Critical Physical Geography

The Field Guide to Mixing Social and Biophysical Methods in Environmental Research

Edited by

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10. Fieldwork safety planning and risk management

Floreana Miesen

Fieldwork safety challenges

Fieldwork for environmental research may involve activities based in isolated locations and therefore come with a set of complex safety challenges (Fig. 10.1). Environmental and site-specific challenges could include rugged terrain and unstable ground; cliffs with rockfall, landslide or avalanche activity; severe weather conditions; encounters with wildlife; and exposure to harmful plants and pathogens. These challenges may be compounded where fieldwork is undertaken in remote locations with limited or only slow access to help. Operational hazards are also significant, encompassing risks associated with field activities, equipment use, and transportation, with common challenges including fatigue, unfamiliarity with heavy and unwieldy equipment, and the potential for injuries. Social and personal hazards add another layer of complexity, involving barriers to personal comfort and safety, group dynamics and stress during long and strenuous stays outdoors (see Miesen and Gevers, Chapter 9).

Fieldwork safety concerns differ significantly from those in the laboratory, where standard protocols and established prevention and response mechanisms are in place. Managing safety in the field can feel overwhelming due to the need for adaptive and dynamic strategies tailored to the unpredictable nature of the environment. Increasingly, research institutes require their employees to provide written safety plans or risk assessments, yet often lack professional guidance on defining and implementing concrete safety measures. This chapter offers an introduction to addressing fieldwork safety in a structured manner,

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enabling field teams to enhance their preparedness and response capabilities effectively.

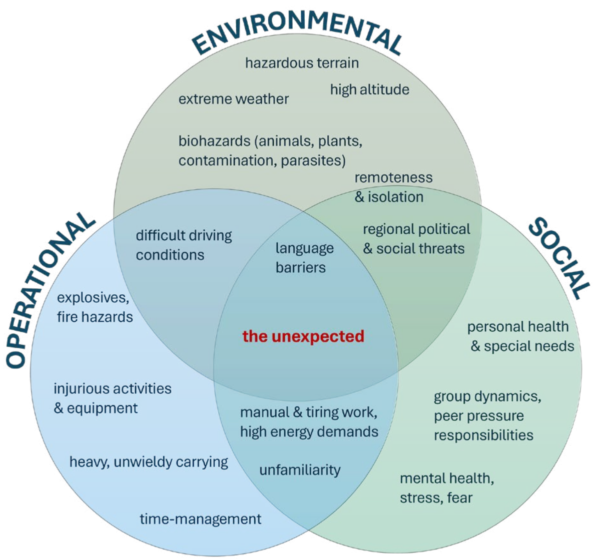

Fig. 10.1 Examples of challenges associated with fieldwork in the context of safety, classified by environmental, operational or social context

Safety planning

Risk assessment

Many research institutes require a formal risk assessment for planned fieldwork activities, where risk is defined as the product of the probability of a hazardous event occurring and the severity or impact of such an event. Typically, a 3x3 matrix is used as the basis of classifying the acceptability of the associated risk (Fig. 10.2). Safety measures must then be defined to mitigate the risk to an acceptable level. In a fieldwork context, risk assessment can be highly subjective due to the lack of reliable statistics or data and non-standardised accident reporting protocols (Cantine 2021), unlike in industrial settings where such information is more readily available. Risk assessments also do not account for the complex conditions that lead to an accident, where hazards or risk factors accumulate and/or interact over various timescales (Lundberg et al. 2009; Vanpoulle et al. 2017).

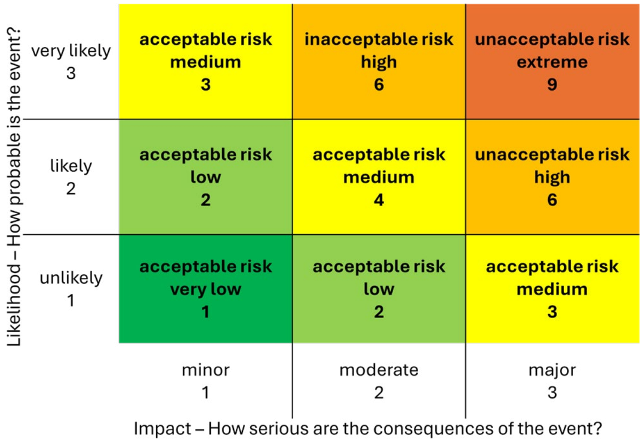

Fig. 10.2 Risk Matrix

Bowtie model for risk management

While risk assessments for environmental fieldwork are often formalised, defining mitigation measures remains challenging due to the unique nature of each campaign. Without standard protocols, fieldworkers often rely on personal judgment and anecdotal experiences from colleagues.

