GICHD

DIFFICULT TERRAIN IN MINE ACTION

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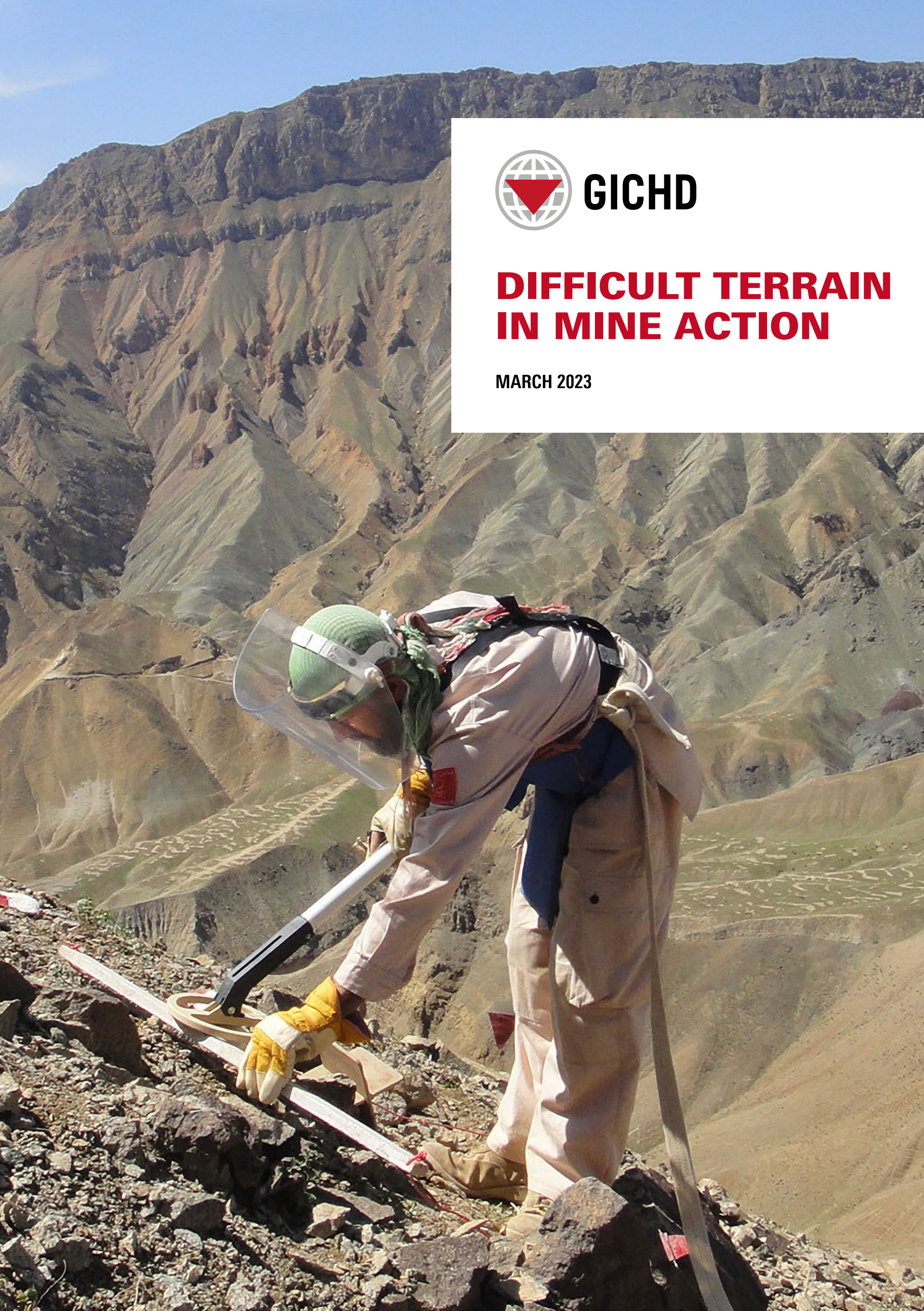

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Cover photo: The HALO Trust

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The study was written by Armen Harutyunyan (GICHD), Alain Nellen (GICHD), Stanislav Damjanovic (GICHD), Nigel Howard (Pinpoint Consulting Services Ltd), David Hewitson (Fenix Insight Ltd) and Katrin Atkins (RISKey GmbH).

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OVERVIEW

Over the past few years, difficult terrain has increasingly influenced land release in many countries and territories. Understanding of planning and work processes in difficult terrain is essential in the mine action sector. The matter is of increasing relevance to completion initiatives under the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction (Anti-Personnel Mine Ban Convention) and the Convention on Cluster Munitions.

Several States Parties have requested an extension of the deadline for completion of the destruction of the ordnance governed by those treaties, at least partly because their progress in the final stages of meeting clearance obligations has been slower than anticipated, often owing to difficult terrain.

Difficult terrain also impinges on the people conducting land release operations. There can be qualitative as well as quantitative benefits, if their quality of life at a remote site can be improved, or if their productivity can be increased through the use of a simple and efficient methodology that mitigates the challenges posed by the terrain.

This study defines difficult terrain as land where inflexible physical constraints or human factors render it challenging to access or release suspected or confirmed hazardous areas. In other words, difficult terrain hinders mine action resources in getting to workplaces and in working there. The hindrance may be that an operator is compelled to use a non-preferred or costly land release method that is perhaps not described or codified in relevant norms, standards or procedures.

The present study identifies several categories of physical constraints that are encountered globally. These are high elevation, steep slopes and cliffs, dense vegetation, water obstacles, sand dunes and sandy beaches, seasonal variation and weather, and remoteness. Operations facing such constraints are often complicated further by human factors related to legislation and social and cultural considerations. Such factors can also lead land to be classified as difficult terrain, as they often influence the everyday planning and implementation of land release procedures.

Practical difficulties and innovative solutions have been identified in several countries and territories dealing with difficult terrain. Other sectors that provide complex services also have to contend with terrain complicated by conflict, legislation and social and cultural factors. Many of their solutions have elements in common with those already adopted by the mine action sector; these include research and development, the adaptation of normative frameworks and prior planning.

Nevertheless, challenges continue to exist in terms of organisational learning. The obstacles thrown up by difficult terrain have not changed, and they continue to impose limitations on the mine action community. As such, there is a fundamental need for the mine action community to continue to extract examples of good practice from the wealth of deep-rooted experience and expertise that exists in the sector in order to ensure that current and future programmes are able to overcome the complexities presented by difficult terrain. This study provides some examples of good practice to guide mine action practitioners in their efforts to mitigate the difficulties posed by such terrain, produce realistic and successful plans and deliver safe, effective and efficient land release. Ultimately, the aim is to ensure that knowledge gained by stakeholders can be shared and used to mitigate successfully difficulties related to terrain, leading to the confident release of hazardous areas.

This study is the first phase in a series of research initiatives to be conducted by the GICHD, with further publications expected to cover specific aspects of the topic of difficult terrain in mine action. These should include a publication on difficult maritime terrain that will focus on better understanding explosive ordnance risks in underwater environments and a study on minefields in border areas.

INTRODUCTION

Since the 1980s, humanitarian mine action programmes have returned vast quantities of contaminated land to safe use, thereby reducing the risk of injury or death for hundreds of thousands of people. Nevertheless, many countries and territories continue to suffer from the harm caused by landmines and other explosive ordnance, and, with early clearance efforts often prioritising areas that are easy to access or easy to clear, the remaining hazardous areas are increasingly those that are difficult to access, survey and / or clear, including in difficult terrain.

This trend is reflected in global metadata. Sustained and increased resourcing of mine action, triggered by the signing of the Anti-Personnel Mine Ban Convention in 1997, was reinforced in the early 2000s as donor countries began associating mines and other explosive ordnance with their national security interests. This led to a sustained reduction in the number of casualties, which reached a low of 3,456 in 2013.[1]

Since then, however, this trend has begun to reverse. There were 7,073 casualties in 2020, the sixth consecutive year of casualties above the record low of 2013.[2] This is explained partly by contamination from new conflicts, especially in the Sahel and the Middle East, and migration, but difficult terrain is a contributing factor. Simply put, the final stages of clearance are the hardest, and historically the areas that have been cleared have often been those where gains could be made most easily, without difficult terrain. Such areas, however, tend not be of the highest socio-economic value during conflict recovery. Casualty trends from legacy contamination (as opposed to new contamination) may thus have become asymptotic: a flattening curve that never quite reaches zero.

