EUROPEAN COMMISSION

JOINT RESEARCH CENTRE

Tropical Cyclone IDAI: analysis of the wind, rainfall and storm surge impact

P. Probst, A. Annunziato

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In the aftermath of the IDAI Tropical Cyclone, which devastated large portion of the Mozambique, Malawi and Zimbabwe in the period 14 March to 19 March 2019, UN OCHA established the Assessment & Analysis (A&A) Cell, providing input to needs-based analysis outputs of the Emergency Operations Cell (EOC) that for this case was set-up in Beira, Mozambique.

In this context, the A&A is currently collecting data in the field to compare this with secondary data, expert judgement, and results from the first assessments. The first reports in this second phase will be district profiles where they want to include a map showing assessment coverage overlaid with impact from the tropical cyclone.

The A&A therefore requested the support of JRC in providing the best possible map and data showing the wind speed on land from the tropical cyclone. This small document, connected with the dedicated shape files, illustrates the way the files have been produced from the ancillary data.

In particular, the following data sets are provided:

1) Wind
    a. GDACS buffers
    b. NOAA Satellite data analysis
    c. NOAA HWRF forecasts
2) Rain
    a. Global Precipitation Measurements (GPM)
3) Storm Surge
    a. Maximum water level from JRC analysis using HWRF data

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 160-180 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, but the remnants of IDAI still produced heavy rainfall, with additional flooding.
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.
Consequently, several countries have been affected by floods since the beginning of March, causing extensive damage and deaths.

Affected countries: Mozambique, Malawi, Zimbabwe, Madagascar.

GDACS RED ALERT TC IDAI:
http://www.gdacs.org/report.aspx?eventtype=TC&eventid=1000552&episodeid=24

