BUILDING RESILIENCE TO GEOHAZARDS

Delivering strategic priorities amidst a changing climate

The Geological Society

A policy brief from The Geological Society

Geohazards are natural Earth processes that potentially pose a risk to environment, infrastructure, and/or human life. With the capacity to affect core elements of society, geohazards can delay or prevent the effective delivery of the UK's strategic goals. The UK landmass and surrounding seabed can be affected by a range of geohazards resulting from the country's varied geology, landscape and extensive coastline. Some hazards are caused by several different converging natural and human-made conditions, and many are likely to increase in severity and frequency due to our changing climate. These geohazards include:

Land hazards:

- Landslides / avalanches
- Soil erosion
- Ground gas (e.g., radon, methane, carbon dioxide)
- Mine water pollution
- River flooding
- Sinkholes and subsidence

Marine and coastal hazards:

- Submarine landslides
- Tsunamis
- Coastal erosion
- Coastal flooding
- Subsidence
- Saltwater intrusion

Many of these hazards can have impact at both local and national levels, with the UK's high population density and aging critical infrastructure raising the risk of disruption. However, not all geohazards are dynamic or instantaneous events - some occur slowly or cumulatively, resulting in hazardous conditions over longer periods of time. In addition, the UK's access to energy, resources, and transport routes can be affected by far-field impact from hazards occurring in other countries (e.g., air travel disruption due to volcanic ash released by the Icelandic volcano, Eyjafjallajökull in 2010).

Understanding geohazards allows us to predict how impacts will play out, helping to mitigate the severity and extent of effects. Decision-making informed by research, geoscience data, and engineering measures is crucial for minimising the risk of harm to populations and environments, and supporting resilient infrastructure, especially in the context of changing climate.

IMPACTS OF CLIMATE CHANGE

The geological record shows that atmospheric CO_2 concentrations drive climate change, and research has demonstrated that greenhouse gases emitted by human activities are altering the Earth's climate more rapidly than ever before. These changes directly affect our environment as well as the health and wellbeing of populations. Through changes to the frequency and volume of rainfall, sea level, and average temperature, climate change will impact the frequency and scale of geohazard events, both in the UK and elsewhere in the world.

Certain settings that were once considered at low risk from hazards will need to be reassessed in the face of changing climate. This is true for both natural and human-made contexts. For example, mine waste can be destabilised both physically and chemically by extreme weather, resulting in the leaching of acid and contaminant-rich chemicals into the food and water supply chains.

Climate change will also change behaviour, and future populations must be equipped with strategies to face changing risks with resilience and adaptability. To mitigate future climate change, and deliver resilient decarbonisation, the drive for renewable energy will require effective consideration of the impact of evolving geohazards.

Ground failures, including landslides and subsidence, result in emergency repairs to transport networks that cost 10 times more than planned works. Network Rail report that weather-related incidents have cost at least £3 billion over a 15-year period. Increasingly, preparedness for changing hazards affected by climate change will be the most cost-effective way to ensure resilient planning and infrastructure.

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HEALTH

Maintaining safe and healthy communities, resilient to environmental change and hazardous events, requires consideration of the interplay between society, services, and environment. In addition to posing direct risk to life and human health, geohazards can impact the ability of healthcare facilities and emergency response services to operate effectively, especially after a high-impact event where infrastructure is damaged or access is impaired. Strategic planning by the agencies responsible for national health and safety should consider the impact of geohazards on societal services and wellbeing.

TRANSPORT, ENERGY AND COMMUNICATIONS

Resilient transport, communications and energy infrastructure are crucial to modern life. Society is increasingly dependent on internet and cloud computing services, especially with the growth in use of AI and further reliance on data centres. Across transport networks, energy and communications infrastructure, both existing infrastructure and planned developments are at risk from geohazards. Renewable energy projects such as wind farms can be affected by both land and marine geohazards. Linear transport infrastructure, such as road and railway lines, are particularly vulnerable to ground stability hazards like landslides or subsidence. Submarine cables, transporting data and electricity, keeping us connected, are vulnerable to marine landslides, subsidence, or seabed erosion from strong ocean currents. When developing resilient infrastructure to secure the UK's energy supply, maintain communications, and ensure reliable transport networks, the full range of UK geohazards must be considered during planning and development.

NATURE AND HABITATS

Geohazards impact terrestrial, hydrological, and coastal processes, which can have knock on effects for environmental stability and biodiversity. On land, hazards such as landslides, soil erosion, and subsidence damage vegetation coverage and remove nutrient dense soils, whilst marine geohazards such as underwater landslides, turbidity currents, and submarine volcanic eruptions can disrupt the seafloor and interfere with the overlying water column. Processes occurring in both environments affect ecosystems at the coastal transition. At varied scale, these hazards damage and can sometimes destroy habitats and inhabiting wildlife. Many of these hazards impact ground and surface water sources, threatening the fresh water supply. Protecting and conserving the natural environment – including from the impacts of geohazards - is critical to health, resilience, sustainability and economy.

AGRICULTURE, FOOD AND WATER

Many UK geohazards arise from interactions between soil, rock and water with consequences for agriculture that can threaten seasonal food supply. Fluctuations in the frequency and volume of rainfall result in sequential over-wetting and drying of soils with direct effects on crop productivity. In coastal areas, soil salinity can have impacts on water and soil quality with implications for food security and public health. The complicating factor of our changing climate, leading to increasingly variable and severe weather.

HOUSING AND COMMUNITY PLANNING

Land and coastal geohazards can affect housing and community assets like hospitals, schools and social centres, with potential to impact property structure, value and the viability of future developments. Landslides, sinkholes, subsidence, and coastal erosion can cause direct damage, affect ground stability, or increase the likelihood of flooding. Insufficient understanding of locally relevant hazards can hinder community safety as well as future town and country planning.compounds these issues.

TO BUILD RESILIENCE

1. Better understand our Earth and the intersecting processes that influence its environments and systems, in the context of our changing climate and evolving populations.
2. Collect environmental data and make it accessible and open, in line with best practice, to foster collaboration.
3. Strengthen public engagement, build capacity, and enable access to resources that create resilience and empower communities in the face of the reality of climate change.
4. Remove barriers to management of interconnected geohazards that crosscut public policy and planning priorities or multiple environments.

About The Geological Society

The Geological Society of London is the UK's national society for geoscience, providing support to over 12,000 members in the UK and overseas. Founded in 1807, we are the oldest national geological society in the world.We provide professional support to our members, as well as impartial scientific information and evidence to policy makers and the public.

Scientific advice for this brief was provided by Matt Owen and Jim Griffiths.

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