LIBYA: EXTREME HEAT RISK ALONG MIGRATION ROUTES

OVERVIEW

Libya has recently experienced numerous extreme weather events, particularly flash floods and heatwaves, that have significantly affected communities across the country. These events, which have occurred with increased frequency, highlight how climate change affects Libyan communities, with vulnerable populations being the most affected. Data analysis is a critical tool in anticipating how these events may affect migration and displacement. Maps like those produced during this collaboration can enable analysts to identify at-risk communities and understand the specific needs of displaced, host, and mobile populations. Research teams from the International Organization for Migration (IOM) and the AI For Good Lab came together to investigate how extreme heat impacts migrants journeying through Libya as well as host communities residing along migration routes, and how these effects will evolve as a result of climate change. Two key findings from this collaboration are:

1. The risks experienced by migrants and host communities residing along migration routes will increase significantly under a +2°C climate scenario. Currently **8%** of the mapped migration routes by distance lie in areas that experience dangerous levels of heat. In the +2°C climate scenario, that is projected to increase to **72%**.
2. The heat-related risks experienced by migrants are less severe in the colder winter months, though winter migration involves its own unique set of risks. Because migrants who enter southeastern Libya from Sudan are principally displaced by conflict, that migration pathway is traversed all year round, while the western pathways are more commonly traversed in winter. As a result, migrants experiencing heat-related hazards are more likely to be found on the eastern pathways than the western pathways.

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DATA AND METHODS

Maps of migration pathways were compiled by the IOM Libya office and shared with the AI for Good Lab.

High-resolution data on climatic conditions was pulled from TerraClimate, a dataset made available by Climatology Lab.[1, 2] This dataset includes current conditions and climate conditions under a +2°C climate scenario.

Defining Dangerous Heat Conditions

To create risk maps, we calculated ***heat index*** according to the formulation provided by the U.S. National Weather Service. Heat index considers temperature and relative humidity. The National Weather Service provides risk levels defined by thresholds of heat index values. The four levels are: caution, extreme caution, danger, and extreme danger.

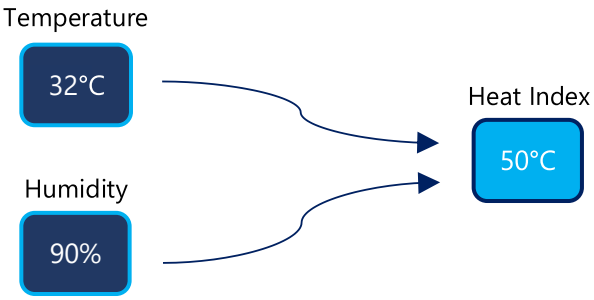
This report focuses on the **extreme caution** and **danger** bands.[3] Heat index values in the extreme caution band reflect conditions in which heat disorders are possible for all individuals with prolonged exposure and/or physical activity. Heat index values in the **danger** band reflect conditions in which heat cramps and heat exhaustion are likely with prolonged exposure and/or physical activity, and heat stroke is possible.[4]

These classifications likely **underestimate** the risks experienced by migrants and host communities residing along migration routes in Libya. Documentation on the heat index notes "since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15°F."[5] In arid regions of Libya, shade is scarce and wind is common. In the context of the Libyan climate, heat index values in the **danger** band may represents risks typically associated with the **extreme danger** band, where all individuals are at high risk of heat stroke.

Defining Dangerous Heat Conditions

Formulas and thresholds are provided by the U.S. National Weather Service.[4]

Heat Index is calculated from temperature and humidity



Bands of heat index values represent risk profiles

Caution	27-32°C	Heat-related illnesses possible in high-risk individuals
Extreme Caution	32-39°C	Heat-related illnesses possible with prolonged exposure
Danger	39-51°C	Heat-related illnesses likely with prolonged exposure
Extreme Danger	51°C+	Heat stroke likely

FINDINGS

Projections of Heat Increases

Currently, it is uncommon for heat index values to reach the **danger** band of the heat index. During the hotter summer months,[6] heat index values reach the **extreme caution** band nearly every month, but rarely extend into **danger**. During the winter months, heat index values rarely reach the **extreme caution** band. Migrants on the mapped pathways, then, are not frequently exposed to heat index levels in the **danger** band.

