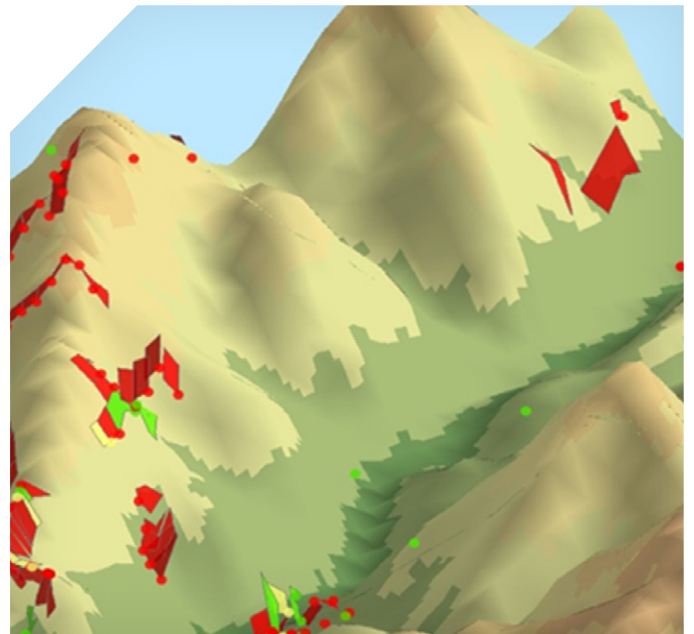
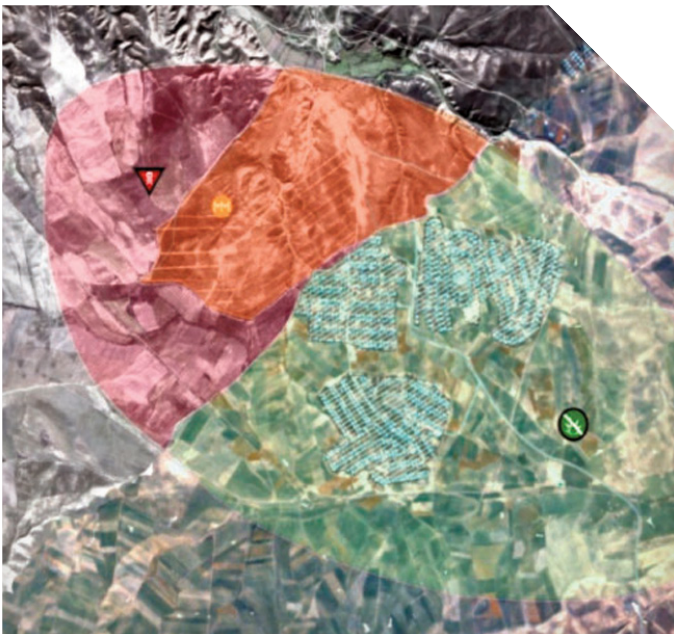


GEOGRAPHIC INFORMATION SYSTEMS IN MINE ACTION

Jointly produced by the Geneva International
Centre for Humanitarian Demining (GICHD) and
the University of Geneva

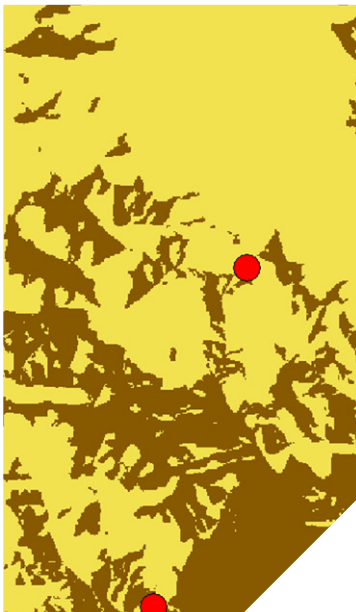
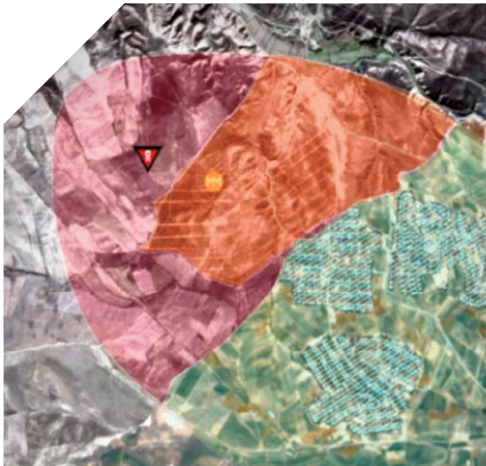


EXECUTIVE SUMMARY

This issue brief illustrates several possible applications of geographic information systems (GIS) in mine action. By producing visual, quantifiable results, GIS tools can help country programme managers, regional office managers, operations managers, operations officers and IMSMA officers make improved decisions. By integrating data from various sources and domains, GIS opens demining processes (eg prioritisation and tasking, demining capacity assessment, operational planning etc) to a wide range of relevant geospatial factors.

With these models, transportation network connectivity, soil characteristics, vegetation, slope and other factors that have significant influence on demining activities are better taken into account. More generally, a wide range of environmental, socio-economic and cultural specificities of mine-affected regions can be integrated, significantly improving the evidence and understanding on which managers can base their decisions. This issue brief is illustrated with concrete examples of cases of GIS tools being used in mine action and in other fields. ■

TABLE OF CONTENTS



1	INTRODUCTION AND STRUCTURE	p 4
2	PRODUCING 2-DIMENSIONAL OVERVIEW MAPS	p 6
3	ENHANCING THE PICTURE WITH 3D ANALYSIS	p 10
4	ANALYSING ACCESSIBILITY	p 14
5	PRIORITISING ACTIVITIES AND EVALUATING COST	p 15
6	FUTURE GIS DEVELOPMENTS	p 17
7	BIBLIOGRAPHIC REFERENCES AND DATA SOURCES	p 19

1. INTRODUCTION AND STRUCTURE

Contents

1

INTRODUCTION AND STRUCTURE

2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

Geographic Information Systems (GIS) allow the capture, management, analysis and display of geographically referenced information. They are used to integrate various sources of data and analyse their spatial relationships, allowing us to make informed planning and business decisions. When applied appropriately, these systems enable new forms of analysis and insight.

