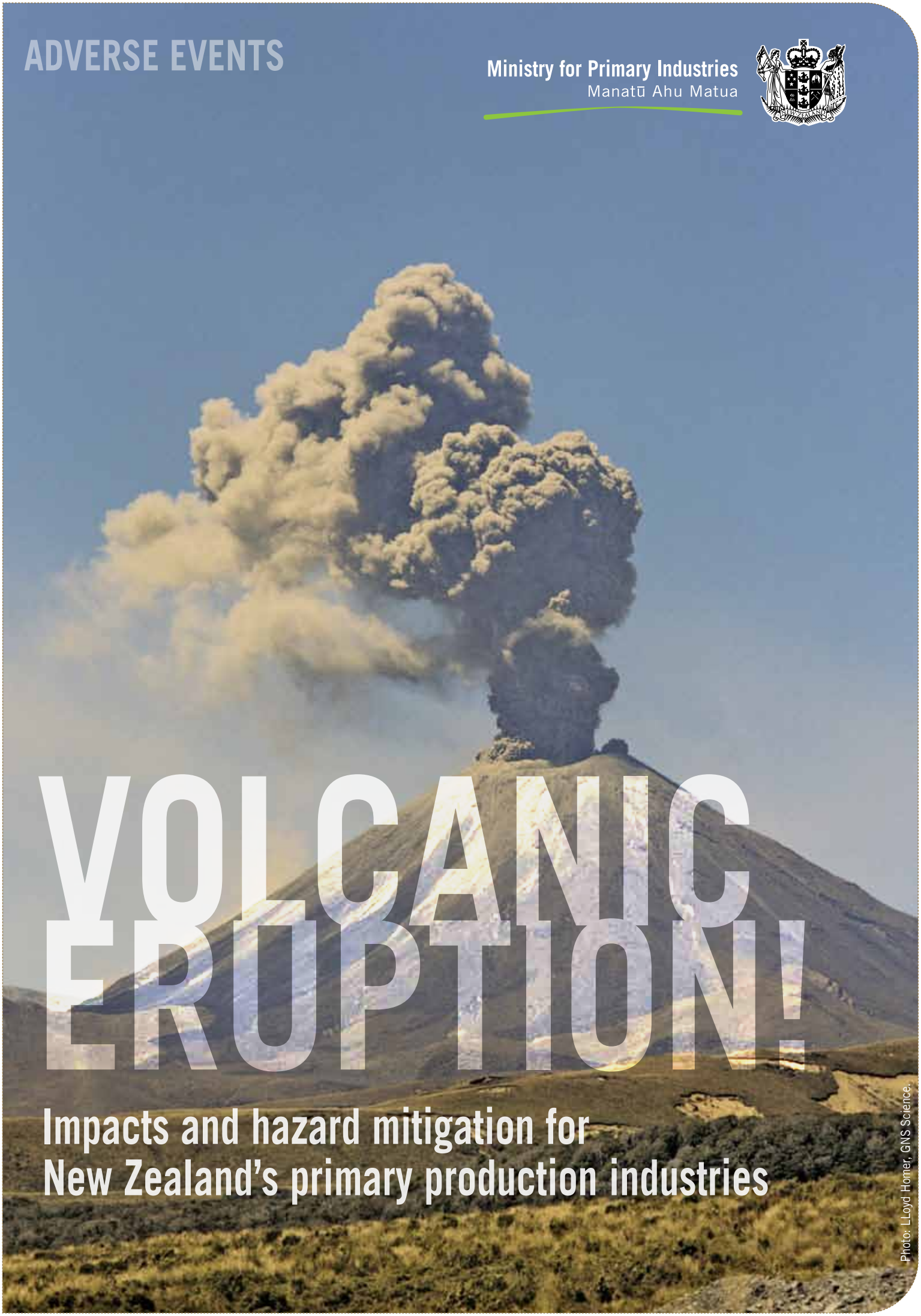
ADVERSE EVENTS

Ministry for Primary Industries
Manatū Ahu Matua



VOLCANIC ERUPTION!