For this report, we examined 7,000km of migrant pathways mapped by IOM. Only 550km – 8% – of those routes pass through areas that reach the **danger** level of heat index values at least one month out of every twelve, a threshold for regularly reaching dangerous levels of heat.

There are segments of the migration routes that do regularly experience dangerous heat levels. The route segment on the eastern side of the country that passes through Jalu runs for 650km, 40% of which passes through areas that regularly experience heat index values in the **danger** band.

[1] climatologylab.org/terraclimate.html
[2] Abatzoglou, J., Dobrowsk, S., Parks, S. et al. TerraCliamte, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015. Sci Data 5, 170191 (2018). https://doi.org/10.1038/sdata.2017.191
[3] Heat index values reaching the extreme danger band were not observed very infrequently, although heat index values in the danger band in Libya may represent risks typically associated with the extreme danger band, as explained above.
[4] https://www.weather.gov/ama/heatindex
[5] https://www.weather.gov/safety/heat-index#:~:text=NWS%20also%20offers%20a%20Heat,air%2C%20can%20be%20extremely%20hazardous.
[6] Summer months here are defined as April-September, with winter months defined as October-March, in keeping with https://www.britannica.com/place/Libya/Climate

Under projections of a climate scenario in which global temperatures rise by 2°C, the heat-risk profile along these migration routes changes significantly. While only 550km of the routes currently pass through dangerous areas, 5,000km – **72%** – of the pathways are projected to pass through dangerous areas in the +2°C climate scenario. **100%** of the route segment through Jalu would be in areas that regularly reach the **danger** band of heat index values.

Figure 1 shows the heat index levels that are reached in different areas of Libya. We have mapped the average of the yearly maximum heat index over a 15-year stretch. We have chosen to look at yearly maximum values because we are concerned with how dangerous the heat conditions may be in any given area. By plotting the *average* of yearly maximum values, we can illustrate the extent to which each area tends to experience dangerous conditions.

Figure 2 shows the same information as Figure 1 but uses the projected climate conditions under the +2°C climate scenario. While current climatic conditions include large swaths of the country that regularly experience heat index values in the **extreme caution** band (Figure 1), projected climate conditions would shift many of these heat index values into the **danger** band (Figure 2).

Though this report is focused primarily on the risks experienced by migrants traversing particular routes, increasing temperatures pose challenges to host communities and internally displaced persons as well. As Figure 2 illustrates, municipalities across Libya, particularly in eastern and southwestern Libya would experience more dangerous levels of heat in a +2°C climate change scenario. The municipalities of Ghat and Alkufra already experience high risks of flash flooding, and worsening heat conditions would put already vulnerable populations at greater risk. In Alkufra, for example, where there is already a sizable population of persons displaced due to recent flooding, increased risks from exposure to heat could further affect community resilience. This is just one example of how increased risk of exposure to extreme heat could affect local communities across Libya, especially those already housing vulnerable populations.

Seasonal Differences in Risk Exposure

One unsurprising but potentially impactful finding from this research is the extent to which heat-related risks are more severe during the hotter summer months. Figure 3 and Figure 4 show the average yearly maximum heat index value for summer months and winter months respectively .

