SUPPLEMENTAL MATERIAL

**Supplement 1-Data preparation for use in AccessMod**

All data preparation was carried out in Quantum Geographical Information System (QGIS) (version 3.4)[24] in limited combination with R (version 3.5.2)[25]. As indicated in Table 1, most data layers were retrieved from open data platforms. All raster- and shapefiles were saved in the projection system of Mozambique, i.e. UTM-37S [EPSG:32737]. All raster files were aligned using the digital elevation model (DEM) as reference. The data preparation process is fully described below for each data set.

*Elevation*

Anisotropic accessibility analyses, in other words analyses accounting for travel speeds on slopes, were carried out for this study. Elevation data were obtained from the Shuttle Radar Topography Mission (SRTM) in tiles at a resolution of 30 meters and mosaiced to cover the whole country[38]. Slopes were derived from it and accounted for when modelling walking movements.

*Land cover*

The land cover data set of the African continent[27] was clipped to the extent of Mozambique, leaving a small buffer around the country to prevent loss of data cells at the border. The data set was resampled at a resolution of 30 meters using nearest neighbor interpolation.

*Road network*

The pre-cyclone road network dataset was retrieved from Open Street Map (OSM) through the Geonode Platform of the National Institute for Disaster Management Mozambique (INGC), as this dataset was perceived to represent the most recent information on the roads and could be linked to the damaged roads, as indicated by the Logistics Cluster of the World Food Program (LOG-WFP). Road classes that were not indicated as official classification by OSM, were removed from the data[48].

LOG-WFP provided the most up to date data on road network damages. However, the road constraint shapefile was updated frequently by overwriting previous versions, without

storing data historically. Therefore, historical post-cyclone status of roads and road segments was manually digitized from PDF maps provided by LOG-WFP[28,29]. The PDF maps were manually cross-referenced with the OSM road network layer, to include post-cyclone status, i.e. 1) open 2) restricted 3) closed.

Roads were then reclassified based on the unique combination of road type and post-cyclone status, resulting in 34 unique road classes (e.g. primary road, primary road restricted, secondary road closed). All roads were given a specific travel speed, accounting for the different scenarios. In the pre-cyclone scenario for instance, all primary road classes (i.e. primary road, primary road restricted, primary road closed) had the same travel speed. Whereas in the post cyclone scenario, the restricted and closed road types had a travel speed and travel mode accounted for their damages, as can be seen from Suplement 2.

*Barriers to movement*

Rivers and lake shapefiles were obtained as lines and polygons from the National Directorate for Water Resource Management (DNGRH) and accuracy was checked using satellite imagery as a reference, using Microsoft Bing Imagery as a background through the QGIS QuickMapServices Plugin. Only primary rivers and lakes were taken for the analyses, under the assumption that smaller rivers and streams were passable by the population. Water bodies were perceived as being impassable at all scales.

Flood extent caused by Cyclone Idai was taken from 19 March 2019 and flood extent for Cyclone Kenneth was taken from 2 May 2019, because extents were visually inspected and found to be largest on those dates and thus represent the biggest constraints for health care access. All flooded areas were treated as impassable at those dates, considering the depth and extent of the floods.

*Population data*

High resolution population density estimates for children under five were downloaded at 30 meter resolution from the Facebook Connectivity Lab and Center for International Earth Science Information network[30]. The raster was projected in Mozambique's projection system, UTM-37S [EPSG:32737], by using nearest neighbor interpolation. Loss of population

caused by reprojection and clipping to country borders, was corrected for by smoothing the lost population equally over the raster cells. This was done by using a multiplication factor of the difference between the total sum of population before and after data processing using the raster calculator.

*Health facilities*

The geographic coordinates of all health facilities were obtained through the Humanitarian Data Exchange platform (HDX) and were originally sourced from the Ministry of Health in Mozambique (SIS-MA)[34]. The data was cleaned to exclude coordinates far outside of the country borders. Coordinates that fell just outside Mozambique were relocated within the country extents. Five health facilities were cross-referenced with other data sources (e.g. Neonatal Inventory Survey UNICEF, OpenStreetMap, Google Maps) because they were located on barriers, such as open sea, rivers or lakes.

Information on damaged health facilities was provided by the World Health Organization (WHO). This data did not include GPS coordinates, thus names of the damaged health facilities were cross referenced with the original health facility shapefile to include post-cyclone status of each facility, i.e. functional or non-functional. For damaged health facilities that were not included in the original health facility shapefile, coordinates were retrieved from a neonatal inventory performed by United Nations Children Fund (UNICEF) and also added as facility to the original health facility data, representing the pre-cyclone situation. Non-functional health facilities were filtered-out for geographical accessibility analyses reflecting the post-cyclone scenarios.