Impacts and hazard mitigation for New Zealand's primary production industries

Photo: LLoyd Homer, GNS Science.

VOLCANIC CENTRES

Volcanic activity, although relatively rare in New Zealand, is a major natural hazard that can inflict widespread damage to life and property. Ten volcanic centres in the North Island are considered active.

WARNING SIGNS

A volcano can show signs of unrest weeks prior to an eruption, however predicting the timing, magnitude and distribution of volcanic eruptions is not an exact science – so be prepared for false alarms.

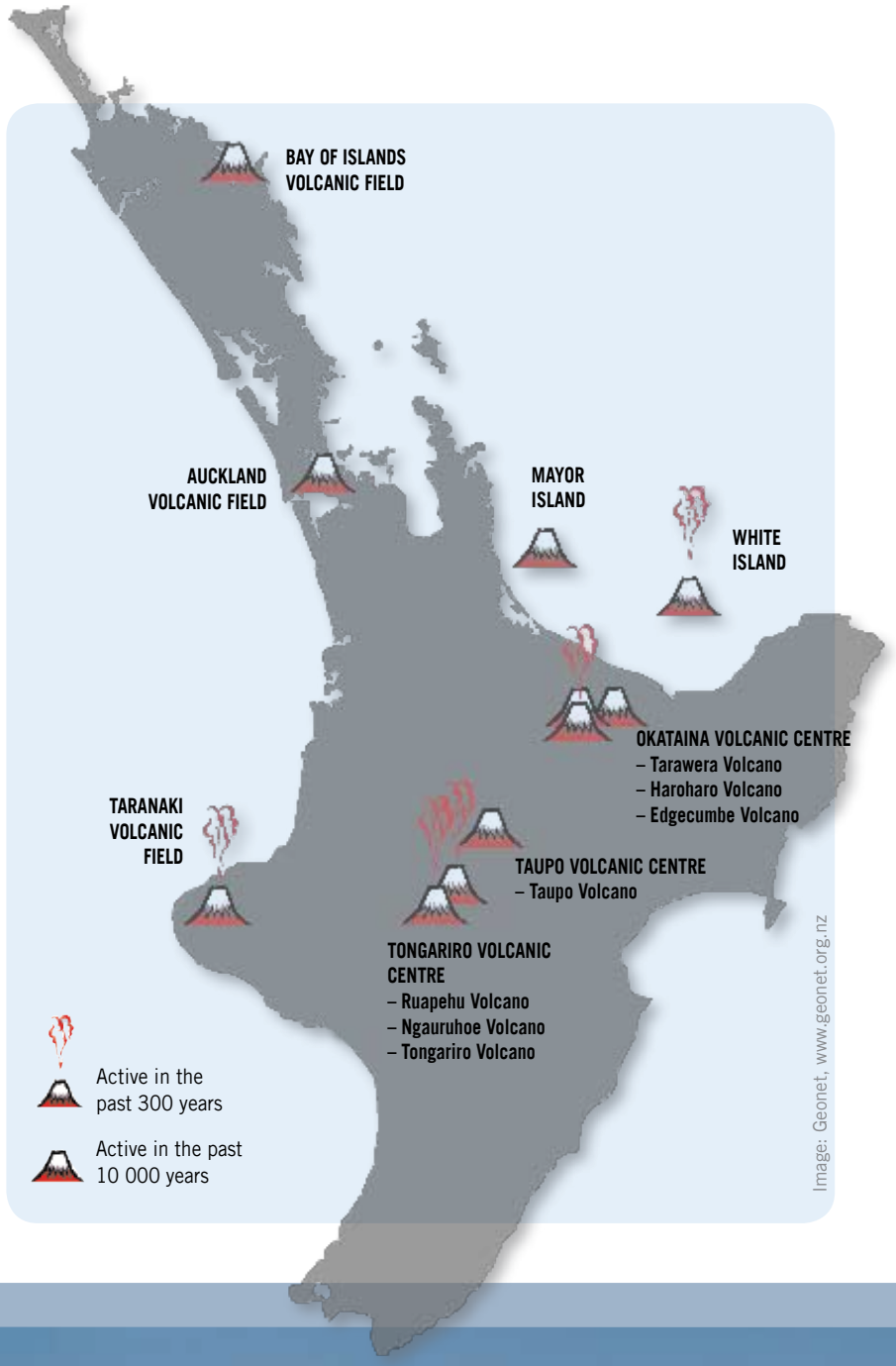
GeoNet (the government volcanic monitoring network) continuously monitors volcanic activity in New Zealand. Volcanic alerts are communicated through bulletins issued to local and regional authorities, and the media.