Meanwhile, land release in difficult terrain is challenging, resulting in a slower release of the land back to the community – another asymptotic curve. Several countries have cited difficult terrain as a leading factor in their requests for extension of the deadlines for fulfilling their obligations under Article 5 of the Anti-Personnel Mine Ban Convention and Article 4 of the Convention on Cluster Munitions.[3] Unsurprisingly, the issue is frequently raised by national mine action authorities and demining organisations during workshops, conferences and debates.[4] Nonetheless, there have been successes, such as the completion by the United Kingdom of Great Britain and Northern Ireland of clearance in remote, boggy land in the Falkland Islands/Malvinas three years ahead of its Article 5 deadline of 31 March 2024.[5]

Existing literature on the subject is often self-published and comprises good practice guides and post project monitoring, evaluation and learning reports. The present study has analysed such resources in order to identify good practices that can be documented and used across the sector.

The information in this study comes from several sources, including:

- Field visits to four mine action programmes in Serbia, Bosnia and Herzegovina, Croatia and Kosovo;
- Interviews with several representatives of authorities and land release operators, including on active working sites;
- Open-source mine action information from the Landmine and Cluster Munition Monitor and Mine Action Review, including national treaty reports and extension requests;
- Information obtained by the GICHD during studies, research, assessments and field visits conducted previously.

The study aims to support mine action stakeholders, including regulatory and contracting authorities and land release operators, in understanding their options when planning activities and working where difficult terrain poses a challenge. It highlights good practices through the lens of physical and human constraints and, in doing so, seeks to provide planning tools and operating techniques for stakeholders to mitigate the adverse impact of difficult terrain in land release operations.

DIFFICULT TERRAIN IN MINE ACTION

Definition and exclusions

Throughout much of history, humankind has made efforts to alter the terrain to turn it to its advantage. The term 'difficult terrain' is thus used, interpreted and nuanced differently by different groups.

A definition from the construction sector focuses on hazard, namely 'a location that results in labour, materials, plant, and communication risks due to its physical or geographical location'.[6] Some organisations in the foreign aid sector define difficult terrain in terms of its restrictiveness, as in an environment that prohibits accessibility.[7] Some militaries also refer to difficult terrain in terms of encroachment on operational freedom, with implications for cost and complexity such as 'a constantly increasing tactical airlift requirement'.[8] For United States support interventions in Africa, difficult terrain 'significantly increased the cost of these operations'.[9] In other sectors, the similar term 'hostile terrain' is used as much to describe mountains, deep forests, stretches of desert and other areas that are hard to pass as areas with potentially unwelcoming inhabitants.

It is important to note that what constitutes difficult terrain is subjective and relative; something that poses a difficulty in one context may not do so in another. For the mine action sector, the concept of difficult terrain is most relevant to land release operations, which are also the most resource-intensive element of mine action programmes globally. The terrain is difficult whenever it hinders resources' ability to reach workplaces (hazardous areas) and to work there (to conduct release activities, whether surveys or clearance). The hindrance may be that an operator is compelled to use a non-preferred or costly clearance method that is perhaps not described or codified in norms, standards or procedures, in addition to slowing down overall progress.

The present study proposes the following definition of 'difficult terrain' in the context of mine action:

'Difficult terrain' is land where inflexible physical constraints or human factors render it challenging to access or release suspected or confirmed hazardous areas.

The study identifies the most common or significant physical constraints and human factors that cause terrain to be classed as difficult. Some constraints have been excluded from the study because they have already been studied / researched. These include the nature of the soil (e.g. hardness, magnetic properties), which can cause difficulties where manual excavation or metal detectors are employed, the depth of the contamination and the physical properties of the mines and other explosive ordnance. Finally, the study excludes constraints arising from physical damage or security conditions, such as destruction caused by explosive weapons in populated areas and access constraints owing to security concerns.

Sites of cluster munition strikes in Lebanon include cliffs, where clearance may require development of approaches other than those set out in current national standards. *Image: GICHD*

High elevation, steep slopes and cliffs

High elevation poses a challenge for the implementation of mine action survey and clearance activities. Several constraints arise from geographical and topographical factors, such as difficulties in setting up the infrastructure needed to support a complex land release operation. Other challenges in operating in this environment include the need for adaptation of site layouts, reduced safety distances, and falling rocks. Moreover, communications systems, social infrastructure and medical support are often rudimentary or barely function.

Some land release operators tackle such challenges by providing deminers with climbing equipment, building steps and taking other safety measures. In several countries, deminers use ropes and pins in the ground and a strap around the waist to prevent slips and falls when moving within and travelling to and from hazardous areas. Another risk mitigation measure practised by deminers globally is to conduct clearance activities uphill wherever possible. This minimises the risk of items falling downhill on to uncleared areas or of mines or other explosive ordnance being disturbed and falling downhill towards the deminer.

Work in areas of high elevation, on slopes and on mountains is more energy- and resource-intensive. Such terrain is a challenge in **Lebanon**, impeding access to some of the remaining sites of cluster munition strikes and thus hindering the country's progress towards meeting its clearance obligations under the Convention on Cluster Munitions. In some parts of **Lebanon**, cluster munitions have been found in areas that are accessible only by using mountain climbing techniques and equipment, requiring operators to invest in specialist training and equipment.

In such circumstances, national authorities may permit land release operators to deviate from the criteria established for use in open areas. For example, in hazardous areas where a sheer cliff is within the 'fade-out' area (an area less than 50 metres from a cluster munition found during clearance), a surface search (as opposed to a subsurface search) may be acceptable. In such cases, the use of remote-sensing and imagery analysis may also be incorporated into the decision-making process.

The topography of **Tajikistan** is predominantly mountainous (93 per cent). This means that some 7.8 million of the country's 8.5 million square metres of mine contamination are in the mountains, including some at altitudes of between 3,000 and 4,500 metres in areas difficult to access. This is a serious consideration, given that some aspects of land release, including surveys conducted on foot with equipment and manual mine clearance, are physically taxing. At higher altitudes, there is less oxygen in the air, requiring more effort from workers' lungs

Hazardous areas in Tajikistan at the altitude of 3,208 metres

to deliver oxygen to their bloodstream. Acute mountain sickness can affect people of normal or high fitness levels at altitudes as low as 2,000 metres above sea level, and humans rarely inhabit locations above 3,000 metres above sea level. As such, the national authority in Tajikistan requires deminers to obtain a doctor's attestation of fitness / physical suitability for work at high altitudes.

Another difficulty of working in suspected hazardous areas in high mountains is that such areas are sparsely populated, leading to a lack of informants for non-technical surveys, a crucial component of the land release decision-making process. The use of fewer sources of data leads to lower confidence in the survey findings. To overcome this challenge, the national standards and practices in Tajikistan allow multidisciplinary teams to conduct nontechnical and technical surveys simultaneously rather than sequentially. The augmentation of the non-technical survey with a technical investigation has brought greater confidence in the findings of such surveys in sparsely inhabited areas. Furthermore, the process was more cost-efficient, as teams did not have to travel to the same difficult-to-reach areas more than once. There is now a broader discussion under way about the more general application of the simultaneous survey approach in certain contexts, but the rationale for doing so is particularly evident when it comes to difficult terrain.

Bosnia and Herzegovina is also predominantly mountainous, with its highest peak more than 2,300 metres above sea level. Some of the remaining tasks for future land release operations can be found in high mountains and sometimes in canyons or riverbeds. Mines have been placed on steep slopes, which makes demining complex and challenging. Such areas are much more susceptible to erosion, which, along with slope gradient, can cause very intense shifts in the minefields, such that cleared areas become contaminated again.

