Flood Zone: Impact of Heavy Rains on Humanitarian and Human Security Situation in El-Fasher and Zamzam IDP Camp

2 August 2024

Yale SCHOOL OF PUBLIC HEALTH
Humanitarian Research Lab

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I. Key Findings

Widespread flooding due to heavy rains in Zamzam Internally Displaced Persons (IDP) camp and El-Fasher, North Darfur (including Abu Shouk and Al Salaam IDP camps) exacerbates the area's ongoing humanitarian crisis. This flooding occurs alongside confirmation of Famine (IPC 5) in Zamzam since June 2024 by Famine Early Warning Systems Network (FEWS NET).[1] The Yale School of Public Health's Humanitarian Research Lab (HRL) assesses significant displacement within El-Fasher as well as major movement of new IDPs from El-Fasher to Zamzam IDP camp since April 2024 *(see Detailed Findings below)*.[2] The flooding heightens the urgent need for humanitarian organizations to freely access displaced and besieged communities. Before the rainy season began in July, El-Fasher and surrounding communities had sustained widespread conflict-related damage to homes, healthcare facilities, markets, and clean water. El-Fasher and Zamzam already suffered from severe malnutrition and limited commodities, including potable water, for months prior to the heavy fighting that began in April.[3]

Yale HRL assesses that widespread flooding, which has likely caused animal and human fecal contamination of water supplies, has impacted key humanitarian facilities and residential areas in El-Fasher and Zamzam IDP camp. The following locations are observed to be significantly flood-affected, including some locations underwater:

- Nine of thirteen identified water distribution points in Zamzam IDP camp;
- Eleven of 42 active locations with temporary structures for IDPs in El-Fasher and Zamzam;
- At least four healthcare facilities in El-Fasher;
- At least two markets in El-Fasher, including the main livestock market;
- Facilities identified as latrines in at least two schools in Zamzam IDP camp; and
- Over 0.92 square kilometers of standing floodwater, equivalent to approximately 125 FIFA football pitches of visible flooding across Zamzam IDP camp alone.

Flooding, even in peacetime, can have severe humanitarian and public health impacts, including increasing the risk of infectious disease outbreaks, including cholera and other forms of waterborne disease. During armed conflicts flooding can cause even more severe humanitarian and public health impacts due to the pre-existing vulnerability of conflict-affected populations. These impacts include:

- Reducing scarce supplies of potable water;[4]
- Spreading human and animal feces from latrines and corrals into water points and living areas;[5]
- Increasing the risk of waterborne disease including cholera, malaria, dengue, skin disease, and respiratory infections;[6]
- Shifting positions of unexploded ordnance (UXO);[7]
- Damaging and contaminating limited food stores;[8]
- Causing seed stores to rot, damaging crops, and infecting livestock;[9]
- Limiting freedom of movement of civilians fleeing violence and impeding humanitarian actors from reaching them;[10] and
- Damaging temporary IDP structures and critical humanitarian infrastructure such as healthcare facilities.[11]

Humanitarian access is crucial to respond to existing urgent needs caused by the conflict and mitigate a more severe public health emergency that the flooding may cause in El-Fasher and Zamzam.

II. Detailed Findings

Displacement within El-Fasher and to Zamzam

There has been significant displacement within El-Fasher and civilian flight to Zamzam IDP camp and other locations in the region before the flooding. This displacement most recently began when at least 43 communities west of El-Fasher and Zamzam were razed in arson attacks beginning in April 2024. More displacement occurred when over 2 square kilometers of El-Fasher city proper were destroyed by fighting since 10 May 2024.[12]

Conflict-related displacement causes high-density civilian gatherings in relatively small areas. Even in the dry season and without flooding, the phenomenon of displaced people clustering together in search of safety and shelter increases the chance of waterborne disease.[13]

Yale HRL identifies through satellite imagery analysis at least 49 currently active IDP locations as of 9 July, including 21 locations that have been established and/or grown between 15 April and 9 July 2024 in and around El-Fasher. These IDP locations contain over 2,634 temporary structures. They are present in El-Fasher, Zamzam, Saloma, Umm Gameira, Shagara Musa, Shagara Humaida, and Tawilah.

Yale HRL also confirms that significant displacement has occurred due to civilians leaving temporary IDP shelters across El-Fasher. Displacement patterns in El-Fasher appear to include displacement from Abu Shouk and conflict-destroyed areas in the eastern and southeastern neighborhoods of El-Fasher. The majority of displacement is toward routes exiting El-Fasher: running south along the B26 road in El-Fasher toward Zamzam, south into Zamzam and surrounding areas, and southwest in communities toward Tawilah. Imagery and the latitude/longitude of these locations has been withheld from the public due to human security concern for these vulnerable populations.

As of 6-9 July, Yale HRL has identified:

- 26 active IDP locations across El-Fasher, including Abu Shouk and Al Salaam IDP camps, composed of over 1,700 active temporary structures as of 6-9 July;
- Fourteen active IDP locations with over 650 active temporary structures across Zamzam IDP camp and the nearby Saloma and Umm Gameira communities just outside Zamzam as of 6-9 July;
- Displacement from thirteen locations in El-Fasher, including nine inactive locations vacated since 15 April, predominantly in Abu Shouk and in the eastern and southern neighborhoods of El-Fasher that have experienced heavy fighting;
- Displacement within El-Fasher predominantly toward the southern exit points of El-Fasher along the B26 road in areas outside RSF control, as well as locations adjacent to the conflict-related destruction;

- Significant displacement toward Zamzam with an increase of temporary structures at eleven of the fourteen active locations, of which six are newly established since 15 April; and
- Significant displacement toward communities to the west of El-Fasher, including the establishment of settlements in Shagara Humaida and throughout Tawilah.

The displacement into Zamzam is occurring in a community that has been experiencing widespread food insecurity and malnutrition since before RSF's siege on El-Fasher. As of 1 August 2024, FEWS NET confirmed Famine (IPC 5) in Zamzam, citing evidence from Yale HRL of targeted razing in El-Fasher and large-scale displacement from the city into Zamzam.[14] Nutrition surveys conducted by Médecins Sans Frontières (MSF) in March and April 2024 prior to major fighting in El-Fasher assessed that 30% of screened children and 33% of screened pregnant and breastfeeding women were found to suffer from Severe Acute Malnutrition (SAM).[15] As of 18 June 2024, humanitarian aid providers in Zamzam reported insufficient supplies of essential nutrition commodities necessary to respond to a significant increase in severely malnourished children, on top of month-long mass shortages of food, fuel, and water across Zamzam.[16]

Recent Flood Impact on Key Sites in Zamzam

Heavy rains flooded Zamzam and El-Fasher between 23 and 25 July 2024.[17] According to analysis of satellite imagery from 26 July 2024, at least 0.92 square kilometers (920,000 square meters, or approximately 125 football pitches)[18] of Zamzam camp were observed submerged in flood water.[19] This represents the area with visible standing water in satellite imagery, a significant underestimate of the area of Zamzam which has been negatively impacted by the flooding.

