OCHA United Nations Office for the Coordination of Humanitarian Affairs

# An approach to primary healthcare service areas for landmine victims in Colombia

Cartagena, Colombia
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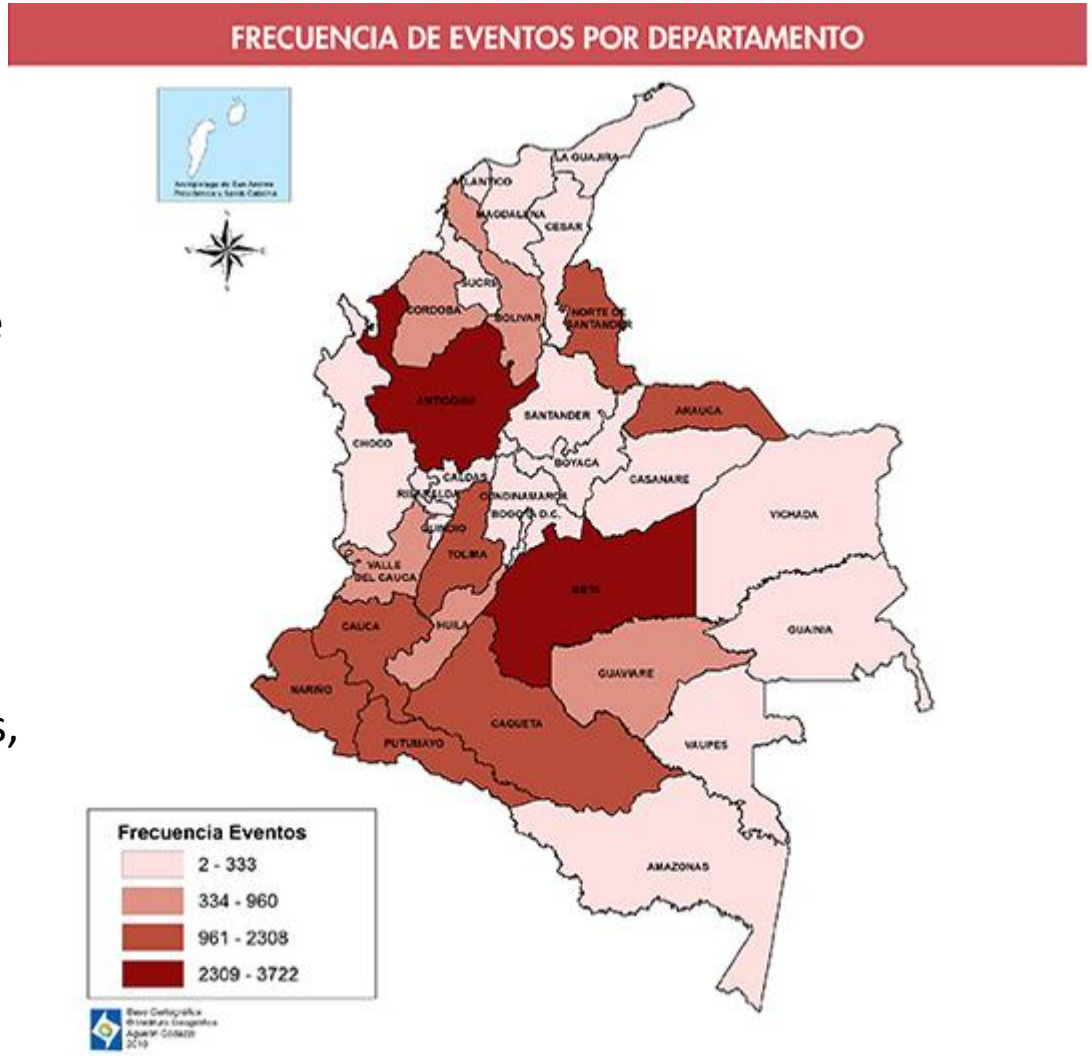
# 1. Abstract.

Colombia is one of the most affected countries by landmines/UXO in the world, due to a war that spans the last 50 years. Every year, the number of people killed and injured increases considerably. Many of the affected live in rural areas, where most accidents occur, far from the cities where healthcare facilities are concentrated.

