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Executive Summary

Heavy rain and floods are affecting several African countries (Malawi, Mozambique, Zimbabwe, Madagascar) since the beginning of March, causing extensive damage and deaths.

The number of fatalities, due to the passage of Tropical Cyclone IDAI, is still increasing. In Mozambique, 150 people are reported dead (including 66 killed by flooding in early March in the Provinces of Tete and Zambezia). In Zimbabwe, 98 people are reported dead, 217 people are still missing and at least 15,000 people have been affected. In Malawi, 56 people have been killed, nearly 580 injured and more than 100,000 displaced. In Madagascar, 3 people died and more than 1,000 have been affected. These figures are expected to further increase, especially in Mozambique.

In addition, in Zimbabwe, the Marowanyati dam in Buhera (Manicaland Province) has overflown and many families are displaced, while in Mozambique, outside of Beira, a dam collapsed on 17 March causing extensive damage according to media reports.

The European Commission's Copernicus Emergency Management Service has been activated for Mozambique, Zimbabwe and Malawi and several maps have already been produced to assist the response.

Alerts are issued for flooding in Buzi and Pungoe river basins in the next 72 hours (https://reliefweb.int/sites/reliefweb.int/files/resources/ROSEA_20190318_Mozambique_Cyclone%20IDAI_Flash%20Update%234.pdf).

*This report is an update of a first report that was issued on 13th March.*
1. Situation assessment

1.1 Meteorological Situation
Tropical Cyclone IDAI made landfall near Beira city (pop. 530 000) in Sofala province (Mozambique) on 14 March evening, as an intense Tropical Cyclone. Strong winds (max. sustained winds 170-180 km/h, with higher gusts), heavy rains and a large storm surge (calculations: up to 4.5 m) affected this area. After the landfall, it moved over Mozambique towards eastern Zimbabwe, weakening. However, the remnants of IDAI are still producing heavy rainfall, with additional flooding (see Section 2).

The same weather system, before developing into a Tropical Cyclone over the Mozambique Channel, moved over Mozambique and Malawi on 4-9 March (see map below), causing heavy rain and floods.

As a consequence, several countries have been affected by floods since the beginning of March, and the number of deaths is still increasing (see Section 1.4).

Affected countries: Mozambique, Malawi, Zimbabwe, Madagascar.

Figure 1 Track of IDAI (GDACS,JTWC), last 2-weeks rainfall accumulation (NASA-GPM), storm surge calculations (JRC)
1.2 Hydrological Situation

According to media reports situation is critical in smaller coastal basins (Pungwe, Revue, Save and Licungo). Especially, large spread flooding is reported in Pungwe River (https://www.reuters.com/article/us-zimbabwe-cyclone/death-toll-in-mozambique-cyclone-floods-could-surpass-1000-president-idUSKCN1QZ0OS?il=0), affecting the city of Beira. Unfortunately, there is no measurements available for these smaller river basins. The river discharge estimation for the larger basins based on Satellite Microwave Radiometry provided by the Dartmouth Flood Observatory is shown below (Figure 2). Estimated discharge in the Zambezi River Basin upstream of confluence with Shire is decreasing in the last days and currently is already below the 1.5-year threshold (Figure 3). Similarly, the discharge is falling down in in the Shire River upstream to junction with the Zambezi River (Figure 2: Location 253 and 56, Figure 4) but the discharge remains still above 10-years threshold. Discharge estimates for the Zambezi River downstream of the confluence with the Shire River are exceeding 1.5 year return level (Figure 5) in the last couple of days.

Figure 2: Maximum observed flood extent on 18th of March 2019 for Zambezi and Shire Rivers. Red is mapped flooding from this event. Blue is a reference normal water extent. Light gray is all previously mapped flooding, since 1999. Source: Dartmouth Flood Observatory
1.3 Storm Surge Situation

Tropical cyclone IDAI caused extended storm surge along the coastal area of Sofala province, especially in the area of the city of Beira, on 14 March evening. According to JRC calculations (using...
as input the atmospheric data of NOAA HWRF of 15 March 00:00 UTC), the coastal area of Beira city (Pungwe and Buzi Delta Rivers), was the mostly affected (see figure below), with a maximum of:

- **4.4 m near Beira on 14 March 22:00 (UTC)**

The coastal impact calculations are included in the GDACS report of the IDAI Tropical Cyclone:


Figure 6 JRC Storm surge calculations due to Tropical Cyclone IDAI and max. storm surge estimated near Beira
Note:

- The JRC storm surge estimations cannot be confirmed by the sea level measurements, since there are no stations available in the area.
- JRC storm surge calculations don't include wave, tide and river effects. It is important to note that the estimated max. storm surge is in the area of a delta river (Pungwe and Buzi Delta Rivers), therefore the effective level (storm surge+tide) may be larger: in fact the torrential rains that may have affected the areas during the passage of a Tropical Cyclone IDAI may have increased the river flow and its outflow could have been impeded by the incoming storm surge. This could have created more floods in the surrounding areas of the cities close to the delta river.
Figure 8 Beira City as of 18 March, after the passage of TC IDAI (source: IFRC).


