

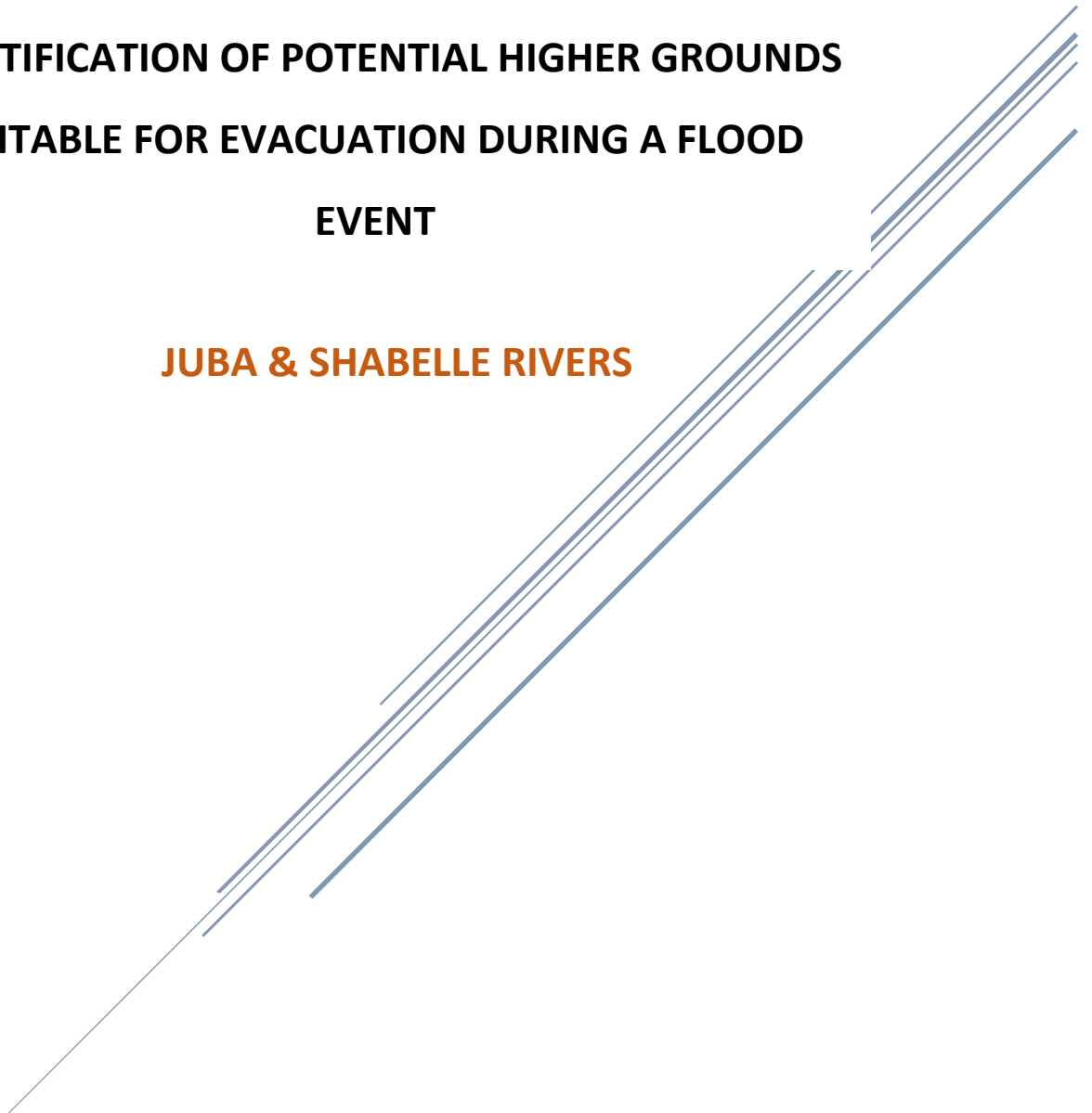


Food and Agriculture
Organization of the
United Nations



**IDENTIFICATION OF POTENTIAL HIGHER GROUNDS
SUITABLE FOR EVACUATION DURING A FLOOD
EVENT**

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Introduction

Somalia has been grappling with the enduring and escalating impacts of climate change. One of the most tangible manifestations of this environmental challenge is the recurrent occurrence of riverine and flash flooding across various regions within the country. The consequences of these flood events have been particularly pronounced in major urban centers, such as Beletweyne and Jowhar, where the devastation and loss has been substantial. According to an analysis undertaken by FAO-SWALIM, 79% of Beletweyne town was inundated during the 2023 Gu rainy season.

In view of this, there is a pressing need to formulate and implement a comprehensive set of strategies aimed at both prevention and protection. These measures are imperative to safeguard lives and mitigate the staggering economic losses associated with flood disasters.

One key component of this strategy is proactive flood management, which entails the timely evacuation of areas at risk of flooding before the onset of disaster. This step is paramount to minimize the loss of both property and human lives. However, it is essential to consider the coordination of such evacuations, including identifying suitable higher ground where displaced individuals can be relocated.

Identifying appropriate elevated terrain serves a dual purpose: it ensures the safety of those at risk and provides a strategic vantage point for delivering essential services and humanitarian aid. Access to clean water, shelter, food, and medical assistance becomes more viable in areas that are less prone to flooding.

To attain these objectives effectively, a rigorous methodology has been developed and applied. This methodology is designed to comprehensively understand the dynamics of flood events in Somalia. It considers factors such as historical flood patterns, land use land cover, Water availability and terrain analysis to pinpoint potential high-ground evacuation sites.

Datasets Used in the Analysis

A total of 9 derived datasets were used to undertake a suitability analysis to identify the potential areas for location of a flood evacuation site namely:

1. Flood Extent
2. Elevation
3. Slope
4. Topographic Wetness Index (TWI)
5. Drainage Density
6. Strategic Boreholes
7. Settlements
8. Land Cover and

9. Roads

Methodology