Be aware that volcanic eruptions may not be short-term events. Volcanic unrest may continue for extended periods.

VOLCANIC ASHFALL

Volcanic ash can potentially be distributed hundreds of kilometres from the volcano, even through relatively small explosive eruptions.

Volcanic ashfall presents the biggest volcanic threat to New Zealand's primary production industry. The impacts of other hazards such as lahars, pyroclastic airborne deposits and volcanic gases are likely to be restricted to much smaller areas.



1996 RUAPEHU ERUPTION.

Fine ash is generally more damaging and can be transported further than coarse ash.

CHARACTERISTICS:

- small, jagged pieces of rocks, minerals and volcanic glass (as pictured below);
- hard, silica-based and does not dissolve in water;
- extremely abrasive and mildly corrosive;
- conducts electricity when wet.

DAMAGING EFFECTS:

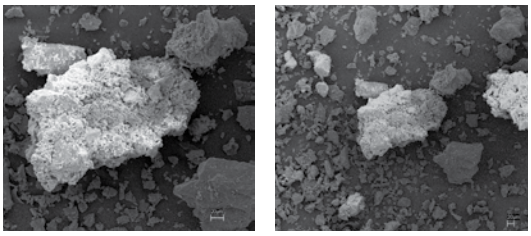
- penetration of human and animal lungs causing respiratory distress;
- penetration of buildings and machinery;
- surface coatings can be highly acidic;
- adheres readily to crops.

The characteristics of the ashfall deposited can vary at different locations.

ASHFALL THICKNESS DEPENDS ON:

- size of the eruption and the volume of material erupted;
- distance of a particular site from the volcano;
- wind and climatic conditions controlling the ash plume dispersal.

In the event of an eruption, government agencies will rapidly analyse volcanic ash and communicate key findings to the public. Findings will help predict effects, and direct mitigation and rehabilitation strategies.



Electron microscope image of ash particles.

PROJECTED ECONOMIC LOSSES

For New Zealand's active volcanic centres, small eruptions such as the 1995/96 eruptions of Ruapehu Volcano are most probable. Larger volcanic centres, such as Taupo and Okataina, are capable of major eruptions although these are relatively rare.

If the 1315 AD Kaharoa eruption from the Tarawera volcano were to happen today, it is predicted that over 13 000 farms would be affected by 20mm of ashfall, and approximately 2200 farms could receive as much as 100mm ashfall. Economic loss modelling suggests that this could cause losses of $2.5–2.9 billion to dairy farming alone.

Even a small eruption from Ruapehu volcano, which would affect approximately 1700 farms through light ashfall (under 20 mm) could cause an estimated $1.0–1.3 million in losses to dairy farming – mainly due to reduced animal weight gain and reduced pasture growth.

CASE STUDY 1

LIVESTOCK IMPACTS FROM THE 1991 ERUPTION OF HUDSON VOLCANO, CHILE

The eruption deposited volcanic ash over an area of 150 000 km^2, mainly in the Santa Cruz province of Argentina, but also as far away as the Falkland Islands.

Several million livestock perished across the region, primarily due to gastrointestinal complications from ingestion of ash and starvation due to covered feedstock.