Figure 9 After the passage of TC IDAI (source: WMO)

1.4 Impact Assessment

The number of fatalities and extensive damage due to the passage of Tropical Cyclone IDAI, is still increasing. The latest updated humanitarian impact (since the beginning of March) is shown below, but search and rescue operations are still on-going. The full scale of damages is not yet known (lack of access to affected areas), therefore these figures are expected to rise, especially in Mozambique.

Malawi:

According to the latest report (Department of Disaster Management Affairs - DoDMA of Malawi and the United Nations Office of the Resident Coordinator in Malawi, 16 March), the official figures confirm **56 deaths**, 577 people injured and another 3 missing. In addition, 125 000 people have been displaced (see ECHO Daily map of 18 March). Electricity and water supplies have been impacted.

On 8 March, the government of Malawi declared a State of Disaster in the affected areas, following the heavy rains and floods that affected the southern areas of the country.

Most affected districts (see figure below): Zomba, Zomba city, Machinga, Nsanje and Phalombe.

![Figure 10 Impact of Malawi Floods](https://reliefweb.int/sites/reliefweb.int/files/resources/SitrepNo1-MalawiFloods-16March2019.pdf)
Mozambique:
As of 19 March (ECHO Daily Flash 19 March), 150 people are reported dead, including 66 killed by flooding in early March in the Provinces of Tete and Zambezia and another 84 killed after TC IDAI landfall. According to some media reports, President has said that the number of deaths could rise above 1,000. UN OCHA report also mentions 267 classrooms and 24 health units being affected in the Sofala, Manica and Zambezia Provinces.
The extensive damage has been reported in the city of Beira and surroundings villages. Beira city remains cut off from surroundings, communication lines are cut and some affected communities are not accessible. As of 19 March, media reported that River Buzi burst its bank, causing extensive flooding. The Central Hospital emergency is non-operational due to significant damage.
In addition, according to UN OCHA report of 18 March, a dam collapsed on 17 March outside of Beira, causing extensive damage.
Most affected regions are in Sofala, Manica, Zambezia, Tete (Figure below).


Figure 11 Impact of Malawi Floods (source: UN OCHA)
Zimbabwe:

As of 19 March (ECHO Flash 19 March), **98** people are reported dead, 217 are missing and 15 000 people have been affected. According to the latest UN OCHA report (18 March), at least 923 houses have been destroyed in Chimanimani, Mutasa, Mutare, Chipinge, Buhera, Chikomba, Gutu and Bikita districts and in Buhera (Manicaland Province) the **Marowanyati dam** burst and families have been displaced (see description below).

Areas mostly affected: Manicaland and Masvingo provinces, with Chimanimani and Chipinge the hardest-hit districts.

![Figure 12 Impact of Zimbabwe Floods (source: UN OCHA)](https://reliefweb.int/report/zimbabwe/zimbabwe-floods-flash-update-no-2-18-march-2019)

**The Marovanyati Dam**

Marovanyati Dam, whose construction is almost complete, is located on the Mwerihari River, a perennial stream with an annual flow of 182 million litres. The capacity of Marowanyati Dam is 50 million cubic metres with the dam expected to provide water for Murambinda Growth Point, Dorowa Mine and irrigation water for surrounding communities.
The embankment is 35m high, 177m wide and 470m long and has four sections – the downstream fill (stable earth), the core (impermeable earth), upstream fill (stable earth) and rip-rap (rocks that dissipate the waves). [https://www.manicapost.co.zw/marowanyati-dam-buheras-game-changer/](https://www.manicapost.co.zw/marowanyati-dam-buheras-game-changer/)

The Marowanyati dam has overflowed and many families are displaced. Crops and livestock have been destroyed in all affected areas. Overall, more than 2,500 households (12,500 to 15,000 people) are estimated to be affected. However, an accurate assessment of the number of people impacted and displaced is difficult to establish at this point, as many district wards remain inaccessible.