Effective decision-making in mine action is driven by geographic factors. Population distribution, infrastructure, terrain and vegetation directly influence the ways in which mines/ERW impact on communities or nations as a whole. These must be taken into consideration when developing strategies for managing hazardous areas to ensure that operations are well prioritised, context-specific and efficient. This issue brief aims to highlight the benefits that mine action programmes may derive from adopting and using GIS technologies, tools and data by leveraging their ability to account for a wide range of geographic factors. The brief targets strategic and operational stakeholders involved in mine action. The objectives of this issue brief are to demonstrate how GIS can:

- generate intuitive maps at various scales, eg, for operators in the field and for strategic stakeholders at country level;
- increase the accuracy of area size calculations;
- improve prioritisation and planning of field operations; and
- help model the nominal operational difficulty of demining and determine which assets are suitable for a given task.

This issue brief is structured as follows:

Section 2 explains how map production at different geographical scales can be usefully applied in mine action.

Section 3 demonstrates how more advanced spatial data processing such as 3-dimensional analysis can improve measurements such as area size calculations.

Section 4 shows how GIS-based road network analysis tools can be applied to mine action.

In **Section 5** these data are taken a step further with GIS by helping with priority setting (eg for hazard clearance) and for evaluating the level of effort required for different demining tasks.

Section 6 reviews some of the main trends in GIS development, namely the potential for geoportals to improve geographic information dissemination and sharing.

1.

GIS are not meant to replace existing solutions such as IMSMA but are rather meant to complement them. GIS provides advanced spatial functions that IMSMA does not offer, and efficient tools exist for bridging IMSMA with GIS.

Technical descriptions of specific GIS tools that were developed for the mine action community through the collaboration between the University of Geneva and the GICHD are included in a digital annex to this brief available for download [here](#)¹. ■

Contents

➔ 1

INTRODUCTION AND STRUCTURE

2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

¹ <http://www.gichd.org/lima/reports-publications/detail/publications/issue-brief-gis-for-mine-action>

2. PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

Contents

1

INTRODUCTION AND STRUCTURE

→ 2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

When taking decisions in humanitarian demining, information often needs to be integrated with a geospatial component. Typical decisions that humanitarian demining stakeholders have to make vary and relate to different factors. These include:

- the geographic location of hazards and their type;
- historical information about hazardous areas;
- marking in the field;
- the type of mine risk education provided or yet to be provided;
- the location of populations, internally displaced persons and returnees;
- the location of the working teams;
- local terrain conditions;
- weather conditions;
- accessibility, eg, information about infrastructure, traffic, security;
- logistical constraints; and
- the assets deployed in an area and tasks carried out.

This section illustrates how GIS – in particular maps – improves decision-making in mine action.

Large-scale hazardous area location maps

One of the primary goals of GIS is to allow for the production of maps. A basic but effective cartographic method consists of representing every hazardous area by a polygon delimiting its boundaries, and/or by a point symbol marker at its central XY coordinates.

These polygons and points can be overlaid on top of other layers (eg topography, urban areas, critical infrastructure, land cover, land use changes, development and populated areas etc) and with base maps (eg Google Earth imagery, OpenStreetMap, etc) to help experts make informed decisions and reports about their activities. In **FIGURE 1**, hazardous areas are displayed at a large scale with satellite imagery as background information. The village built after the clearance operations is visible in the right half of the area of concern.

2.



FIGURE 1 | Map showing hazardous areas at a large scale with satellite imagery as background information.

Contents

1

INTRODUCTION AND STRUCTURE

→ 2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

Similarly, overlaying hazard locations with information about slopes, roads and meteorological conditions or with a layer showing the current position of the teams might help decision-making in regard to optimising access to contaminated areas.

The information that is shown on maps needs to be updated at appropriate intervals. In the case of demining activities, the update can be weekly or even more frequently. The process of updating geospatial information is sometimes complex and can be significantly improved using GIS mobile applications such as ArcPad (Esri 2013a) and web-based applications such as the IMSMA^{NG} Remote Entry (GICHD 2013a). Interaction between operators in the field and database administrators could greatly benefit from the use of such tools.

Updating geospatial information involves recording attributes, such as the type of hazards, their status and other relevant information, in addition to XY coordinates. This information can then be represented on maps. For example, areas contaminated by ERW can be displayed with symbols sized proportionally to the estimated or observed number of items; alternatively they could be displayed with different symbols and colours depending on their type or status.

It is also possible to filter which type of hazard or task will be shown on maps, by displaying certain features only. For example IMSMA officers might want to report on confirmed hazardous areas (CHA) or suspected hazardous areas (SHA) only, and operations managers might want to display how many tasks remain incomplete in a specific area. Operations managers can also produce large-scale maps showing the number of tasks their organisation has cleared over the last month, how many new SHA/CHA have been identified, and where these tasks and SHA/CHA are located.

Examples of large scale maps showing various mine action information are provided in GICHD (2013b).

Contamination density maps

Aggregated information may be more suitable for maps at lower geographical scales, eg, at province and national levels. With large amounts of data, hazard maps become unreadable due to records overlapping each other (**FIGURE 2 – LEFT**).

