The environmental dimensions of Libya’s flood disaster

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A view of the devastated Libyan city of Derna on September 21st 2023. The unprecedented storm led to thousands of deaths but has also impacted the environment, and shed light on Libya's environmental vulnerabilities in a changing climate. Credit: Dipartimento Protezione Civile/Flickr

> The catastrophic flooding in eastern Libya is a human and environmental disaster that has claimed thousands of lives. In this report we examine the main environmental considerations in the short and long-term, both to help inform the humanitarian response and later recovery. We also reflect on how years of conflict and insecurity in Libya contributed to the disaster.

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An unprecedented weather system

The Storm Daniel *medicane* made landfall in Libya on 10th September, after causing record-breaking rainfall and flooding in Greece. Winds of 70-80 km/h damaged infrastructure and generated dust storms, whilst record rainfall of between 150-240 mm caused flash flooding in the wadis (seasonal rivers) of the Jebel Akhdar plateau.

A weather system like Storm Daniel was unprecedented in Libya. Scientists had calculated it as a 1-in-300 to 1-in-600 year event. However, climate change makes such an event 50 times more likely, and up to 50% more intense. It is likely that warmer sea surface temperatures in the Mediterranean played a role, this year they were 2-3°C above average.

There has been relatively little attention on the environmental consequences of the disaster. The following considerations include cases from across the flood-affected area, which OCHA estimates is home to more than 880,000 people.

1. Water and sanitation

The key environmental health challenge on the ground is to reduce the risk of infectious diseases following damage to water, sanitation and hygiene (WASH) infrastructure, healthcare facilities, and through the stagnation of floodwaters.

Between the 14th-18th September, 243 cases of sickness linked to stagnant or sewage-tainted water were reported across Derna, Soussa and Al-Makhili. In the city of Al-Marg a cesspit flooded, covering roads and residential areas. In Sousse, sewers were reported blocked with sediment. In Bayda, the sewage treatment plant was inundated with flood water. Sewage in wastewater ponds mixed with floodwater, and the flood damage to operating equipment and administrative buildings is likely.

The region's water company warned against drinking well water and started conducting sampling, whilst local medical professionals warned of the likely spread of disease. Addressing the damage from the floods may divert funds from proposed improvements to the water network.

The environmentally sound management of the dead – who may eventually exceed 20,000 – is also an important part of the humanitarian response. There was a rush to bury the dead quickly, with OCHA reporting mass graves of more than 1,000 bodies. In part, this rush was due to misplaced fears of infectious disease from dead bodies. The mass burials led the WHO and ICRC to issue advice that the health risk is small, unless the dead body is near or in water supplies.

WASH and waste infrastructure was already in a poor state before the crisis. In Derna, the desalination plant was inoperational; our investigation in 2021 showed oil leaking into the sea. The provision of medical equipment and supplies was impacted by the instability in Libya. To help prevent a secondary health crisis, the UN quickly released $10 m and launched an appeal for a further $71.4 m.

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Flooded and damaged wastewater treatment facility in Al-Bayda