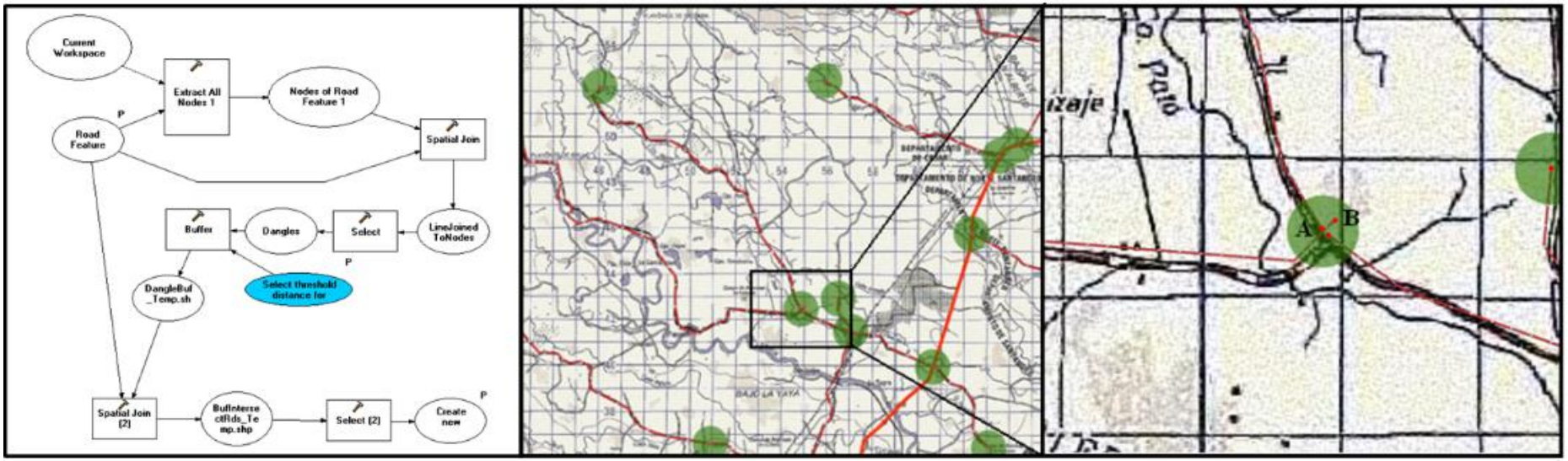
We present a methodology to delineate hospital service areas based on GIS transportation network analysis, detecting those healthcare facilities closest to landmine victims in Colombia, and measuring accessibility to primary healthcare facilities for these victims.




Source: http://www.accioncontraminas.gov.co/

# 2. Building a Transportation Network

## 2.1 Ensuring Connectivity of the Network




**Left:** Simple geoprocessing model to verify the connectivity of all the features and the junction elements. **Center:** the green circles are the output of the geoprocessing model to verify connectivity and highlights the topological errors, the black box is the frame of a zoom. **Right:** A) Arcs undershot, the red points show a segment of a line falls short of another line that it should intersect, B) Arcs overshot, it is also possible to identify that at least one node does not connect to any other arc.

# 2. Building a Transportation Network

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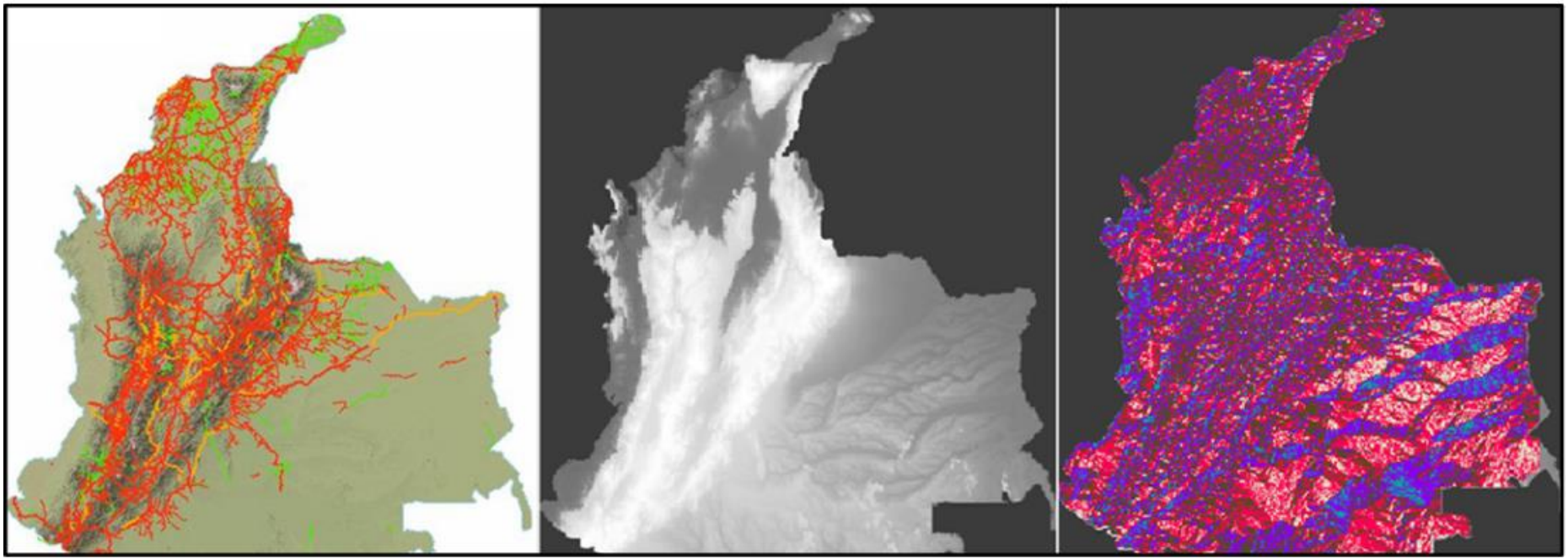
## 2.2 Finding the least-cost route for paths and makeshift roads