2.

Instead of showing all hazards in this way, it is possible with GIS to estimate the contamination density using spatial statistics tools (**FIGURE 2 – RIGHT**). In the ArcGIS suite, the Kernel Density interpolator (Esri 2013b) computes in each location of the map a density value that depends on the number of hazards found within a given distance. A colour ramp is then applied in accordance with the density values, in our example yellow corresponding to low densities and red to high density.

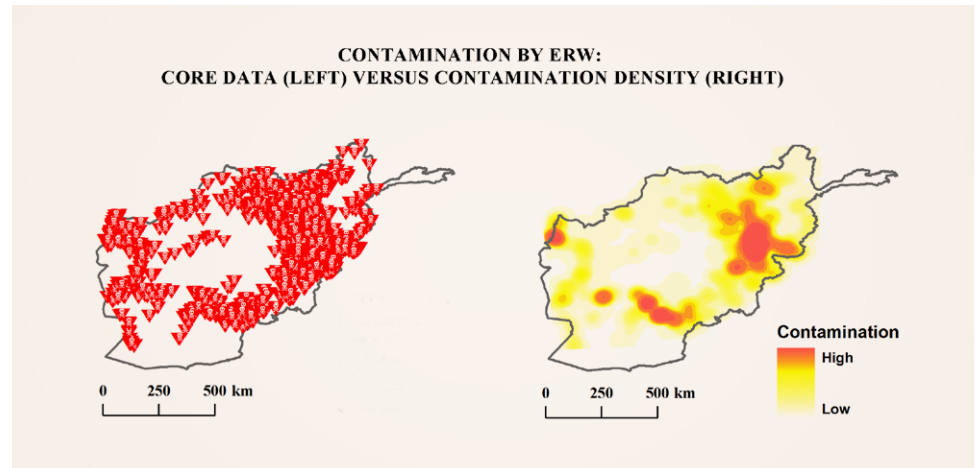


FIGURE 2 | Density map showing contamination in Afghanistan. Vector data (points or polygons) representing the exact localisation of hazards is being interpolated with the ArcGIS “Kernel” function into density grids.

The primary purpose of contamination density maps is for country programme managers to show the variations of landmine contamination in their area of action and so provide an overview of the progress of demining activities in their area of work. In turn, donors could have a better overview of the contamination in some regions, which could help prioritise donations.

Information on contamination can also be generated for each administrative unit, eg for each province, as shown in **FIGURE 3**. These common types of maps are called “choropleth” maps. ERW areas are aggregated by administrative unit and coloured according to the contamination, optionally normalised by the area of each unit.

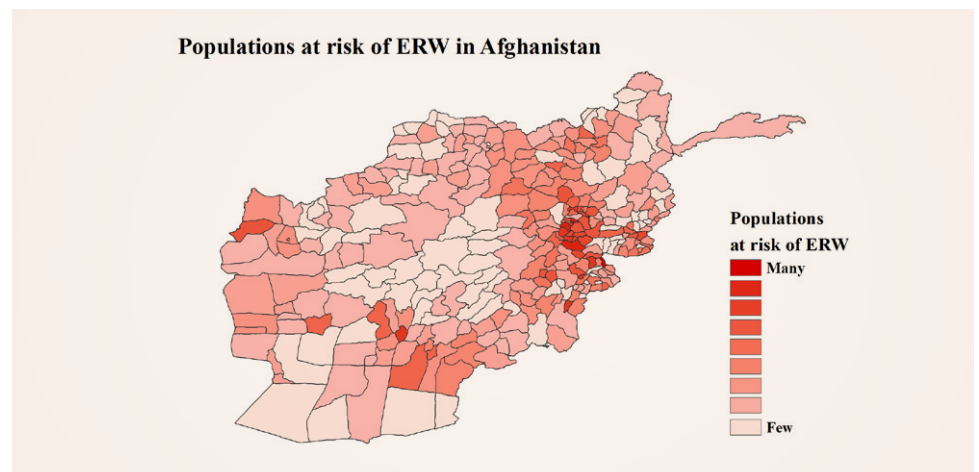


FIGURE 3 | Map showing ERW contamination in Afghanistan at the province level.

Contents

1

INTRODUCTION AND STRUCTURE

2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

2.

Maps showing populations at risk of ERW

Another promising application of GIS in mine action is the production of maps showing where populations are most exposed to the risk of ERW. In the example below (**FIGURE 4**), the map from Figure 3 was combined with population density data. The result of this combination is a thematic map showing populations at risk of ERW at district level.

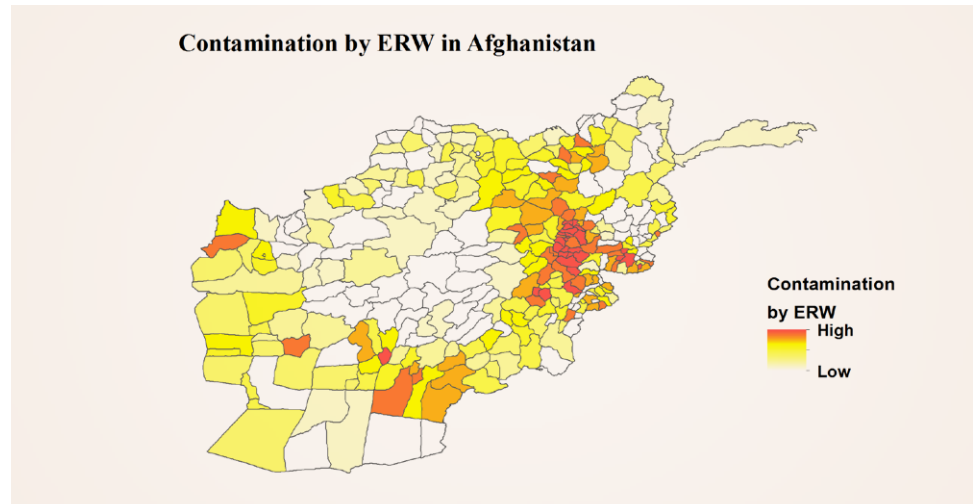


FIGURE 4 | Map showing populations at risk of ERW in Afghanistan at the district level.