Storm Daniel disaster, September 2023

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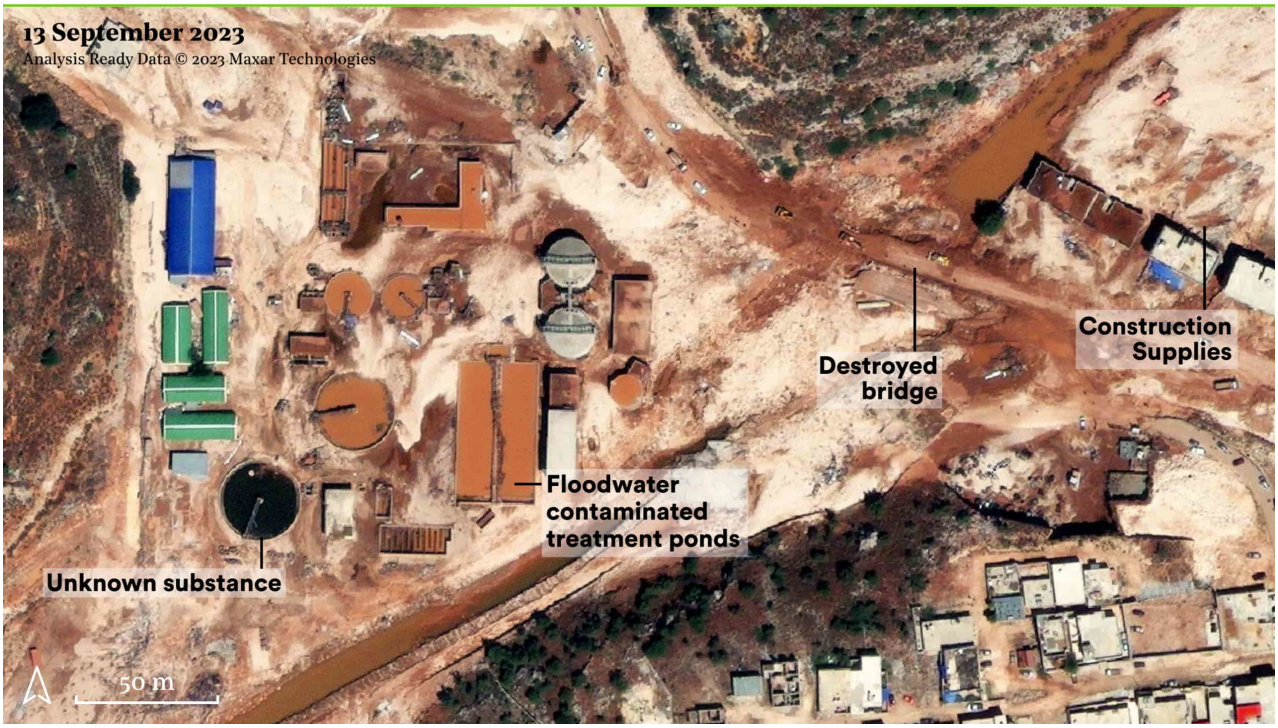

2. Safety of environmental infrastructure

The greatest devastation was in Derna. Two dams collapsed, allowing a 100 m wide channel of floodwater to cascade into the city. It is thought that the Abu Mansour and Al-Bilad dams failed not only because of the volume of rainfall, but also decades of

negligence. As such, there are serious concerns around the safety of other dams in the region.

In particular there are concerns surrounding the Al-Qattarah dam, upstream of Benghazi. Despite the authorities reporting that the dam is in good condition, unconfirmed reports indicated that it is leaking. If it were to collapse following extreme rainfall, Benghazi would be exposed to a disaster akin to Derna's. There are also concerns about the Al-Jaza dam, which may have only avoided collapse because the authorities installed water pumps to relieve pressure. Detailed investigation of these structures is essential ahead of the winter rains.