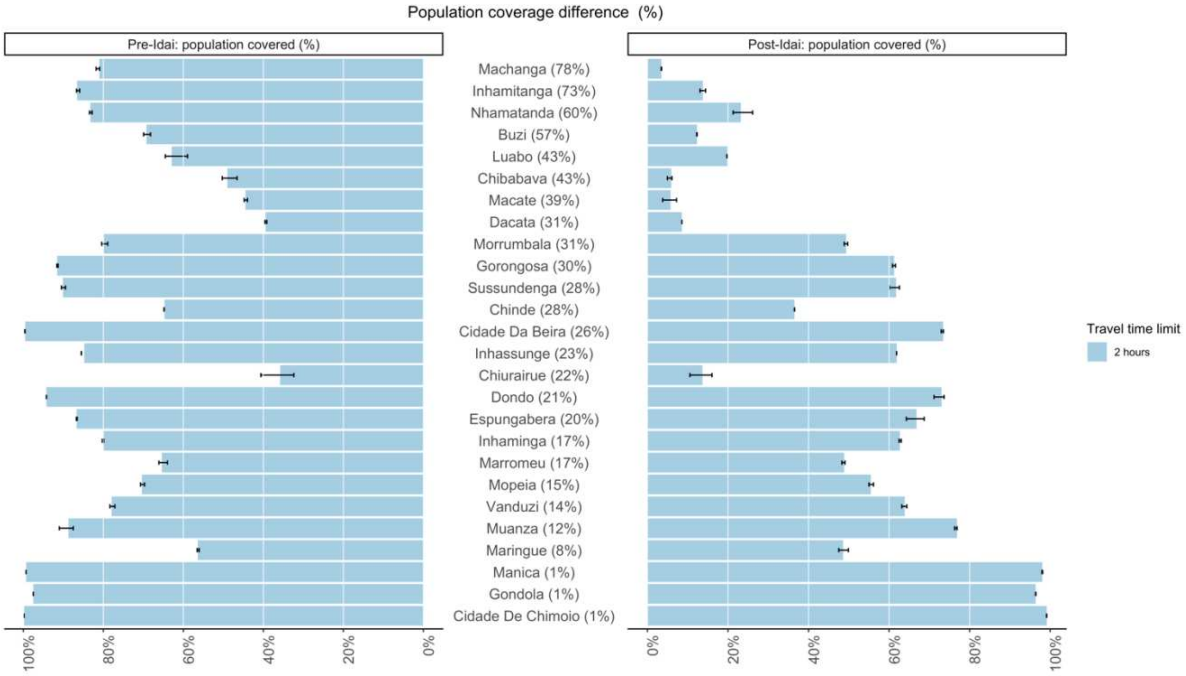
*Travel scenario*

Both our travel scenarios were developed in close collaboration with country representatives from UNICEF and were adapted to our target population, namely children under five accompanied by a parent (Suplement 2). Flood waters were assumed to be a full barrier to movement to the target population, thus health facilities located in flooded zones were completely inaccessible and flood waters were impassable.

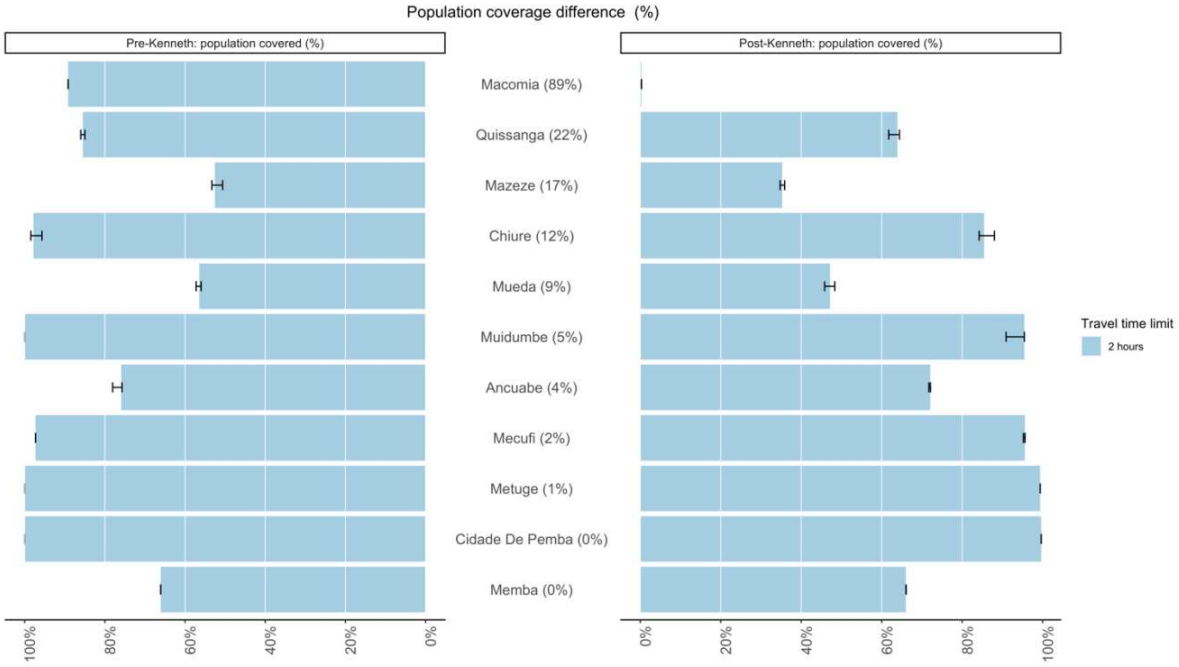
**Supplement 2-** Travel scenarios pre-cyclone and post-cyclone