Demining in the mountains is also a challenge in **Croatia**. During its planning, the national authority (the Croatian Mine Action Center) uses topographical maps, digital orthophotos and vector layers that contain mine action and other related data. This helps it to model the nominal operational difficulty of the demining to be undertaken and to determine the size of the task and the optimal assets for each hazardous area. The process also provides accessibility information, which is crucial considering the intensity of vehicle use in survey and clearance operations.

Steep slopes can prevent or hinder the deployment of machines or animals. Mine detection dogs cannot be deployed at high altitudes, as their sense of smell, and thus their efficiency, is affected. Mine clearance machines cannot always be used efficiently at high altitudes owing to the inclination and barometric pressure.

Given the risks, operators often pose the following questions when considering whether to use such assets in such conditions:

- Will there be capital expenses associated with the deployment of mechanical assets in hazardous areas on steep slopes? If so, what is the cost / benefit ratio?
- Will the deployment of a mechanical asset be a simple solution or a complex challenge in the hazardous area in question?
- Is the deployment of a mechanical asset the best tool available in the toolbox for the specific hazardous area?
- Is there a risk that the vehicles or plant equipment will get bogged down in soft ground? If there is, given that mechanical assets are particularly at risk when the hazardous area is also hilly, wheeled assets are to be avoided and tracked assets used, but only if necessary.

Dense vegetation

The clearance of vegetation and other natural features usually takes far more time than the search for mines and other explosive ordnance, visually or with instruments. While vegetation-cutting has environmental impacts, land release operators deploy mechanical and manual vegetation-cutting assets to maximise productivity and minimise costs in contaminated areas that contain high and dense vegetation, in line with national laws related to environmental protection and conservation. Some vegetation types pose significant planning challenges.

Vegetation-cutting was one of the first applications of mechanical assistance to humanitarian demining and has been in use since the early 1990s. Land release operators frequently use nonintrusive commercial agricultural tractors fitted with extendable cutting arms. The vehicle tracks or wheels remain in a safe area, but the cutting implement swivels to work in a contaminated area. Such vehicles often include some armouring, such as thickened plexiglass windows, to protect the operator from injury should there be an uncontrolled explosion. The deployment of such assets often yields a high cost–benefit ratio for clearance operations in areas of thick vegetation.

In **Cambodia**, for example, the Cambodian Mine Action Centre reports that the removal of reeds, bamboo and other vegetation takes up to 70 per cent of the time spent on mine clearance.[9] Bamboo is particularly challenging owing to its fibre being extremely hard, which sometimes requires the use of chainsaws to cut through overhanging and heavy foliage in densely contaminated minefields.

Vegetation-cutting mechanical assets used in Cambodia *Image: GICHD*

A land release operator in Cambodia compared data from 190 manual demining lanes that had no mechanical support for vegetation-cutting with data from 43 minefields that had benefited from such assistance, provided by 11 different machines. Productivity in the demining lanes with the mechanical cutting support was higher by an average of 73.8 per cent.[11] Similarly, the use of vegetation / brush cutters by the operators allowed the deminers to focus on clearance instead of managing vegetation: one brush cutter supported a team of 30 deminers. This approach is believed to have doubled clearance rates as of 2005 when 14 brush cutters were introduced to the Cambodia Mine Action Centre to support the manual demining platoons.[12]

Similarly, in **Kosovo**, the Kosovo Mine Action Centre and land release operators have collaborated to improve the standard operating procedure for battle area clearance. The change has allowed operators to walk on uncleared areas to cut vegetation in the areas affected by cluster munition strikes, thereby enabling more efficient instrument-aided detection. As a result, one team reported a 66 per cent increase in productivity from one month to the next.[13]

The presence of vegetation adversely affects the safety and efficiency of land release operations, especially in areas of recent conflict where there is a tripwire threat. For example, minefields in **Ukraine** can often contain difficult-to-see grenades placed on trip wires hidden in vegetation. These hazardous areas are resource-intensive to clear, compounded by the absence of minefield records and inconsistent minelaying patterns. The presence (perceived or otherwise) of functioning tripwires necessitates the use of manual tripwire drills, which, in dense vegetation, slows clearance considerably. To mitigate this, one land release operator in Ukraine began deploying a remote-controlled vegetation-cutting machine ahead of manual deminers, reporting a four-fold in clearance rates per deminer per day. While, at first, the operating gain brought about by the higher productivity was offset by the capital expenditure on the acquisition and operation of the asset (including the purchase of armour, a shield and a camera, personnel training, monthly running costs and the formation of a mechanical support team), savings began to be made after 4.6 months.[14]

In **Croatia**, the government prioritises the deployment of mechanical assets and mine detection dogs, reporting that they contribute to high productivity. Its national mine action policy, issued by the Ministry of the Interior, takes this differential treatment of ground prepared by mechanical assets into account: the maximum number of square metres that one deminer is allowed to clear in one day (five working hours) is greater on ground prepared by a machine than on ground that has not been (400 versus 800 square metres).[15] The productivity difference can be six-fold in rocky areas with dense vegetation where flails cannot be used. Croatia has over 40 mechanical assets (used primarily for flailing) and an average of 500 deminers working across the country at any given time; mechanical assets are a significant multiplier of productivity at the country level.

Apart from flailing and cutting, manually or using machines, another method of removing vegetation is burning. Some standards allow burning to remove vegetation to facilitate land release operations.[16] In such cases, organisations should ensure that the burning is controlled to prevent the fire from spreading to other areas and causing an unacceptable risk. In some regions, the burning of vegetation may be strictly prohibited (such as in natural reserves), or special permission from the local authorities may be needed before any vegetation can be burnt. The type of explosive ordnance contamination may also influence the decision whether to permit burning. For example, the presence of NATO submunitions with incendiary functions following the war in **Kosovo** in 1998 –1999 made it unsafe to control the burning.

There may also be legal implications regarding the removal of vegetation. For example, in **Croatia**, 99 per cent of explosive ordnance contamination is in forests, most of which are in protected parks and reserves such as Natura 2000, a European Union-coordinated network throughout member States for threatened species and habitats, in which vegetation-cutting is regulated. As such, the national authorities set requirements to mitigate or minimise damage to the environment, including to protect biodiversity. Below is an extract from a preliminary demining plan issued by the Croatian Mine Action Center to a land release operator.

'Within the boundaries of the site, the contractor may cut vegetation up to the level that enables safe demining, ongoing control and final quality control by the Ministry when removing trees that are smaller than 10 cm in diameter. For the cutting of trees that are larger than 10 cm in diameter, the contractor shall obtain the consent of the contact person designated by the investor or the private landowner.'

In **Colombia**, the government requires compensatory planting to be carried out in areas where vegetation-cutting cannot be avoided in order to offset the adverse effects of land release activities. Nevertheless, land release operators frequently lack the expertise needed to ensure that the right tree is planted in the right place; more partnerships with local experts and organisations would help the land release operators.[17]

