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ARTICLE

Numerical Modelling of Waves and Surge from Cyclone Mekunu (May 2018) in the Arabian Sea

M. A. Sarker*

Technical Director, Royal HaskoningDHV, Rightwell House, Bretton, Peterborough PE3 8DW, United Kingdom

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ABSTRACT

Cyclone Mekunu developed in the Arabian Sea on 22 May 2018 and made landfall near the Port of Salalah (Oman) on 25 May. Wide spread damages to properties and coastal facilities and human casualties were reported in Yemen and Oman. Less information on numerical modelling of waves and surge is publicly available on this cyclone. Therefore, numerical modelling of Cyclone Mekunu was carried out in the present study to derive waves and storm surge. The MIKE21 Spectral Wave Model and the Flow Model were used in coupled mode to simulate the waves and surge from the cyclone. Model results of waves and surge are presented in this paper for illustration purposes. The methodology of the present study can be used to simulate any cyclone around the world.

1. Introduction

Cyclone Mekunu developed in the Arabian Sea on 22 May 2018 and hit the Omani coastline near the Port of Salalah. The cyclone made landfall near Raysut (Oman) on May 25 2018. Less information on numerical modelling of waves and surge is publicly available on this new cyclone. Therefore, this paper has concentrated on this event to illustrate the use of numerical modelling to simulate waves and surge generated by cyclones.

The latest version of the MIKE21 Flow Model [1] and the Spectral Wave model [2] developed by DHI were used which enabled the application of the latest technical advancement. Generally, a spectral wave transformation model is run first to derive radiation stress to input into a tidal model. In the present study, the wave and tidal modelling were carried out simultaneously in a coupled mode where the tidal model obtained the necessary radiation stress directly from the spectral wave model and thereby improved the accuracy of the model prediction. The use of powerful computers allowed the adoption of fine model mesh (grid) to improve accuracy in simulation results. Besides the model results at selected key locations, two-dimensional plots of model results are provided in the paper to allow researchers and practitioners to extract model results anywhere within the

**Corresponding Author:*
M. A. Sarker,
Technical Director, Royal HaskoningDHV, Rightwell House, Bretton, Peterborough PE3 8DW, United Kingdom;
Email: zaman.sarker@rhdhv.com

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wider region. Cyclones can result in negative surges (reduction in water depth) which can affect the operation of coastal facilities and ports. Therefore, maximum negative surges are also provided along with a two-dimensional plot showing values over a wider region.

Model results presented in this paper are provided for illustration purposes and should not be used for practical projects for which use of local survey bathymetry data and detailed local calibration of the model using measured data are essential. However, the methodology can be used to simulate any cyclone around the world.

2. Major Cyclones in the Arabian Sea

Literature search was carried out to identify major cyclones to have crossed the Arabian Sea since 1945 and affected the Omani coastline. A list of the selected cyclones is provided in Table 1. Tracks and pressure fields of the selected cyclones were obtained from the Joint Typhoon Warning Center (JTWC), USA [3]. Data of these selected cyclones are listed in Table 1 [3].

Table 1. Major Cyclones in the Arabian Sea during 1945-2018 [3]