No calculation has yet been done on the possible impact of the
Figure 14 The impact in the area of the landfall, as estimated by Copernicus and International Space Charter data is shown in the image above. The image, obtained with data before the landfall, as far as regards Charter data, does not include the coastal impact.
2. Potential Development

2.1 Meteorological forecast

The remnants of IDAI (Ex-IDAI) could still produce heavy rainfall over the next week over Mozambique and eastern Zimbabwe, causing additional flooding. The latest ECMWF deterministic weather forecasts (2019-03-19 00:00 UTC) shows that heavy precipitation (exceeding 200mm in 10 days) is forecasted for central Mozambique (Figure below). Such high intensity of precipitation can be also seen in the dedicated Meteograms (next Section 2.2) where amounts higher than 150 mm are forecast during a 6-hour interval over the area of Marromeu.
2.2 Meteograms

Special (pinpoint) Meteograms based on the Ensemble Prediction System and the deterministic single model operational forecast of ECMWF have compiled for the areas listed below (see details in Figure 16):

- Beira, Mozambique
- Marromeu, Mozambique
- Chimanimani, Zimbabwe
- Nsanje, Malawi
- Salima, Malawi
- Phalombe, Malawi

Figure 16 Positions of (pinpoint) areas used in Meteograms.
Meteograms contain information coming from both the deterministic single model high-resolution (HRES) forecast and the Ensemble Prediction System (EPS) comprising 50 members plus one (the Control forecast). The horizontal resolution of the HIRES is ~8 km whereas the resolution of ensemble members (and control) is ~16 km. HRES is denoted by blue, whereas Control forecast (of the ensemble) is denoted by red color. The values of the ensemble are contained in a box plot type of diagram that graphically depicts groups of numerical data through their quartiles while maximum and minimum values are highlighted by whiskers.

The first panel of the meteogram contains the total (low - medium & high) cloudiness in octas. The second panel refers to the total (convective and large-scale precipitation) utilizing values (mm) estimated over 6-hour intervals. The third panel refers to the instantaneous (averaged over 10 minutes) wind speed values in m/s. The fourth panel refers to the temperature in deg Celsius at 2-meter height.

**Figure 17 Meteograms for Beira, Mozambique and Marromeu, Mozambique**
2.3 Hydrological Forecast

The latest GloFAS forecast shows the very high probability of exceeding the 20-year return level threshold (Figure 19) in the Pungwe, Revue and Save River Basins. The main Zambezi River is forecasted to exceed 5 years return with medium probability. The probability of exceeding 5-years return level is still high in the lower section of Chire River (upstream of confluence with Zambezi) in next 10 days. River discharge in the Zambezi River (Figure 21) is currently below 5-years return level, but it is forecasted to rise in the next days, with the peak on 25\textsuperscript{th} exceeding 5-years return level. Chire River (Figure 25) is forecasted to exceed 5-years return level and steadily decreasing in coming days. It is predicted to be below the 5-years return level from 25\textsuperscript{th} of March.

The situation in the coastal basins of Buzi, Save and Revue Rivers is more critical (Figures 20-23). The latest GloFAS predictions shows that these rivers are extremely high (exceeding 50-years threshold) and discharges are forecasted to slowly decrease. The upper parts of Buzi and Revue and Save River (Figures 20-23) should go below the 5-years return level on 29\textsuperscript{th} of April. The most critical prediction is for the Pungwe River (Figure 24) which is already exceeding 200-years threshold and is forecast to significantly rise until 21\textsuperscript{st} of March.
FLOODS in Malawi and Mozambique - JRC Emergency Report #030 - UPDATE # 1 – 19 Mar 2019

Figure 20 GloFAS 2019-03-19 hydrological forecast for Save River (Location 1)

Figure 21 GloFAS 2019-03-19 hydrological forecast for Upper Buzi River (Location 2)
FLOODS in Malawi and Mozambique - JRC Emergency Report #030 - UPDATE # 1 – 19 Mar 2019

Figure 22 GloFAS 2019-03-19 hydrological forecast for Upper Revue River (Location 3)

Figure 23 GloFAS 2019-03-19 hydrological forecast for Lower Buzi River (Location 5)
Figure 24 GloFAS 2019-03-19 hydrological forecast for Pungwe River (Location 4)

Figure 25 GloFAS 2019-03-19 hydrological forecast for Chire River (Location 6)
Figure 26 GloFAS 2019-03-19 hydrological forecast for Zambezi River (Location 7)
2.4 Impact Forecast

The map below shows the JRC assessment of the total number of people potentially affected by the flooding. The inundated areas were estimated combining the predicted exceedance of 20-years return levels according to the latest GloFAS prediction and static flood hazard (based on GloFAS climatology) corresponding to a flood event with the return period of 100 years (blue shading). The estimated flooded area was overlaid with the Global Population Grid of the Global Human Settlement Layer which depicts the distribution and density of population in 2015 expressed as number of people per 250m grid cell [https://ghsl.jrc.ec.europa.eu/ghs_pop.php](https://ghsl.jrc.ec.europa.eu/ghs_pop.php). This analysis shows that potentially the most affected regions (based on the forecast of 19/04) are: Nhamatanda, Chupanga, Campo.