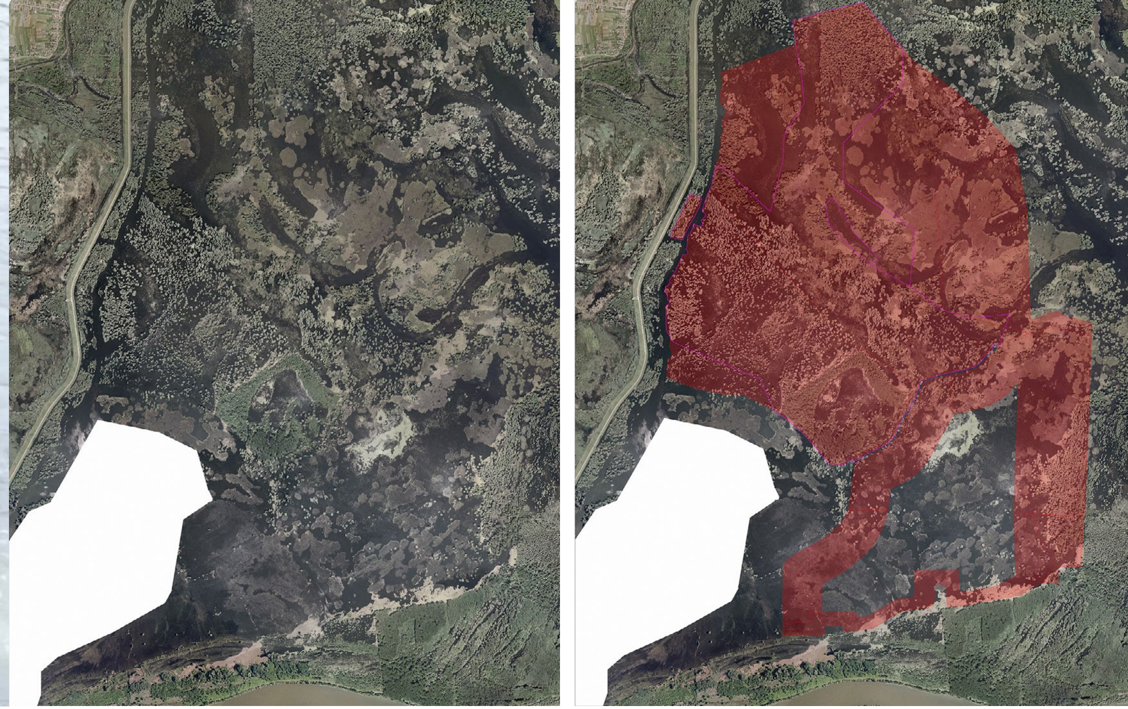
Thailand Mine Action Centre survey team using rubber rafts to get to a survey site *Image: Thailand Mine Action Centre*

Water obstacles

Mines are sometimes placed in water on purpose, either in tidal zones off beaches (for example, in Denmark, the Falkland Islands/Malvinas and Ukraine) or in the shallows of lakes or rivers (for example, in Cambodia, Croatia and Thailand).

Heavy rainfall can cause water levels to rise, which can lead to flooding in an area where landmines are located, making it difficult for people to access the area safely and for mine clearance efforts to be carried out. Mines and explosive ordnance can also be displaced into water because of flooding or related soil movement. Permanent or temporary waterways and seasonal wetlands can pose challenges to land release. Water obstacles can interfere with standard detection equipment, and they can hinder or prevent traditional mechanical clearance methods. Access may require specialised equipment and skills, such as boats and diving capabilities.

The issue of landmines and floods received renewed attention during flooding in the Balkans in 2014. Following one of the worst floods in the history of the region, the authorities of **Bosnia** and **Herzegovina** appealed to the international community for more equipment and satellite screening support in order to track the movement of mines displaced by the floods.[18] Habitual seasonal rains cause water levels to rise, which may move explosive items on or in the ground to previously cleared areas, as seen in the **Lao People's Democratic Republic** in 2018.[19]



Kopački Rit, a hazardous area in a nature park in Osijek-Baranja County, Croatia
Left: The dark green areas are forests under seasonal water
Right: The area affected by explosive ordnance (4.17 square kilometres) is superimposed on to the same area.
Images: Croatian Mine Action Center

Water obstacles hindered the completion of clearance in the **Falkland Islands/Malvinas**. To mitigate waterlogging or flooding after rainfall, the land release operator redirected standing water to other areas using natural draining methods and pumps. The time required to perform this task was factored into the planning to ensure that the timeframe and resources required were realistic.

In north-eastern **Croatia**, most of the remaining hazardous areas are between the Danube and Drava rivers and are subject to seasonal flooding, which creates wetlands and marshes and hinders clearance. When the river levels are high owing to high groundwater levels and rain, parts of the surface can be submerged under 2 metres of water. The challenges posed by wetlands are addressed through thorough planning. In its tasking documentation, the Croatian Mine Action Center indicates whether a hazardous area is prone to flooding. When the ground is predicted to be wet, the additional time and resources required are taken into consideration in the allocation of the tasks to land release operators. They must inform the Croatian Mine Action Center if the amount of water on the ground prevents them from performing work of good quality, in which case an operational pause is considered. Parts of the hazardous area can be accessed only by canals and rivers, so boats are used, with the agreement of the management of the nature park Kopački Rit. These details are clearly indicated in the tasking documentation, allowing land release operators to plan effectively during the tendering and preparation phases.

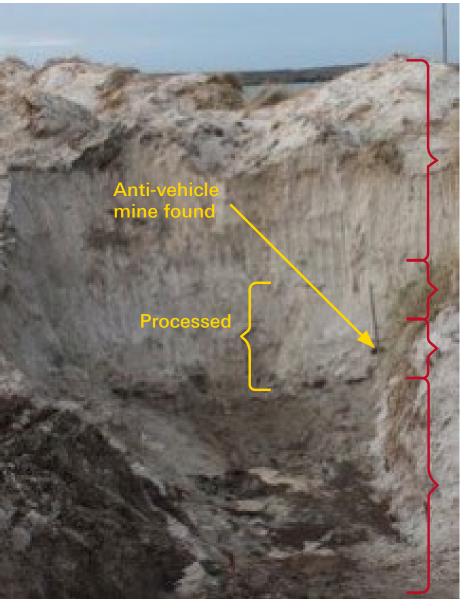
Sand dunes and sandy beaches

Several countries and territories have, or have had, hazardous areas in sandy terrain. Land release in the **Falkland Islands/Malvinas** took place on sandy beaches that were interspersed with rocky outcrops and extensive dunes. The sand in the mined areas near the capital, Stanley, was extremely fine and easily shifted by the constant winds. Notably, the topography of the minefields at the last site to be cleared – Yorke Bay – had significantly changed between the time of the minelaying and the clearance, resulting in mines being recovered at depths of up to 15 metres.

In 2017, an environmental impact assessment conducted during the land release programme identified measures to be taken to mitigate the challenges of working in sand:

- No part of a sand dune would be left in an unstable condition which might lead to a collapse of sand into the excavated area; and
- Where it was reasonably practicable, excavated sand was to be placed or replaced in a manner and location that allowed a natural creation or reformation of sand dunes.[20]

Although historic minelaying records were available in the Falkland Islands/Malvinas, the initial localisation of the minefield was done using a three-dimensional approach. On the basis of records, experience of other minefields and technical survey excavations, it was ascertained that the mines had originally been laid in the sand and not in the underlying clay layer. The land release operator, therefore, followed the clay layer and, using excavators with sifting buckets or passing sand through an independent sifter, processed all the sand around and above the clay layer that could potentially contain mines with a view to finding the first mines. Once the depth of the mines had been established, all the sand that was more than a metre above the mines (the overburden) was removed, without being processed. The greatest challenge was to identify how the topography of the ground had changed from the time that the mines were laid in 1982. Photographs taken at the time, as well as information from local people, were essential in this process. When mines had been laid in an area where the local topography had changed significantly since 1982, a much deeper hazardous layer was excavated and processed and a far greater margin of potential error was accorded to the hazardous layer. Ensuring the safe management of the operations in this difficult terrain required considerable effort.



An excavation shows a mine and the layers of material around it

A photograph of the same area taken in 1982 from a different perspective shows the lack of sand dunes and mines visible at the surface

Images: Guy Marot

The approach described above was effective for recovering mines, but the machinery used significantly disrupted the original pattern / layout of the minefields. Identification of the precise position of a specific mine became impossible. Machine clearance gives an operator an idea of where a mine is to be found, as opposed to determining exactly where it with the surgical precision of manual or animal detection. To guard against the risk of missing mines, therefore, wider and deeper sections of the land were cleared. Nevertheless, the advantages in terms of the speed (without sacrificing safety) brought by the deployment of mechanical assets, in comparison with other potential methods, were carefully considered as part of a cost–benefit analysis and judged to be the superior option.

Seasonal variations and weather

Difficult weather conditions are one of the main factors affecting land release operations. Extreme heat or cold can exhaust deminers and animals and affect machines, which can have an impact both on deminers' ability to work effectively and on the safety of operations. It can also make it difficult for deminers to concentrate, reducing productivity. Extreme cold, wind, rain and snow can disrupt operations completely, as in the **Balkans, the Caucasus and Ukraine** where snow can halt clearance operations for weeks or months.