Serial	Year	Codes & Names	Time & Date		Max 1-minute sustained wind speeds, Vmax (knots)	Minimum central pressure, MSLP (mb)	Radius of max winds, MRD (nm)
			Start	End			
1	1959	1	18-05-19 18:00	24-05-19 00:00	Unknown	Unknown	Unknown
2	1962	1	27-05-19 18:00	30-05-19 00:00	Unknown	Unknown	Unknown
3	1963	2	17-05-19 18:00	26-05-19 12:00	Unknown	Unknown	Unknown
4	1966	13	31-10-19 18:00	11-11-19 12:00	Unknown	Unknown	Unknown
5	1970	1	28-05-19 06:00	02-06-19 12:00	Unknown	Unknown	Unknown
6	1970	11	10-10-19 18:00	13-10-19 00:00	Unknown	Unknown	Unknown
7	1971	19	14-12-19 06:00	21-12-19 00:00	Unknown	Unknown	Unknown
8	1972	2	25-06-19 06:00	27-06-19 00:00	Unknown	966*	Unknown
9	1972	3	01-07-19 06:00	02-07-19 00:00	Unknown	966*	Unknown
10	1976	6	27-08-19 00:00	09-09-19 00:00	Unknown	991*	Unknown
11	1977	TC 02A	09-06-19 00:00	13-06-19 00:00	60	Unknown	Unknown
12	1977	TC 04B	27-10-19 00:00	04-11-19 12:00	40	Unknown	Unknown
13	1978	TC 03A	03-11-19 00:00	13-11-19 00:00	80	Unknown	Unknown
14	1979	TC 02A	16-06-19 00:00	20-06-19 00:00	50	Unknown	Unknown
15	1979	TC 04A	16-09-19 00:00	25-09-19 00:00	55	Unknown	Unknown
16	1983	TC 01A	09-08-19 00:00	10-08-19 12:00	45	Unknown	Unknown
17	1987	TC 03A	04-06-19 06:00	12-06-19 00:00	50	Unknown	Unknown
18	1992	TC 06A	29-09-19 00:00	04-10-19 12:00	55	Unknown	Unknown
19	1994	TC 03A	05-06-19 12:00	09-06-19 18:00	45	Unknown	Unknown
20	1995	TC 02A	11-10-19 00:00	18-10-19 12:00	50	Unknown	Unknown
21	1996	TC 02A	09-06-19 00:00	12-06-19 12:00	40	Unknown	Unknown
22	1998	TC 08A	11-12-19 18:00	17-12-19 18:00	65	Unknown	Unknown
23	2001	TC 02A	24-09-19 00:00	28-09-19 12:00	35	997	30, 55
24	2007	TC 02A (Gonu)	31-05-19 06:00	08-06-19 00:00	145	898	10
25	2010	TC 03A (Phet)	30-05-19 12:00	07-06-19 06:00	125	929	15
26	2011	TC 03A	01-11-19 00:00	05-11-19 06:00	55	982	30
27	2011	TC 04A	07-11-19 12:00	11-11-19 12:00	35	996	25, 35, 40
28	2011	TC 05A	25-11-19 12:00	01-12-19 06:00	35	996	40
29	2014	TC 04A (Nilofar)	25-Oct-14	01-Nov-14	115	937	10
30	2015	TC 01A (Ashobaa)	07-Jun-15	12-Jun-15	55	982	30
31	2018	TC 02A Mekunu	21-May-18	27-May-18	100	943	19

3. Cyclone Mekunu (2018) Data

3.1 Formation of Cyclone Mekunu

As reported in [4], the system started as low pressure in the south-western region of the Arabian Sea on 20 May 2018 as an area of deep convection. Figure 1 [4] shows the best track chart of Mekunu from 21 May 11:00 UTC to May 27 02:00 UTC and Figure 2 [4] shows the wind and pressure histories in that track. Initially, Mekunu moved westward for almost 24 hours while it was a tropical depression. It veered then northwards on 22 May 06:00 UTC after it was classified as deep depression and continued in this direction until it has dissipated inland over Dhofar Governorate. On 22 May 12:00 UTC, the Oman Directorate General of Meteorology (DGMET) classified the system as a tropical storm and got the name Mekunu from the WMO Regional Specialised Meteorological Centre-Tropical Cyclones, India (RSMC) later that day. Twenty-four hours later, Mekunu was classified as a Category-1 tropical cyclone by DGMET. The system intensified further in the following three days up to tropical cyclone of Category-2 with maximum 10-minutes sustained wind speed of 85 to 90 knots on 25 May 2018 08:00 UTC; a few hours before making landfall as Cateogry-1 at around 20:00 UTC on 25 May; 25 km southwest of the Salalah city. Mekunu rapidly weakened by land interaction and continental dry air mass intrusion. The system gradually dissipated over the empty desert on 27-28 May. The movement average speed

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was 11.5 km/h since it was classified as a tropical storm to its landfall. The above information was obtained from [4].

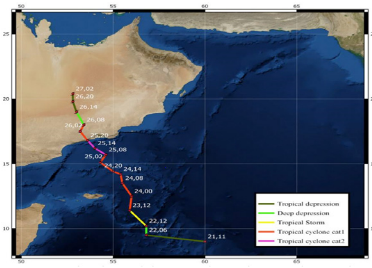

Figure 1. Track and intensity of Cyclone Mekunu (2018) [4]

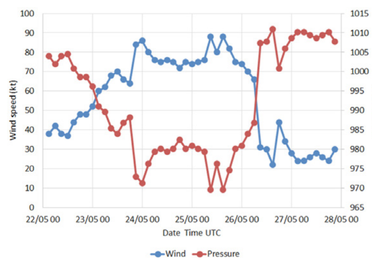

Figure 2. Maximum wind (blue) and lowest pressure (red) along the path of Cyclone Mekunu [4]

3.2 Damages from Cyclone Mekunu

Wide spread damages to properties and coastal facilities and human casualties were reported in Yemen and Oman. Cyclone Mekunu killed at least 20 people throughout the Socotra Island. The cyclone killed four people and injured twenty others across the Yemeni mainland. Seven people were killed in Oman with an estimated damage of US$1.5 billion. The above information was obtained from [5].

