Mapping Flood Risk Zones from Remote Sensing Data

Abstract

Floods pose a major threat to populations of drainage basins as contemporary climate change is leading to more extreme weather events and rising waters. By using photogrammetry and object-based image analysis (OBIA) on high resolution satellite imagery, it is possible to receive information about the topography of an area and simulate different scenarios of water level rise. With this method, a flood risk-map of a region of the River Magdalena, Colombia was created using only a tri-stereo set of SPOT satellite imagery.

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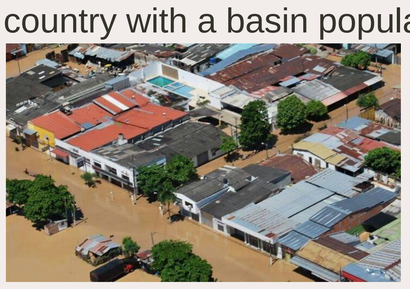
Study Area

Rainy seasons in the past decades have caused several hundreds of deaths and serious economic impact for Colombia (Gallego et al., 2018).The river Magdalena is the principal fluvial system of Colombia and the major axis of economical development of the country with a basin populated by nearly 80% of the Colombian population (Jiménez-Segura et al., 2009). The study area is and approximately 110 km^2 zone of the Magdalena's basin, near the city of La Dorada.



La Dorada flooded by the Magdalena in 2017 (source: Botero González, 2017)

Data

The tri-stereo imagery was downloaded from Airbus' official website.

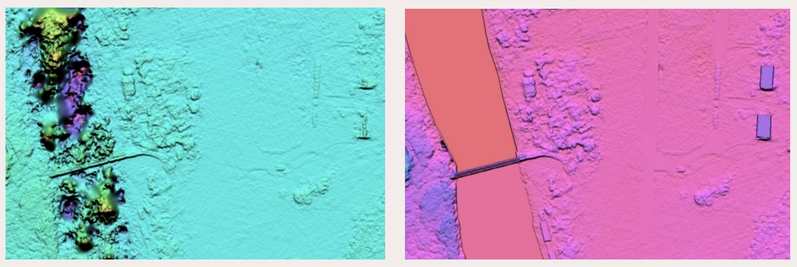
Scene ID	Sensor	Date	Resolution
SEN_SPOT7_20170701_150027300_000	SPOT7	01.07.2017	1.5 m (pansharp)
SEN_SPOT7_20170701_150045900_000	SPOT7	01.07.2017	1.5 m (pansharp)
SEN_SPOT7_20170701_150120600_000	SPOT7	01.07.2017	1.5 m (pansharp)