**Left:** road network classification. **Center:** 30 meter SRTM-DEM. **Right:** back link raster (BackLink_Temp) is used to retrace the least costly route from the destination to the source over the cost distance surface, we use this simple geoprocessing model to create the most likely paths from the landmine/UXO accident location to the nearest road.

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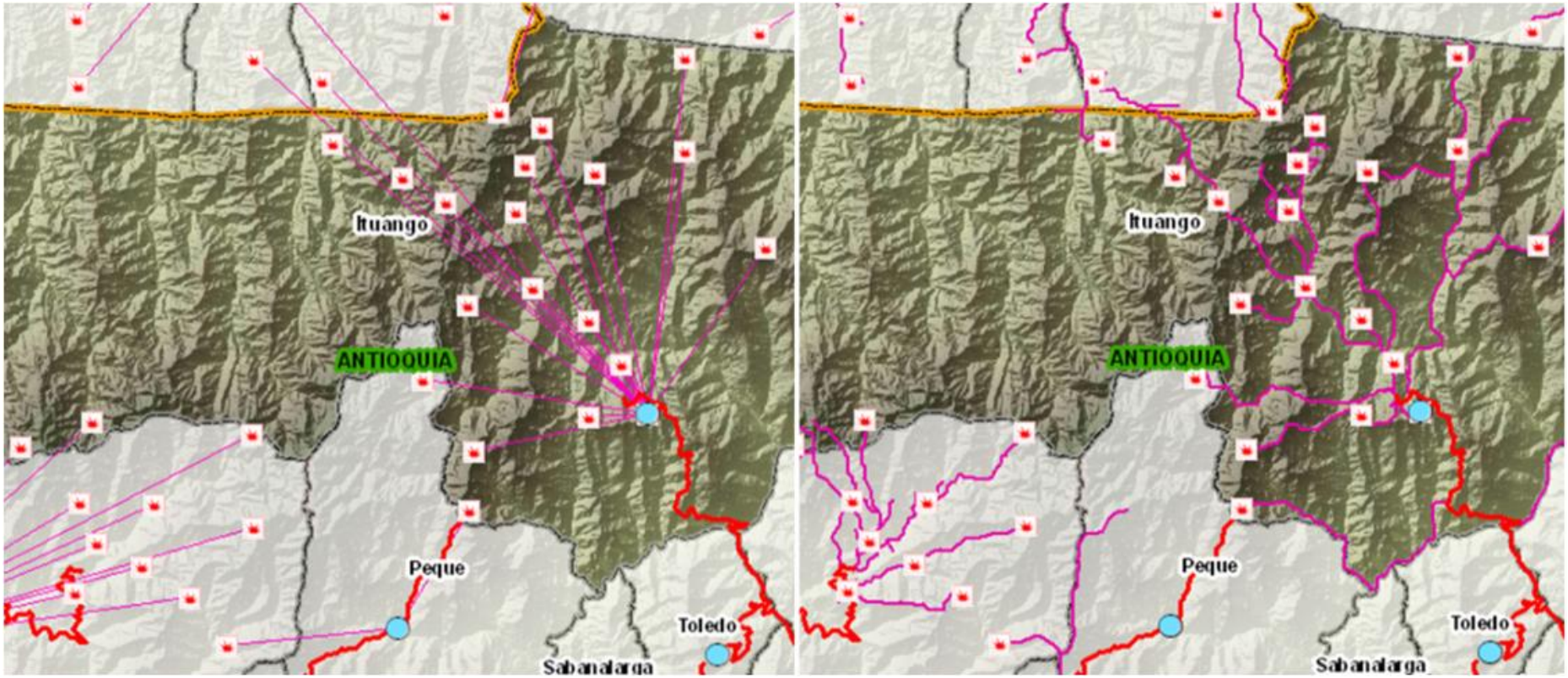