3.3 Track and Data of Cyclone Mekunu

The track (route) of Cyclone Mekunu was obtained from [4] and is shown in Figure 1. The cyclone data was obtained from JTWC [3] which contains 6 hourly information including date and time, tracks (path), maximum sustained wind speeds, radius of maximum sustained wind speeds and the minimum central pressures. The Cyclone Mekunu data is provided in Table 2.

3.4 Wind and Pressure Fields Generation

Table 2. Track and Data of Cyclone Mekunu (2018) [3]

Date & Time	Duration (hour)	Longitude (°E)	Latitude (°N)	Radius (km) of maximum winds	Maximum wind speeds (m/s) [1-hour mean]	Central pressure (hPa)
22-05-18 00:00	0	57.5	9.1	83.3	14.5	999
22-05-18 06:00	6	57.2	9.6	83.3	14.5	1000
22-05-18 12:00	12	56.8	10.2	92.6	16.6	993
22-05-18 18:00	18	56.4	10.6	92.6	20.7	985
23-05-18 00:00	24	56.1	10.9	92.6	22.8	989
23-05-18 06:00	30	56.2	11.4	83.3	24.9	986
23-05-18 12:00	36	56.1	11.9	46.3	26.9	974
23-05-18 18:00	42	55.8	12.5	46.3	31.1	976
24-05-18 00:00	48	55.7	13.0	46.3	33.2	963
24-05-18 06:00	54	55.6	13.7	46.3	33.2	971
24-05-18 12:00	60	55.4	14.3	46.3	33.2	963
24-05-18 18:00	66	54.9	14.9	46.3	33.2	963
25-05-18 00:00	72	54.7	15.2	46.3	35.2	964
25-05-18 06:00	78	54.6	15.7	37.0	37.3	960
25-05-18 12:00	84	54.4	16.3	22.2	41.5	948
25-05-18 18:00	90	53.9	16.7	9.3	41.5	953
26-05-18 00:00	96	53.5	17.2	9.3	35.2	963
26-05-18 06:00	102	53.3	17.9	9.3	29.0	970
26-05-18 12:00	108	53.1	18.6	9.3	22.8	982
26-05-18 18:00	114	52.7	18.9	9.3	18.7	989
27-05-18 00:00	120	52.3	19.0	9.3	14.5	996
27-05-18 06:00	126	52.0	19.0	9.3	12.4	1000

The MIKE21 Cyclone Wind Generation Tool developed by DHI [6] was used to generate the cyclonic wind and pressure fields. The tool allows users to select one of the four equations for this purpose. The Young and Sobey equation (1981) was used in the study as all the six input parameters required by this equation were available for the study. Thus, the uncertainties in calculating some of the parameters (through empirical relationships) required by the other equations were

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avoided. These wind and pressure fields were used to drive the wave and surge model described later.

4. Surge Modelling of Cyclone Mekunu

In addition to larger waves cyclones also generate storm surges which are abnormal rises (or falls) of sea level near the coast. Storm surges can result in major inundation of low lying coastal areas.

4.1 The Model

The two-dimensional Regional Tidal Hydrodynamic Model for the Northern Arabian Sea set up by Royal HaskoningDHV using the MIKE21 Flow Model FM software of DHI was used in the study. The higher order numerical scheme was used to improve accuracy in model prediction. The model domain is shown in Figure 3. The model bathymetry was obtained from C-Map Database [7] for which Royal HaskoningDHV has a license.