Based on predefined criteria as indicated in table 1 below, each of these datasets were first clipped to areas outside the flood extent but within a maximum distance of 10 Km from the flood extent boundary. The outputs were then reclassified into two classes namely; Suitable and Not Suitable. Using an iterative approach, each of these datasets was used to assign a weight to the suitability of a site. These weights are indicated in table 2 below. Thereafter, a multi-criteria evaluation weighted overlay operation was undertaken to determine the potential areas for evacuation sites. An area was then computed for the potential sites and their distance from the flood extent established.

The output was then post – processed to remove invalid geometries and each site was ranked based on the distance from the flood prone area. Sites closer in distance were deemed most suitable, hence a higher rank.

The final layer was then visually checked based on the density of the topographic Wetness Index (TWI) which is based on runoffs during floods. Areas with dense TWI were eliminated to remain with only continuous areas.

Suitability Criteria

Dataset	Source	Suitability Criteria	Reasons
Flood Extent	Merge of SWALIM historical extent and GLOFAS El Nino forecast Extent	The area had to be away from the flood extent but within a maximum distance of 10 Km from the flood extent boundary.	Areas within the flood extent are vulnerable thus not suitable for evacuation. On the other hand, evacuation may often involve movement through walking or the use of animals. Far evacuation areas may not be effective since people may choose to settle in areas near their

			displaced areas as they await the situation to normalize.
Elevation	SRTM 30 Metre	Variable Beletweyne - (200 – 250 Metres) Jowhar - (120 – 180 Metres. Afgooye - (100 – 180 Metres) Dollow & Luuq - (180 – 250 Metres) Baardheere - (100 – 200 Metres) Derived by analysis of the profile of the flood extent. Area must be greater than maximum elevation within the flood extent profile.	Area must be higher than the flood plain. Equally, these areas must be flat that is suitable for resettlement.
Slope	Derived	Areas that have a slope of <20 degrees.	Area must be flat or undulating to allow easy flow of water through the settlement. Steep areas may be unsuitable for housing or temporary economic activities.
Topographic Wetness Index (TWI)	Derived using SAGA Tools	Areas with an index of less than 18	Area with higher TWI is along drainage channels that may be prone to flash flooding.