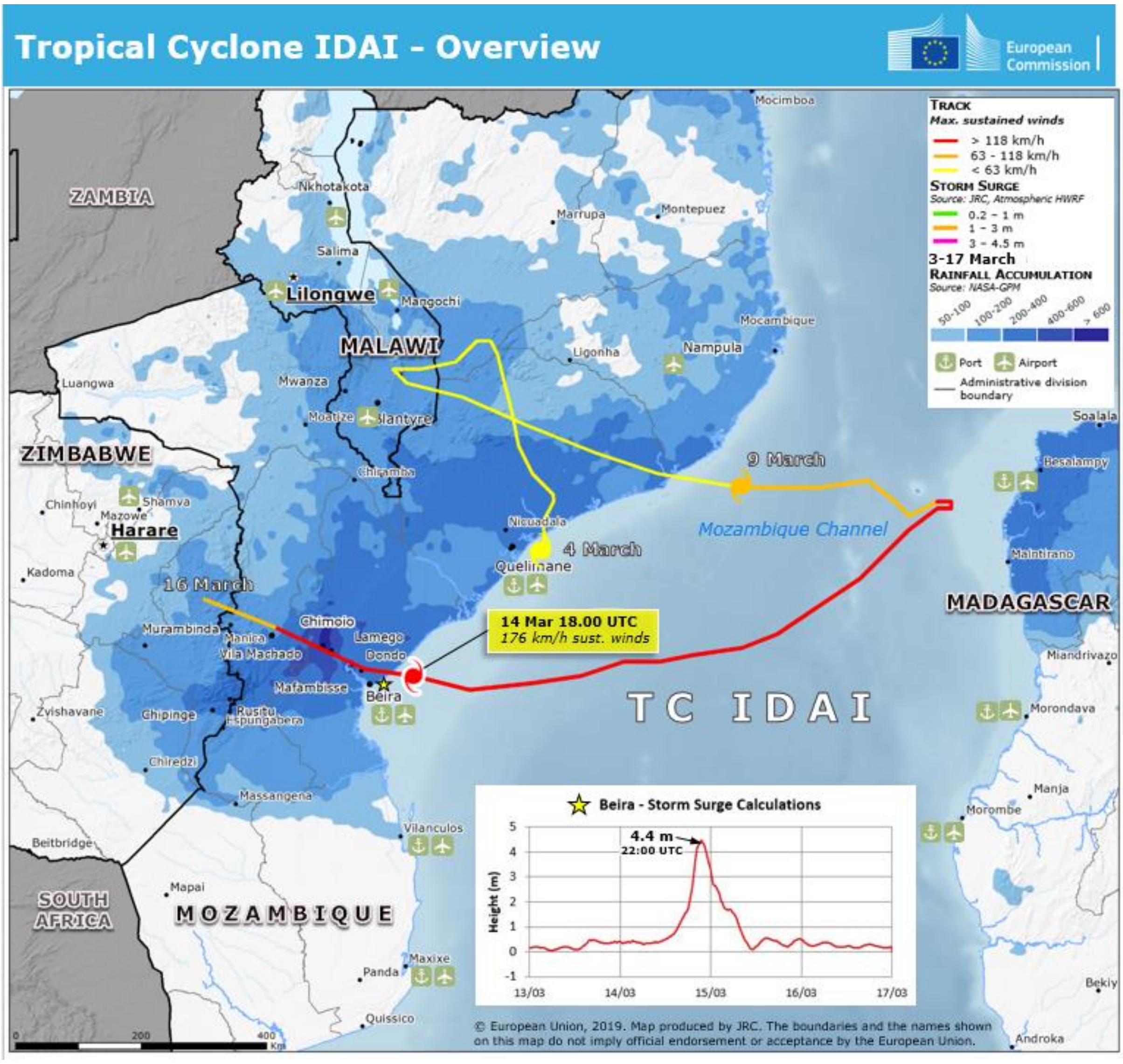

Figure 1 - *Track of IDAI (GDACS, JTWC), 2 weeks rainfall accumulation (NASA-GPM), storm surge calculations (JRC)*

2. WIND:

2.1. Global Disaster Alert and Coordination System (GDACS)

In the current GDACS Wind Alert System, the wind radii[1] data (34, 50, 64 kt equivalent to 63, 93, 119 km/h) provided in the TC bulletins are used to calculate the three wind buffers (see more information at http://www.gdacs.org/Knowledge/models_tc.aspx), shown in the table below. The system automatically calculated the population inside these buffers.

The impact for TC IDAI is available at:
http://www.gdacs.org/report.aspx?eventtype=TC&eventid=1000552&episodeid=24

Kml file TC track + Wind Buffers:
http://www.gdacs.org/kml.aspx?profile=archive&eventid=1000552&eventtype=TC

Wind Buffer (GDACS)	1 min Sustained Winds		TC Classification[2]
	knots	km/h	
RED	≥ 64	≥ 119	Category 1 or Higher
ORANGE	50 – 63	93 - 118	Tropical Storm
GREEN	34 – 49	63 - 92	