Adapting industrial safety management models, such as the *bowtie model*, to environmental fieldwork can provide useful guidance (e.g., Rasch et al. 2019). The bowtie model, developed in the late 1970s and early 1980s, is widely used in high-risk industries like aviation, material production, and oil and gas exploration and exploitation (de Ruijter and Guldenmund 2014). This model offers a comprehensive, systematic and visually illustrative approach to hazard management, facilitating both accident prevention and consequence mitigation through safety barriers. The model consists of four main components (Fig. 10.3):

1. Hazards—the central point representing the potential source of harm or loss of control.
2. Threats—conditions or activities that could lead to the hazard materialising into an unwanted event (i.e., accident).
3. Consequences—potential outcomes if the hazard is realised, leading to an accident or secondary incident.

4. Safety Barriers—measures which can intervene in the trajectories leading to or from the threat (Sklet 2006). These can be proactive (left side), i.e., preventative measures, detailing the threats and barriers to prevent incidents; or reactive (right side), i.e., mitigation measures to minimise the impact and to regain control.

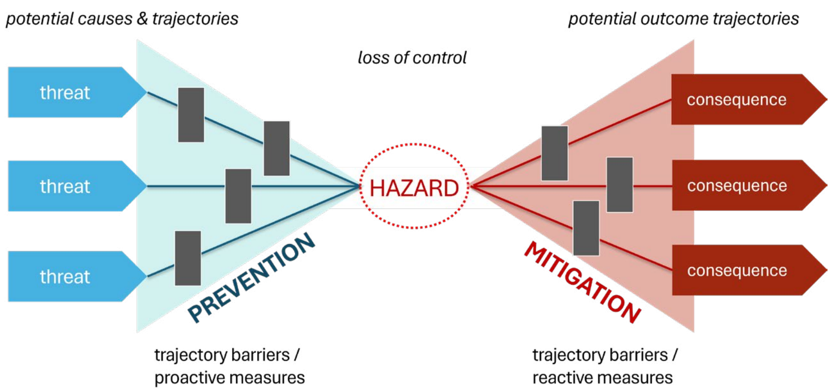

Fig. 10.3 Bowtie model

Proactive and reactive safety barriers in fieldwork

Defining safety barriers for fieldwork can be overwhelming as there are often no standard protocols. A structured approach to safety management is recommended, which classifies safety barriers into (1) strategic (good planning and foresight), (2) skill-based (training and experience), and (3) equipment-based (protective and rescue equipment). Effective hazard management should prioritise these barriers in this order. While essential, relying solely on equipment is inadequate if proper planning and training are lacking. Carrying a high-quality piece of safety equipment, such as a comprehensive first aid kit, can create a false sense of safety, as such equipment is useless if no one on the team know how to use it. Equipment should be viewed as the last resort to keep the team safe, with strategic planning and skill development forming the foundation of a robust safety protocol. See Table 10.1 for examples of proactive and reactive measures related to planning, training, and equipment.

Table 10.1 Examples of proactive and reactive measures in safety planning, training and equipment.

	Proactive measures (examples)	**Reactive measures (examples)**
Planning	Pre-fieldwork site assessment • Consultation of climate charts and seasonal weather records • Natural hazard maps (identify safe access routes, areas to avoid etc.) • Local knowledge and advice, previous field experiences, reconnaissance trip if possible Schedule • Identification of season/time-dependent hazards, consultation of local event schedules (e.g., road closures, hunting season, hydropower flushing schedule) • Realistic time schedule incl. rest time and unexpected delays • Proper acclimatisation when ascending to high altitudes • Agreement on No-Go Criteria, plan check-out and check-in (e.g., logbook), buddy systems Health and wellbeing • Food supply planning that accounts for high energy demands • Pre-field medical check-up, counselling	• Emergency routine (info on SAR numbers, nearest doctor / emergency room / hospital) • Local distress signal • Back-up plan or alternative route • Nearest shelter (open shelter / warden cabin etc.) • Life or limb emergency card with critical health info and next of kin carried by participants

Training	• Navigation / Orienteering skills • Mountaineering, rope handling, river crossing etc. • Offroad driving • Correct use of safety equipment • Field equipment handling • Harassment, discrimination prevention	• Wilderness first aid • Evacuation protocols (e.g., on ship) • Use of satellite communication devices • Use of rescue equipment • Firearms, wildlife defence • Self defence • Bystander intervention, conflict resolution, emotional first aid
Equipment	• Adequate outdoor clothing (rain gear, shoes with grip / ankle support) • Personal protective equipment (helmets, gloves, goggles, hearing protection, high-vis clothing, personal floatation devices, dry suits, steel-capped boots, sun hat) • Personal technical terrain equipment (crampons, snowshoes, poles) • Local site securing (ropes, barriers, shields, shelter, shading, patting, high-vis marking) • Satellite communication devices for updates on weather, road conditions, etc. • Drinking water purification systems	• First aid kit • Emergency shelter (bivy bag, tent, etc.) • Spare clothes • Fire extinguisher • Avalanche beacon and probe • Satellite communication device to call SAR • Rescue line (throw bag) • Rescue floatation device • Crevasse rescue kit

The description of equipment above relates to personal protection, but a non-negligible risk may also come from poor training in field methods and instrumentation—training that is not only crucial for collecting reliable data, but also avoiding the hazards associated with poor equipment use. For drone flying, for instance, many countries require theoretical and practical training, as well as certification by law (see Kasvi, Chapter 45). Without this training, the risk of accidents and crashes is significantly higher, leading to potential damage to expensive equipment but also personal risk. Such incidents can be dangerous not only to the operator but also to bystanders and uninvolved people and may interfere with aviation. In numerous nature reserves, drone flying is prohibited due to the disturbance it causes to wildlife and the environmental harm from debris and lithium-ion batteries of crashed drones. Proper training ensures safe and responsible drone operation, mitigating these risks effectively.