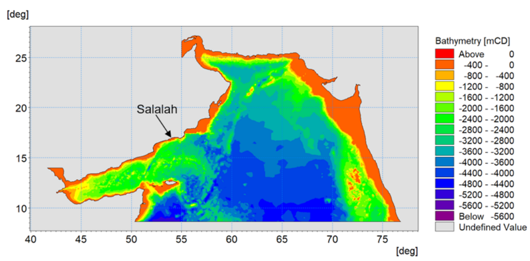

Figure 3. Model extent and bathymetry

4.2 Methodology

The MIKE21 Flow Model FM was coupled with the MIKE21 Spectral Wave (SW) model where the tidal model obtained the necessary radiation stress directly from the wave model and, thereby, improved the accuracy of model prediction. The use of powerful computers allowed the adoption of fine model mesh (grid) to improve accuracy in simulation results.

The cyclone surge model was driven by the cyclonic wind and pressure fields described earlier. A constant water level of +2.5mCD was imposed at the open boundaries. An initial water level of +2.5mCD was maintained over the entire model domain. This +2.5mCD was subtracted from the modelled surface elevation to obtain surge.

4.3 Model Validation

The MIKE21 Flow Model was calibrated by its developer DHI. The model is widely used by researchers and practitioners worldwide for simulating cyclone surge. Royal HaskoningDHV has also used the model successfully for simulating cyclone surge for countries bordering the Arabian Sea and the Bay of Bengal. Royal HaskoningDHV has also published various journal papers such as [8] to [15] where the MIKE21 Flow Model was used to simulate cyclone surge. Guidelines and recommendations provided by DHI were applied in the study along with the experience of Royal HaskoningDHV on cyclone surge modelling particularly those within the Arabian Sea region.

Time-series plots of the measured and modelled surge from Cyclone Mekunu at Port of Salalah were reported by [16] as shown in Figure 4. The source of the modelled surge in Figure 4 is the JRC Calculations (GDACS - Global Disaster Alert and Coordination System, https://www.gdacs.org/report.aspx?eventtype=TC&eventid=1000453). The source of the measured surge in Figure 4 is the Directorate General Meteorology and Air Navigation (Oman) included in the JRC Sea Level Database available at https://webcritech.jrc.ec.europa.eu/SeaLevelsDb/Tools/Chart/?deviceId=989. Maximum modelled storm surge of 0.5-0.8 m at distances approximately 50 km either side of the cyclone landfall site was reported by [16]. According to [16], storm surges were less than 0.5 m beyond this boundary. The measured and modelled maximum storm surges at selected locations at either side of the cyclone landfall site are provided in Table 3 from [16]. These locations are shown in Figure 5 [16]. Figures 4 and 5 were extracted from the Emergency Response Coordination Centre (ERCC) – Directorate General for European Civil Protection and Humanitarian Aid Operation (DG ECHO) Daily Map | 28/05/2018 (https://erccportal.jrc.ec.europa.eu/getdailymap/docId/2514) produced by the Joint Research Centre (JRC) upon the ERCC request. Figure 5 [16] also shows the location where the cyclone made landfall.

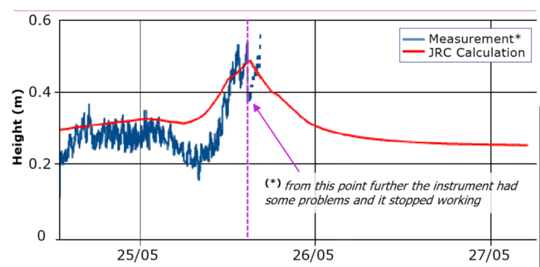

Figure 4. Measured and JRC modelled surge during Cyclone Mekunu at Salalah Port [16]

Figure 5. Locations at both sides of Cyclone Mekunu landfall site [16]

The wave and tidal models were run simultaneously (in coupled mode). Therefore, the Port of Salalah was not included in the model to avoid complexities in wave simulations related to wave reflection from and diffraction around structures. A series of model runs were carried out in the present study by changing model parameters (such as bed resistance in terms of Manning's number) and the model results were compared to the measured surge. Model results were extracted at the northern end of Port of Salalah (approximate latitude 16.95°N) to compare with the measured surge. The maximum measured and modelled surges are provided in Table 3.