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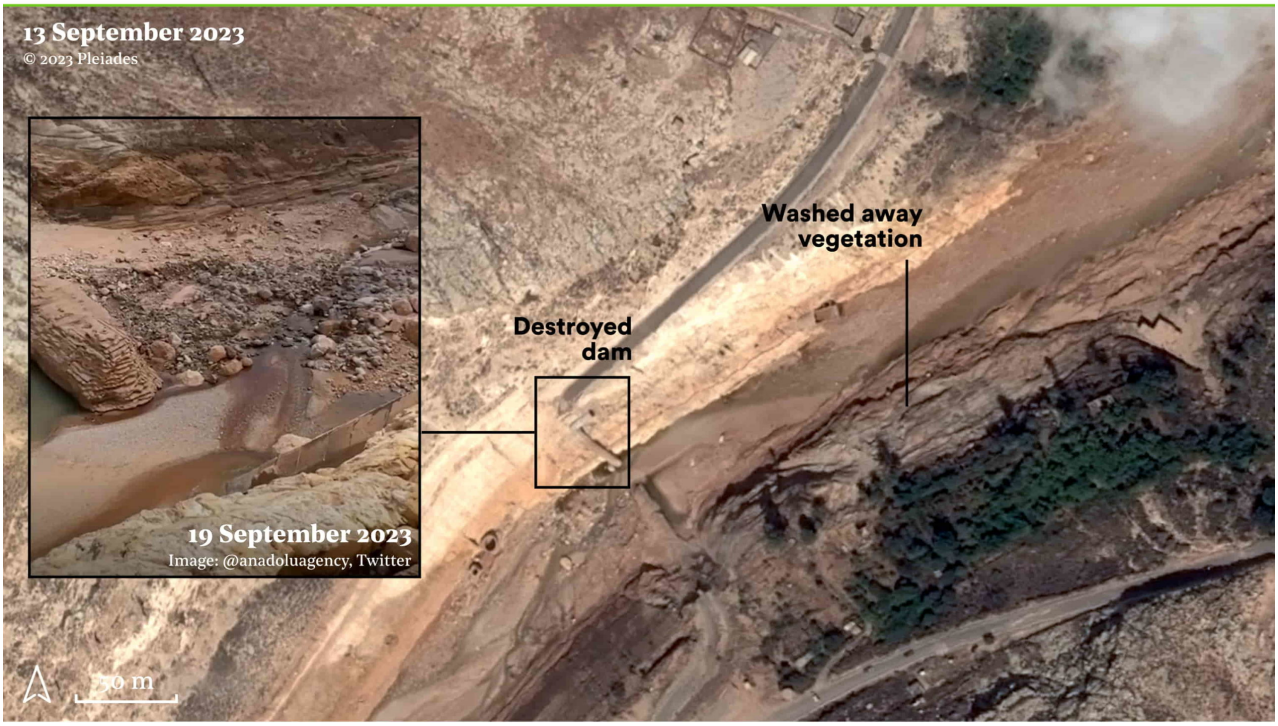
The destroyed Al-Bilad dam, just South of Derna

Storm Daniel disaster, September 2023



3. Pollution

In the storm's aftermath, the displaced population, and the environment, will be exposed to hazardous pollutants in the debris and mud, which is 3 m thick in places. Potential contaminant sources are diverse, including residential properties, industrial areas, medical facilities, wastewater treatment centres, informal landfills, and fuel tanks in vehicles and storage facilities.

Debris and sediments pose sanitation issues by blocking rainwater drainage systems, increasing the residence time of runoff within urban centres, subsequently increasing the risk of diseases. Libya's solid waste management challenges will make the environmentally sound clearance and treatment of the debris and sediment difficult.

As well as the diffuse pollution from debris and mud, there are likely to be point sources of pollution from hazardous sites that have been damaged or disrupted by the floodwaters. In some cases pollution will have been released into the floodwaters, though for others the release may have been delayed, or have yet to occur. Where it has entered soils or groundwater, pollution from such facilities may not be immediately visible. Potential point pollution sources should be mapped as part of a wider impact assessment.