Bridging GIS with IMSMA

A condition for using GIS efficiently in mine action is that users are able to extract IMSMA data on a frequent basis. In order to reduce the time required to accomplish repetitive spatial data processing tasks, the GICHD has developed the *Simplified Toolbar to Accelerate Repeated Tasks* (START), an ArcGIS plug-in designed for quickly extracting IMSMA data for GIS analysis. This tool will also facilitate the conversion of Excel and GPS files to geospatial information (eg, the boundaries of a hazardous area) and the production of maps. More information about START can be found in Lacroix (2013) and in the technical annex. ■

Contents

1 INTRODUCTION AND STRUCTURE

➔ 2 PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3 ENHANCING THE PICTURE WITH 3D ANALYSIS

4 ANALYSING ACCESSIBILITY

5 PRIORITISING ACTIVITIES AND EVALUATING COST

6 FUTURE GIS DEVELOPMENTS

7 BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

3. ENHANCING THE PICTURE WITH 3D ANALYSIS

Contents

1

INTRODUCTION AND STRUCTURE

2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

The use of three-dimensional (3D) tools allows elevation values (also called Z-values) to be included as well as XY-values when visualising and analysing geospatial data. Generating 3D surfaces is simple with GIS tools and, if conducted properly, 3D analysis can bring significant added value to mine action activities. It can help:

- increase the accuracy of area size calculations of contaminated surfaces;
- more realistically assess the operational difficulty of demining in a region by integrating slope and elevation into the analysis;
- better prepare field operations;
- determine the potential location of mines that may have moved over time through water run-off or surface movement; and
- report on demining activities in a more visually intuitive manner.

A major advantage of 3D GIS is that the accuracy of surface area calculations is increased. With 3D analyses, the actual shape of the terrain is taken into account instead of a flat projected surface. For example, a surface on a 25 per cent slope gradient has an area that appears three per cent smaller when projected onto a flat 2D surface than it actually is. As the slope increases, so does the difference between 2D and 3D measurements.

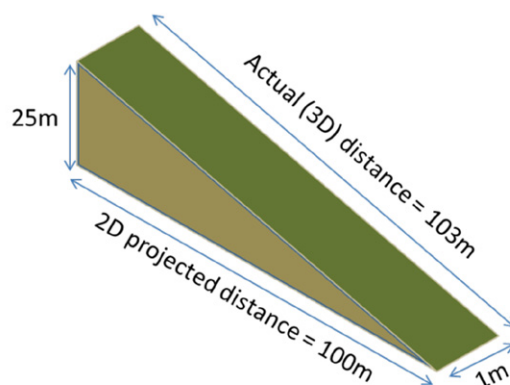


FIGURE 5 | The effect of slope on distance and area projected in 2D.

Therefore, 3D analyses help reduce reporting errors of areas contaminated and processed.

3.

In addition, 3D GIS allows the generation of surface models depicting the maximum rate of change of an attribute (such as height) between each cell and its neighbours (eg the slope at the cell's location).

A slope dataset for Afghanistan is illustrated in **FIGURE 5**. This dataset is derived from the Shuttle Radar Topography Mission (SRTM) digital elevation model (Jarvis *et al.* 2008), though many sources are available. A relevant use of slope datasets in mine action consists of combining them with contamination data to provide a better understanding of how this factor affects operational difficulties when using machines, dogs and human beings. In GIS, the slope function often comes with what is known as the hillshade function, which simulates the illumination of a surface by setting a position for a hypothetical light source. The hillshade function coupled with slope and elevation images greatly improves the visualisation of a surface for analysis or graphical display, eg, to show the exact location of mine action teams or to enhance marking and fencing. A hillshade raster is shown in **FIGURE 6**.