Table 1 *- Wind buffers used in GDACS*

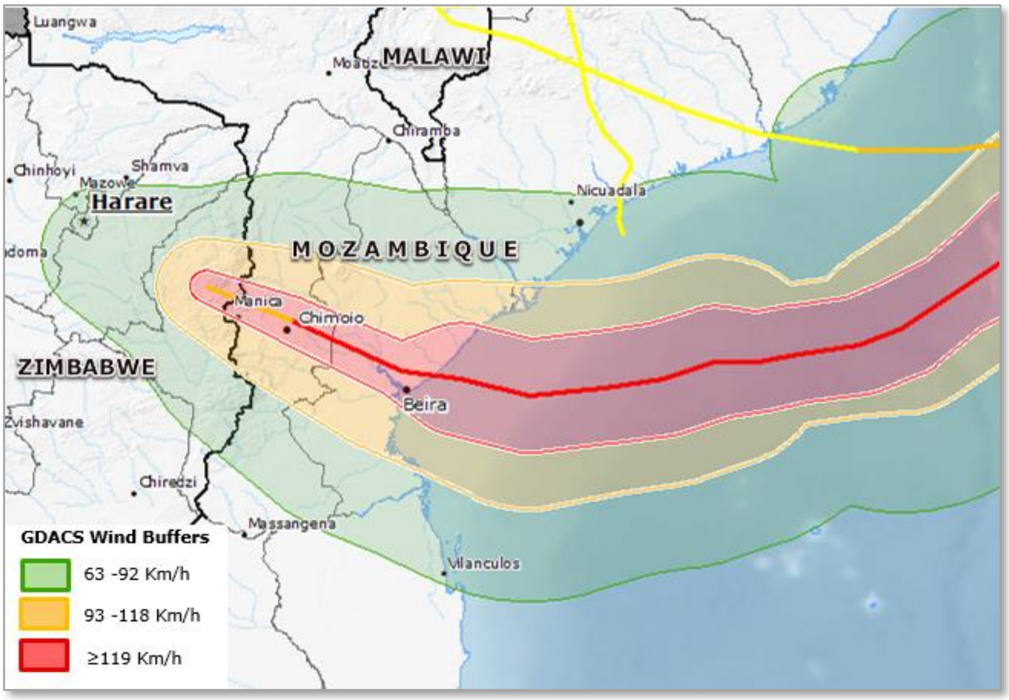

Figure 2 *– GDACS Wind buffers for TC IDAI*

[1] Wind radii represents the maximum radial extent – in nautical miles - of winds reaching 34, 50, and 64 kt in each quadrant (NE, SE, SW, and NW). These data are provided in each TC bulletin issued by the TC warning centres at least every six hours. The threshold of the velocity (34, 50, 64kt) could vary from centre to centre.

[2] TC classification used in GDACS (see Saffir-Simpson Hurricane Wind Scale- SSHWS, NOAA https://www.nhc.noaa.gov/aboutsshws.php)

2.2. NOAA Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA)

The surface winds obtained (just before / after landfall) using the satellite product of NOAA - National Environmental Satellite Data and Information Service (NESDIS) *Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA)*[3] are shown below (2 different scale, LEFT/RIGHT).

According to this data, few hours before the landfall TC IDAI had maximum 1-min sustained winds of 180 km/h (equivalent to a Category 3 in the SSHWS, see GDACS Table).