Table 3. Maximum storm surges during Cyclone Mekunu

No.	Locations	Measured maximum surge (m) [16]	Modelled maximum surge (m) by JRC [16]	Modelled maximum positive surge from the present study (m)			
				Manning's n = 1/32	Manning's n = 1/44	Manning's n = 1/60	Manning's n = 1/100
1	Al Ghaydah	-	<0.5	-	-	-	0.19
2	Dhalkut	-	<0.5	-	-	-	0.21
3	Port of Salalah	0.54	0.49	0.48	0.49	0.50	0.52
4	Taqah	-	<0.5	-	-	-	0.28
5	Mirbat	-	<0.5	-	-	-	0.31
6	Sadah	-	<0.5	-	-	-	0.24

Table 3 shows that the measured maximum surge of 0.54m at Port of Salalah is slightly higher than those found by JRC [16]. The measured maximum surge is also slightly higher than those found in the present study. Most probably the measurement location was inside the port and hence there was funneling effect which raised water level there. Nevertheless, the modelled maximum surge from the present study is close to the measured maximum surge. Therefore, further adjustment of model parameters was considered unnecessary in the present study.

The modelled maximum surge of 0.52m found in the present study (with Manning's n = 1/100) at the northern end of Port of Salalah is close to the measured maximum surge of 0.54m. The modelled surge of 0.52m found in the present study at the northern end of Port of Salalah is also close to the modelled surge of 0.49m found by JRC [16]. Modelled surge found in the present study at other locations are less than 0.5m as also found by JRC [16]. As mentioned earlier, the tidal and the wave models were run concurrently (in de-coupled mode) in the present study. The maximum significant wave heights from the four runs tested in the study were very similar (as described later). Therefore, it was concluded that the present model (Run 4 with Manning's n = 1/100) was reasonably capable to re-produce the tidal hydrodynamic process of Cyclone Mekunu.

4.4 Model Results and Discussions

Statistical analyses of model results were carried out using the MIKE21 Tool to derive mean and maximum surge values over the Arabian Sea during Cyclone Mekunu. Modelled maximum positive surge (rise in sea surface) from the present study is shown in Figure 6 (zoomed-in view). Higher positive surge was found along the cyclone track as expected with its maximum value at the location of landfall. Maximum positive surge at selected locations at either side of the landfall location are provided in Table 4. The maximum positive surge of 0.82m was found at the location of landfall. Positive surge intensified at bays (Port of Salalah and Mirbat) due to funneling effect. As expected, the values of the maximum positive surge gradually reduced at places away from the landfall site.

Figure 7 shows the temporal variation of surge on the track at a location where the surge was maximum. The maximum hindcast surge of approximately 0.82m was found at a location of 16.877°N, 53.776°E on 25 May 2018 at 20:00. Surge higher than 0.5m were sustained for a duration of about 2.5 hours and surge higher than 0.25m were sustained for a duration of about 6.0 hours.

Modelled maximum negative surge (fall in sea surface) from the present study is provided in Table 4 and is also shown in Figure 8 (zoomed-in view). Higher fall in sea surface (up to 0.15m) was found at places away from the landfall site. This is because of the fact that the cyclone raised the sea surface near the landfall site which in turn pulled the water from the neighbouring places to maintain the equilibrium. Fall in sea surface at landfall site was relatively small (about 0.06m).

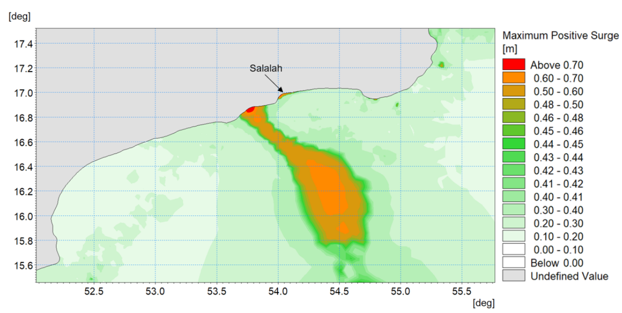

Figure 6. Maximum modelled positive surge during the entire duration of Cyclone Mekunu

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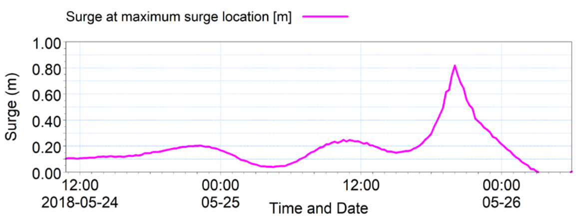

Figure 7. Time-series of modelled surge on the track at 16.877°N, 53.776°E where surge was maximum