Yale HRL has assessed through satellite imagery analysis that:

- Nine out of thirteen identified water points in Zamzam are assessed to be flooded with likely contaminated water, including one point reportedly co-located with a food store;
- Multiple latrines at school facilities in Zamzam have been confirmed as flooded, a likely undercount of the total number of latrines affected by flooding;
- One location for IDPs was significantly impacted, flooding at least 44 of the 76 temporary structures present with standing water; and
- Significant flooding throughout Zamzam IDP camp, including in residential areas.

Yale HRL's findings are consistent with the International Organization for Migration (IOM)'s 28 July report that heavy rain and flooding across Zamzam from 23–25 July reportedly destroyed an estimated 1,018 houses and 816 latrines.[20] Open source videos from 24 July depicting flooding in residential neighborhoods and shelter centers in Zamzam are consistent with both Yale HRL and IOM findings.[21]

Flood Impact on Key Humanitarian and Public Health Facilities in El-Fasher

Floodwaters are visible in satellite imagery across El-Fasher. Yale HRL has assessed through imagery analysis:

- Four hospitals and healthcare complexes have visible flooding on the grounds, including the South Hospital, Sayyed Al Shuhadaa Health Center, Babakir Nahar Health Center, and the Al-Saudi Hospital complex, including the Saudi Maternity Hospital and Al-Saudi Hospital as of 26 July 2024.
- Two markets in El-Fasher appear underwater, including El-Fasher's livestock market, Mawashi Market.
- Ten of 26 active temporary IDP locations in El-Fasher have partial flooding or are surrounded by standing water.
- At least four emergency food and water distribution locations (including community kitchens) in El-Fasher are fully or partially flooded.
- Heavy rains have flooded homes across El-Fasher and Abu Shouk IDP camp.

Additionally, Yale HRL has identified damage to the roof of the Pulse of Life (Nabd Al-Haya) hospital between 21-25 July, following news reports alleging that an RSF drone strike damaged the facility's solar panels on 24 July.[22] There is significant impact on healthcare facilities across El-Fasher, many of which have been subject to bombardment, razing, or other conflict-related damage prior to the flooding.[23]

Flooding in the livestock market, which during normal operation facilitates the sale and slaughter of livestock, is a particularly concerning vehicle of contamination. This report is not able to systematically assess the effects of flooding on latrines, toilets and plumbing, and current human fecal waste, but it is highly likely to have had a significant impact.

III. Methodology

Yale HRL utilizes data fusion methodologies of open source and public and commercially available remote sensing data. Yale HRL produced this report through the cross-corroboration of open source and remote sensing data, including satellite imagery and thermal sensor data.

Place names were identified using UN P-codes obtained via the United Nations Humanitarian Data Exchange (HDX) and International Organization for Migration (IOM)'s Displacement Tracking Matrix (DTM) Sudan. This baseline source of information was then verified and informed through open source analysis by Yale HRL's analysts with relevant cultural and linguistic skills. In some cases, communities may have names similar to other communities or may be known by multiple names.

This report builds on highly granular raw data including satellite imagery analysis, coordinates, charts, and maps which is not being released publicly for human security reasons. This report's underlying data has been provided to the Famine Review Committee (FRC) to support their Integrated Food Security Phase Classification (IPC) compatible Famine Early Warning Systems Network (FEWS-NET) food security alert.

Temporary Structure Assessment

Yale HRL conducted its assessment of temporary structures at IDP locations through a multistep process:

(1) **Possible locations:** Analysts generated a list of locations where IDPs were reported to flee to or where imagery analysts had assessed temporary structures consistent with IDP shelter since 15 April 2024. Most locations refer to clusters of temporary structures often located within the walls of a clearly defined space, such a school facility. There are a few locations, most notably Tawilah, where these temporary structures are dispersed throughout a region or neighborhood rather than clustered. Those locations are denoted in the archive but assessed as a single location.

(2) **Assess Status, Change over Time, and Number of Temporary Structures**: Analysts then assessed activity and change over time between 15 April and 9 July 2024 at these possible IDP locations.

   a. **Status**: Locations were classified as active or inactive, based on the presence of temporary structures consistent with IDPs as of 6-9 July 2024 or the most recent image at the time of analysis.

   b. **Type of Activity and Change over Time**: The type of activity at each location between 15 April and 6-9 July 2024 was classified as either "increase" or "decrease" in temporary structures, "no significant change," "new location," or "vacated." The time before and after a change in the number of temporary structures (increase, decrease, vacated) or establishment of a new location was recorded. Analysts also logged a qualitative descriptor of the change over time.

   c. **Number of temporary structures**: Analysts counted the number of temporary structures consistent with IDPs present at each active location in imagery as of 6-9 July or the most recent image prior to 9 July, along with the imagery date.

The assessment of temporary structures consistent with those used by IDPs was conducted through multitemporal change detection. Analysts assessed the number of temporary structures visible, comparing them to baseline satellite imagery approximate to 15 April 2024. This report only assesses the presence of temporary structures and does not assess the status or potential occupancy of permanent structures.

Flood Impact Assessments

Yale HRL conducted a flood assessment analysis using multitemporal change detection of a dataset generated with open source and remote sensing data. Analysts compiled and categorized locations related to food, shelter, and survival across El-Fasher and Zamzam using open source and remote sensing data including satellite imagery. These categories included: markets, shelters or locations for temporary IDP structures (see above analysis), locations reported to be distributing food or water (including community kitchens and shelters), healthcare facilities, and water points (only systematically assessed in Zamzam). These locations were then geolocated and corroborated to a high confidence standard based on open source and satellite imagery analysis.

Analysts assessed potential flooding impact on each location category for indicators that the location or facility was visibly impacted by standing water between 26 - 30 July 2024. Facilities were typically assessed on a scale of affirmative floodwater impact, no visible impact assessed, not applicable (locations without sufficient data), and proximate visible standing water outside the compound, facility, or location, but not within the boundaries of the compound, facility, or location itself. The final assessment category was included to provide a record which can support actors on the ground, as the public health and humanitarian impacts of proximate flooding include limited access to the location and identifying possible contamination to or near the location.

Limitations

There are significant limitations to the data fusion methodology. The information environment in Sudan does not have the breadth of data available in other locations and there is likely a significant reporting bias for those who provide open-source reporting.

Satellite imagery analysis is limited by available imagery over time and space. Imagery available with certain off-nadir angles can produce challenges to assess phenomena on the ground, until multiple images with corresponding off-nadir angles and ground-level photographic and video materials emerge to help inform the analysis.

Satellite imagery analysis was the determining assessment factor in classifying locations as impacted or not impacted by flooding. The assessment is therefore limited by what is visible in satellite imagery during the precise date and time that the image was taken. Floodwaters may recede before a sufficiently clear satellite image is taken. Additionally, this relies on an assessment of visible standing water. Areas may be saturated and impacted by heavy rains but not show standing water visible in satellite imagery, and that is not recorded. Standing water was visible in too many locations across El-Fasher to assess and calculate the flooded areas during the course of this assessment.