Seasonal considerations should be factored into land release operators' work plans and survey and planning processes, including assessment and prediction of the accessibility of future hazardous areas. Other potential seasonal considerations are periods with shorter operational days (especially in higher-latitude countries and territories) and the availability of local infrastructure to mitigate seasonal conditions (such as the availability of the fire service during dry spells, shade in summer and community services and roads that might be affected by rain run-off in mountainous areas during rainy seasons). National authorities may opt to regulate some aspects of operations in relation to seasonal variations; in **Tajikistan**, land release operations at high altitudes are limited to a maximum of 65 working days per year.

In eastern **Ukraine**, prior to the intensification of the hostilities in February 2022, land release operations were typically suspended from mid-December through to the end of February. During this period, the ground is frozen, preventing the investigation of metal detector signals and thus full manual demining operations. Mechanical clearance, however, is possible to

Image: NPA

TM 57 AV mine located in Bosnia and Herzegovina

Image: The HALO Trust

An Afghan deminer with protective visor fitted with an umbrella for protection against the sun

a certain extent, as bulldozers and excavators can still dig into the frozen ground. Another mitigation measure used in Ukraine to allow some continuity in the operations is the preparation of contaminated soil piles prior to the start of the cold weather, which may then be manually and mechanically processed during winter.

The wind was a challenge in land release operations in the **Falkland Islands/Malvinas**. The operations were reported to have suffered, on average, 10 days' loss of productivity each year owing to high winds.[21] Constant, strong winds had a debilitating effect on staff and team leaders, and supervisors risked being blown into dangerous ground; deminers, however, were somewhat protected when conducting manual excavation in lanes. Worksite communication and control became difficult. Whistles and shouts could not be easily heard over the noise generated by the wind passing through deminers' visors. Even with earplugs fitted, staff sometimes could not hear the detectors and locators over the noise of the wind, requiring work to stop until conditions permitted its resumption.[22]

Working in marshes is another challenge for demining staff, and it can be a dangerous task. Marshes are wetland environments that are often flooded, making them muddy and unstable. Certain precautions need to be taken when deminers work in these environments. Deminers should be correctly clothed with appropriate warm layers and suitable waterproof clothing. This would include multiple layers of gloves, including those that reach the elbow, wellington boots and, where required, chest waders in addition to waterproof trousers and jackets.

Exposure to extreme heat can result in occupational illnesses and heat exhaustion, which can, in turn, increase the risk that deminers have accidents. For example, the intense heat in **Western Sahara**, which at times reaches 50 degrees Celsius, necessitates that deminers take more frequent breaks.

In some countries and territories, mine action organisations use periods of inclement weather to conduct refresher training or to take workforce-wide annual leave, local labour laws permitting. Such practices are prevalent in countries like **Afghanistan**, where bulk leave or stand-down is taken during the hot and cold seasons, and in Eastern Europe, the Balkans and the Caucasus, where it happens during the cold winter period.

Operators need to provide deminers with the equipment and training that they need to protect themselves from the sun, cold, rain, mud and snow

Image: Guy Marot

Many land release operators adapt equipment and uniforms to give workers greater protection from the sun and its harmful effects. Some examples of protective gear are:

- Wide-brimmed hats or caps;
- Sunglasses;
- Light-coloured, loose-fitting clothing; and
- Portable shading devices, such as umbrellas or canopies.

Survey vehicle stuck on a remote road in Sudan due to local floods and mud

Image: National Mine Action Centre – Sudan

Operators need to provide deminers with the equipment and training that they require to protect themselves from the sun, cold, rain, mud and snow and to remind them regularly to use these items and to following other precautions, such as staying hydrated and taking regular breaks.

It is important to take account of the vagaries of the seasons and problematic or changing terrain right from the earliest stages of the planning cycle to ensure that the requisite resources and time are allocated to the task. This is essential at the levels of the national authorities and land release operators, especially as weather extremes become more regular due to climate change.

A damaged bridge required the HALO Trust to use an improvised raft to get a demining vehicle across a river

Image: The HALO Trust

Remoteness

The remoteness of some of hazardous areas can present many challenges for land release operations, including difficulties of access or of ensuring the provision of the necessary resources and support. Challenges may relate to transportation, communication and access to basic necessities, such as food and water and medical care. Remoteness can also make it challenging to conduct emergency medical evacuations in the event of an accident. Operators at remote worksites should take such challenges into account in their planning to ensure the safety and well-being of their workers.

To overcome deficiencies in infrastructure, land release operators have sometimes built their own access roads, repaired bridges and improvised ways to get through obstacles. More important is instilling in the workforce a mindset of adaptation and problem-solving, with safety precautions prioritised. Land release operators should identify, as part of survey and task planning, potential locations for camps, taking into account their proximity to services and the time needed to travel to and from the worksite and any resupply locations.

At times, the remoteness of hazardous areas can make it difficult to operate at the site from a normative perspective. In **Bosnia** and **Herzegovina**, current standards stipulate that a casualty must be transported to the nearest adequate medical facility within 60 minutes of the accident.[23] In most areas of difficult terrain, it is impossible to evacuate the casualty by road within the stipulated timeframe. As such, tasks in difficult-to-access areas in Bosnia and Herzegovina are often categorised as low priority, even though those areas are where many of the accidents are recorded. There are two possible ways of overcoming the challenge: either the organisation of additional helicopter support like in **Tajikistan** or **Thailand**, or the possible amendment of the national standards to allow for a more extended evacuation period, as long as proper trauma support is first provided on site.

Tasks in remote locations are some of the most challenging that land release operators perform. Not only is task delivery difficult, it is exacerbated by accessibility problems related to project set-up, logistics and the on-site sustainability of personnel, right through to casualty evacuation. Such sites imply extreme working conditions for staff and a lack of the services enjoyed by locations closer to a population centre.

A suspected hazardous area in Bosnia and Herzegovina where operations cannot occur owing to the site's distance from the nearest hospital *Image: GICHD*

Experience from outside the mine action sector has given rise to a few good practices that can also be applied in mine action. The humanitarian sector delivers health services to remote places and faces challenges in transporting and storing sensitive medicines.[24] Organisations in this field are experienced in operating in inhospitable environments, conflicts and natural disasters.[25] For example, Médecins Sans Frontières, in its Akobo project in **South Sudan** in 2018, used mobile clinics that travelled by boat or by car. By adapting its medical equipment to be highly transportable, Médecins Sans Frontières was able set up makeshift medical facilities that included a basic healthcare clinic, a waiting area and additional tents used as private consultation spaces. It established clinics in seven locations that had previously been termed inaccessible, treating over 2,000 patients per month.[26]

Many of the practices from other sectors are already in use in mine action. In **Cambodia**, **Tajikistan**, and other countries and territories that have many remote hazardous areas, land release operators often establish camps for deminers close to the worksite and construct (where possible) a helipad in case there are casualty evacuations to be carried out. In **Western Sahara**, such camps are so isolated that it takes up to 16 hours for an operational team to deliver food or water there. Remote sites always lack nearby, adequate healthcare facilities. In the Nuba Mountains of **Sudan** and **South Sudan**, 'some mine casualties are transported for hours and sometimes days on animals, bicycles, carts or homemade stretchers to the nearest public health facility'.[27]

In **Thailand**, deminers also face a geographical landscape of extremes, including remote areas that are difficult to access. To overcome this, projects such as the Ruang Phueng operation have been introduced, using helicopters to transport the deminers to the areas where they need to carry out their functions. Teams in Thailand are also provided with other auxiliary assets to overcome the challenge of the remoteness of the mined areas, including boats and motorcycles.[28]

Above: A tented demining camp in a remote area of Tajikistan *Image: GICHD*

Land release team members equipped with mountain bikes to help them get to mined areas

The mine action and commercial sectors address the challenges posed by remoteness through workforce arrangements such as long-distance commuting or the construction of semi-permanent camps.[29] Experience gained in the other sectors has indicated that long-distance commuting is more attractive to single workers, usually men, who are more willing to work long hours in uncomfortable conditions than those living with their families in conventional mining communities. Long-distance commuting also poses the risk of acceptance issues among any local population. Given that long-distance commuting can skew the recruitment base towards single men, consideration should be given to employment equity and the options for hiring staff locally. In mine action, the duration of a task would be a principal determinant of whether staff would be hired remotely and then engage in long-distance commuting or whether local hiring would occur.