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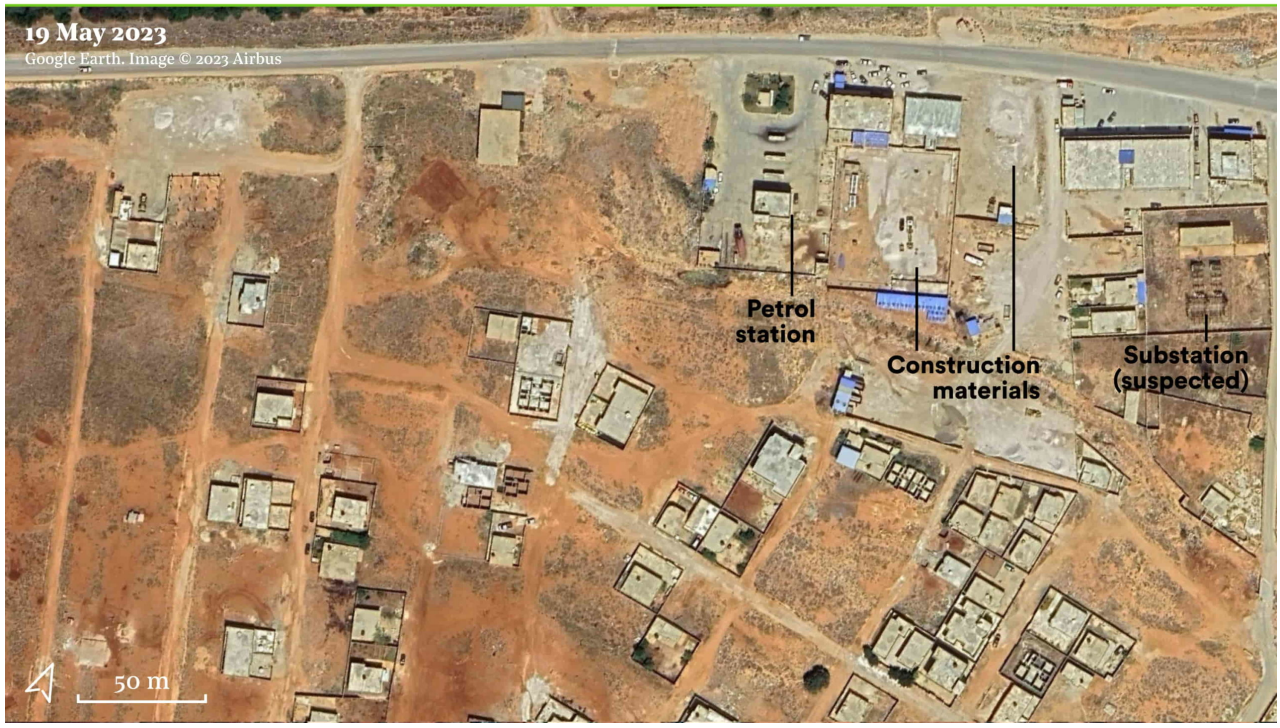
Point sources affected by flooding in Soussa that may pose a pollution risk

Storm Daniel disaster, September 2023



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Point sources affected by flooding in Soussa that may pose a pollution risk

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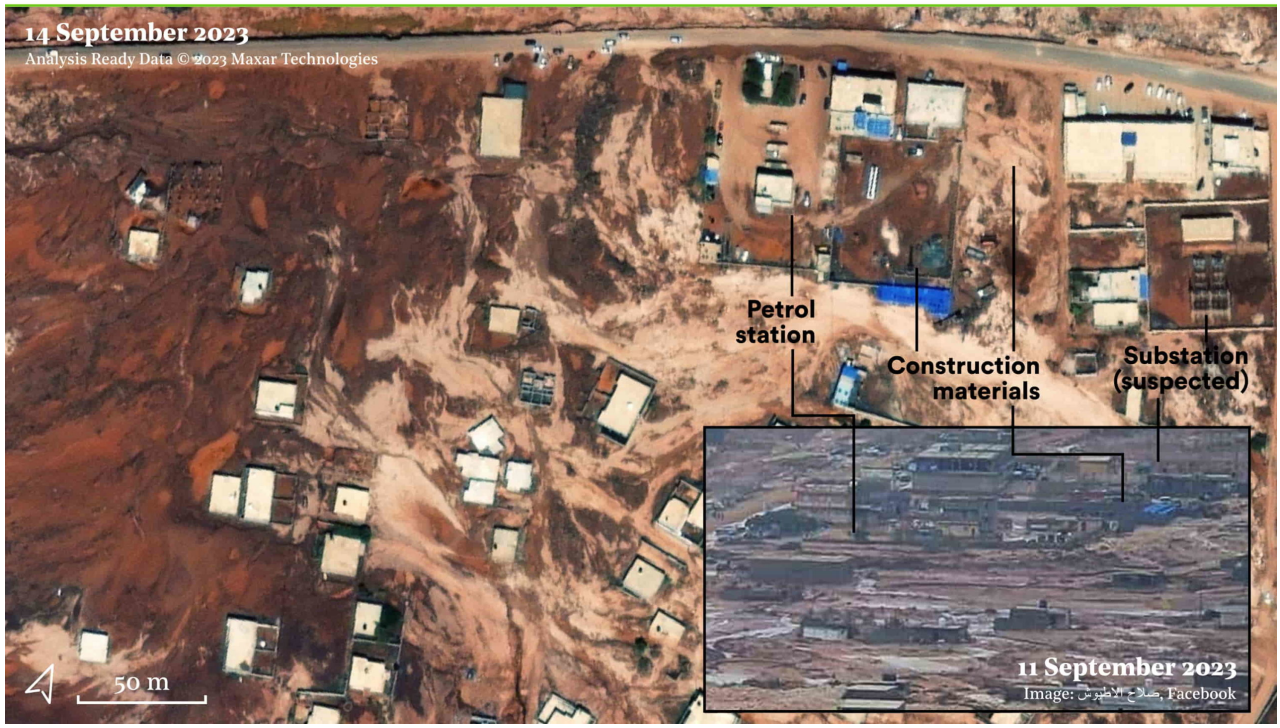