While summer heat index values reach at least the **extreme caution** band in much of the country, winter heat indexes do

Figure 1: Average Annual Max Heat Index Under Current Climatic Conditions

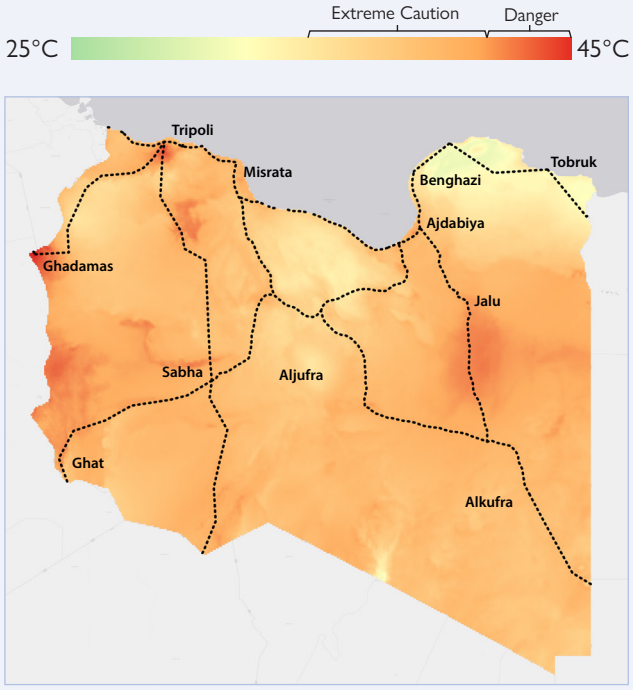
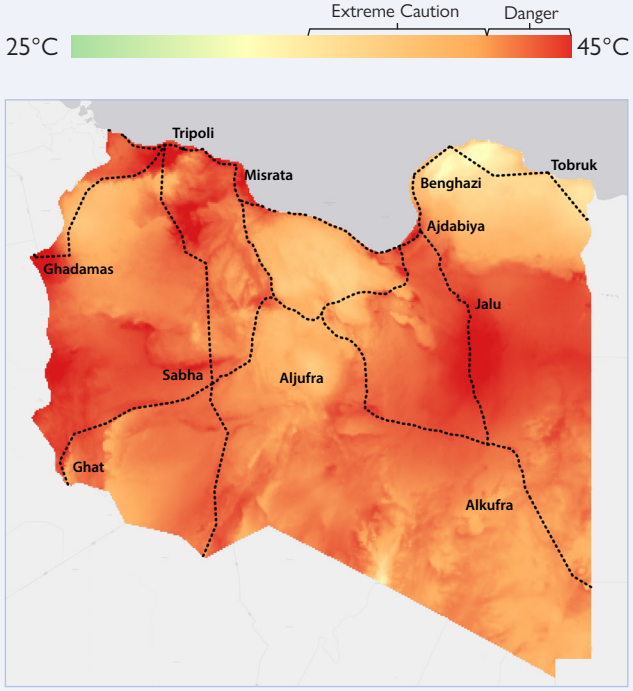


Figure 2: Average Annual Max Heat Index Under a +2°C Climate Scenario



[7] The annual maximum heat index value always occurs during the summer months, so the map of average annual maximum heat index value for the summer months (Figure 3) is identical to the overall yearly map (Figure 1).

not reach that level of risk. Across over 99% of the migration routes, winter heat indices reach **extreme caution** levels during winter months less than once a year.

On the western migration pathways, including those routes that enter Libya through Algeria and Niger, migration is more common in the winter when heat conditions are more favorable. The eastern pathways, however, carry many migrants displaced due to conflict. As a result, these pathways are traversed during summer and winter alike.

Migrants traveling through Libya at any time of year face myriad challenges, and migration during the winter months carries its own set of risks. In this report we are focusing on heat-related risks. During the summer months, those risks are more severe, and during the summer months the eastern pathways see greater traffic. Therefore, simply because of the difference in seasonal migration patterns, migrants experiencing heat-related risks are more likely to face those risks on the eastern migration paths.

CONCLUSION

This analysis was designed to assess the heat-related dangers faced by migrants journeying through Libya and to project how these risks may evolve due to climate change. These dangers are very likely to worsen as a result of climate change, posing risks not only to migrants but also to local communities throughout Libya.