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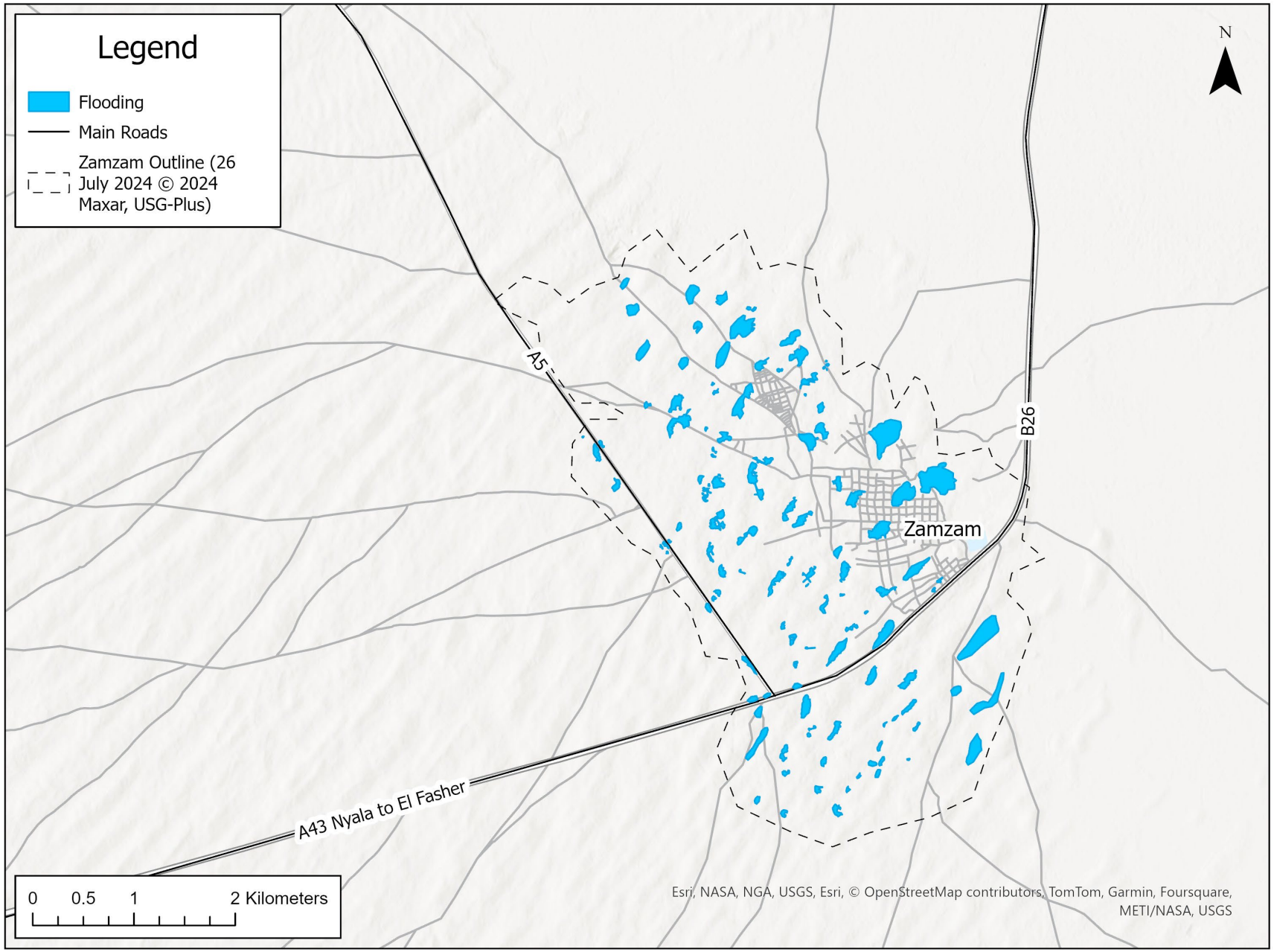
Flooding in Zamzam on 26 July 2024



Map produced 01 August 2024.

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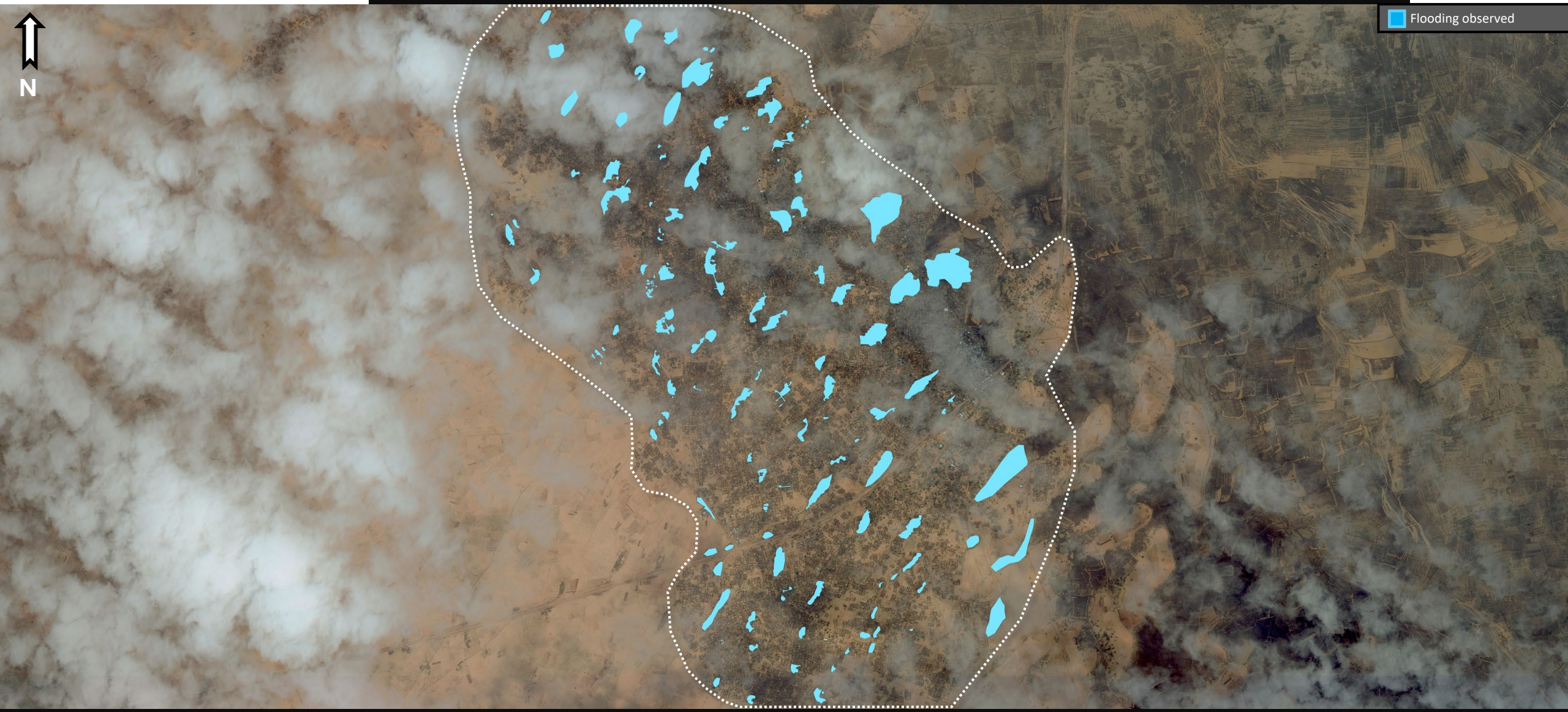
El-Fasher

Zamzam IDP Camp

According to analysis of satellite imagery, on 26 July 2024 approximately 920,000 sq. meters of the camp has been observed submerged in flood water.