Image processing

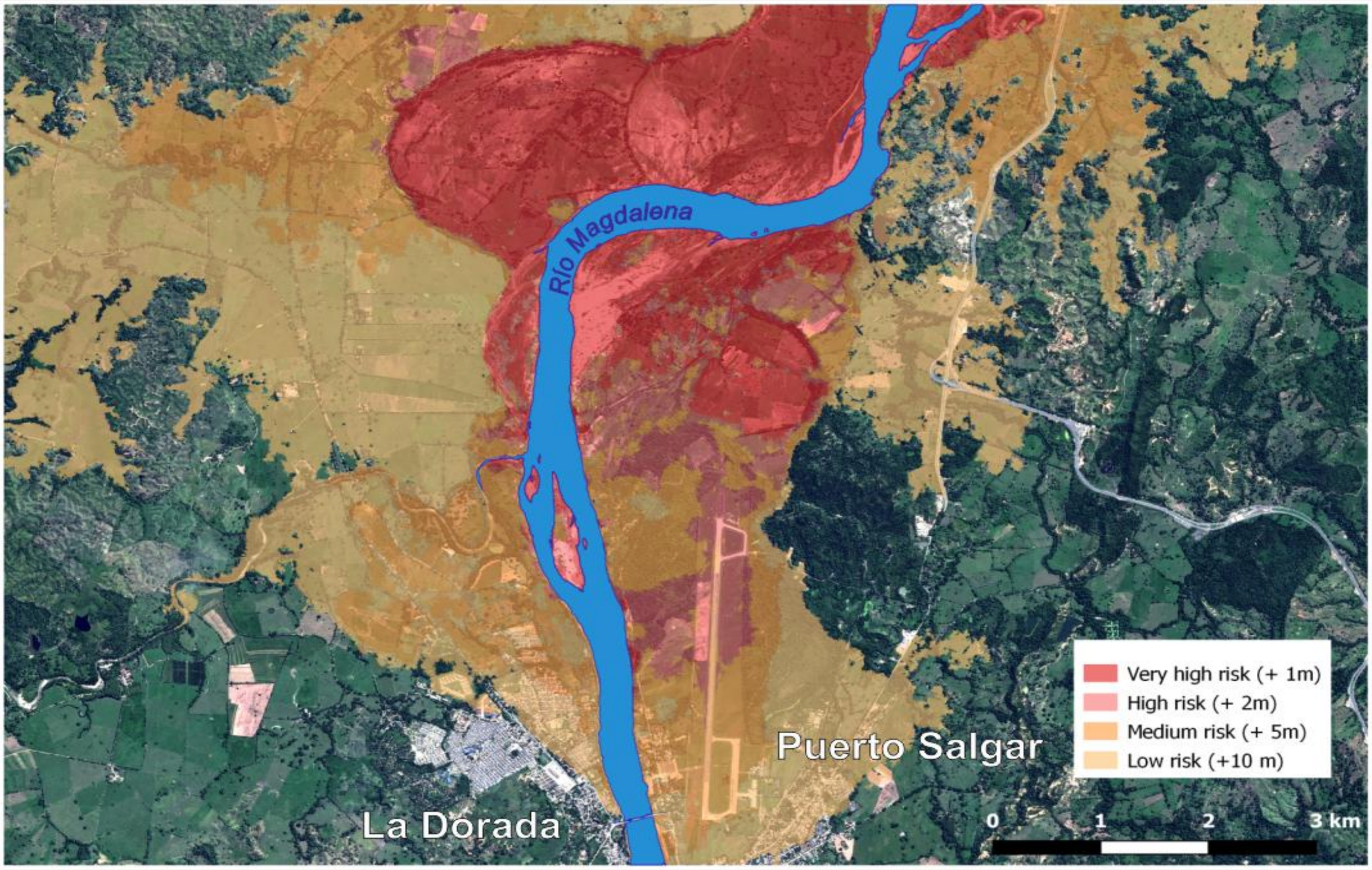
The image processing was performed in PCI Geomatica OrthoEngine. Tiepoints were automatically collected and stereopairs were generated from the three images. An elevation model of 1.5 m resolution was built using the method Semi Global Matching. In addition, an orthomosaic was created from the three images.

DEM Editing

The digital surface model contained heavy noises, especially on buildings and water surfaces. Therefore, it had to be manually corrected. A terrain model was then created from the result using the python tool DSM2DTM.



Digtal Surface Model before (left) and after (right) manual correction



Object-based analysis

OBIA was performed in eCognition with the following steps:

1. Multiresolution segmentation
2. Detection of river using NDWI and geometric threshold values
3. Detection of objects that have an elevation value below the new water level
4. Merge objects
5. Delete objects isolated from the main water body
6. Export classifications as shapefiles

Result

The classification was imported to QGIS where the map was created. The area of each risk zone was calculated:

Water level rise	Area flooded
+ 1 meters	11.49 km2
+ 2 meters	15.75 km2
+ 5 meters	28.54 km2
+ 10 meters	51.55 km2

Future directions

1. A thematic map with land cover classification would give more details about the nature of risk zones
2. Ultra high resolution data like LiDAR or Pleidaes imagery would allow generating more accurate elevation models and flood maps.

References

Botero González, John Jairo 2017. El Magdalena se está tragando a La Dorada y Puerto Salgar. EJE21, viewed 13 May 2020, <http://www.eje21.com.co/2017/05/la-dorada-y-puerto-salgar-no-duermen-por-crecientes-del-magdalena/>

Gallego, J., 2018. Natural disasters and clientelism: The case of floods and landslides in Colombia. *Electoral Studies*, 55(C), pp.73–88.

Jiménez-Segura, L.F., Palacio, J. & Leite, R., 2010. River flooding and reproduction of migratory fish species in the Magdalena River basin, Colombia: Floods and fish reproduction. *Ecology of Freshwater Fish*, 19(2), pp.178–186.

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