Sheep were especially badly affected, as their long winter fleeces were contaminated with ash which weighed them down heavily and contributed to their stress. The eruption occurred at the end of a hard winter which also meant livestock were in poor condition and there was limited supplementary feed available.

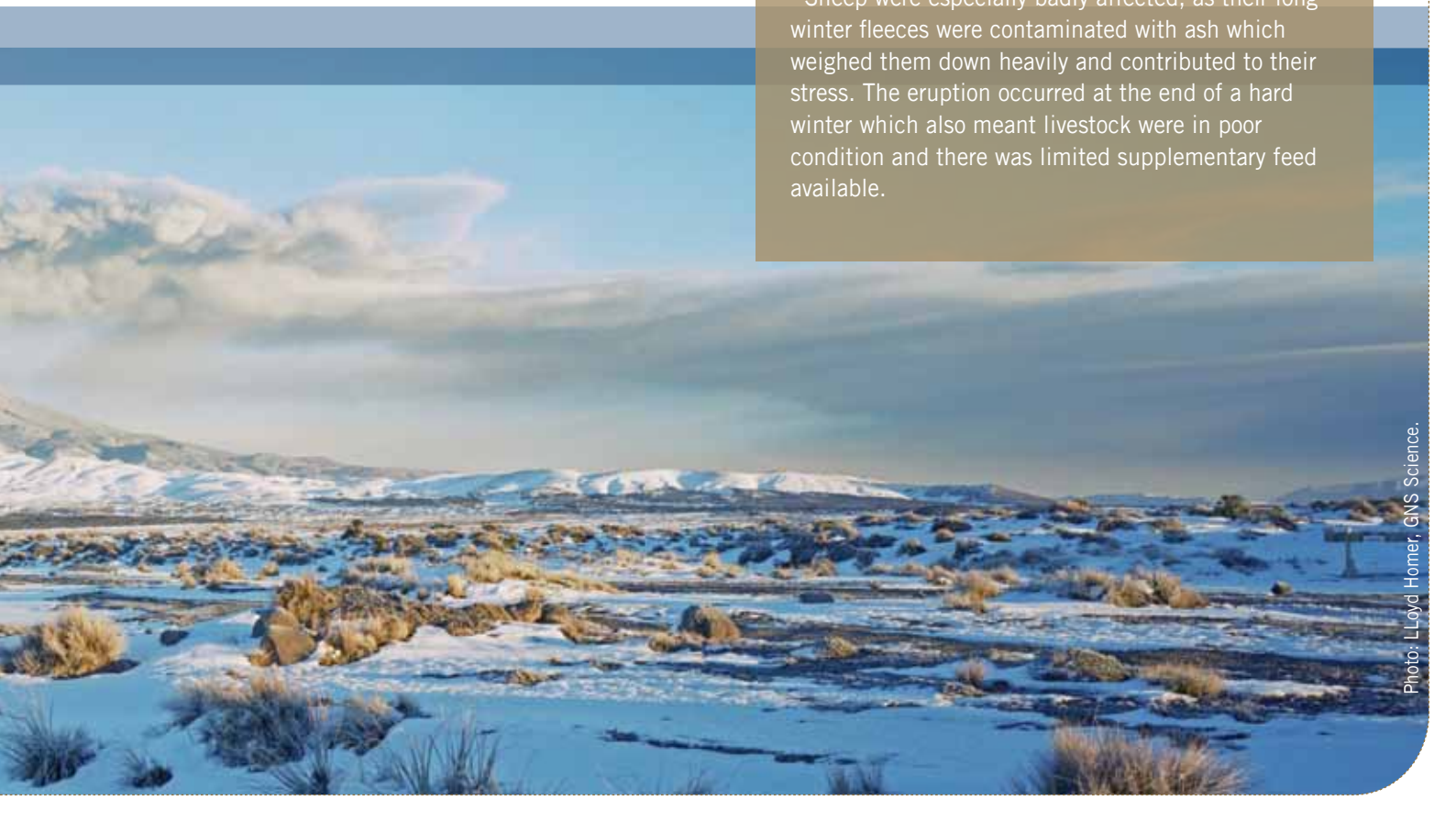


Photo: LLoyd Homer, GNS Science.