26 July 2024 © 2024 Maxar, USG-Plus

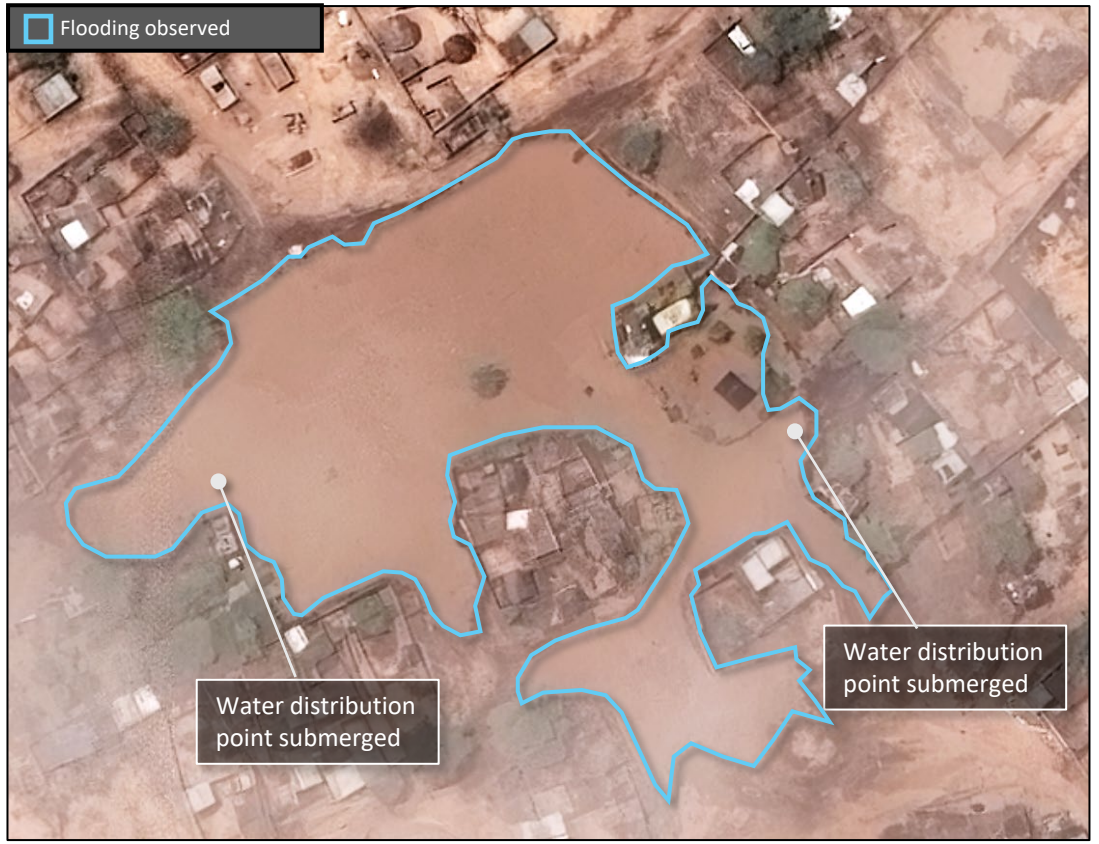
Water Distribution Points, Zamzam

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery shows two water distribution points submerged by flooding as of 21 July 2024, in Zamzam IDP Camp. Observed on 26 May 2024 imagery, a queue of people is present.

In images analyzed between 21 and 26 July 2024, both distribution points are submerged in floodwater.

26 May 2024 © 2024 Maxar, USG-Plus



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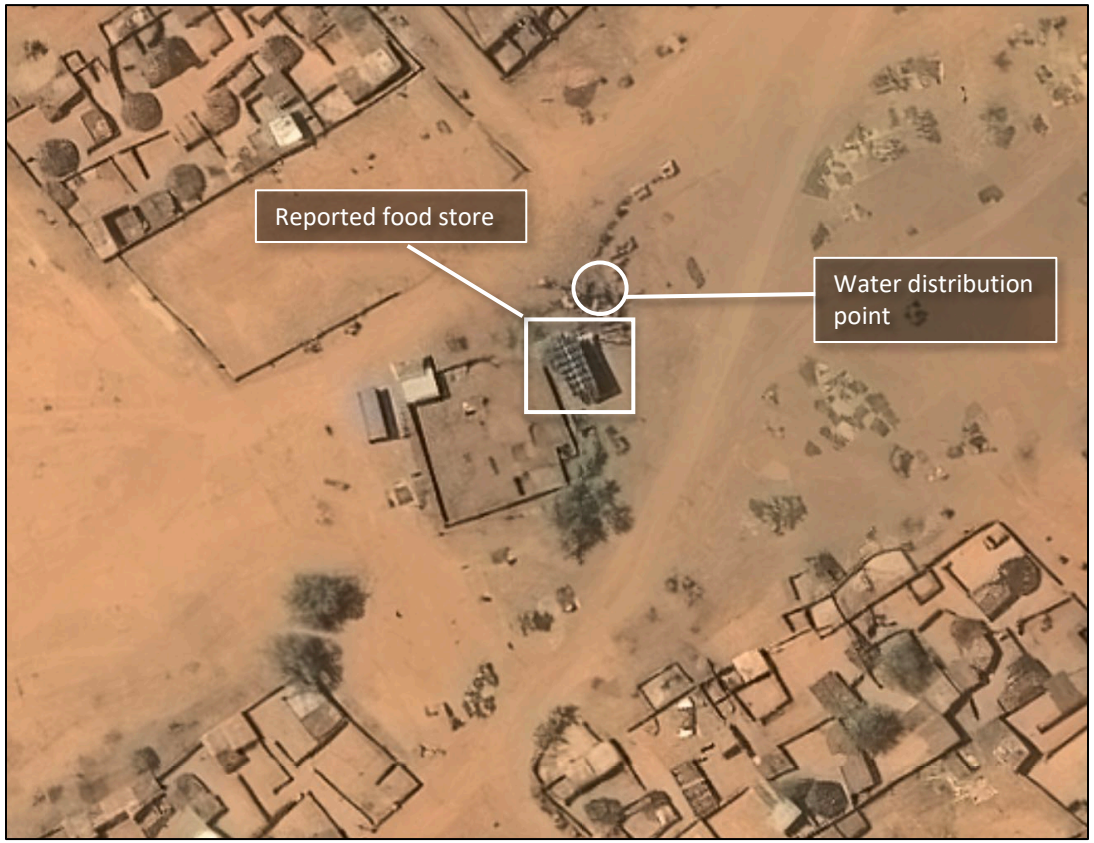
Water Distribution Point and Reported Food Store, Zamzam

FLOODING OBSERVED ON 25 JULY 2024

Analysis of satellite imagery shows a water distribution point and reported food store submerged by flooding as of 21 July 2024, in Zamzam IDP Camp. Observed on 26 May 2024 imagery, a queue of people is present.