Contents

1

INTRODUCTION
AND STRUCTURE

2

PRODUCING
2-DIMENSIONAL
OVERVIEW MAPS

3

ENHANCING
THE PICTURE
WITH 3D
ANALYSIS

4

ANALYSING
ACCESSIBILITY

5

PRIORITISING
ACTIVITIES AND
EVALUATING COST

6

FUTURE GIS
DEVELOPMENTS

7

BIBLIOGRAPHIC
REFERENCES AND
DATA SOURCES

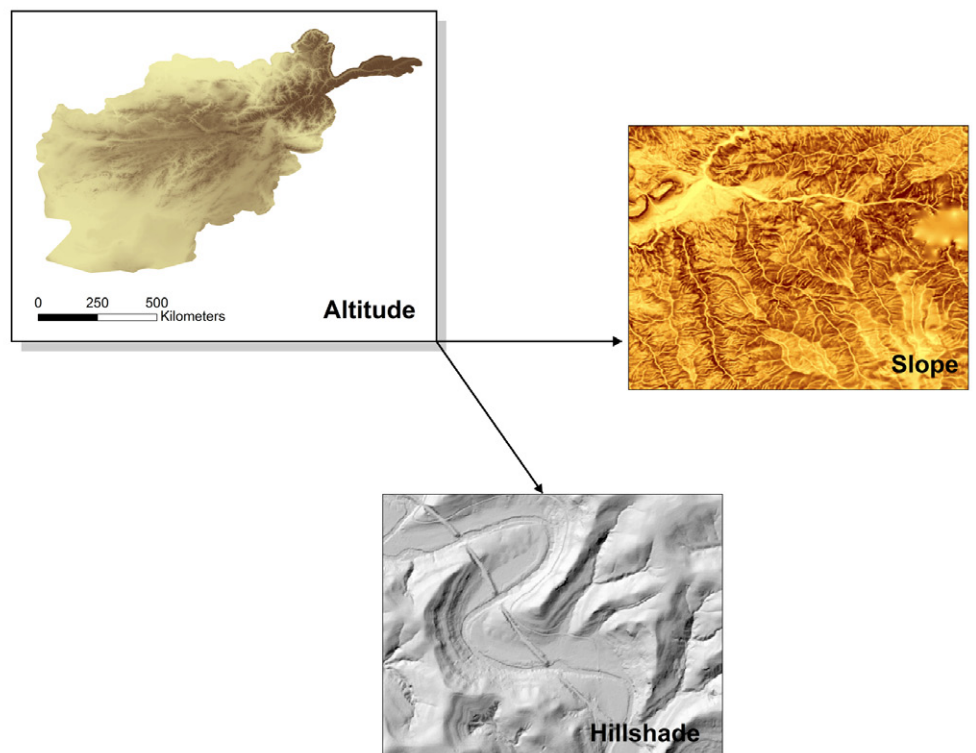


FIGURE 6 | Digital elevation model on Afghanistan and derived slope and hillshade. Data source: Jarvis *et al.* (2008).

Visualising study areas in 3D provides new perspectives and insights that would not be readily apparent from a planimetric (2D) map of the same data.

3.

3D GIS analysis has been successfully implemented by the Mine Action Coordination Centre of Afghanistan (MACCA) for slope analysis. **FIGURE 7** shows an example of a 3D map of hazard locations in the northeast of Afghanistan (MACCA 2010).

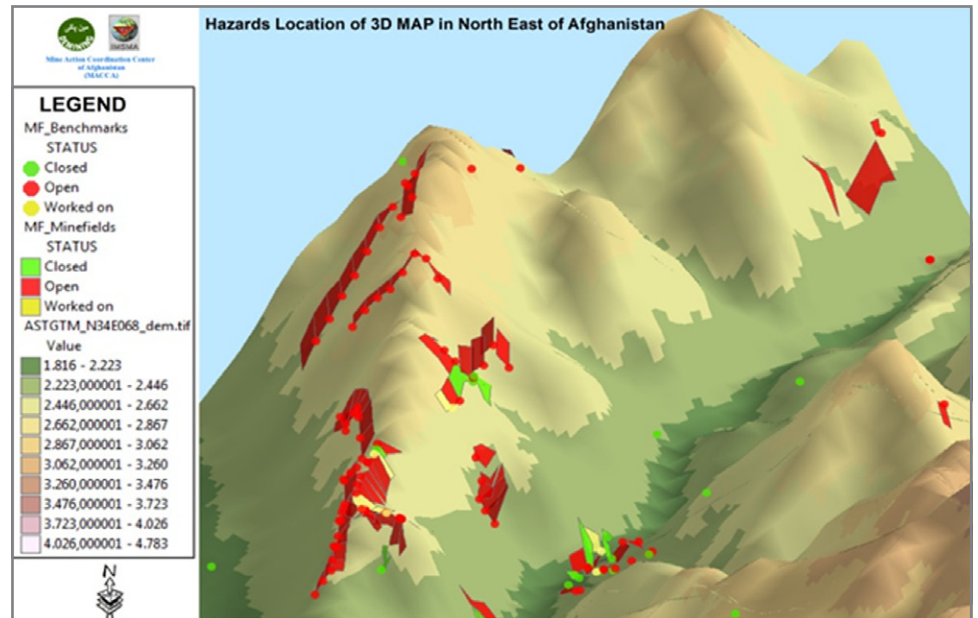


FIGURE 7 | 3D map of hazard locations in north-eastern Afghanistan, provided by MACCA.

Contents

1

INTRODUCTION AND STRUCTURE

2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

A further promising application of 3D GIS analysis in humanitarian demining lies in hydrology and watershed modelling. Hydrological networks can be derived directly from digital elevation models. From the derived network it is then possible to calculate flow length downstream and upstream of a given location, and determine the potential location of mines that may have been displaced over time (**FIGURE 8**).

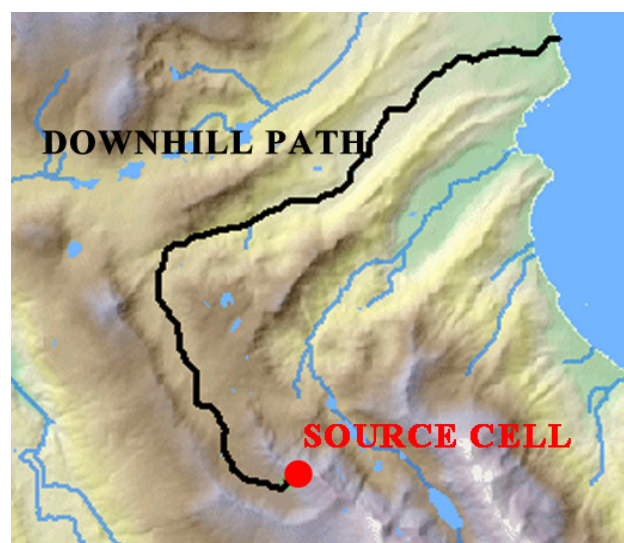


FIGURE 8 | Example of global surface analysis: generation of a downhill path (potential localisation of land mines) from a source cell (initial localisation of the mine).

3.