The remoteness of an area affects the quality of life of individuals living in such communities as well as those who must work there, on a daily or temporary basis. The planning of remote tasks should include consideration of the local economy (for example, the availability of fuel and food), infrastructure (for example, the quality and safety of housing and the availability and quality of health services) and local medical risks.

Remote sites are the great leveller of mine action management. Experience in remote conditions is often required to enhance project management competencies in order to sustain the quality of a project, avoid delays and increased costs, and to maintain the level of quality control. Mitigation of challenges posed by the remoteness of an area is best undertaken during the survey and planning phases. This is when time is available to identify potential issues, establish realistic timeframes, allocate sufficient resources (in terms of both finance and equipment) and speak to as many as possible of the local people who are familiar with the remote site. Not only are logistics and supply chains more complicated in remote sites, but more time and funding may be required to establish suitable accommodation and welfare facilities, healthcare services, casualty evacuation possibilities and mobile communications.

Legislation

Over the past decade, operational environments have increasingly become challenging for the aid community. In mine action, political and regulatory complexities, security threats and the demands of operating globally in the context of pandemics as well as growing concerns over the environment have made programme planning and delivery more complicated. The physical difficulties posed by the terrain are compounded by the rules, norms and laws imposed by governments.

The mine action sector in **Croatia** is governed by laws, by-laws and regulations that are consistent with those of the European Union and related to labour law, occupational safety law and deminers' unions. Environmental restrictions are also subject to those laws and regulations. The remaining hazardous areas in Croatia are located within the European Union-coordinated network Natura 2000 and home to endangered species, including deer and eagles. Land release operators have to mark where eagle nests are detected, and operations within 400 metres of a nest are prohibited during the seven-month nesting period from January to July. Operations are also suspended during the deer mating season, and tasking provisions stipulate that clearance operations should be adapted to ensure that the deer and roe deer can find safe and peaceful places to give birth during September.

The **Falkland Islands/Malvinas** too are home to endangered flora and fauna and fragile terrain requiring careful consideration. Magellanic and Gentoo penguins were present near land release operations. The land release operator, in consultation with the head of the government's Environmental Planning Department, created measures to minimise a negative impact on the environmental at extra cost. These included not operating machinery within a certain radius of penguin colonies and stipulating that any demining taking place within 6 metres of a nesting site was to occur outside the breeding season.[30]

During land release operations in Skallingen, **Denmark**, where explosive hazards had been placed over 70 years previously, a contradiction arose between the International Mine Action Standards (IMAS) and national legislation. The minimum criteria for clearance on the beach were changed during the second phase of the project, which led a losing bidder to take the Danish authority to court. The Danish authority subsequently lost the court case on the basis that European Union and Danish legislation stipulated that a new tender process should have been launched if changes to criteria resulted in the contract value being exceeded by 15 per cent.

Skallingen is also part of the Natura 2000 network. Clearance was conducted in sand dunes, water obstacles (marshes and swamps) and sandy beaches where the local flora and fauna, including endangered species, were protected by Danish law. Environmental standard operating procedures were thus incorporated into the planning and conduct of clearance, including:

- Appointment of a dedicated environmental focal point;
- Restriction of movement in order to minimise disruption of the ground;
- Erosion mitigation measures, such as the restoration of the surface levels of the beach, using the original sand, after clearance of the mines;
- Rehabilitation of the dunes, whereby the contractor had to prevent loss of sand arising from high water levels or rough weather conditions;
- Replanting of vegetation;
- Separation of pebbles from the sand and then their reintegration before beach rehabilitation; and
- Restrictions on demolition work within 300 metres of the coastline between April and August.

Often the fastest way to clear a hazardous area might disrupt threatened habitats. It may therefore be better to clear around them, even if this might lead to the use of slower or more expensive methods.

Many countries and territories have legislation in place relating to peacebuilding processes, territorial disputes or restrictions on access / operations. These can have a wide range of effects on the cost and conduct of land release operations, including stifling access arrangements to a hazardous area; limiting work near or in military installations (for example, demining close to the perimeter of the High-Security Zones in **Sri Lanka** is restricted); governing the types of the organisation permitted to work in an area (for example, in **Syria** only organisations that do not operate in areas outside the Government's control are allowed to work in areas under its control); and the ability of operators to handle explosive or dual-use items (for example, in explosive ordnance clearance in **Kuwait**, land release operators may conduct a search, but they must rely on the military for explosive ordnance disposal).

A demining cooperation meeting about the border between Thailand and Cambodia *Image: Thailand Mine Action Centre*

Border areas

Land release in border areas is another common challenge experienced by the mine action sector, often in places where the frontiers between countries have not been demarcated or are disputed. Land release operations in border areas can be complex and often involve coordination and cooperation among multiple countries and organisations to ensure for example, the safe movement of refugees and migrants. In recent years, an increasing number of border minefields have been cleared in countries such as Jordan, Lebanon, Türkiye and Zimbabwe, and the lessons learnt from these countries should be shared and applied globally.

In some regions, minefields cannot be cleared owing to their proximity to border areas. **Georgia**, for example, has a 7-kilometre border with **Azerbaijan**, with a crossing point known as Red Bridge, which is the only remaining mined area in Georgia. Some 4,400 residents live with the threat of this contamination.[31] Some areas along the non-demarcated international border between **Azerbaijan** and **Armenia** are also reported to contain landmines, but no clearance takes place owing to the ongoing dispute.

The most heavily mined area in **Cambodia** is along the border with Thailand and includes a 1,065kilometre-long minefield, known as K5, that runs along the 798-kilometre Thai–Cambodian border. While some areas along the border have seen clearance activities since the early 1990s, operations have been suspended several times owing to ongoing border disputes. This has contributed to the difficulties faced by Cambodia in meeting its international obligations under the AntiPersonnel Mine Ban Convention.

While the mine clearance efforts of **Thailand** have been relatively successful over past years, with 98 per cent of the mine-contaminated areas now released, the remaining 2 per cent are all on the border with Cambodia. In its 2022 request for an extension of the deadline for completing the destruction of anti-personnel mines in mined areas in accordance with Article 5 of the Anti-Personnel Mine Ban Convention, access to the areas along the border, the geographical landscape and the coronavirus disease pandemic are given as the main reasons why Thailand was unable to meet its obligation to clear all mined areas by 2023. Since November 2020, as the country's land release operations have moved closer to the areas along the border to be demarcated, land release operators in Thailand have occasionally been requested to stop their operations.[32]

Cross-border mine clearance is increasingly seen as contributing to reconciliation, regional confidence and security-building measures and thus is prioritised by donors. While the issue of clearing cross-border minefields is very complex, one possible solution is to use regional and international frameworks to help depoliticise mine action and use it as a conflict-related transformation and reconciliation activity that offers the potential for change.[33]

Social and cultural considerations

There are instances when terrain can be termed difficult as a result of cultural sensitivities. While this is not a common occurrence in mine action, the methodologies for overcoming these issues can highlight good practice that is applicable when considering sites of national sensitivity.

For example, many people in the **Falkland Islands/Malvinas** did not support the clearance of minefields because they thought that the land had little societal or economic value, and they were concerned that clearance would disrupt the environment and the habitat of fauna.