EFFECTS ON PRIMARY PRODUCTION

Even small quantities of volcanic ash can have serious impacts, particularly on rural areas, including:

- contamination and disruption of water supplies;
- contamination of pastures resulting in reduced availability of feed and livestock growth;
- increased maintenance costs, and corrosion of vehicles and machinery;
- reduced crop yields and quality;
- adverse effects on livestock health;
- disruption to power supplies, transportation and communication systems.

FOLLOWING A VOLCANIC ERUPTION IT IS IMPORTANT TO:

- stay aware of the condition of livestock;
- confine stock to a few small paddocks close to supplementary feed reserves to reduce their exposure to heavier ashfall.

PEOPLE

Volcanic ash impacts on human health and wellbeing include:

- respiratory effects causing irritation to nose, throat and airways;
- eye irritation including painful scratches in the front of the eye and conjunctivitis;
- skin irritation (particularly if ashfall is acidic);
- contamination of domestic water supplies (especially roof-fed household water tanks);
- clean-up dangers (risk of injury during activities such as roof cleaning).

PEOPLES' SAFETY SHOULD BE THE FIRST PRIORITY:

- Wear a mask and goggles when operating in an ashy environment.
- Reduce ash in your household by keeping doors and windows closed, and stopping draughts with damp towels.
- Take extreme care, especially when cleaning up, as ash will make surfaces slippery.

In a major eruption it may be necessary for everyone on a farm to be evacuated. In this instance, remember to take pets and working dogs. If possible, move livestock into covered yards or barns to protect them from direct ashfall but do not turn stock loose onto roads as they may hinder evacuation procedures and emergency services.

LIVESTOCK

The main issues will be the contamination, and possible destruction, of pastures and water supplies which can put stock off eating/drinking. If possible, locate stock in areas with access to clean water supplies, close to the homestead, and with access to supplementary feed and water.

Protect supplementary feed supplies by ensuring they are fenced off and covered. If practical, cover stock water troughs for the duration of an ashfall.

PHYSICAL IMPACTS ON LIVESTOCK INCLUDE:

- eye and skin irritation;
- respiratory distress;
- abrasion of teeth and hooves;
- contamination of fleeces;
- blockages of the gastrointestinal tract if quantities of ash are consumed.

The physical effects of ash usually predominate over chemical impacts. However, toxic effects due to the presence of fluoride, selenium and sulphur can also be a problem. Of these, fluoride toxicity is the most common problem. High sulphur concentration in the ash may also induce copper and cobalt deficiencies.

ASHFALL ON SHEEP AFTER THE RUAPEHU ERUPTION 1996.

Photo: NZ Herald.

Fluoride toxicity can fall into two categories – acute (short-term exposure to high concentrations) and chronic (longer-term exposure to lower concentrations).

ACUTE FLUOROSIS SYMPTOMS INCLUDE:

- livestock collapsing on their front legs;
- lesions in the nose and mouth;
- hair falling out around the mouth;
- nutritional and stress-related disorders;
- convulsive seizures, pulmonary oedema, kidney and liver changes;
- tooth condition known as "spiking" may cause outgrowths to develop on molars and making chewing difficult.

CHRONIC FLUOROSIS SYMPTOMS INCLUDE:

- impaired tooth development in young animals resulting in mottling and erosion of enamel and excessive tooth wear;
- lameness;
- skeletal deformity;
- reduced feed and water intake;
- lower weight gain and milk production.

Chronic fluorosis usually takes weeks or months to appear. If you are concerned about toxic effects of ash on livestock, seek veterinary advice as soon as possible.