3D analysis may also address telecommunication issues in the field. For example, viewshed analysis (**FIGURE 9**), which identifies the points on a surface that can be seen from one or more observation points, can help identify optimal satellite receptor or VHF repeater locations. This analysis can also facilitate prediction of the strength of global positioning system (GPS) signals and help in organising overflight operations with unmanned aerial vehicles (UAV) and airplane observations eg, for large-scale mapping purposes.

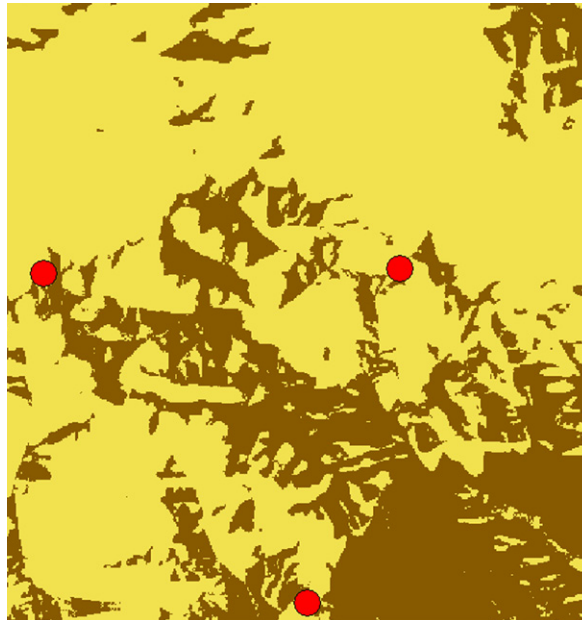


FIGURE 9 | Very high frequency (VHF) coverage: the brown cells are covered by at least one red observation point. Yellow cells are located in radio shadow areas.

Finally, 3D is a smart way of communicating the results or the progress of demining activities. 3D maps and information are often a more appealing and visually intuitive format than flat maps. ■

Contents

1 INTRODUCTION AND STRUCTURE

2 PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3 ENHANCING THE PICTURE WITH 3D ANALYSIS

4 ANALYSING ACCESSIBILITY

5 PRIORITISING ACTIVITIES AND EVALUATING COST

6 FUTURE GIS DEVELOPMENTS

7 BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

4. ANALYSING ACCESSIBILITY

Contents

1 INTRODUCTION AND STRUCTURE

2 PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3 ENHANCING THE PICTURE WITH 3D ANALYSIS

➔ 4 ANALYSING ACCESSIBILITY

5 PRIORITISING ACTIVITIES AND EVALUATING COST

6 FUTURE GIS DEVELOPMENTS

7 BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

In this section we illustrate possible applications of GIS-based transport network analysis tools in the context of mine action. These include:

- dispatching medical care to victims;
- determination of the best location for building a new health facility;
- planning of in-field operations; and
- road clearance management and prioritisation.

With GIS it is possible to build transport network models aimed at minimising travel time (and potentially other attributes such as travel distance and fuel consumption) between two sets of points. One example of such GIS analysis identifies the nearest medical facilities so that assistance can be provided to victims as quickly as possible (Lacroix *et al.*, 2013). More generally, GIS-based road network analysis has numerous applications in the routing of in-field mine action operations, taking into account terrain conditions such as slope, land cover, and road quality.

Roads may be temporarily or permanently blocked due to maintenance work, security issues, flooding or the presence of AV mines and ERW. Taking into account these hindrances is made easier with GIS tools that simulate barriers and estimate their impact on accessibility and travel cost. In this way network analysis can be effectively applied to road clearance management; it can be used both to find the most efficient alternative to dangerous or impassable routes and to prioritise road clearance by analysing which blockages provoke the most severe disruptions to the flow of people, goods and services. Such a method, when applied to optimising access to markets for example, can provide solid quantitative estimates of the socio-economic impacts of alternative clearance choices.

Road network analysis methods are not entirely new to the broader humanitarian sector. They have been successfully applied in the field of humanitarian logistics to locate new warehousing facilities, allocate distribution points to warehouses and provide contingency plans in case of road closures. Given the enormous impact of mines on travel and accessibility, network analysis methodologies provided by GIS can build on these experiences and contribute significantly to improving decision-making and prioritisation in mine action.

A hypothetical case study on the use of GIS-based road network analysis in mine action can be found in Lacroix *et al.* (2013) and in the technical annex. ■

5. PRIORITISING ACTIVITIES AND EVALUATING COST

Contents

1 INTRODUCTION AND STRUCTURE

2 PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3 ENHANCING THE PICTURE WITH 3D ANALYSIS

4 ANALYSING ACCESSIBILITY

5 PRIORITISING ACTIVITIES AND EVALUATING COST

6 FUTURE GIS DEVELOPMENTS

7 BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

One of the primary advantages of GIS lies in its capacity to combine various data sources and generate new information. IMSMA data can be combined with some of the non-IMSMA data described in the previous sections (population density, slope, roads, infrastructure, health facilities) but also human settlements, vegetation types, cropland surface, soil characteristics, schools, etc. This opens interesting perspectives for the mine action community, especially in terms of priority setting.

In combining these data to go beyond data representation, GIS applications can help:

- prioritise hazard clearance based on any number of criteria;
- determine how much time and effort clearance of a particular hazardous area would take, by integrating local terrain and infrastructure conditions;
- decide which type of asset should be deployed by comparing different scenarios based on different asset characteristics under similar terrain conditions; and
- have better knowledge of the accessibility of a planned hazardous area and knowledge of local terrain conditions for planning future tasks.

Policy scoring

Socio-economic impact analyses of landmine hazards have been conducted in various mine action programmes (see for example Benini, 2000), but spatial features have not typically been taken into account. The purpose of such surveys was to classify affected communities with regard to aggregated socio-economic impact indicators (broad nature of munitions, resources and facilities blocked, number of recent victims, etc) caused by unexploded ordnance (UXO). They resulted in national strategic plans, with priority given to clearing areas with high “attribute-based” scores.