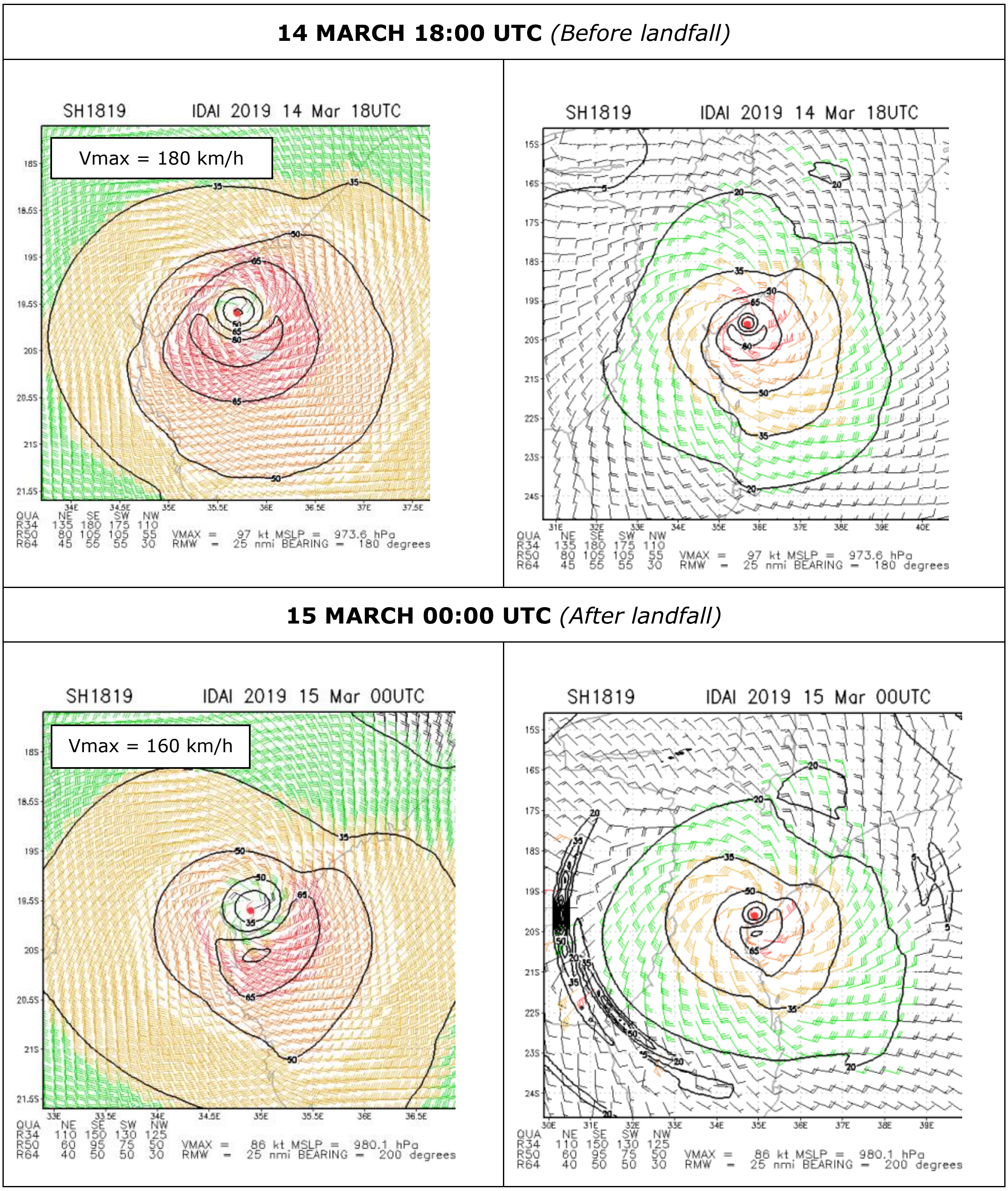

Figure 3 *– NOAA-MTCSWA winds for TC IDAI on 14 March 18:00 UTC (above) and on 15 March 00:00 UTC (below), using two different scales (Left more zoom in) (source: NOAA-NESDIS)*

[3] More information on this product are available at: http://www.ssd.noaa.gov/PS/TROP/MTCSWA_UM.pdf