In images analyzed between 21 and 25 July 2024, the distribution point and grocery store are submerged in floodwater.



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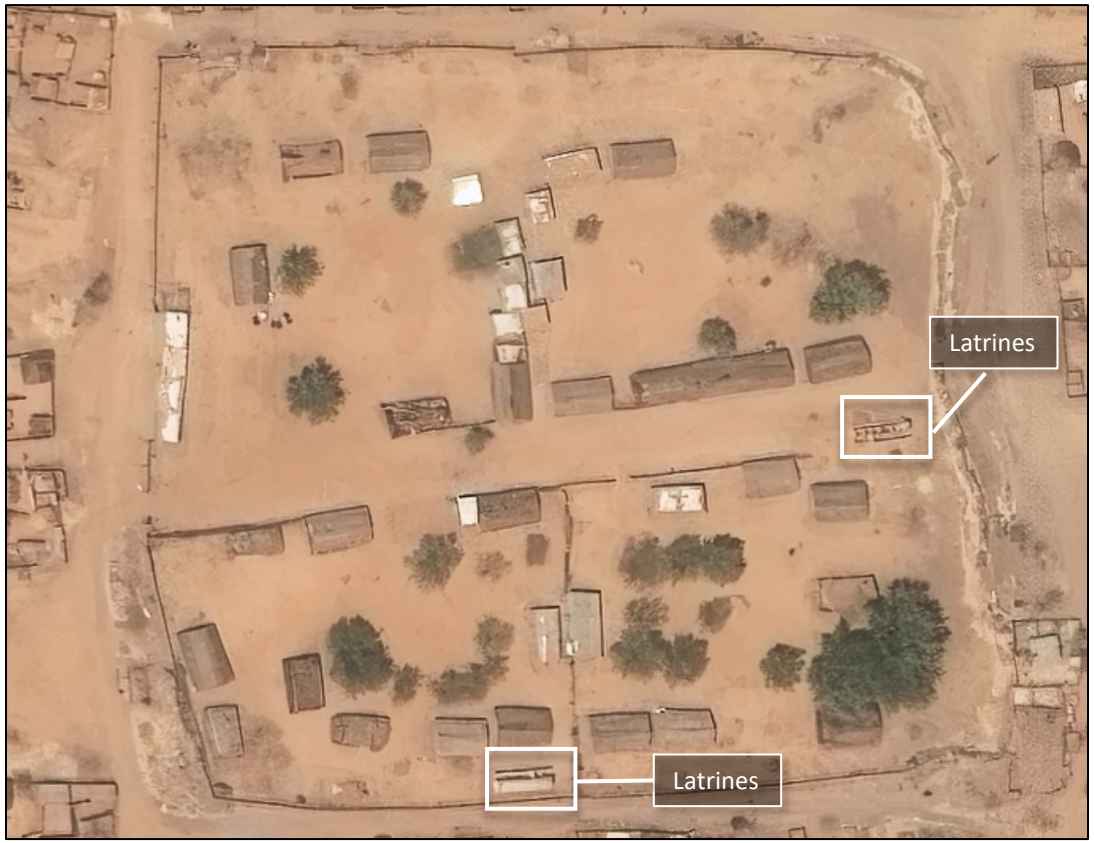
Latrines at Al Salam School, Zamzam

Analysis of satellite imagery shows a roofless toilet facility within the Al Salam School 36 for Adolescents compound submerged in floodwater on 26 July 2024 in Zamzam IDP Camp.

FLOODING OBSERVED ON 26 JULY 2024



26 May 2024 © 2024 Maxar, USG-Plus

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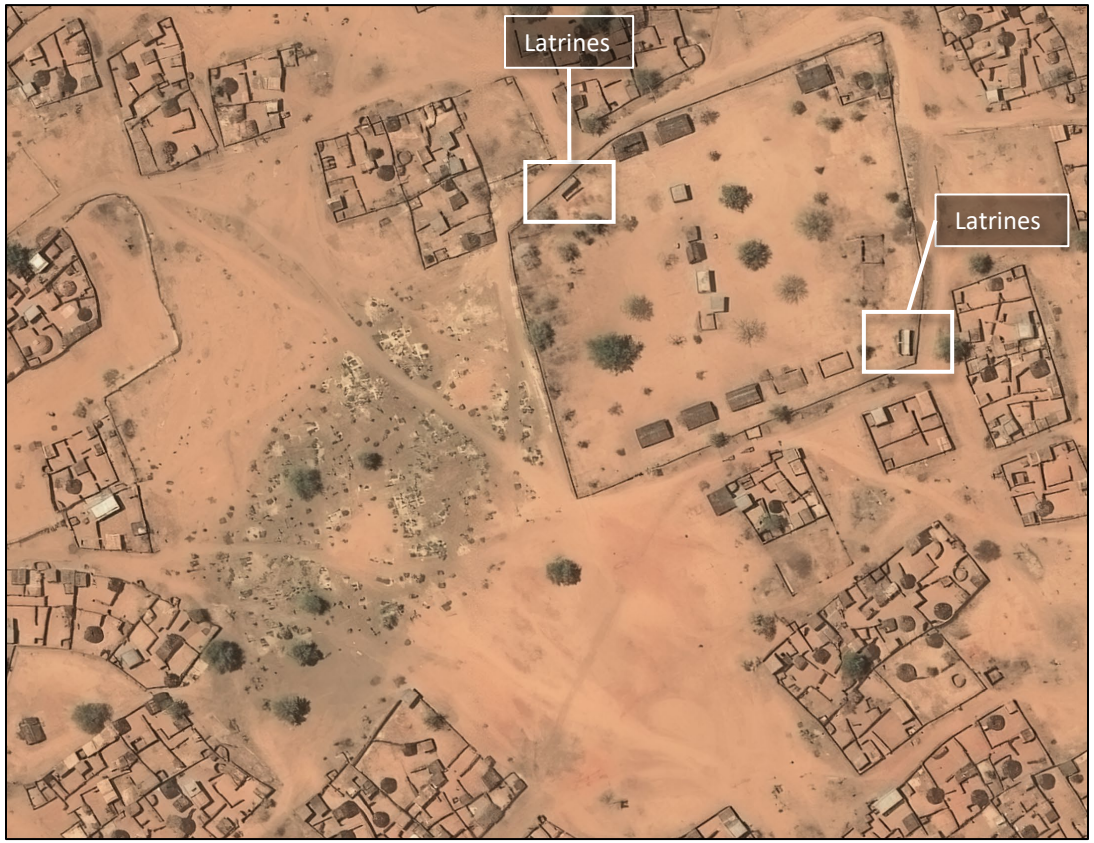
Latrines at School, Zamzam

FLOODING OBSERVED ON 25 JULY 2024

Analysis of satellite imagery shows a toilet facility within a School Compound surrounded by floodwater on 25 July 2024, in Zamzam IDP Camp.