GIS make it possible go one step further, and score hazards in function of their relative proximity to infrastructure of interest. For instance, it is possible to assign scores to hazards based on their distance from hospitals, roads, sensitive infrastructures, populated zones or areas with industrial development. The result of the scoring process can be mapped to facilitate decision-making and priority-setting. More information on this type of analysis can be found in Lacroix (2013) and the technical annex.

5.

Operational difficulty of demining

GIS allow for assessing and visualising ordinal degrees of clearance difficulty on the basis of quantifiable terrain criteria (eg slope, vegetation, ground softness, precipitation, temperature, etc). The 5D (Determining and Displaying the Degree of Operational Difficulty of Demining) analytical method was developed in 2012 by the GICHD and the University of Geneva specifically to facilitate this process.

For any type of mechanical platform (eg flail or tiller), users can enter realistic and measurable operational limits for these criteria (eg high difficulty for slopes between 20° and 30°, low difficulty for slopes below 20°, medium difficulty for urban areas, high difficulty for sandy soil combined with high precipitation). The criteria are weighted according to importance by various stakeholders (eg 20 per cent for slopes, 10 per cent for ground softness) and summed up. Combining the results with an inventory of demining resources can help decide which assets should be deployed to which areas.

The output map provides a visual overview of the ordinal difficulty of demining in the study area, helping operations officers prepare their intervention in the field and providing funders with an accurate picture of the cost of clearance operations. Factors such as weekly/daily precipitation combined with soil water storage capacity, for example are likely to be inputs of the model (for preparing mechanical demining in the field). Factors such as scent contamination and temperature gradients could influence animal detection and could even be integrated in the model. Combined with the prioritisation methods described above, such a model can help justify strategic and operational choices by presenting a quantifiable cost-benefit analysis of the work at hand.

A case study of the 5D tool in Mozambique is described in Lacroix and Escobar (2013) and briefly described in the technical annex. ■

Contents

1

INTRODUCTION AND STRUCTURE

2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

6. FUTURE GIS DEVELOPMENTS

Contents

1 INTRODUCTION AND STRUCTURE

2 PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3 ENHANCING THE PICTURE WITH 3D ANALYSIS

4 ANALYSING ACCESSIBILITY

5 PRIORITISING ACTIVITIES AND EVALUATING COST

→ 6 FUTURE GIS DEVELOPMENTS

7 BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

This issue brief will close with perspectives on the future use of GIS in mine action, with a focus on the sharing of geospatial information through web applications.

Geoportals are collaborative platforms capable of delivering geospatial information from many different sources to a wide group of potential users, regrouping governmental, non-profit and academic institutions as well as individuals. Geoportals of various forms have become increasingly popular in recent years, including in the humanitarian community. Among many others, well-known geoportals include the one developed by the Global Earth Observation System of Systems (GEOSS) (Geo Secretariat 2013) and OpenStreetMap (www.openstreetmap.org). Such platforms seek to connect data providers to public and private audiences with the goal of enhancing and improving decision-making in a wide range of socio-economic sectors. Geoportals are based on the concept of collaboration and partnerships, and are meant to facilitate the production, management and integration of consistent and readily accessible data.

The GICHD is currently working on the development of a geoportal to allow users to share data, maps, GIS tools and results in a standardised way and in well-known formats. The idea is to make it easier for mine-affected countries to disseminate geospatial information inside and outside the mine action community. The possibility of publishing data and maps through Web Map Services (WMS), Web Feature Services (WFS) and Web Coverage Services (WCS) as well as the possibility to process geospatial data through Web Processing Services (WPS) is under study.

In the case of contamination maps for example, such as the one presented on the right side of Figure 2, the GICHD Geoportal will allow users in mine-affected countries to share information related to mine action programmes. The Geoportal will also make it possible for them to document their maps and data with standard metadata to facilitate comprehension and reusability of geospatial information. These metadata are meant to inform the map reader on how and when the map was produced. All metadata will be exportable to a readable format and will be available from mine action authorities upon request. The Geoportal will be able to connect to several different databases, from IMSMA (through the staging area available in version 6.0) to different kinds of customised user databases.

6.

Data providers with limited GIS skills will be able to transfer data and maps via a secure File Transfer Protocol (FTP) to the geoportal server based at the GICHD's premises. This possibility will also serve as safe storage for secure archiving of databases. The Geoportal administrator would then publish them as web services, according to user needs. To increase the flexibility of this solution, it will also be possible to define user groups with specific privileges. In particular, a group of users with advanced GIS skills could be created with the privilege of publishing web services without requiring assistance from the GICHD. For reasons of confidentiality, each user will access a restricted area according to his or her profile, and data providers will control the distribution of their published data (from a specific number of users within the same organisation to anyone who has an internet connection). Finally, users will be able to select the visible layers of information, navigate the maps, see the information associated with the geospatial data by clicking on it, perform queries based on specific attributes (date, location, etc) and export and download data of interest (according to their privileges). ■

Contents

1

INTRODUCTION AND STRUCTURE

2

PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3

ENHANCING THE PICTURE WITH 3D ANALYSIS

4

ANALYSING ACCESSIBILITY

5

PRIORITISING ACTIVITIES AND EVALUATING COST

➔ 6

FUTURE GIS DEVELOPMENTS

7

BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

7. BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

Contents

1 INTRODUCTION AND STRUCTURE

2 PRODUCING 2-DIMENSIONAL OVERVIEW MAPS

3 ENHANCING THE PICTURE WITH 3D ANALYSIS

4 ANALYSING ACCESSIBILITY

5 PRIORITISING ACTIVITIES AND EVALUATING COST

6 FUTURE GIS DEVELOPMENTS

→ 7 BIBLIOGRAPHIC REFERENCES AND DATA SOURCES

Benini, A., A comparison between the “classic” Level-1 Socio-Economic Impact Survey and the emergency survey in Kosovo. *Towards Harmonized Information Systems for Mine Action in South East Europe: proceedings of the workshop, European Commission, Ispra, Northern Italy* (2000).