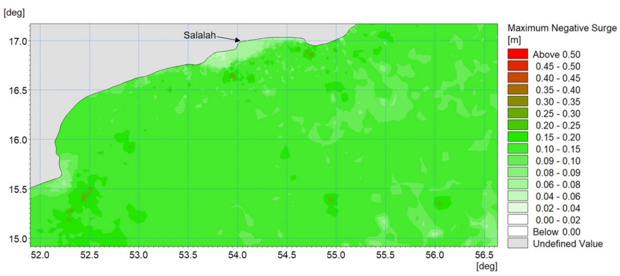

Figure 8. Maximum modelled negative surge during the entire duration of Cyclone Mekunu

Table 4. Maximum storm surges during Cyclone Mekunu from the present study

No.	Locations	Maximum positive surge (m)	Maximum negative surge (m)
1	Al Ghaydah	0.19	0.15
2	Dhalkut	0.21	0.09
3	At maximum surge location	0.82	0.06
4	Port of Salalah	0.52	0.08
5	Taqah	0.28	0.08
6	Mirbat	0.31	0.14
7	Sadah	0.24	0.13

5. Wave Modelling of Cyclone Mekunu

5.1 The Model

The two-dimensional Regional Wave Transformation Model for the Northern Arabian Sea set up by Royal HaskoningDHV using the MIKE21 Spectral Wave Model software of DHI was used in the study.

5.2 Methodology

The cyclone wave model was driven by the cyclonic wind and pressure fields described earlier. A constant water level of +2.5mCD (i.e. 2.0mCD astronomical tide plus 0.5m estimated surge) was used in the model. As described earlier the spectral wave model was coupled with the tidal model to maintain automatic exchange of information from each other.

5.3 Model Validation

The MIKE21 Spectral Wave Model was calibrated by its developer DHI. The model is widely used by researchers and practitioners worldwide for simulating cyclone waves. Royal HaskoningDHV has also used the model successfully for simulating cyclone waves for countries bordering the Arabian Sea and the Bay of Bengal. Royal HaskoningDHV has also published various journal papers such as [8] to [15] where the MIKE21 Spectral Wave Model was used to simulate cyclone waves. Guidelines and recommendations provided by DHI were applied in the present study along with experience of Royal HaskoningDHV on cyclone wave modelling particularly those within the Arabian Sea region.

The maximum modelled significant wave heights found from the four runs in the present study are provided in Table 5.

Table 5. Maximum significant wave heights (Hm0) from various model runs in the present study

Manning's n	Modelled maximum significant wave heights, Hm0 (m)
1/32	11.1
1/44	11.3
1/60	11.1
1/100 (Run 4)	11.2

Table 5 shows that the maximum modelled significant wave heights from various runs carried out in the present study were very similar. It was mentioned earlier that Run 4 (with Manning's n = 1/100) produced a surge which is very close to the measured surge and, therefore, this run was considered as the best run among the four runs carried out in the study. Both the tidal model and the wave model were run concurrently in a de-coupled mode where the two models exchanged information as needed automatically during the simulation. Hence, wave modelling results from Run 4 were also accepted to present in this paper.

Coastal wave height of up to 30 feet (9.2m) was expected during Cyclone Mekunu [17]. Wave height of up to 7.3m (24 feet) were pushing toward the coast of southern Oman during Cyclone Mekunu [18]. It should be noted that such information provided by News Agencies provides only an indication of possible wave heights during the event which cannot be used for comparing with the model results. Nevertheless, the maximum significant wave height of 11.2m found in the present study (see Table 5, Run 4) supports the estimates of the News Agencies. This 11.2m wave height was found off the landfall site at a relatively deep water which will be reduced while travelling further inshore due to various shallow water effects such as bottom friction, shoaling and wave breaking. Thus, the hindcast wave heights found in the present study reasonably agree with those reported by the News Agencies.

5.4 Model Results and Discussions

Figure 9 shows the temporal variation of significant wave height (H_{m0}) on the track at a location where the wave height was maximum. The model results indicate that the maximum hindcast significant wave height (H_{m0}) of approximately 11.2m (with associated peak wave period of 12.0s) was found at a location of 16.459°N, 54.576°E on 25 May 2018 at 11:30 AM. The two-dimensional distribution of wave height contours superimposed by wave directional vectors is shown in Figure 10 for this time-step. The figure indicates that the maximum wave heights were generated in front of the landfall site albeit slightly offshore. This is due to the fact that waves lose energy while travelling in shallow waters due to various shallow water effects such as bottom friction, shoaling and breaking. The temporal variation in the significant wave height and peak wave period is shown in Figure 9. Figure 9 indicates that the significant wave heights higher than 10m were sustained for a duration of approximately 4.25 hours and wave heights higher than 8m were sustained for a duration of approximately 9.5 hours.

