undesirable consequence.

Residual Risk

The remaining level of risk after the risk treatment measures have been taken.

Risk

A measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated from hazard and consequences.

Vulnerability

The degree of loss to a given element or set of elements within the area effected by the landslide hazard. It is expressed on a scale of zero (no Loss) to one (total loss). For property, the loss will be the value of the damage relative to the value of the property; for persons, it will be the probability that a particular life (the element at risk) will be lost, given the person(s) is affected by the landslide.

Consequences

The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life.

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