CIESIN, Columbia University and CIAT (2005). *Gridded Population of the World Version 3 (GPWv3): Population Density Grids* [Online]. Available from: <http://sedac.ciesin.columbia.edu/gpw> [Accessed 29th July 2013]

Esri (2013a) *ArcPad*. [Online]. Available from: <http://www.esri.com/software/arcgis/arcpad> [Accessed 30th July 2013]

Esri (2013b) *Kernel Density* (Spatial Analyst). [Online]. Available from: http://resources.arcgis.com/en/help/main/10.1/index.html#/Kernel_Density/009z0000000s000000 [Accessed 30th July 2013]

Geo Secretariat (2013) *What is GEOSS?: The Global Earth Observation System of Systems* [Online]. Available from: <http://www.earthobservations.org/geoss.shtml> [Accessed 1st August 2013]

GICHD (2013a) IMSMA^{NG} Remote Entry. [Online]. Geneva, GICHD. Available from: <http://www.gichd.org/information-management/imsma-software> [Accessed 30th July 2013]

GICHD (2013b) *Geodetics: A handbook for Humanitarian Mine Action*. [Online]. Geneva, GICHD.

Hijmans, R. (2012). *GADM (Database of Global Administrative Areas)* [Online]. Available from: <http://www.gadm.org> [Accessed 29th July 2013]

European Commission (2013) *INSPIRE: Infrastructure for Spatial Information in the European Community*. [Online]. Available from: <http://inspire.jrc.ec.europa.eu> [Accessed 1st August 2013]

Jarvis, A., Reuter, H.I., Nelson, A., Guevara, E. (2008) *Hole-filled seamless SRTM data V4, International Center for Tropical Agriculture (CIAT)*. [Online]. Available from: <http://srtm.csi.cgiar.org> [Accessed 29th July 2013]

Lacroix (2013) *Contributions of GIS to Efficient Mine Action* [Online]. Ph.D. thesis, Geneva University, Sc. 4571. Available from <http://archive-ouverte.unige.ch/unige:28996> [Accessed 30th July 2013]

7.

Lacroix P., Escobar R. (2012) 5D: A GIS-based approach for Determining and Displaying a Degree of operational Difficulty of Demining. *The Journal of ERW and Mine Action*. [Online] 16(3). Available from: <http://maic.jmu.edu/journal/16.3/rd/lacroix.htm> [Accessed 29th July 2013]

Lacroix P., de Roulet P., Escobar R., Cottray O. (2013) NAMA: A GIS-based Network Analysis approach for Mine Action. Submitted to *The Journal of ERW and Mine Action*. [Online] 17(3).

MACCA (2010) *Hazards location of 3D MAP in North East of Afghanistan*, Kabul ■

Contents

1

INTRODUCTION
AND STRUCTURE

2

PRODUCING
2-DIMENSIONAL
OVERVIEW MAPS

3

ENHANCING
THE PICTURE
WITH 3D
ANALYSIS

4

ANALYSING
ACCESSIBILITY

5

PRIORITISING
ACTIVITIES AND
EVALUATING COST

6

FUTURE GIS
DEVELOPMENTS

➔ 7

BIBLIOGRAPHIC
REFERENCES AND
DATA SOURCES

LIST OF ABBREVIATIONS

5D

Determining and Displaying
a Degree of Operational
Difficulty of Demining

CHA

Confirmed Hazardous Area

ERW

Explosive Remnant of War

FTP

File Transfer Protocol

GADM

Global Administrative Areas

GEOSS

Global Earth Observation
System of Systems

GICHD

The Geneva International
Centre for Humanitarian
Demining

GIS

Geographic Information
Systems

GPS

Global Positioning System

GPW

Gridded Populations of the
World

IMSMA^{NG}

Information Management
System for Mine Action – Next
Generation

INSPIRE

Infrastructure for Spatial
Information in the European
Community

MACCA

Mine Action Coordination
Centre of Afghanistan

NAMA

Network Analysis for Mine
Action

SHA

Suspected Hazardous Area

START

Simplified Toolbar to
Accelerate Repeated Tasks

UAV

Unmanned Aerial Vehicle

UXO

Unexploded Ordnance

VHF

Very High Frequency

WCS

Web Coverage Service

WFS

Web Feature Service

WMS

Web Map Service

WPS

Web Processing Service

The Geneva International Centre for Humanitarian Demining (GICHD) is an international expert organisation based in Switzerland that works to eliminate mines, explosive remnants of war and other explosive hazards. By undertaking research, developing standards and disseminating knowledge, the GICHD supports capacity development in mine-affected countries. It works with national and local authorities to help them plan, coordinate, implement, monitor and evaluate mine action programmes.

The GICHD also contributes to the implementation of the Anti-Personnel Mine Ban Convention, the Convention on Cluster Munitions and other relevant instruments of international law. The GICHD follows the humanitarian principles of humanity, impartiality, neutrality and independence.

Follow us on

gichd.org

facebook.com/gichd

twitter.com/theGICHD

**Geneva International Centre
for Humanitarian Demining**

Avenue de la Paix 7 bis

PO Box 1300

CH – 1211 Geneva 1, Switzerland

T + 41 (0)22 906 16 60

F + 41 (0)22 906 16 90

info@gichd.org