26 May 2024 © 2024 Maxar, USG-Plus

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IDP Compound, Zamzam IDP Camp

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery shows temporary IDP structures submerged by flooding on 26 July 2024, in west Zamzam. Structures affected are 2x2m temporary structures as well as a 6.60x4m hexagon shaped structure consistent with UNHCR IDP tent. Overall, 44 out of 76 IDP structures are assessed to be affected by flooding at this compound.

13 July 2024 © 2024 Maxar, USG-Plus

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Residential Area, Zamzam

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery shows the state of homes in Zamzam Camp on 26 July 2024. In images analyzed between 21 and 26 July 2024, several structures are observed to be submerged in floodwater.

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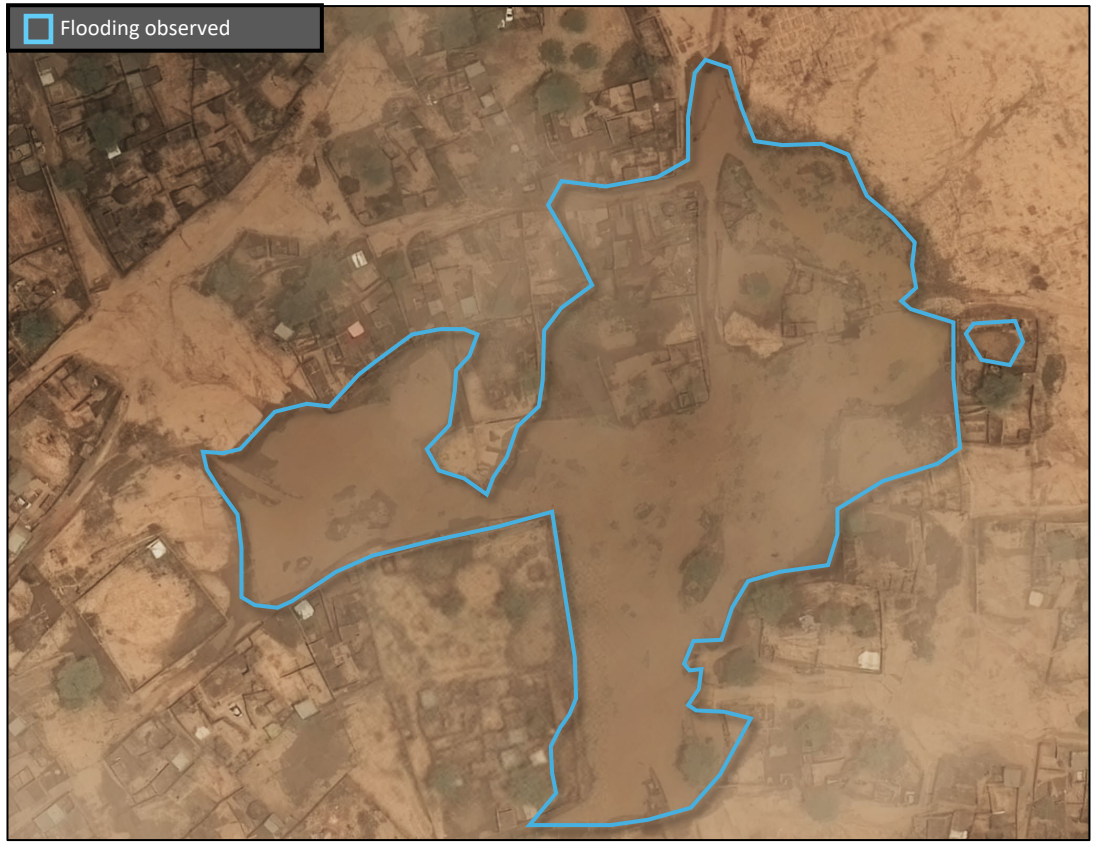
Residential Area, Zamzam

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery shows the state of homes in Zamzam Camp as of 26 July 2024. In images analyzed between 12 June and 26 July 2024, multiple structures are observed to be submerged in floodwater.

12 June 2024 © 2024 Maxar, USG-Plus



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South Hospital, El-Fasher

Analysis of satellite imagery shows flooding between 21 and 26 July 2024, at South Hospital in El-Fasher.

FLOODING OBSERVED ON 26 JULY 2024

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Al-Saudi Hospital Complex, El-Fasher

FLOODING OBSERVED 25 JULY 2024

Analysis of satellite imagery between 21 and 25 July 2024, shows flooding on grounds of a compound containing several healthcare facilities including the Al-Saudi Hospital and Saudi Maternity Hospital in El-Fasher.

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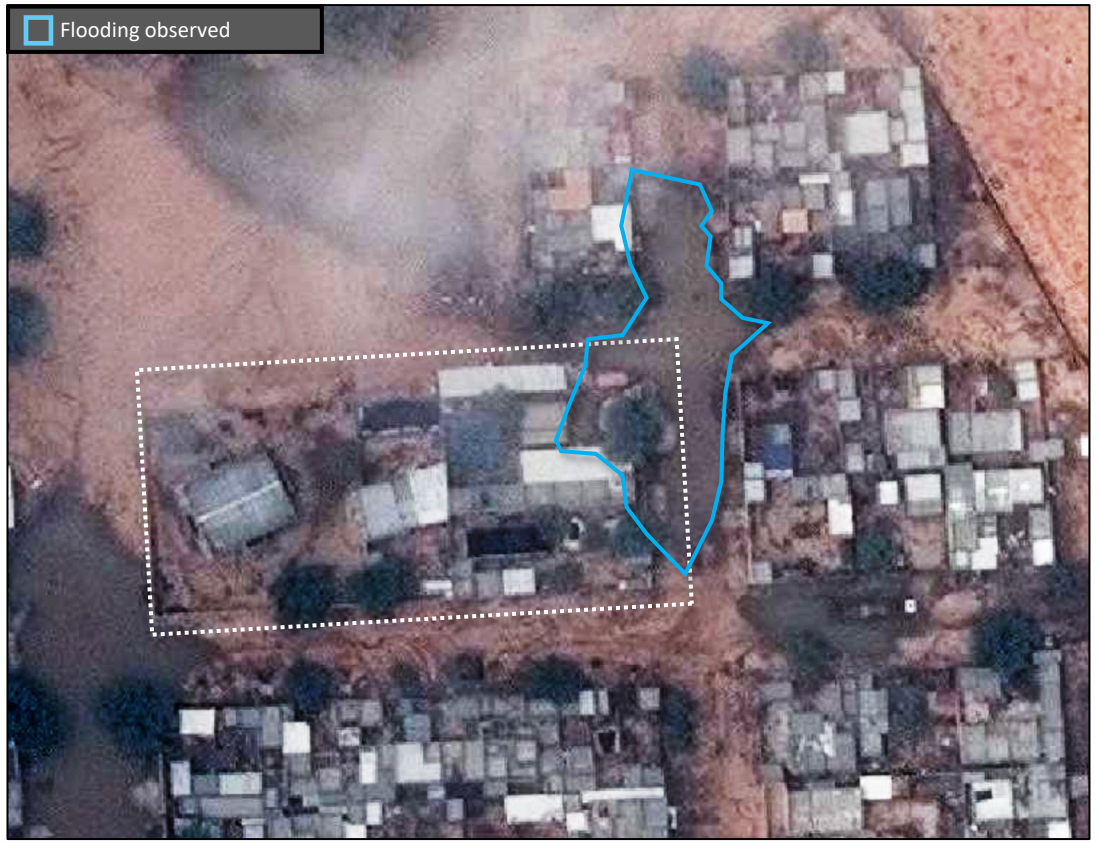
Babakir Nahar Health Center, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery between 19 and 26 July 2024 shows flooding at the Babakir Nahar Health Center in El-Fasher.