JRC has produced 3 wind buffers, as the ones used in GDACS (see Table 1), for TC IDAI from 14 March 18 UTC to 15 March 18 UTC using as input the data of NOAA-NESDIS MTCSWA.

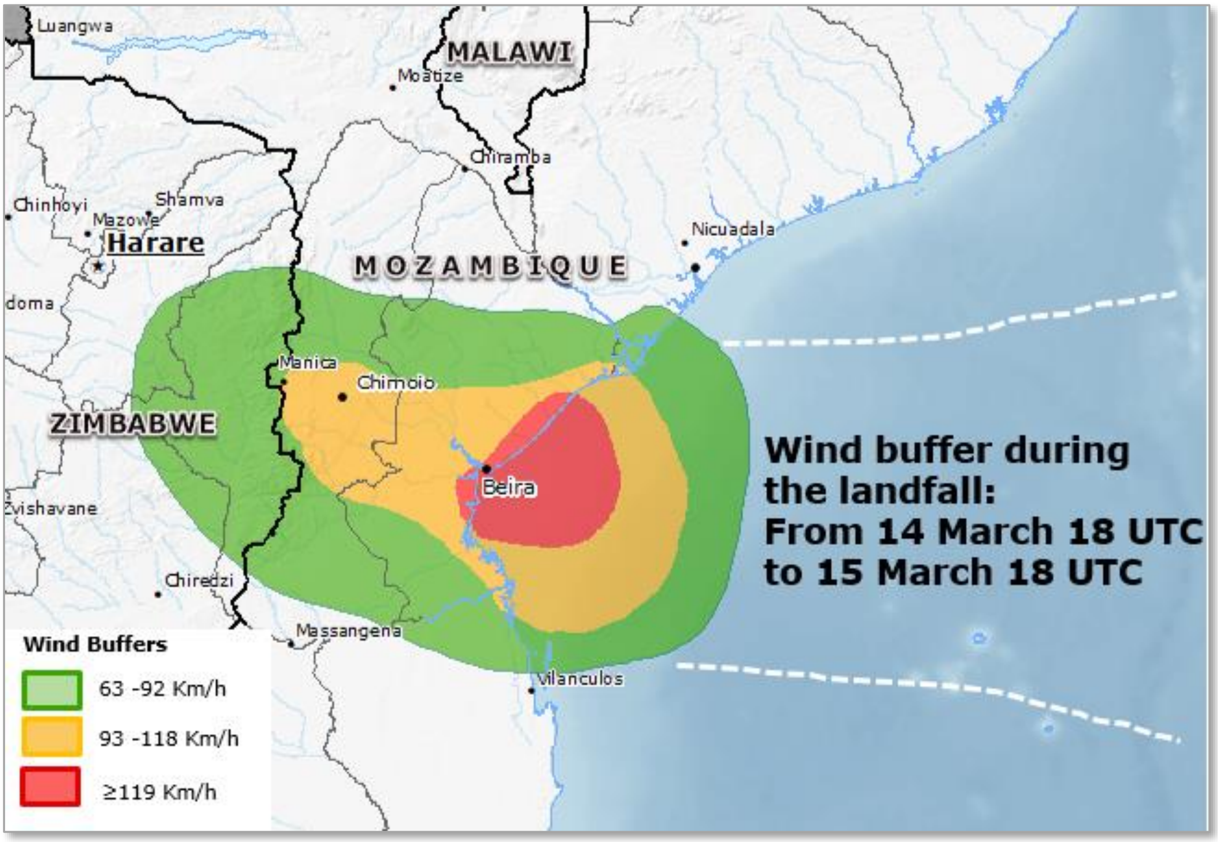

Figure 4 *– Wind buffers for TC IDAI from* ***14 March 18 UTC to 15 March 18 UTC*** *created by the JRC using as input the data of NOAA-NESDIS MTCSWA*