Further statistical analyses of model results were carried out using the MIKE21 Tool [6] to derive mean and maximum wave conditions over the Arabian Sea during of Cyclone Mekunu. Figure 11 shows the maximum significant wave heights during the entire duration of Cyclone Mekunu. The maximum significant wave heights at selected locations were extracted from Figure 11 and are provided in Table 6. It should be noted that the wave heights in Table 6 were extracted at relatively deeper waters to avoid uncertainties in shallow water bathymetry. The modelling results indicate that it was a major event that generated waves up to 11.2m at the height of the storm. The storm took a westerly track and travelled towards south of Port of Salalah resulting in high waves there. The westerly passage of the cyclone meant that the impact on other places along the Omani coastline was limited with conditions less severe than during Cyclones Gonu (2007) and Cyclone Phet (2010) [8-15].

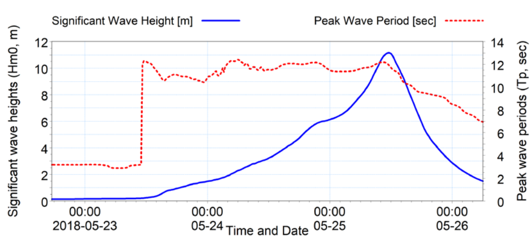

Figure 9. Time-series of modelled significant wave height (H_{m0}) and peak wave period (T_p) on the track at 16.459°N, 54.576°E where wave height was maximum

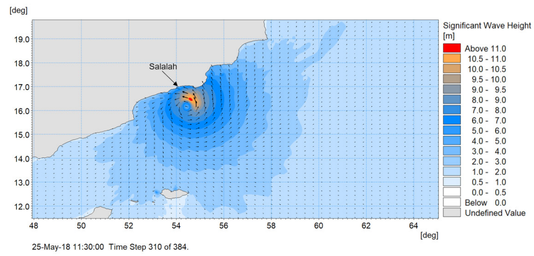

Figure 10. Modelled significant wave heights (H_{m0}) and directions on 25 May 2018 at 11:30 when the significant wave height was maximum

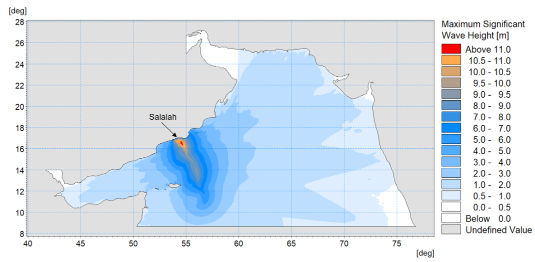

Figure 11. Maximum modelled significant wave heights (H_{m0}) during the entire duration of Cyclone Mekunu

The model results indicate that the impact of the cyclone was greatest along the coast approximately 100km north and south of the landfall site and that the zone of major impact extended over a distance of approximately 250km north and south of the landfall location.

Table 6. Maximum significant wave heights (H_{m0}) at areas close to the landfall site

No.	Locations	Maximum significant wave heights (Hm0, m)
1	Al Ghaydah	2.5
2	Dhalkut	3.5
3	At maximum wave height location	11.2
4	Port of Salalah	5.5
5	Taqah	5.4
6	Mirbat	5.8
7	Sadah	7.6

6. Summary of Findings

Numerical modelling results of waves and surge from Cyclone Mekunu (May 2018) have been reported in this paper. The methodology used in the study can also be used to simulate any cyclone around the world.

The maximum hindcast surge of approximately 0.82m was found at a location close to the landfall site. Surge higher than 0.5m were sustained for a duration of about 2.5 hours and surge higher than 0.25m were sustained for a

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duration of about 6 hours. The maximum significant wave height of approximately 11.2m (with associated peak wave period of 12.0s) was generated off the landfall location. Significant wave heights higher than 10m were sustained for a duration of about 4.25 hours and wave heights higher than 8m were sustained for a duration of about 9.5 hours.

The model results indicate that the impact of the cyclone was greatest along the coast approximately 100km north and south of the landfall site and that the zone of major impact extended over a distance of approximately 250km north and south of the landfall location. The impact of Cyclone Mekunu on the remote places along the Omani coastline was limited with conditions less severe than during Cyclones Gonu (2007) and Cyclone Phet (2010).

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