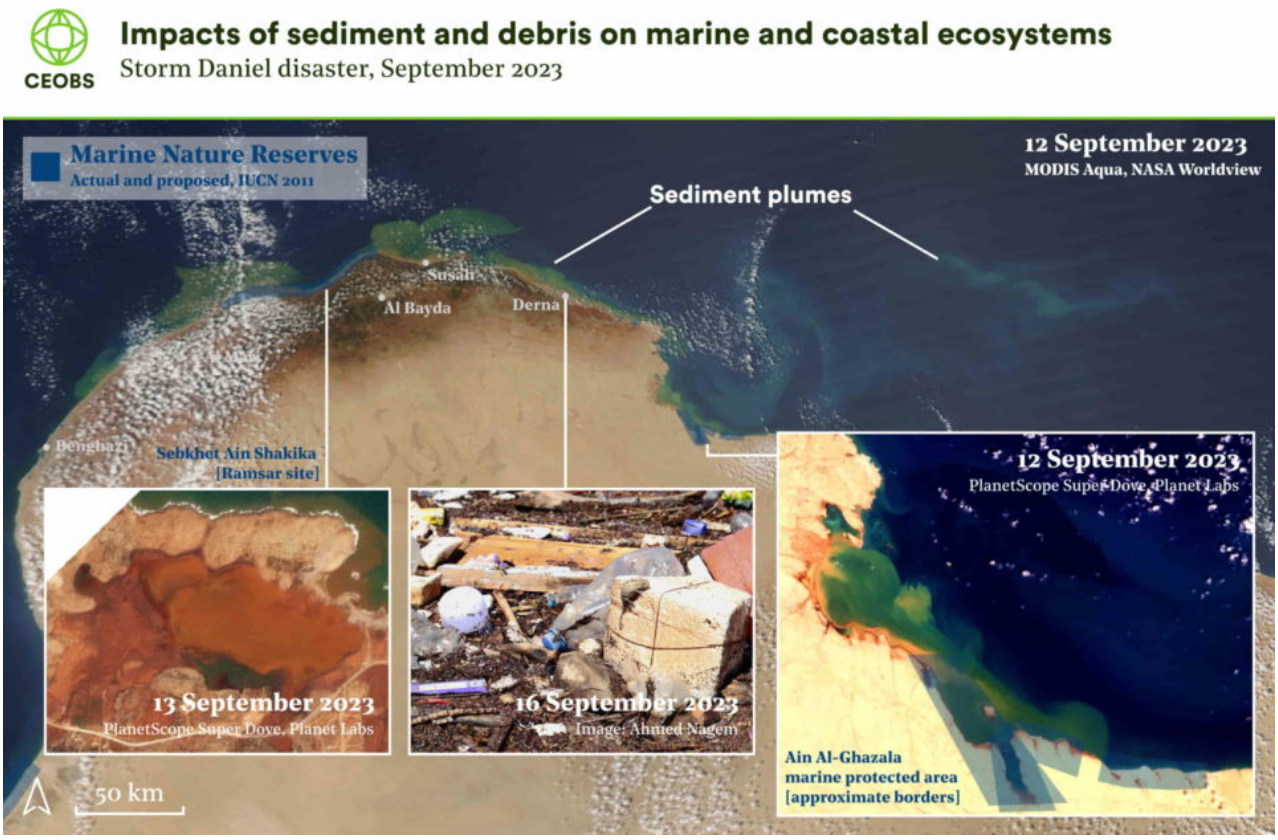
4. Impact on marine and coastal biodiversity