Stakeholder management was a leading challenge during the clearance in Skallingen, **Denmark**. Operations were greeted with resistance in the local media, differing perceptions of the risks and environmental and political concerns. It was hard for the Danish authorities to convince local communities of the danger of the mines, as they had used the area for 60 years without accidents. Furthermore, access to a popular beach was cut off; the local population reportedly cut through the fencing, stole mine warning signs and erected improvised ladders to facilitate access to the minefield. Demining teams had to work in an unpleasant environment, facing community resistance at many levels. To overcome some of the challenges, the Danish authorities took steps to secure internal and external stakeholder support, reportedly with the assistance of a contracted lobbying company. They met the local population several times, placed announcements in the media and distributed posters and flyers, including to tourists. The approach created the conditions needed for the public to accept demining teams working on the beach. Of great importance was the increase in transparency. The authorities showed that associated personnel were approachable, also by opening up local offices.

In **Tajikistan**, the needs of local populations and authorities, especially regarding grazing and herding, were considered during the planning and prioritisation stages of clearance operations. Social cohesion, local cultures and norms and, critically, the local population's perception of outsiders are essential components to be taken in account during planning processes.[34]

While deminers, much like other aid workers, save lives and are of enormous value to society, they are not immune from criticism and, in extreme cases, acts of violence by the populations whom they serve. A recent example of such violence is the attack against humanitarian mine clearance workers in Baghlan-e-Markazi, Afghanistan, in 2021, that killed at least ten people and wounded more than a dozen, many of whom were of the Hazara minority.[35]

CONCLUSION

The boundary between difficult terrain that is inaccessible and difficult terrain that is inoperable is not always distinct and there is often an overlap. As mine action programmes are ever-evolving, it is evident that difficult terrain will continue to have a significant impact on how projects are designed and implemented.

There have been developments in the approach to determining the success of mine action activities. Whereas previously it was simply a metrical assessment of the number of mines and other explosive ordnance destroyed, it now takes an all-encompassing view of the socio-economic impact of land release. The ability to assess the impact of difficult terrain on mine action activities is critical, as it will drive improvements in planning, prioritisation and implementation. The mine action sector has so far had a strong focus on technical performance and continual improvement.

Many industries and sectors pride themselves on adaptation and evolution to cope with challenges, including in relation to difficult terrain. They deploy and update infrastructure and invest significant resources in research and development to identify the most effective solutions. Compared with many industries, the mine action sector sees little such investment. Its most successful innovations have tended to be simple and low-tech. Complex, alleged silver bullets or novel solutions have often turned out not to be widely accepted by the sector. In recent years, however, there has been increasing use of new integrated information-management and data collection approaches and more complex detection and remote-sensing systems. The mine action sector thus increasingly has the option of using technological solutions to avoid risks to land release personnel in difficult terrain. The role of flexibility in programme design and the deployment of technological solutions to address difficult terrain is also vital in the construction, telecommunications and oil and gas sectors.

In planning and implementing activities in difficult terrain, local knowledge of the people, geography, and weather considerations are critical. It is crucial to recognise that gathering such knowledge is a team effort. No national authority or land release operator can mitigate the challenges posed by difficult terrain without information provided by people familiar with the area. Obtaining this requires careful explanation, and the trust of local communities and organisations must be built.

Mine action stakeholders have long understood that clearing a cliff, an anthill or a bamboo clump might be prohibitively expensive if it means adhering to the same standards over the entire hazardous area and consume resources that would have enabled another area to be cleared. In such cases, sensible methods and procedures tailored to the terrain and other specific circumstances have often been used to manage the risk caused by the obstacle in question. At the same time, a key lesson learned by mine action stakeholders is that legislation should not start out too restrictive or hinder the use of efficient and effective solutions; instead, it should ensure staff welfare and safety. Finding this balance can be a challenge, but the risks posed by losing time to roll back heavy legislation and further complicating land release in remote or difficult terrain should be weighed against the risk that land release operations are never completed at all.

The most crucial lesson that can be drawn from this study is that, when difficult terrain is being addressed, time and resources must be given to data collection and planning. Once they are known, most of the challenges associated with difficult terrain can be mitigated. It is expected that there will be a combination of physical constraints in mined areas, with the remoteness of the terrain often being exacerbated by other physical constraints, which are themselves complicated further by human factors. All stakeholders in mine action play a key role in ensuring that difficult terrain does not hinder the work to clear the last remaining parts of hazardous areas. Stakeholders should ensure that adequate resources are available to enable reasonable mitigation measures to be put in place, such as the procurement and maintenance of dedicated machines. If such funds are not available, then the stakeholders should have realistic expectations about what may be achieved with funding available. National authorities should play a key convening role in identifying and obtaining agreement on measures that enable land release operators to operate safely, effectively and efficiently and ensuring that operators take care of their workers under challenging conditions. They should also ensure that the sector is regulated in a balanced manner. For their part, land release operators should continue, within their own institutions and networks, to seek solutions for working in difficult terrain. They are a crucial part of the knowledge management system and should ensure candid and transparent feedback about the difficult terrain to the national and local authorities, donors and communities.

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ANNEX: GOOD PRACTICE MATRIX

The following table summarises the good practice identified in this study. Please note that some solutions are applicable to several types of difficult terrain, which are denoted by the following letters:

- H – high elevation, steep slopes and cliffs
- V – dense vegetation
- W – water obstacles
- S – sand dunes and sandy beaches
- E – seasonal variations and weather
- R – remoteness
- L – legislation
- C – social and cultural

Type(s) of difficult terrain	Challenge(s) related to the difficult terrain	Potential solutions or key considerations
All instances of physical constraints (H, V, W, S, E, R)	**Planning complexity**	Carry out the planning using as many data and information sources are practical (for example, topographical maps, digital orthophotos and vector layers that contain mine action and other related data) in order to model the operational difficulty of the land release operation and to help determine the magnitude of the task, suitable assets and the accessibility of the hazardous area. Key questions that should be asked: • Have we identified and listed all possible sources of information? • Have we used a topographical map to identify any steep contours or altitudes? • Have we examined all available satellite imagery of the area to identify any difficult terrain prior to the deployment? • Have we identified any changes in the terrain between the topographic maps and satellite imagery since the minelaying/EO contamination, e.g. were new roads built, powerlines or water supplies installed etc. • Are there any photographs of the hazardous area? When were they taken? • Do we have information on the vegetation (density, thickness and height), soil (composition and movement) or flooding in or around the hazardous area? • Is there evidence of physical constraints on or near the hazardous area? • Is the hazardous area accessible by vehicles throughout the year? How close can an ambulance approach the site? • Is there a suitable site for AIRVAC near the hazardous area? • Is the weather (temperature, wind, humidity) in the hazardous area different from what mine action workers would normally be exposed to? • Is the timeline/deadline set for the completion of this task realistic?
		Adopt a planning framework that incorporates seasonal or topographic data and factors in a knowledge feedback loop.
		Consider using remote sensing technology in the land release process, to support the decision-making process.

H – high elevation, steep slopes and cliffs, **V** – dense vegetation, **W** – water obstacles, **S** – sand dunes and sandy beaches, **E** – seasonal variations and weather, **R** – remoteness, **L** – legislation, **C** – social and cultural

Type(s) of difficult terrain	Challenge(s) related to the difficult terrain	Potential solutions or key considerations
All instances of physical constraints (H, V, W, S, E, R)	**Accessibility of the terrain to machines and effectiveness of animal detection teams**	Conduct a cost–benefit analysis prior to committing to significant capital expenses.
		Research local supply chains, to ensure efficient support to the deployment assets, including local expertise, spares, fuel, food and water supply chains.
		Adopt the most effective solution in the mine action toolbox. Understand the advantages and limitations of all assets in the toolbox and ensure all requirements will have been met by the proposed solution.
		Check whether environmental conditions might affect the performance of animals or mechanical assets in detecting mines and other explosive ordnance.
		Check the feasibility of deploying mechanical assets. Give preference to machines with tracks rather than wheels on soft or wet ground. Have a plan and the means to recover assets if they get stuck.
	Displacement of mines and other explosive ordnance away from where they were laid/fell	Analyse historical photographs and question local population to ascertain how the topography of the hazardous area may have changed (owing to the wind, floods, human interventions etc.) since contamination.
H, W, S, R	**Evacuation routes for casualties that are long or potentially blocked**	Ensure that there is a possibility for air evacuation, ideally as part of a whole-of-government approach.
		Ensure that medical staff are adequately trained and equipped to meet the unique requirements of the land release / explosive ordnance disposal teams.
H (steep terrain)	**Hazardous areas that may not be safely traversed by personnel unless they have special equipment and training**	Develop and apply different procedures / standards on a case-by-case basis or according to fixed criteria. For example, when the clearance of a hazardous area affected by cluster munitions requires subsurface clearance, allow land release for cliffs/bedrocks that have undergone surface clearance augmented by remote-sensing/imagery analysis.
		Consider the allocation of funding for the procurement of mountain-climbing equipment for deminers in hazardous areas, along with training for its use.
		Consider the use of remote-sensing technology, which may require review of current standards and procedures to allow remote sensing to be considered as one of the methods to confirm or reject the presence of direct or indirect evidence.
H (altitude)	**Low oxygen levels at elevated altitudes**	Require certificates of physical fitness to work at high altitudes. Increase the frequency and duration of rest time during the field operations.
		Recruit and train local personnel who are already acclimatised to the altitude or capable of adapting quickly.