19 July 2024 © 2024 Maxar, USG-Plus



25 July 2024 © 2024 Maxar, USG-Plus

Pulse of Life Hospital, El-Fasher

CONFLICT-RELATED DAMAGE OBSERVED ON 25 JULY 2024

Analysis of satellite imagery between 21 and 25 July 2024, shows the possible damage to the solar power system on the roof of Pulse of Life (Nabd Al Haya) Hospital in El-Fasher. Open sources reported that a drone strike damaged the hospital's solar panels on 24 July 2024.

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Source | https://sudantribune.com/article288774/, archived at https://perma.cc/8NFZ-H9LY, and https://www.darfur24.com/2024/07/27/%D9%85%D9%82%D8%AA%D9%84-%D9%88%D8%A5%D8%B5%D8%A7%D8%A8%D8%A9-75-%D9%85%D8%AF%D9%86%D9%8A%D9%8B%D8%A7-%D9%81%D9%8A-%D8%AA%D8%A8%D8%A7%D8%AF%D9%84-%D9%82%D8%B5%D9%81-%D8%A8%D9%8A%D9%86-%D8%A7%D9%84/, archived at https://perma.cc/FL93-XAWA.

Mawashi Livestock Market, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery between 21 and 26 July 2024 shows widespread flooding throughout the Mawashi (Livestock) Market in El-Fasher.

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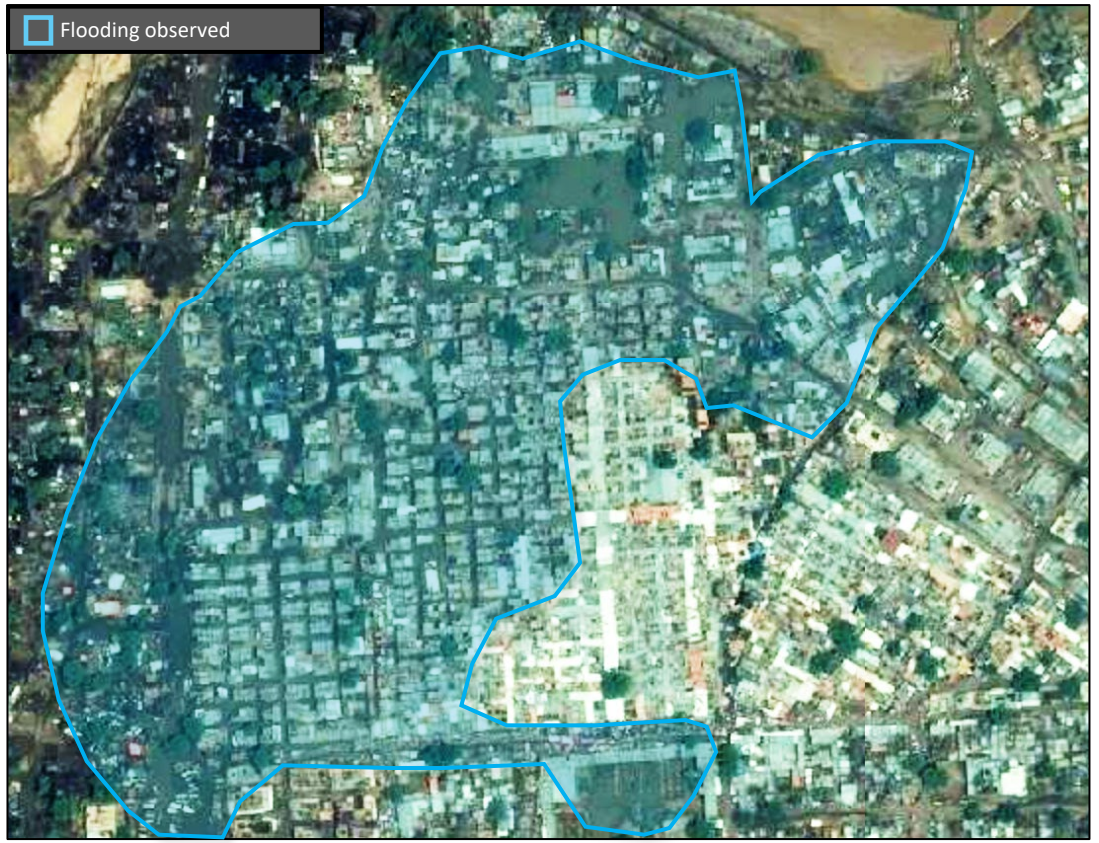

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Abu Shouk IDP Camp and Market, El-Fasher

FLOODING OBSERVED ON 25 JULY 2024

Analysis of satellite imagery between 21 and 25 July 2024, shows the flooding of Abu Shouk IDP Camp in El-Fasher. A significant number of structures, including the camp marketplace, appear to be affected by the flood.

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IDP Location, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery shows flooding of IDP location and temporary IDP structure on 26 July 2024, in southwest El-Fasher. IDP structures appear submerged by flooding at this compound.