Please note that the analysis is based on GloFAS predictions which is simulating only riverine flooding and not considering the effects of dam breaks, urban flooding, backwater effect and coastal flooding.

*Figure 27* Estimation of population affected based on the latest GloFAS prediction (19-03-2019 00UTC). Blue shading denotes the inundated areas assuming the 100-year flood scenario.
3. Copernicus EMS Rapid Mapping Activation

The European Commission’s Copernicus Emergency Management Service (Rapid Mapping) has been activated for Mozambique, Zimbabwe and Malawi and several maps have already been produced to assist the response: https://emergency.copernicus.eu/mapping/list-of-activations-rapid

| EMSR346 | Flood in Mozambique | Activated on 09 March 2019 |
| EMSR347 | Floods in Malawi    | Activated on 10 March 2019 |
| EMSR348 | Tropical Cyclone IDAI in Mozambique | Activated on 15 March 2019 |
| EMSR349 | Flood and Wind Storm in Manicaland, Zimbabwe | Activated on 18 March 2019 |

**Figure 28** Copernicus EMS Rapid Mapping Activations, whose data have been used in the Chapter 1.4
4. Other activities in support to ERCC

4.1 JRC Support to ERCC


As a preparedness action in November 2018 before the start of the TC season, under the request of the Emergency Response and Coordination Centre (ECHO/ERCC), the JRC analysed the relevant past events and seasonal forecast in the SW Indian Ocean, including the TCs in Mozambique. The report is available at: [http://www.gdacs.org/Public/download.aspx?type=DC&id=161](http://www.gdacs.org/Public/download.aspx?type=DC&id=161)

In terms of operational systems the following ones have been activated:
- GDACS, Global Disasters Alerts and Coordination System
- GLOFAS, Global Flood Awareness System
- Copernicus EMS, Emergency Mapping Service

4.2 Virtual OSOCC

Two breaking emergency discussions have been initiated in Virtual OSOCC and several documents, maps and information have been added.

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floods in Malawi</td>
<td>9 March 2019</td>
</tr>
<tr>
<td>Tropical Cyclone Idai in Mozambique</td>
<td>14 March 2019</td>
</tr>
</tbody>
</table>

For the two events many teams are ready to deploy material and logistic support, coordinated by UN-OCHA.

4.3 International Charter

The International Disaster Charter has been activated on both emergencies and is providing a number of maps in coordination with the Copernicus Emergency Management Service; the data have been used in Chapter 1.4.

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
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<tbody>
<tr>
<td>Cyclone Idai in Mozambique</td>
<td>Activated on 14 March 2019</td>
</tr>
<tr>
<td>Cyclone Idai in Zimbabwe</td>
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</table>
5. Expected Updates

JRC is following the situation and will produce an updated report on request if more information are available.

6. References and contact points within JRC

Contact points within JRC: Disaster Risk Management Unit

Technical Responsible:
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Global Disasters Alerts and Coordination System (GDACS):
- Tropical Cyclone IDAI (GDACS Red Alert):
- Floods in Malawi:
- Floods in Mozambique:

Copernicus EMS, Emergency Mapping Service (Rapid Mapping):
- EMSR346 - Flood in Mozambique: https://emergency.copernicus.eu/mapping/list-of-components/EMSR346
- EMSR347 - Floods in Malawi: https://emergency.copernicus.eu/mapping/list-of-components/EMSR347
- EMSR348 - Tropical Cyclone IDAI in Mozambique: https://emergency.copernicus.eu/mapping/list-of-components/EMSR348
- EMSR349 - Flood and Wind Storm in Manicaland, Zimbabwe: https://emergency.copernicus.eu/mapping/list-of-components/EMSR349

Reliefweb: https://reliefweb.int/disaster/tc-2019-000021-moz

https://reliefweb.int/report/mozambique/cyclone-idai-and-floods-cause-massive-destruction-deaths-mozambique-zimbabwe-and
https://reliefweb.int/sites/reliefweb.int/files/resources/ROSEA_20190316_TC%20Idai_Flash%20Update2.pdf
https://af.reuters.com/article/zimbabweNews/idAFL8N2152K6
https://reliefweb.int/disaster/tc-2019-000021-moz
List of abbreviations and definitions

GloFAS - Global Flood Awareness System
GDACS – Global Disaster Alert and Coordination System
HRES - deterministic single model high-resolution
EPS – Ensemble Prediction System
DoDMA - Department of Disaster Management Affairs

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