Migrants entering Libya from Sudan on the route that passes through the Al Kufra district and north toward the town of Jalu traverse a route that is particularly susceptible to dangerous heat conditions. Of the 7,000km of migration routes we analyzed in this report, this route is most likely to exhibit dangerous levels of heat. In a +2°C climate scenario, the heat-related dangers on this route are projected to worsen significantly. In addition, migrants traveling along this pathway are more likely to migrate during summer months, when extreme heat is most common. Humanitarian aid positioned along this route may be in a position to help many vulnerable migrants, both now and in the future.

As global temperatures rise, dangerous levels of heat will become common on all the other migration paths as well, and all the migrants traveling through Libya will be at a significantly increased risk of heat-related illnesses. By mapping migration routes and overlaying high-resolution climatic projections, we hope to galvanize anticipatory action and help direct it to the areas of highest need.

Figure 3: Average Annual Max Heat Index In Summer Months

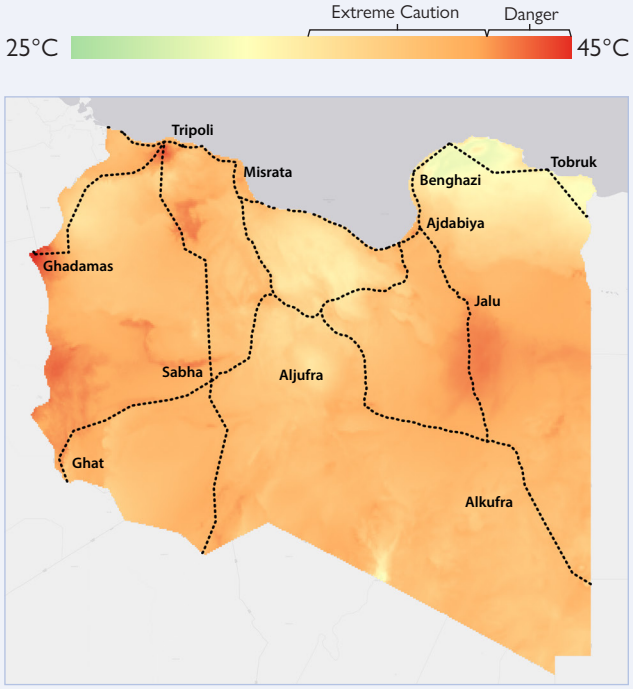
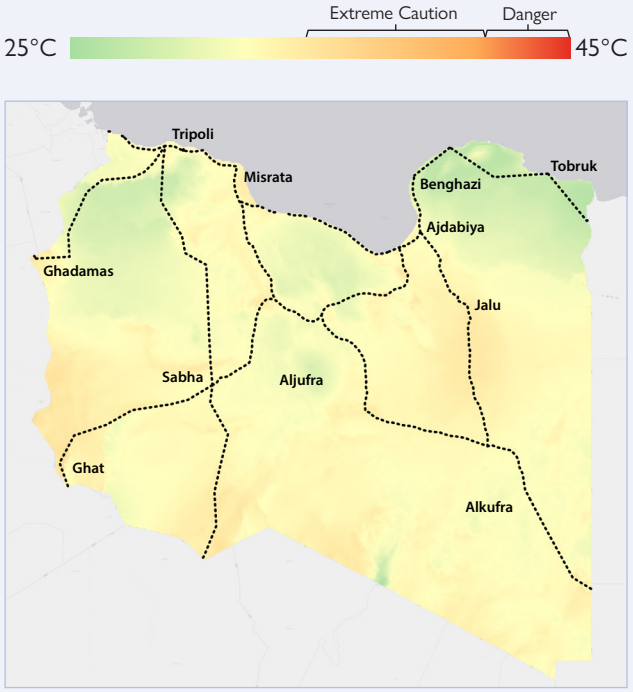


Figure 4: Average Annual Max Heat Index In Winter Months

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