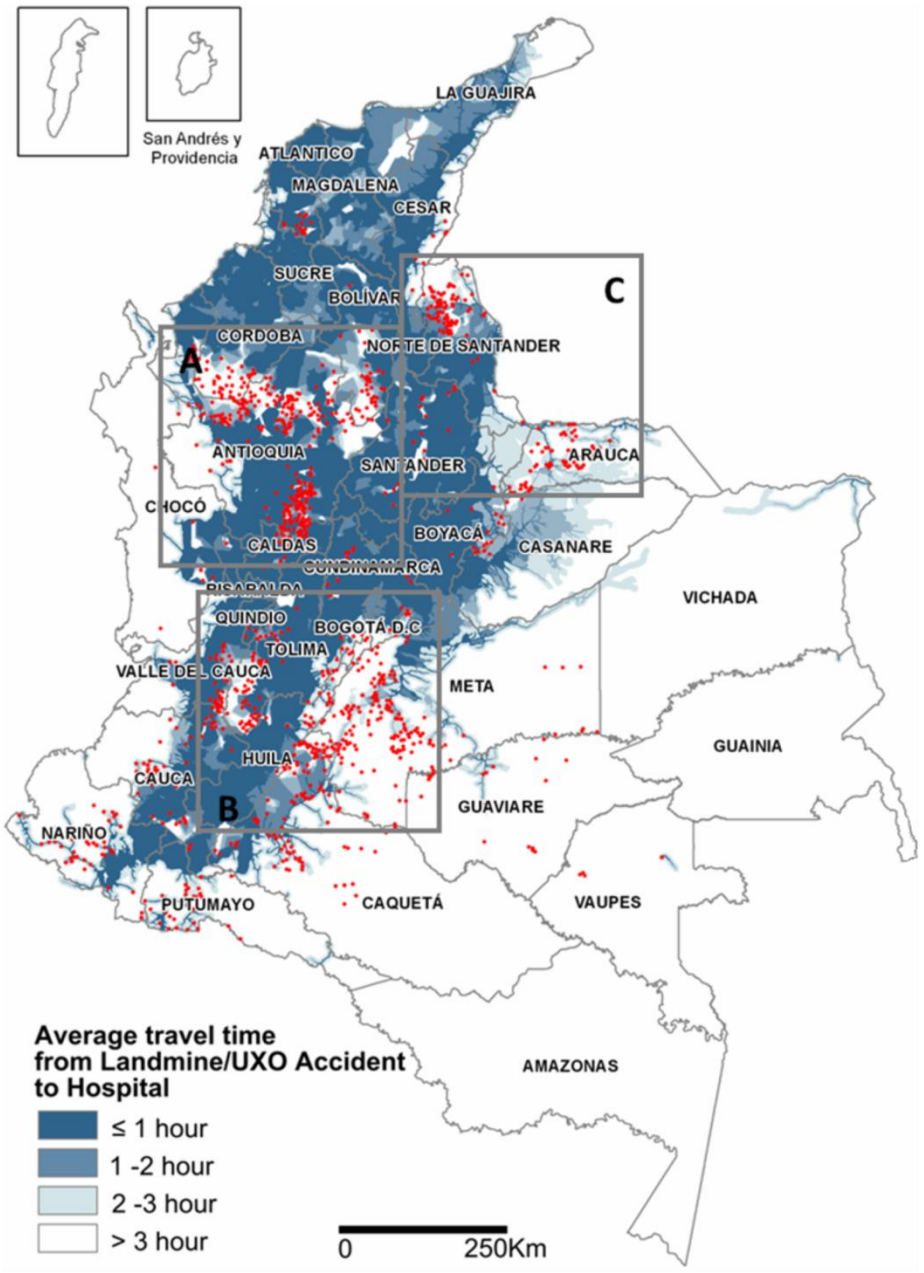

**Left:** straight-lines from location on landmine/UXO accidents to hospitals in urban areas.
**Right:** the result of the least-cost path analysis shows the paths with a good approximation to the true surface distance.