<p>Drainage Density</p>	<p>River Network - SWALIM</p>	<p>Areas that are greater than 70 metres from drainage network</p>	<p>Drainage networks serve as conduits for water across the channel. While some of these areas are often dry, they may be prone to flash floods during wet seasons. Situating the evacuation site further away from these areas will help to mitigate secondary loss occasioned by flash floods. On the other hand, drainage networks are ubiquitous hence it is not possible to exclude them entirely, thus a 70 metre buffer was deemed sufficient.</p>
<p>Strategic Boreholes/ Strategic WaterSources</p>	<p>SWALIM</p>	<p>Areas within a maximum radius of 2 Km of a borehole for Beletweyne and Jowhar. In other Districts where assessment was undertaken, a merge of the 2018, 2020 and 2022 strategic water sources data was used since these areas have few or nonexistent boreholes data.</p>	<p>Water is required to sustain the various needs of the evacuated population. It is thus important that such areas be in proximity to strategic water sources (Boreholes). Open water areas were excluded since they may be contaminated with flood water thus making it unsuitable for consumption.</p>

Settlements	GRID3 Settlement Dataset	Settlements that are greater or equal to 5 ha in size	The existence of a settlement in the area was the first criterion. Settlements of at least 5 ha hold a sizeable population, indicating the suitability of the area for human settlement. Further, they are likely to be in proximity to related services such as markets, schools etc. that may be necessary to settle the evacuees.
Land Cover -	Dot Grid - SWALIM	Areas of Suitable landcover such as bare area, built up areas or natural with sparse vegetation class from the Dotgrid were deemed suitable.	To reduce environmental damage, forested areas or areas with dense woody vegetation were excluded. On the other hand, areas such as water bodies and irrigated farmlands are unsuitable to hold populations.
Roads	Open Street Map (OSM)	Areas that are a maximum of 2 Km from primary, secondary, or tertiary roads. Osm roads were used and only these classes of roads were selected.	These road classes were deemed motorable roads, increasing the ease of access for delivery of humanitarian support if any.

Weights Used for each criterion.

Dataset	Suitability Weight Percentage
Flood Extent	Boolean – Areas had to be outside of flood extent
Elevation	12
Slope	10
Topographic Wetness Index (TWI)	8
Drainage Density	8
Strategic Boreholes	10
Settlements	25
Land Cover -	12
Roads	15

Conclusion

This analysis entailed remote sensing techniques. Consequently, a field verification is required to ascertain the suitability of each site before proceeding with investments in the area. Implementing agencies, should put consideration to the following sustenance factors that may be crucial for the evacuated persons that have not been considered due to the lack of data on the same.

Proximity to schools or other institutions where the evacuated persons may be hosted, proximity to healthcare facilities, pest conditions among others that may be key. Implementing agencies should apply discretions when selecting the target sites.

References

Isa Ibrahim, Kolawole H. Muibi, Abayomi T. Alaga, Oyekanmi Babatimehin, Olusola Ige-Olumide, Oloko-Oba O. Mustapha, Sedenu A. Hafeez, Suitability Analysis of Resettlement Sites for Flood Disaster Victims in Lokoja and Environs, *World Environment*, Vol. 5 No. 3, 2015, pp. 101-111. doi: 10.5923/j.env.20150503.02.

Parajuli, G., Neupane, S., Kunwar, S., Adhikari, R., & Acharya, T. D. (2023). A GIS-Based Evacuation Route Planning in Flood-Susceptible Area of Siraha Municipality, Nepal. *ISPRS International Journal of Geo-Information*, 12(7), 286. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/ijgi12070286>