It is anticipated that there will be a significant impact on many of the coast's ecologically important areas. Habitats and ecosystems are likely to be damaged or disturbed by the vast volumes of polluted sediment and debris. Social media imagery captured the debris

near Derna, but it is likely to have spread along the coastline. This part of Libya's coast is an important feeding and nesting area for turtles, seabirds and fish, and is home to regionally important seagrass beds, containing near pristine hotspots.

Polluted sediment and debris can impact the entire marine food chain, from phytoplankton upwards, with knock-on impacts for fishing livelihoods. The greatest impact is likely along the coastal strip, for example satellite imagery shows flooding of Sebkhet Ain Shakika, part of the El Kour Natural Park. This site is a coastal lagoon and Ramsar site, and was reported to be in near-natural condition. Another location likely affected is the Ain Al-Ghazala protected area, which features exceptional biological diversity unique in the Mediterranean, with the lagoons acting as turtle breeding sites.

The work of conservation groups, such as the Alhaya Life Organization for the Protection of Land and Marine Creatures, is also likely to be disrupted.



The role of the conflict in the disaster

Libya has been beset by prolonged conflict and political fragmentation since 2011. This has resulted in weak governance, characterised by the neglect of essential infrastructure, such as dams, and reducing the capacity and resources available for disaster preparedness and response.

Infrastructure neglect

The dams that collapsed in Derna were built in the 1970s, likely based on short-term rainfall records, not 1-in-300 year events like Storm Daniel. Libyan civil society organisations suggested that the authorities were aware of the risks, but had been too

dysfunctional to act on the multiple warnings.

A government study in the 1990s found cracks and fissures in the dams' structures; these were attributed to a storm in 1986. An unpublished study in 2006 also reported on the danger, leading to the contracting in 2007 of a Turkish firm, Arsel, to carry out maintenance, and to build a third dam. Like many foreign companies, Arsel left the country when fighting broke out in 2011. Although the company's website stated that repairs were completed in 2012, this has now been deleted. No third dam was built. During Derna's occupation by Islamic State, Arsel's machinery was stolen and the building site left abandoned.

New contractors were not appointed until 2020, after officials allocated €2.28 m to assess the dams. However, a later audit revealed that this work was not undertaken, likely due to the insecurity in the country at the time. There was no follow up, despite ongoing warnings, such as that of hydrologist Abdul Wanis Ashour in a 2022 paper:

> "The current situation in the Wadi Derna basin requires officials to take immediate measures to carry out periodic maintenance of existing dams, because in the event of a huge flood, the result will be disastrous".

The lack of accountability, financial negligence and deterioration of institutions and infrastructure is characteristic of governance in eastern Libya. It is for these reasons that many Libyans are calling for any investigation to be led by international experts.