# 3. Determination of Hospital Service Areas

The service areas method helps to determine the minimum distance or shortest path from a point (source) to another point (destination), minimizing travel time across a road network, and takes into account the relief factor impedance (measured as expensive or difficult to go through a section of track).

We used this method to calculate the average travel time from places of occurrence of a landmine accident to the nearest hospital (Level 1, 2 and 3).

Red points are GPS referenced locations of accidents during the period from 1990-2012.



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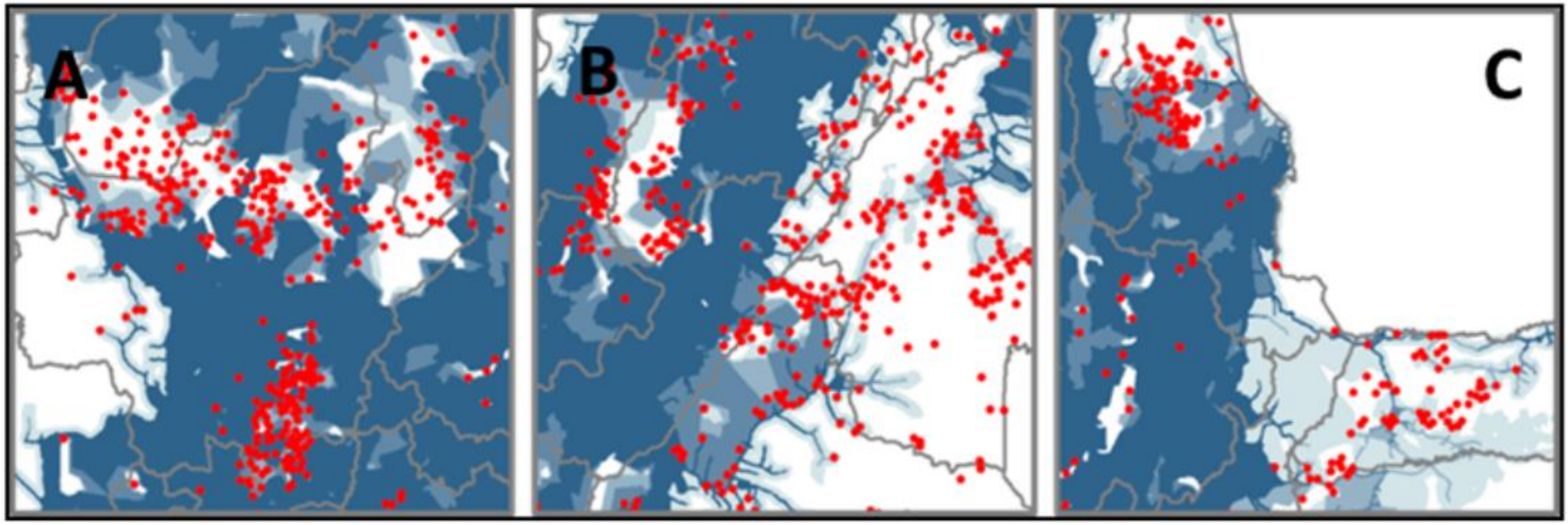


**Zoom boxes** to important regions of concentration of landmine accidents **A: "Nudo de Paramillo"** and "**Suroriente antioqueño"** B: South of **Tolima** department including **"Paramo y Cañon de Las Hermosas"**, C: **Norte de Santander** and **Arauca** departments. These regions have shown an historical presence of NSAGs and use of landmines to block access, besides having geographic characteristics that make hospital service allocation more difficult.

# 4. Conclusion

This work presents results for GIS Service areas and closest facilities determination to delineate hospital service areas in order to measure accessibility to primary healthcare facilities for landmine victims.

- We used these to identify the most affected areas for blocked access to primary healthcare facilities.

- We obtained a set of hospitals service areas that show how accessibility varies with impedance; we found higher localization of care with an expected time of travel of less than one hour in the Andean region with few exceptions that correspond to historical presence of NSAGs, especially where these explosive devices have been installed with the purpose of blocking access, and larger regions with more than 3 or 4 hours of expected time of travel.

- These areas allow us to notice the disparity in accessibility for healthcare in several regions of the country.