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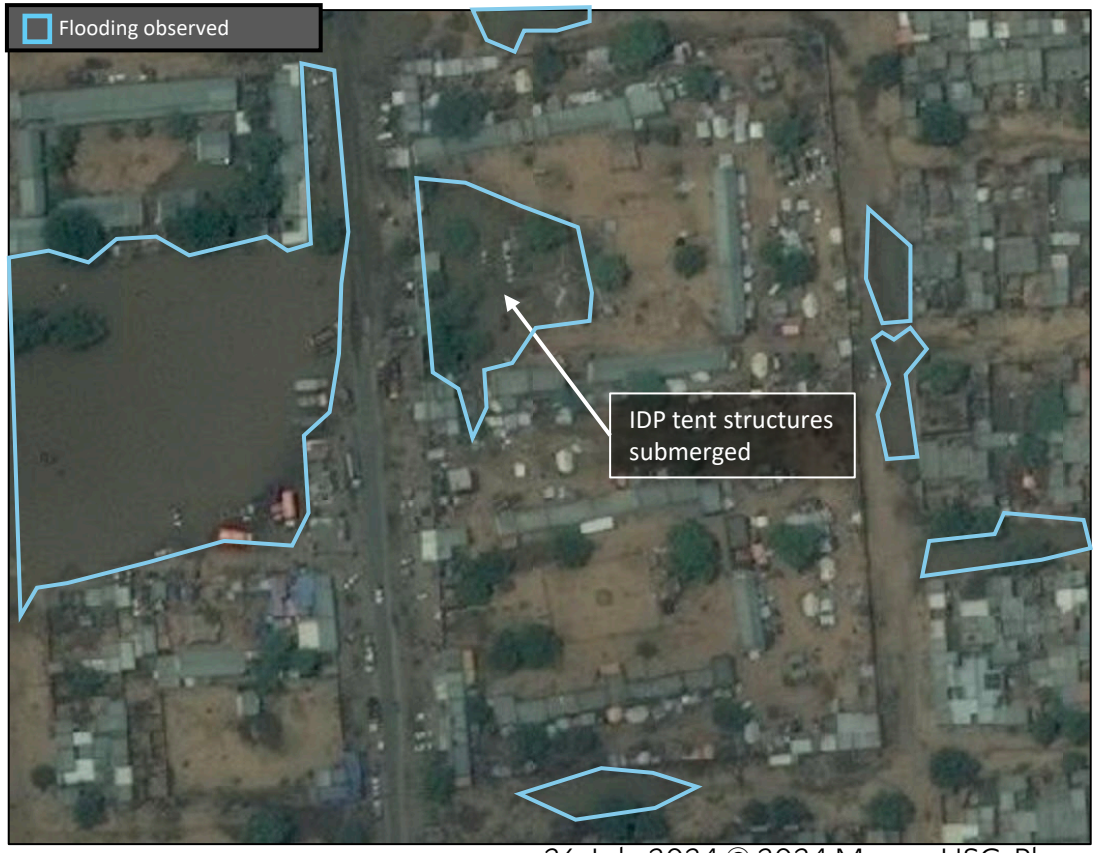

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IDP Locations, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery shows two compounds, previously identified as IDP locations, affected by flooding on 26 July 2024 in El-Fasher. The street as well as part of the compound appear flooded, but no IDP structures are immediately affected.

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IDP Location and Food Distribution Point, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery between 21 and 26 July 2024 shows flooding at Al-Ittihad Secondary School for Girls, a school currently used as IDP compound that has also served as a food distribution point in El-Fasher. At least two of the 56 IDP structures are assessed to be immediately affected by flooding at this compound.

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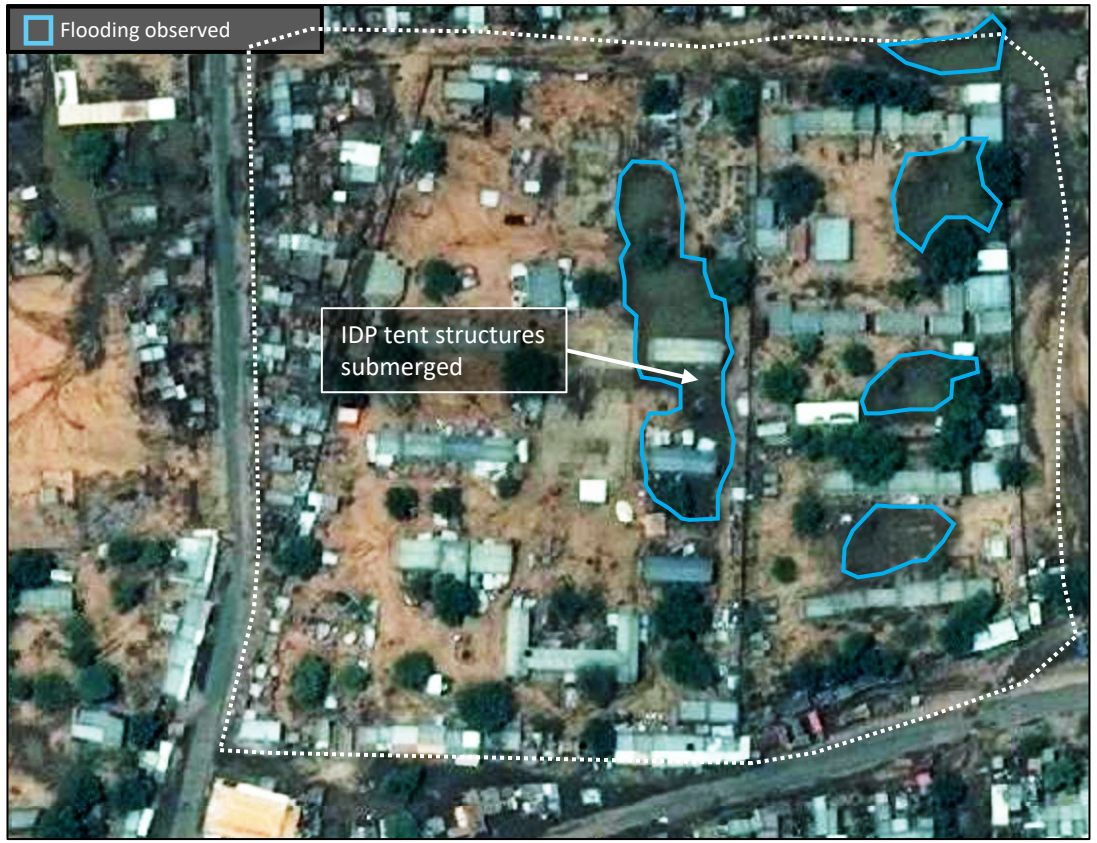

26 July 2024 © 2024 Maxar, USG-Plus

Source | HRL_MMC_030

Water Distribution Point, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery between 21 and 26 July 2024 shows flooding at the Migration Center that has also served as a water distribution point in El-Fasher.

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Source | HRL_MMC_031

Food Distribution Point, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery between 21 and 26 July 2024 shows flooding at Al-Salam School 1, a location that has been used as a food distribution point in El-Fasher.

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Source | HRL_MMC_029

Ibn Sinaa Food Distribution Center, El-Fasher

FLOODING OBSERVED ON 26 JULY 2024

Analysis of satellite imagery between 19 and 26 July 2024, shows flooding at the Ibn Sinaa Food Distribution Center in El-Fasher.

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Source: HRL_MMC_032

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https://medicine.yale.edu/lab/khoshnood/