2.3. NOAA Hurricane Weather Research and Forecast (HWRF)

The NOAA Hurricane Weather Research and Forecast (HWRF) is a non-hydrostatic coupled ocean-atmosphere model, which utilizes highly advanced physics of the atmosphere, ocean and wave. It makes use of a wide variety of observations from satellites, data buoys, and hurricane hunter aircraft. The ocean initialization system uses observed altimeter observations, while boundary layer and deep convection are obtained from National Centers for Environmental Prediction (NCEP)-GFS. Over the last few years, the HWRF model has been notably improved, implementing several major upgrades to both the atmospheric and ocean model components along with several product enhancements. The latest version of HWRF model has a multiply-nested grid system: 18, 6, 2 km of resolutions. The TC forecasts are produced every six hours (00, 06, 12, and 18 UTC) and several parameters are included (e.g. winds, pressure and rainfall).

More information at: http://www.nws.noaa.gov/os/notification/tin15-25hwrf_cca.htm

TC IDAI:
https://www.emc.ncep.noaa.gov/gc_wmb/vxt/HWRF/tcall.php?selectYear=2019&selectBasin=Southern+Hemisphere&selectStorm=IDAI18S

JRC has created the same wind buffers (see Table 1) using as input the data of HWRF.

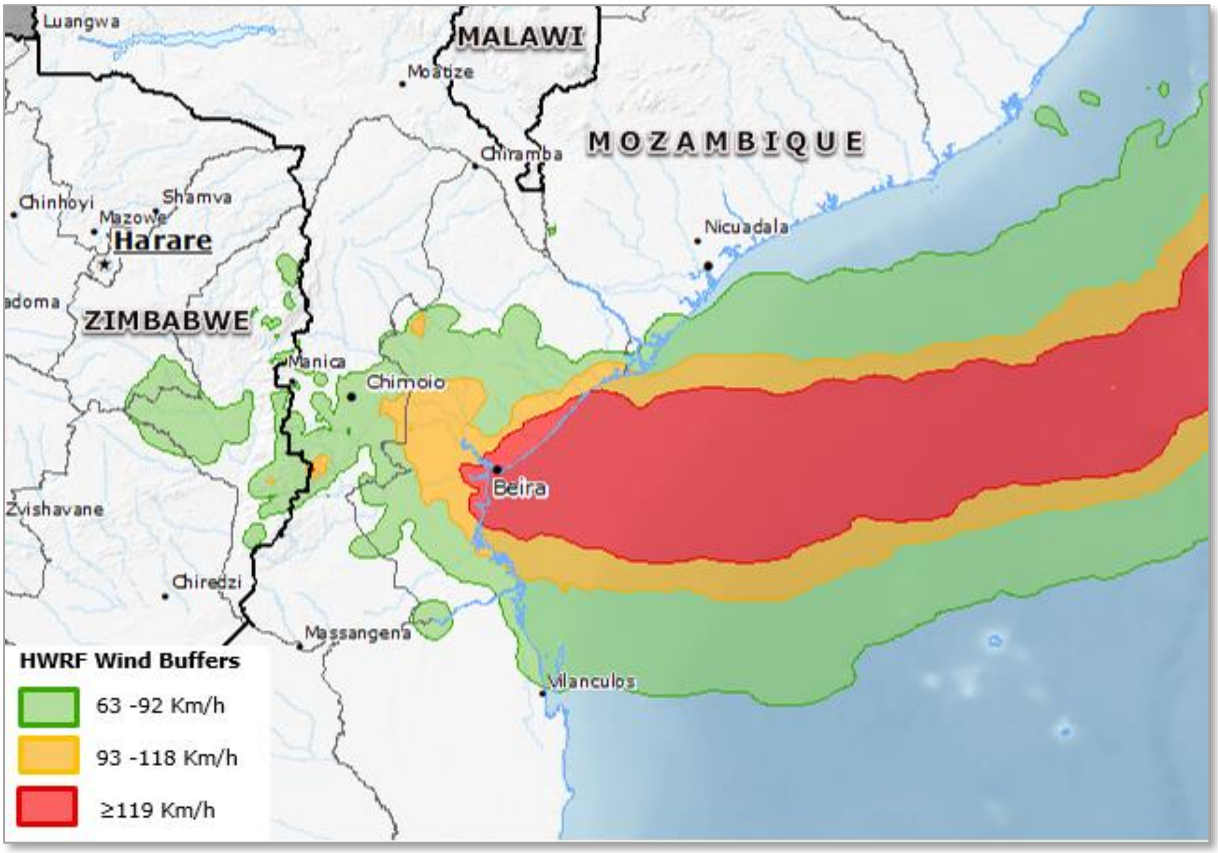

Figure 5 *– Wind buffers for TC IDAI created by the JRC using as input the data of NOAA-HWRF*

2. RAINFALL

NASA-Global Precipitation Measurement (GPM)

The accumulation rainfall obtained using the satellite product of NASA-GPM (Global Precipitation Measurement[4]) are shown below. More than 600 mm of rainfall affected several areas of Mozambique during the passage of TC IDAI.