Disaster preparedness and response

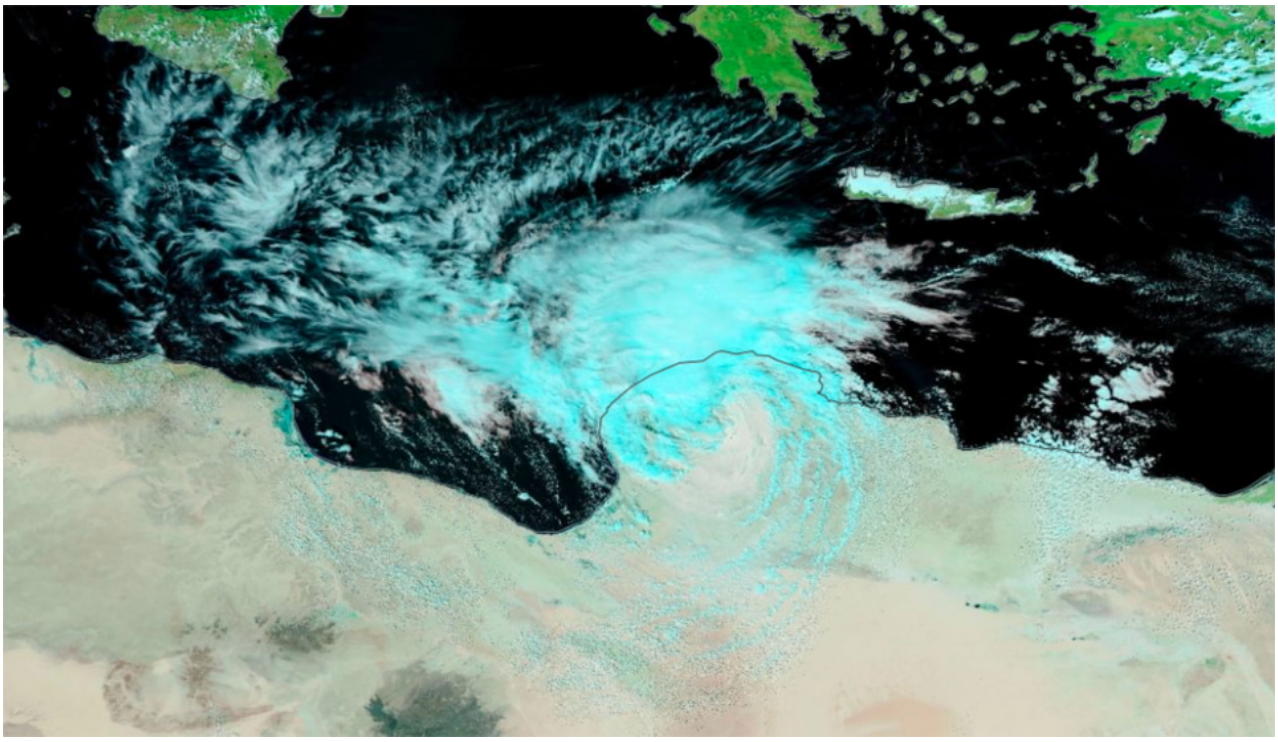
The World Meteorological Organisation suggested that many deaths could have been prevented if Libya had had an adequate weather warning service. Before the storm's landfall, Libya's Meteorological Society issued a warning but only for heavy rain and flooding; it did not address risks from ageing dams. The organisation has seen its capacity undermined by staff shortages and dysfunctional IT systems.

There are conflicting reports about whether a mandatory curfew was in place for Derna during the storm, together with the evacuation of coastal residents. The mixed messages meant many people relocated to the city's badly affected central areas. The authorities underestimated the situation, meaning local organisations such as the Red Crescent were left to provide primary assistance.

It took days before the magnitude of the disaster became apparent and an international response was activated. A number of factors likely contributed to this: the scale of the disaster and loss of lives and infrastructure; cloudy skies preventing rapid satellite assessments; a lack of a presence in the area owing to the political and security situation; and also the media focus on the flooding in Greece and earthquake in Morocco. At the time of writing, a number of flash assessments have been published. These include reports from UNICEF, REACH, ACAPS and DTM, whilst UNOSAT and Copernicus mapping is available on a GIS portal.