| Label | Pre-cyclone | | Post-cyclone | |
|---|---|---|---|---|
| | Travel speed (km/h) | Travel mode | Travel speed (km/h) | Travel mode |
| Shrubs | 3 | Walking | 1.5 | Walking |
| Herbaceous Vegetation | 3 | Walking | 1.5 | Walking |
| Cultivated and Managed Vegetation Agriculture Cropland | 3 | Walking | 1.5 | Walking |
| Urban Built Up | 3 | Walking | 1.5 | Walking |
| Bare Sparse Vegetation | 3 | Walking | 1.5 | Walking |
| Permanent Water Bodies | 3 | Walking | 1.5 | Walking |
| Temporary Water Bodies | 3 | Walking | 1.5 | Walking |
| Herbaceous Wetland | 3 | Walking | 1.5 | Walking |
| Closed Forest Evergreen Broad Leaf | 3 | Walking | 1.5 | Walking |
| Closed Forest Deciduous Broad Leaf | 3 | Walking | 1.5 | Walking |
| Open Forest Evergreen Broad Leaf | 3 | Walking | 1.5 | Walking |
| Open Forest Deciduous Broad Leaf | 3 | Walking | 1.5 | Walking |
| Open Sea | 3 | Walking | 1.5 | Walking |
| Trunk | 80 | Motorized | 50 | Motorized |
| Trunk Restricted | 80 | Motorized | 1.5 | Walking |
| Trunk Closed | 80 | Motorized | 1.5 | Walking |
| Primary | 80 | Motorized | 50 | Motorized |
| Primary Restricted | 80 | Motorized | 1.5 | Walking |
| Primary Closed | 80 | Motorized | 1.5 | Walking |
| Secondary | 50 | Motorized | 40 | Motorized |
| Secondary Restricted | 50 | Motorized | 1.5 | Walking |
| Secondary Closed | 50 | Motorized | 1.5 | Walking |
| Tertiary | 30 | Motorized | 15 | Motorized |
| Tertiary Closed | 30 | Motorized | 1.5 | Walking |
| Tertiary Restricted | 30 | Motorized | 1.5 | Walking |
| Road | 20 | Motorized | 10 | Motorized |
| Raceway | 3 | Walking | 3 | Walking |
| Residential | 20 | Motorized | 10 | Motorized |
| Residential Closed | 20 | Motorized | 1.5 | Walking |
| Living Street | 20 | Motorized | 10 | Motorized |
| Service | 3 | Walking | 1.5 | Walking |
| Track | 15 | Motorized | 10 | Motorized |
| Pedestrian | 3 | Walking | 1.5 | Walking |
| Pier | 3 | Walking | 1.5 | Walking |
| Path Closed | 3 | Walking | 1.5 | Walking |
| Path | 3 | Walking | 1.5 | Walking |
| Footway | 3 | Walking | 1.5 | Walking |
| Bridleway | 3 | Walking | 1.5 | Walking |
| Cycleway | 3 | Walking | 1.5 | Walking |
| Steps | 3 | Walking | 1.5 | Walking |
| Unclassified | 3 | Walking | 1.5 | Walking |

**Supplement 3- Relative population coverage pre- and post-cyclone Idai.** Ordered on relative difference. Difference indicated between parentheses. Error bars indicate the coverage uncertainty, considering -20% and +20% travel speeds.



**Supplement 4- Relative population coverage pre- and post-cyclone Kenneth.** Ordered on relative difference. Difference indicated between parentheses. Error bars indicate the coverage uncertainty, considering -20% and +20% travel speeds.