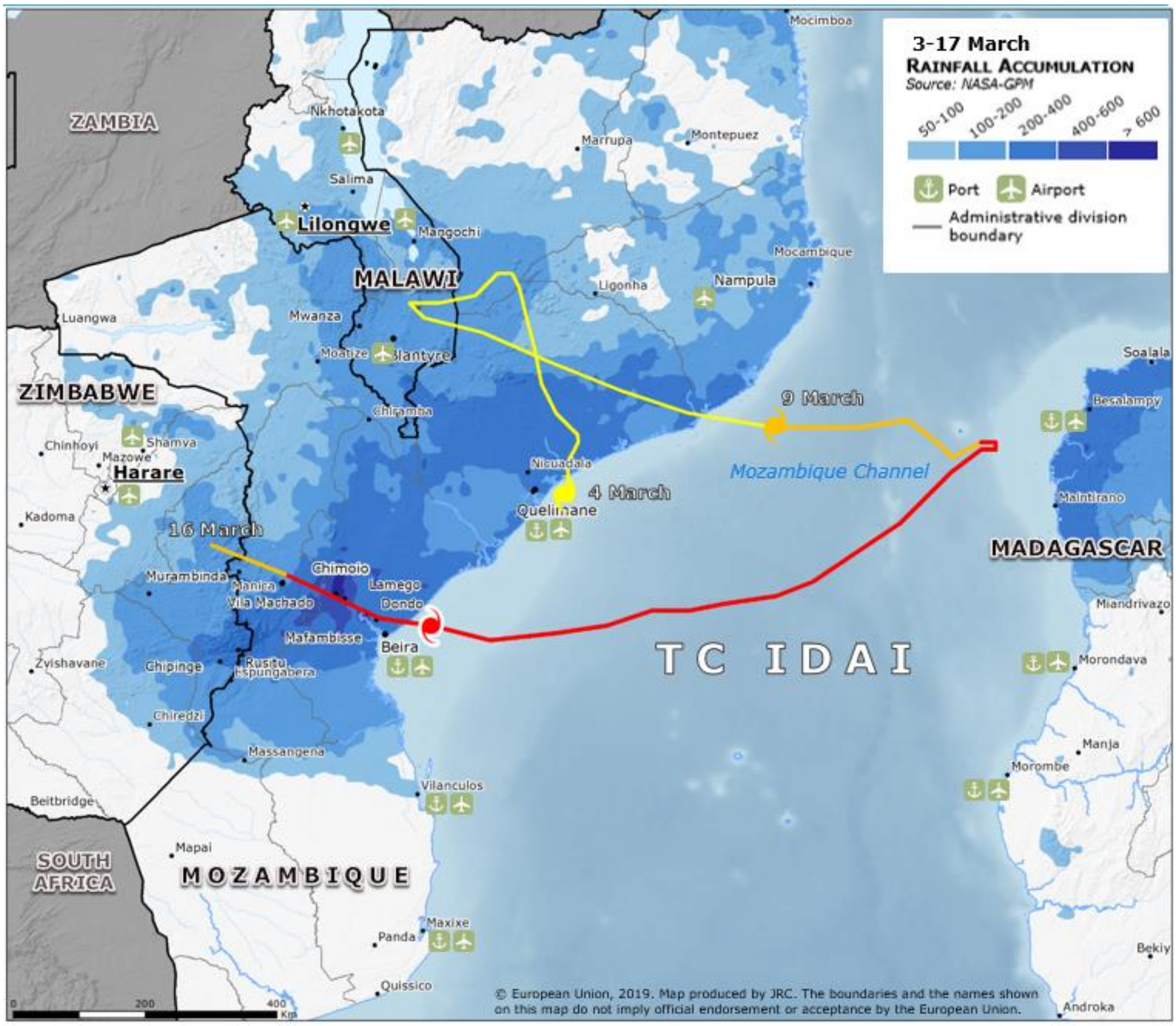

Figure 6 – *Rainfall accumulation rainfall 3-17 March 2018 (data source: NASA-GPM)*

[4] NASA-GPM (Global Precipitation Measurement): https://www.nasa.gov/mission_pages/GPM/main/index.html

3. STORM SURGE

JRC Storm Surge Calculations

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:

http://www.gdacs.org/Cyclones/report_source.aspx?eventtype=TC&eventid=1000552&system=HWRF