LIVESTOCK EVACUATION

The logistics involved in mounting a rescue operation for animals mean a major livestock evacuation would face numerous challenges.

The number of animals that could be moved to safety depends on:

- time available;
- number of truck and trailer units required;
- number of round trips able to be made per day;
- volcanic impacts on farm and transport infrastructure;
- limited feed sources and facilities for handling evacuated livestock at final destination.

If livestock evacuation is a possibility, farmers and rural organisations in a region should formulate plans before an eruption crisis, including priority of evacuation, potential evacuation destinations and reserves of supplementary feed.

WATER SUPPLIES

Groundwater-fed supplies are relatively resilient to ashfall contamination. However, extraction equipment such as electric pumps and windmills are vulnerable. Springs offer a source of uncontaminated water and should be fenced off from livestock following an ashfall.

Surface water supplies such as dams and streams are vulnerable to ashfall contamination.

MAJOR EFFECTS ON RURAL WATER SUPPLIES are likely to include:

- turbidity (high levels of suspended ash in water) causing clogging of fine irrigation nozzles and accelerated wear and tear on equipment such as pumps;
- physical blockages of pipes, drains and channels;
- water sourced from roof-fed household water tanks becoming undrinkable due to a bitter, metallic taste;
- heavy water demand for clean-up operations;
- abrasional damage to moving parts of equipment and motors, and arcing and flashover damage to electrical equipment;
- power cuts affecting electrically-powered water supplies.

Volcanic ash can cause short-term chemical changes to water quality due to the release of soluble components from freshly-fallen ash. In general ashfall is likely to make water undrinkable (metallic-tasting and discoloured) before it presents health risks. In the event of an ashfall, authorities will analyse ash composition and advise on the presence of any toxic elements that may pose a health hazard.

Livestock are likely to tolerate short-term consumption.

CASE STUDY 2

FLUORIDE TOXICITY FROM THE 1995/96 ERUPTIONS OF RUAPEHU, NEW ZEALAND

Volcanic ash from the eruptions contained high levels of fluoride.

Over 2000 lambs and ewes in the North Island died from acute fluoride poisoning after ingesting ash-contaminated pasture over several days. The animals were under considerable stress following a hard winter and had lambs at foot.

The first sheep deaths on the Rangataiki plains in Taupo began nine days after 1–3mm of ashfall, and continued for a further seven to 10 days, affecting two to three percent of the flock.

ACID AEROSOL DAMAGE TO CHILLI PEPPER PLANTS IN PETUNG VILLAGE (WHICH RECEIVED 10 MM ASHFALL DURING THE 2006 MERAPI ERUPTION, INDONESIA).

Photo: Grant Kaye.

HORTICULTURE

There is little that can be done to protect horticultural crops from ash deposits. The extent and nature of crop damage depends on the type of crop, stage of crop development, the depth of ashfall and characteristics of the ash. The timing of the ashfall in relation to weather events is also important. The types of damage from ash deposits on horticultural crops are also likely to increase the susceptibility of crops to disease. Harvesting operations are likely to be disrupted due to abrasion to machinery, visibility problems and health hazards.

EFFECTS ON HORTICULTURE ARE LIKELY TO BE:

- transpiration and photosynthesis inhibited due to clogged leaf pores blocking sunlight;
- contamination of edible parts of crops, and fruit and leaf blemishes, can occur – making crops unsuitable for sale and consumption. Affected crops may require testing to determine if they meet food safety standards after an eruption;
- defoliation may occur as the weight of heavy ashfall can strip leaves and break weak branches, particularly if the ash is wet;
- disruption of pollination processes which may result in reduced fruit set and smaller or deformed fruit;
- acidic ash may cause burning of plant tissue causing death of plant buds, and russet, delayed maturity, fruit drop or impeded colour development in fruit.

Consider covering or washing ash off particularly valuable crops, and stocking up on sprays and protective treatments for crops as appropriate.