**Supplement 5- Travel time per community in Idai affected districts.** Fifty most affected communities by means of accessibility loss. Ordered on absolute travel time difference.

| Community | District | Pre-cyclone travel time (h) | Post-cyclone travel time (h) | Difference pre- and post-cyclone (h) |
|---|---|---|---|---|
| **Mucinemo** | Buzi | 1.3 | 63.6 | 62.3 |
| **Bupira** | Buzi | 1.1 | 62.3 | 61.3 |
| **Massuinda** | Buzi | 1.2 | 60.1 | 58.9 |
| **Njanga** | Buzi | 4.3 | 59.1 | 54.7 |
| **Guenje-Sede** | Buzi | 2.9 | 57.3 | 54.4 |
| **Mbereaizique** | Buzi | 2.9 | 57.3 | 54.4 |
| **Shiniziua Chinhale** | Muanza | 24.0 | 77.8 | 53.8 |
| **Chipota** | Muanza | 24.4 | 78.0 | 53.6 |
| **Wiriquizi** | Muanza | 22.2 | 74.1 | 51.9 |
| **Chingamuzi** | Muanza | 22.7 | 74.5 | 51.8 |
| **Mussacazwidje** | Buzi | 3.5 | 55.3 | 51.8 |
| **Mussacazwidje** | Buzi | 3.5 | 55.3 | 51.8 |
| **Magua** | Buzi | 4.8 | 56.6 | 51.8 |
| **Nkolone Praia** | Muanza | 20.7 | 72.3 | 51.7 |
| **Mukulumba 1** | Muanza | 20.4 | 71.8 | 51.4 |
| **Mukulumba cidade** | Muanza | 20.2 | 71.4 | 51.2 |
| **Nhanganga** | Muanza | 19.9 | 70.8 | 50.9 |
| **Mutanda** | Buzi | 5.4 | 55.3 | 49.9 |
| **Macova-Mutanda** | Buzi | 6.3 | 55.1 | 48.9 |
| **Puanda** | Buzi | 2.9 | 51.6 | 48.7 |
| **Luanda 1** | Muanza | 18.8 | 67.4 | 48.6 |
| **Nhamacalango** | Muanza | 17.4 | 65.8 | 48.4 |
| **Sengo** | Dondo | 5.3 | 53.5 | 48.2 |
| **Luanda 2** | Muanza | 18.0 | 65.8 | 47.8 |
| **Praia Nova** | Dondo | 3.9 | 51.5 | 47.6 |
| **Praia Farol** | Dondo | 3.8 | 51.4 | 47.6 |
| **Bingue Sede** | Muanza | 16.4 | 63.8 | 47.4 |
| **Nkonde 2** | Muanza | 16.4 | 63.8 | 47.4 |
| **Massitche** | Dondo | 7.1 | 54.5 | 47.4 |
| **Goonda Majaca** | Chibabava | 6.5 | 53.3 | 46.8 |
| **Ngomole** | Muanza | 10.1 | 56.7 | 46.6 |
| **Ngalazi** | Dondo | 6.0 | 52.3 | 46.3 |
| **Nhacudjica** | Buzi | 6.3 | 52.4 | 46.1 |
| **Chitundo** | Dondo | 2.0 | 47.7 | 45.7 |
| **Macarate** | Chibabava | 5.3 | 51.0 | 45.7 |
| **Nhamissassa** | Muanza | 15.9 | 61.5 | 45.6 |
| **Docue** | Buzi | 5.7 | 51.3 | 45.6 |
| **Khome 1** | Dondo | 1.4 | 46.8 | 45.4 |
| **Nherere 2** | Muanza | 14.0 | 59.0 | 45.0 |
| **Parange** | Buzi | 3.6 | 48.6 | 45.0 |
| **Njocho** | Buzi | 5.9 | 50.9 | 45.0 |
| **Binda** | Machanga | 0.7 | 45.2 | 44.6 |
| **Khome 2** | Dondo | 0.6 | 45.2 | 44.6 |
| **Veruca** | Chibabava | 4.1 | 48.6 | 44.5 |
| **Mamunge** | Buzi | 5.1 | 49.2 | 44.1 |
| **Birirane** | Muanza | 13.1 | 57.2 | 44.1 |
| **Vala-vala** | Buzi | 5.2 | 49.2 | 44.1 |
| **Muche** | Gorongosa | 1.5 | 45.5 | 44.0 |
| **Machiquire** | Buzi | 2.6 | 46.1 | 43.5 |
| **Nhazwicasse** | Gorongosa | 1.0 | 44.5 | 43.5 |

**Supplement 6- Travel time per community in Idai-affected districts.** Point locations of communities in Idai-affected districts.