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The use of Geographic Information Systems for environmental impact assessments in Mine Action

The problem

Contamination by mines and explosive remnants of war (ERW) leaves severe and lasting impacts on civilian populations in affected countries. Victims require long-term assistance and livelihood and development opportunities for individuals and communities are reduced as mines and ERW prevent safe access the farmlands and trade centres. Humanitarian Demining (also called Mine Action) encompasses a set of activities that aim to prevent and address these problems caused by contamination by mines, cluster munitions and ERW. In particular, it consists of five groups of activities or pillars: (1) mine/ERW risk education; (2) demining (survey, mapping, marking and clearance); (3) victim assistance; (4) stockpile destruction; and (5) advocacy against the use of anti-personnel mines and cluster munitions.[i]

[Mechanical clearance operations with MiniMinewolf 240, MineTech International, Malakal, South Sudan 2010, photo taken by Mikael Bold

Demining is an expensive and time-consuming activity. Technologies have been developed to reduce costs and increase effectiveness and efficiency. For instance, mechanical demining has increased cost-efficiency allowing the quick processing of large areas. However, by its very nature, mine action involves direct interaction with the environment, through physical activities such as clearance and destruction of explosives. Therefore, these methods can represent a risk to the environment, potentially affecting land through soil degradation, erosion, deforestation and chemical pollution.

According to the "do no harm" approach, it is critical for mine action organisations to consider the possible negative impacts of mine clearance operations. They must ensure they do not lead to longer-term vulnerability or threaten livelihoods and food security and, by mitigating environmental damage, they should contribute to disaster risk reduction. The combined use of remotely sensed data and Geographic Information Systems (GIS) can be a sound solution[ii] to assess pre-contamination conditions, monitor both the environmental impact and the effects of mitigation activities, analyse consequences of natural disasters on contamination, and, finally, support an evidence-based decision making process[iii].

The science

Large availability of remotely sensed data, at different temporal and spatial resolutions, combined in a GIS with other data sources (population distribution, protected areas, infrastructure, etc.), can support the analysis and the decision making in all phases of environmental impact assessments: (i) characterisation of the environmental baseline information (i.e. status before the contamination, potential use and productivity of land, biodiversity and ecological value, etc.), (ii) scoping and impact identification, by assessing the vulnerability of ecosystems, (iii) impact prediction, by evaluating the risk of damage, (iv) impact evaluation on all environmental components (hydrosphere, biosphere, lithosphere and atmosphere), after the damage occurred, (v) monitoring of the impact mitigation measures[1]. In addition to high resolution satellite imagery, new generation of affordable and easy-to-use Unmanned Aerial Systems (UAS) can provide multi-temporal input data to monitor both demining operations and the correspondent environmental effects[2].

[High Resolution (4 cm-pixel size) optical image, Azerbaijan, August 2012, taken by Inna Cruz (GICHD) using a Swinglet CAM UAS]

Static topographic data in addition to imagery change detection, multispectral analysis and supervised classification would be the main input layers for building an environmental geodatabase that can be used to provide reference data for a GIS-based multi-criteria analysis (MCA) system. The MCA system implements a pre-defined decision making model, which takes into account the spatial relationship (i.e. proximity, intersection, inclusion, etc.) of relevant indicators to estimate impact and priorities. Similar to other domains, the accuracy and fitness-for-purpose of these methods are critically related to both the availability of accurate and updated data and the correct definition of the evaluation process (model and set of indicators).

The application to policy and practice

The Mine Action sector relies on a number of international conventions and on International Mine Action Standards (IMAS) which "provide guidance, establish principles and, in some cases, define international requirements and specifications"[iv].

The IMAS have been developed since 1990s through a consultative process involving UN agencies, donors, national mine action authorities, the International Organisation for Standardisation, militaries, commercial companies and experts. The IMAS encompass 14 chapters,[v] among them the IMAS 05.10 is about information management. In particular, the IMAS 05.10 states that national mine action authorities should[vi] ensure that their programmes have a dedicated GIS officer, information management staff receives adequate GIS training, and finally that GIS is integrated in the record management system and geospatial data is available and accessible. The IMAS 05.10 is a good example showing that GIS technology has been integrated into practice and is considered as an essential element in the setup of a mine action programme.

Did it make a difference?

Remote evaluation minimizes the risk for operators in contaminated post-conflict areas and ensures objective, spatially comprehensive and multi-temporal data collection and analysis. Finally, the rapid evolution of technology increases the cost-effectiveness of these approaches.

As an example, the large flooding occurred in Bosnia in May 2014 disrupted marking of mined areas and shifted landmines. The National Mine Action Centre (BHMAC) requested support from the European Union/GIO and the European Space Agency (ESA)/Space Assets for Demining Assistance (SADA) projects for mapping affected areas and evaluate possible consequences on the hazard distribution (movement of landmines) and population safety. The GIS products were delivered in few hours and included multi-temporal analysis of the flood extension combined with critical infrastructure, population distribution and mines areas. These maps were considered as a valuable support for planning emergency response, mitigation activities and future demining operations.

This example also shows that the integration of GIS into the information management system for mine action, as requested by the IMAS mentioned above, can make a difference not only in supporting planned humanitarian demining, but also contribute to

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disaster risk reduction by providing information useful for evidence-based decisions on how to respond to exceptional natural events affecting the scope and distribution of mine risks.

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[iv] GICHD, A Guide to Mine Action. 2014. Geneva, pp. 68.
[v] See: http://www.mineactionstandards.org/standards/international-mine-action-standards-imas/imas-in-english/ [Accessed 24 September 2014].
[vi] 'Should' is used to indicate the preferred requirements, methods or specifications. See IMAS 05.10, p. 1. http://www.mineactionstandards.org/fileadmin/MAS/documents/imas-international-standards/english/series-05/IMAS_05.10_Information_Management_for_Mine_Action__Ed.1__Am_1_.pdf. [Accessed 24 September 2014].

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