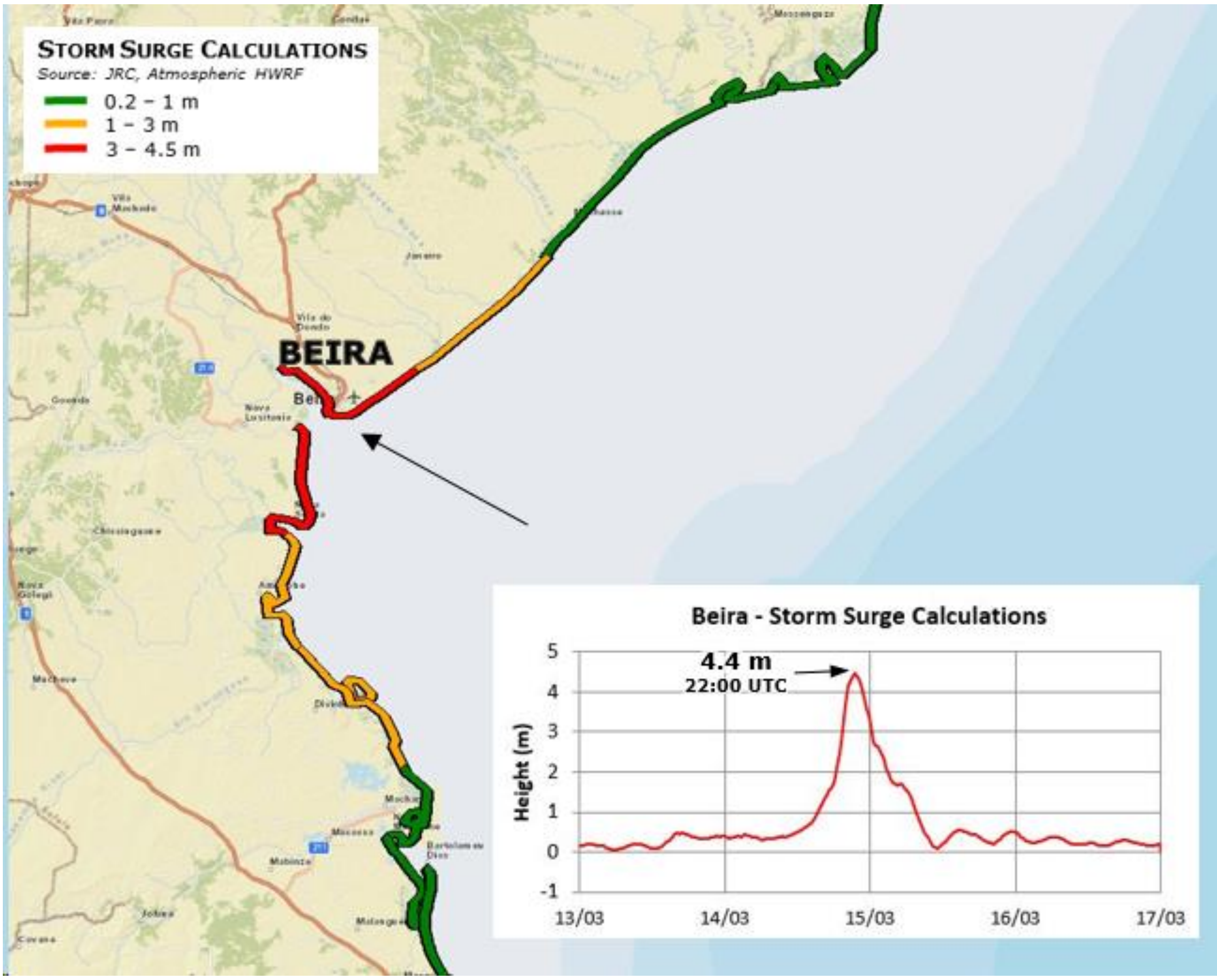

Figure 7 – *JRC Storm surge calculations due to Tropical Cyclone IDAI and max. storm surge estimated near Beira*

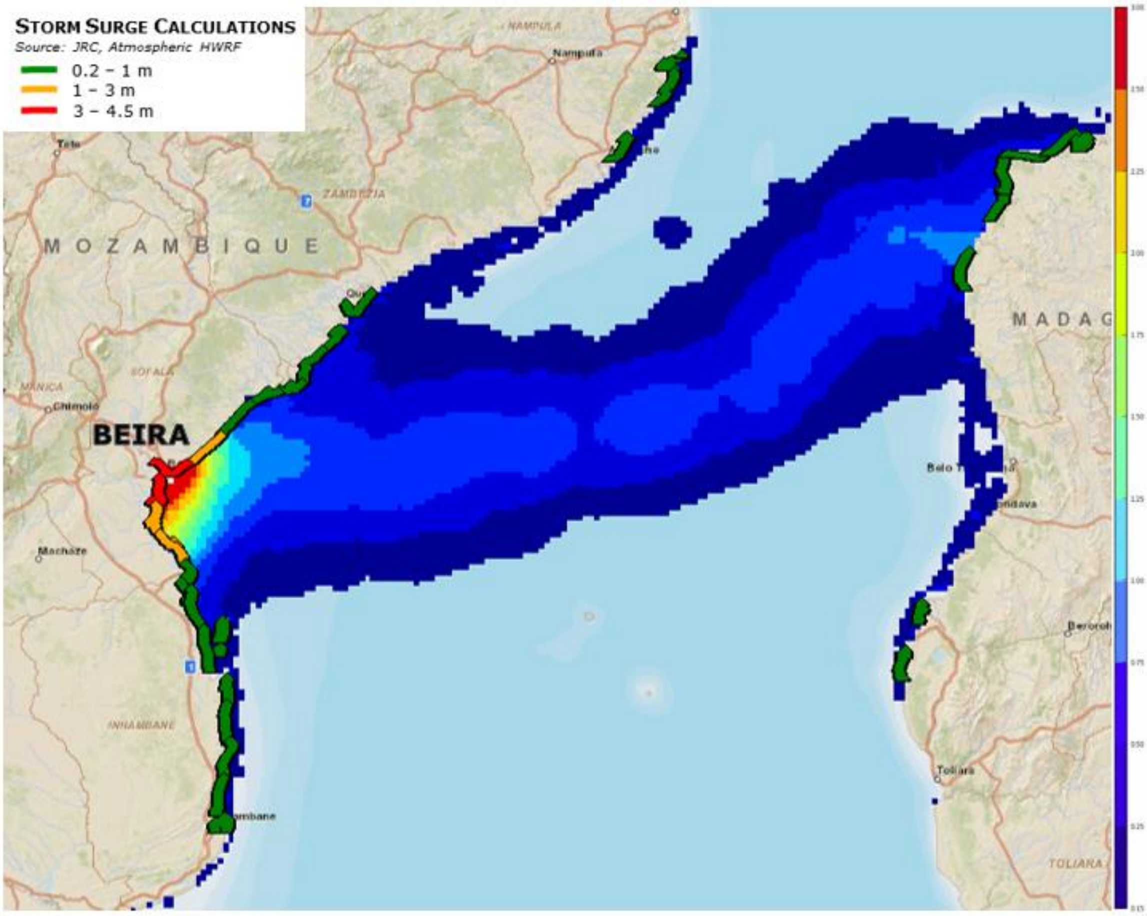

Figure 8 - *JRC Storm surge calculations due to Tropical Cyclone IDAI*

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: infact the torrential rains that may have affected the areas during the passage of a Tropical Cyclone IDAI may have increase 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.