After an eruption, options for removing ash from crops include using overhead irrigation, shaking crops and using air blowers. Ash should be cleared from the base of trees and vines to prevent plant disease or death. Mixing the ash into the topsoil is well suited to annual crops where regular cultivation is a normal practice and adding organic matter and fertiliser will encourage plant and root growth. Defoliated trees will probably drop fruit. However, where there is partial defoliation, thinning of fruit to better align the ratio of leaves to fruit should be considered.

Ashfalls can also have a serious effect on insects and birds, disrupting the spread of pollen. Bees are especially vulnerable to airborne ash, as the surface characteristics which make them effective pollen collectors also make them effective collectors of ash. Relocating beehives out of the areas likely to receive significant ash will assist hive survival.

FORESTRY

Production forests are thought to be relatively resilient to even heavy ashfalls. The extent to which ashfall will affect forestry plantations will depend on the age/size of the trees and the depth of the ash. Small, young trees are more vulnerable to chemical impacts and branch breakage.

EFFECTS ON THE FORESTRY INDUSTRY are likely to include:

- suspension of harvesting operations to avoid equipment damage and human health hazards;
- bending and breakage of branches and tree tops due to weight of ashfall;
- potential for lightning strikes which may start forest fires;
- logs being more prone to sap stain.

CASE STUDY 3
MODELLING LIVESTOCK EVACUATION

A study modelling the evacuation of livestock from the Taranaki region in the event of a large volcanic eruption found that over 208 000 cows would need to be evacuated from farms receiving at least 100 mm of ashfall. Other findings were that this scale of evacuation would take at least 43 600 hours and cost in excess of NZ$2 million.

Evacuation would require 264 livestock truck and trailer units working around the clock for seven days, or 88 units working continuously for 21 days.

An evacuation of this size has never been attempted in New Zealand. It is doubtful that there would be sufficient transport resources to evacuate stock before supplementary feed and water supplies were exhausted, and doubtful that surrounding regions could support this number of evacuated stock.

1996 RUAPEHU ERUPTION AT DUSK.

OTHER PROBLEMS FOLLOWING VOLCANIC ACTIVITY

VULNERABILITY OF ELECTRICITY SUPPLIES:

› Volcanic ash is conductive when wet and deposition of ash on electrical equipment can cause widespread damage and disruption to electricity distribution networks. This is likely to be a major disruptive factor for modern farming operations.

FARM EQUIPMENT:

› Farm machinery are likely to be severely impacted. Motorised equipment may suffer abrasional damage to motors and other moving parts, there will be accelerated wear and tear on seals and bearings, and ash will clog air, oil and fuel filters.
› Vehicle radiators and milk and fruit cooling vats may block with ash, leading to reduced cooling efficiency.
› Computer and electrical equipment will be susceptible to damage and arcing if damp volcanic ash penetrates seals.

TRANSPORT:

› Driving during ashfalls should be avoided because of reduced visibility, obscured road markings and slippery surfaces which give reduced traction.

TELECOMMUNICATIONS:

› Disruption to telephone and radio communications is likely as ash particles may penetrate contact breakers and induce short-circuiting.
› Telecommunication exchanges are susceptible to ash damage and power outages, which may cause disruption to landlines and mobile phone networks, and internet access.

RECOMMENDATIONS

The following recommendations are intended to increase preparedness for volcanic ashfall, mitigate against damaging effects, and promote rapid recovery to full production.

LONG-TERM PLANNING

Planning well in advance of adverse events such as volcanic eruptions could really reduce losses in a crisis. Discuss potential vulnerabilities and how they might be mitigated with neighbours and local rural groups.