Coordination between the authorities in western and eastern Libya has been limited, and power struggles over aid are expected. Faith in the response of the eastern military authorities has been low, amid distrust of its communications. Platforms like Facebook have instead fulfilled the role of distributing information.

Hundreds protested in Derna, demanding answers and responsibility, promoting a crackdown by the Libyan Arab Armed (LNA) Forces. The LNA arrested protesters and mistreated and interrogated journalists, ordering them to leave the city. Areas of Libya controlled by the LNA have long been considered an information black hole. The presence of the LNA has reportedly hampered the provision of relief, and it is widely thought that Haftar is suspicious of Derna's population. Saddam Haftar, the youngest son of the LNA warlord Khalifa Haftar, was placed in charge of the disaster response, despite having been accused by the UN and Amnesty of serious crimes.



Storm Daniel along the Libyan coast, 10 September 2023. Imagery: NOAA-20/VIIRS Corrected Reflectance (Bands M11-I2-I1) via NASA Worldview.

Four long-term environmental considerations

The disaster exacerbated or drew long-overdue attention to a number of the environmental problems that Libya faces.

1. Unexploded ordnance

Libya is heavily affected by mines and explosive remnants of war. This includes legacy contamination from WWII, as well as from its armed conflict since 2011. Mine action in the country is piecemeal and underdeveloped, and in the wake of the floods the ICRC warned that explosive devices may have been mobilised by flood waters and deposited in sediments and debris.

The precise risks in Derna and other affected areas are difficult to ascertain. It is understood that Libya's mine action authorities were prevented from surveying the area, and as one of the last strongholds of ISIS fighters, contamination with war remnants may be similar to that in the city of Sirte.[1]

2. Solid waste management

For settlements hit by the flooding, and in the affected region more generally, the burden of managing solid waste from the flood will exacerbate pre-existing stresses. Libya's solid waste management architecture is weak, and has suffered from years of poor environmental governance, as well as the fragmentation of the country. This not only affects long-term disposal sites, many of which are informal and present pollution risks, but also waste collection.

The implications can be seen across the country, with urban and agricultural areas, and the coastline, badly affected by solid waste. Inadequate management presents a range of health risks, for example in Tripoli, high rates of informal waste burning have been found to have exacerbated respiratory illnesses in those in proximity to sites.

3. Displacement and vulnerability

It was estimated that the flood event displaced at least 43,000 people, including 30,000 people in Derna. In addition, eastern Libya was already hosting around 46,000 internally displaced people, as well as registered and unregistered refugees and asylum seekers. Since 2011, Libya has seen multiple waves of displacement and return linked to the conflict, with most displaced people staying within the municipalities from which they were displaced.

Those already displaced, and those continuing to be drawn to Libya as a transit point to Europe, are likely to be more exposed to the effects of extreme weather events, for example through lower quality housing or shelter, or fewer resources for recovery.

4. Disaster warning and adaptation

The intensification of *medicaines* has been linked to climate change. Libya's years of fragmentation and instability have not only exposed lethal weaknesses in its infrastructure management, they have also fragmented its disaster management and response mechanisms. Libya's National Meteorological Center needs extra resources if it is to fulfil its role in the response system.

Despite its vulnerability to climate change, there has been limited governmental and societal attention on climatic risks. Awareness raising projects could help, although political divisions hinder cohesive action. On the international level, prioritising stability at the expense of sustainable development has been criticised, and different approaches will be required to increase climate resilience.

Climate models predict that Libya will see higher temperatures, and less rainfall overall, with the rainfall that it does receive less predictable and more extreme. While *medicaines* of the scale and intensity of Storm Daniel may remain infrequent, adapting to increasing rates of flash flooding, extreme heat and worsening water scarcity will prove difficult in the absence of political stability.

This report was written by Malak Altaeb, an independent environmental policy consultant and researcher, and Leon Moreland, Eoghan Darbyshire and Doug Weir at CEOBS.

1. Exchanges with The HALO Trust.