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Type(s) of difficult terrain	Challenge(s) related to the difficult terrain	Potential solutions or key considerations
V	**Dense vegetation that slows clearance**	Deploy non-intrusive mechanical and manual vegetation cutting methods.
		Deploy intrusive (operated from within hazardous area) mechanical vegetation-cutting assets, preferably operated remotely (and certainly if the asset is not armoured to protect the operator).
		Permit the burning of light vegetation under certain specific controlled conditions. Liaise with the local/State environmental protection services to obtain their approval.
W	**Waterlogging**	Redirect standing water to other areas using natural draining systems and pumps.
	Seasonal flooding	Indicate in the tendering / tasking documentation whether hazardous areas are prone to flooding. Allocate sufficient additional time to the land release operators to cover related downtime and the time spent mitigating the flooding or redirecting surface water.
S	**Collapsing dunes**	Carefully place any excavated sand in a stable manner and research options of returning the excavated land, sand or soil, back to its original place.
	Restoration of dunes	Place or replace excavated sand in a manner and location that allows the natural creation or reformation of sand dunes.
	Uncertainty regarding the depth of mines in or above the sand layer	Analyse any historical records or interview former minelayers / local people to establish whether the mines were laid in or beneath the present sand layer.
		Establish the depth of explosive ordnance contamination through demining at the suspected depth and adjust follow-up technical survey and clearance depth accordingly.
E (and in some cases R)	**Knowledge of the weather in and around the hazardous area**	Ensure that desk assessments and surveys capture data on the weather throughout the year, and not just on the days of any visit/analysis, ideally through contact with individuals who live there.
		Collect year-round weather information from local residents during field interviews and from official statistics (and forecasts), if available.
	Ensuring worker comfort / welfare	Ensure that staff, including visitors, at worksites are clothed and equipped for the worst-case weather scenario during the seasons in which they are present at the site and that spare stocks exist.
		Establish clear and simple criteria to enable team leaders independently to decide at the start of the working day whether to proceed to the worksite (for example, in relation to snowfall, temperature and windspeed).
	Hot weather	Reduce working time and increase number of breaks.
		Provide adequate supply of drinking water and ensure sufficient hydration (drinking water) at frequent intervals.

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Type(s) of difficult terrain	Challenge(s) related to the difficult terrain	Potential solutions or key considerations
E (and in some cases R)	**Hot weather**	Adapt equipment and uniforms to protect workers from the sun and its harmful effects. Some examples include: • Wide-brimmed hats or caps; • Sunglasses; • Light-coloured, loose-fitting clothing; • Portable shading devices, such as umbrellas or canopies; • Training for staff so that they can protect themselves from the sun and heat; and • Regularly reminders to field staff to use the above items and take other precautions, such as staying hydrated and taking regular breaks in the shade. • Mosquito repellents (especially in wooded areas) • High boots in areas with a risk of encountering poisonous snakes and scorpions (especially during the period following hibernation)
	Cold weather	Avoid scheduling manual clearance during seasons where it can be reasonably predicted that the ground will be too frozen to allow for manual excavation / investigation signals, or adjust the techniques used. Consider mechanical processing.
		Supply the teams with warm and waterproof clothing and footwear, gloves, hats etc.
		When the temperature is close or below 0 degrees Celsius, ensure teams have a possibility to warm up during the breaks using firewood and/or charcoal or other means such heated tents.
	Wet ground	Ensure that deminers are correctly clothed with appropriate warm layers and suitable waterproof clothing for the task at hand (for example, multiple layers of gloves, including those that reach to the elbow, wellington boots and, where required, chest waders, in addition to waterproof trousers and jackets).
L	**Environmental and ecological complexities**	Ensure the availability, ideally at the country level, of the expertise needed to provide advice on the operational impact of legislation in relation to environmental, ecological, heritage and archaeological issues.
		Consider commissioning a third-party environmental impact assessment to guide the land release operator.
		Consider long-term planning to reduce the risk of deforestation that would adversely affect local biodiversity in post-clearance areas.
L, C	**Political sensitivities in remote areas**	Ensure that land release operators, especially those working with remote communities, understand their work within any politically sensitive context (for example, if there is a peace process underway involving population groups in the area).

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Type(s) of difficult terrain	Challenge(s) related to the difficult terrain	Potential solutions or key considerations
L, C	**Political sensitivities in remote areas**	Ensure that relevant government officials, local authorities, civil society and the media understand the importance of mine action work and the value of the presence of any people from outside the community.
	The remoteness of the site does not allow for casualty evacuation timelines that comply with national standards, and thus operations cannot occur.	Consider using helicopters as part of a whole-of-government approach, where available assets within the national structure can be used for casualty evacuation.
		Amend national standards to allow for more extended evacuation periods, provided that the care on site and in transit is sufficient and that extended care providers are available.
		Establish contacts and make agreements with the relevant authorities to evacuate casualties across the border, in cases where the remote site is closer to the medical infrastructure of the neighbouring country.
C (and R in some cases)	**Ensuring a welcome by and contributing positively to local communities**	Where possible, hire and train locally, partner locally and source supplies locally to support local economy.
		Ensure that a proper assessment of local resources is conducted during the planning stages for the deployment of teams in remote areas in order not to cause shortages of water and food resources for the local population.
		Seek for alternative options for logistical and food supplies prior to deployment of a relatively large number of team that may negatively impact the local economy.
		During planning at the desk assessment or survey stage and before the deployment of personnel or assets to establish camps, seek advice about working in an area from the people who actually live there.
		Engage with local/regional authorities at an early stage of demining intervention to inform operational planning. Use the links with the local authorities for the initial introduction with remote communities.
		Partner with organisations skilled at community and group integration (for example, peacebuilding organisations at the global level and civil society conflict-resolution groups at the local level).
		Ensure that personnel hired from other regions and municipalities and deployed in remote areas are briefed on and made familiar with local traditions, customs and cultural peculiarities by community engagement/liaison officers or equivalent senior managers.
R	**Lack or absence of local people / informants to contribute to the survey.**	Consider combining the technical survey and the non-technical survey efforts, especially in sparsely inhabited areas, to avoid registering hazardous areas based on insufficient information and to eliminate the need for inefficient multiple visits.
		Consider issuing task orders that allow technical survey immediately after identification of hazardous areas by the non-technical survey teams and prior to their validation by national mine action centres.
	Distance to the operational area which complicates hiring and logistical support	Depending on the scale of the contamination in the remote area, consider building semi-permanent camps and sub-offices/locations to allow hiring and training locally to reduce waste and minimise downtime due to long distance travel.

GICHD

Geneva International Centre for Humanitarian Demining
Maison de la paix, Tower 3
Chemin Eugène-Rigot 2C
P.O. Box 1300, 1211 Geneva 1, Switzerland

Phone | +41 22 730 93 60

Fax | +41 22 730 93 62

Email | info@gichd.org

gichd.org