Example: Bowtie Model for safety planning and risk management when sampling a turbulent mountain stream

Figure 10.4 shows a bowtie analysis for a scenario where fieldworkers need to enter a turbulent, cold and strong mountain stream to undertake sampling. The person may fall in the water for different reasons, with various harmful consequences. Proactive and reactive measures related to planning, training and equipment are defined as safety barriers. Note that some personal protective equipment such as helmets are defined as reactive barriers here. The helmet will not prevent the person from falling, but it will interrupt the trajectory towards more harmful consequences. In a different setting, e.g., when working below a cliff, a helmet would provide a proactive barrier to the hazard of head injuries from falling rock.

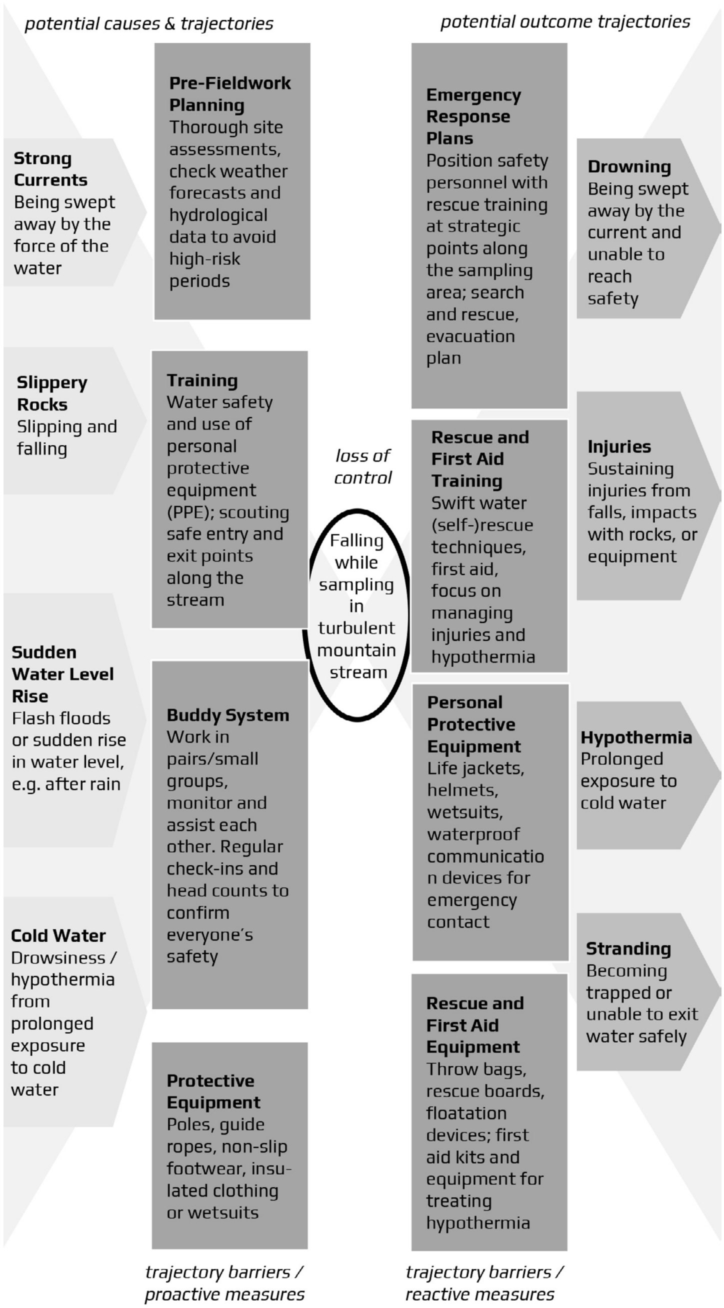

Fig. 10.4 Exemplary Bowtie analysis of water sampling in a turbulent mountain stream

Conclusion

Managing fieldwork safety is inherently complex due to the unpredictable and diverse environments researchers encounter. Addressing these challenges effectively requires a structured and adaptable approach. Emphasising thorough planning, comprehensive training, and proper equipment use is crucial for both preventing and mitigating hazards. By integrating these elements, field workers and field teams can improve their preparedness and response capabilities, ensuring safer and more successful research activities. Like laboratory safety protocols, research institutes should offer guidance on risk management and establish reporting systems to normalise and encourage risk awareness, treating fieldwork as a professional activity where fieldworkers are adequately protected from harm.

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