PLANNING AHEAD

› Stock up on general emergency supplies such as a reserve of water, food, batteries, candles, and gas/fuel for at least three days.
› Ensure farm insurance cover is adequate and covers crop, livestock and/or pasture insurance for volcanic impacts.
› Maintain a resilient power supply by checking power lines and poles are in good working order and free from overhanging branches, purchasing a generator and ensuring key equipment can be run from tractor power take-offs (PTOs).
› Keep water distribution systems well-maintained; connect distribution systems with separate sources into a single network, have maximum storage in covered water supplies where possible and ensure sumps, drainpipes and drain grills are clear.
› Ensure farms have adequate tank water storage and that stored water can be distributed if pumping facilities are disrupted, by locating tanks on top of topographic highs so water can be gravity-fed.
› Take steps to protect the farm's household water supply by installing a disconnect valve on roof-fed rainwater tanks and stockpiling bottled water.
› Have access to a 4WD vehicle if possible to ensure mobility during natural disasters.
› Have a good supply of engine and milking machine filters, lubricating oil, brake and hydraulic fluids, and seals.
› An air compressor in good working order is useful for cleaning ash from machinery.
› Locate sites, away from critical farm areas, suitable for dumping ash after a clean up and consider what can be used to cap the ash deposits – e.g. soil may prevent ash being remobilised by wind or water erosion.

Photo: Lloyd Homer, GNS Science.

- Ensure ladders, brooms, shovels, and bucket and blade attachments on tractors are on hand for cleaning up.
- Stay up to date with servicing of equipment and machinery.
- Stock up on preventative masks and goggles.

AFTER AN ERUPTION

- Prioritise farm activities by developing a list of facilities that must be kept operative versus secondary operations.
- Clean-up of roofs, roads, tracks and paved surfaces should be considered a priority to prevent remobilisation of ash. Damp down fine ash with a small amount of water and sweep with a broom. Too much water will result in a slurry that may set hard, block drains and make removal more difficult.
- Be careful to conserve water supplies.
- Remove ash from roofs to prevent them from collapsing.
- Regularly check pumps, filters and water intake structures for blockages and signs of damage.
- Build back better; reconstruct water and electricity supply systems or equipment in a more resilient manner to prevent reoccurrence of the same problems.
- Analysis of soil fertility indicators can help inform the best management approach for soil rehabilitation

APPENDIX

LAHAR: Lahar is an Indonesian word describing mud flows and debris flows that originate from the slopes of a volcano. Lahars consist of mixtures of erupted volcanic material and water which flow downhill, typically following existing drainage systems. Lahars can be highly dangerous because of their speed and highly destructive to objects in their path.

Typically, lahars will impact flood plains and livestock should be removed from low lying areas if this is a potential hazard to your farm. Contact your regional council for advice.

PYROCLASTIC AIRBORNE DEPOSITS: Explosive eruptions produce blocks (solid) and bombs (molten) that usually land within two kilometres of the vent, and volcanic ash that can be deposited up to hundreds of kilometres distant.

GROUND-HUGGING FLOWS: Unless it is a very large eruption, pyroclastic flows, lava flows, and ballistic blocks and bombs, are unlikely to travel far enough from the volcano to cause a significant hazard to primary industries.

VOLCANIC GASES: Volcanic gases such as CO_2 and SO_2 may result in acid rain causing damage to plants, buildings and equipment. These gases present risks downwind from the erupting crater and are typically only a hazard within several kilometres of the crater.

MORE INFORMATION

VOLCANIC MONITORING IN NEW ZEALAND
www.geonet.org.nz/

HEALTH HAZARDS OF VOLCANIC ASH AND GUIDELINES ON HOUSEHOLD PREPAREDNESS BEFORE, DURING AND AFTER AN ASH FALL
www.ivhhn.org

IMPACTS OF VOLCANIC ERUPTIONS TO INFRASTRUCTURE AND COMMUNITIES – VOLCANIC ASH IMPACTS WEBSITE
volcanoes.usgs.gov/ash

IMPACTS OF VOLCANIC ERUPTIONS ON AGRICULTURE, HORTICULTURE AND FORESTRY AND POTENTIAL MITIGATION MEASURES
www.mpi.govt.nz/environment-natural-resources/funding-programmes/natural-disaster-recovery/volcanic-eruptions.aspx

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