IMPACT-BASED FORECASTING

DOST-PAGASA

Hazard Situation Simulation

WMO PTC/GCC Workshop on Impact-based Forecast and Warning Services,
Muscat, Sultanate of Oman | 05 – 09 November 2023

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Short recap

Relationship between Exposure and Vulnerability

Exposure

Definition of exposure;

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. **(UNISDR Definition)**

or another way of describing it;

Exposure is the total value of elements at-risk. It is expressed as the number of human lives, and value of the properties, that can potentially be affected by hazards. Exposure is a function of the geographic location of the elements. **(WMO Definition)**

Vulnerability

Definition of vulnerability;

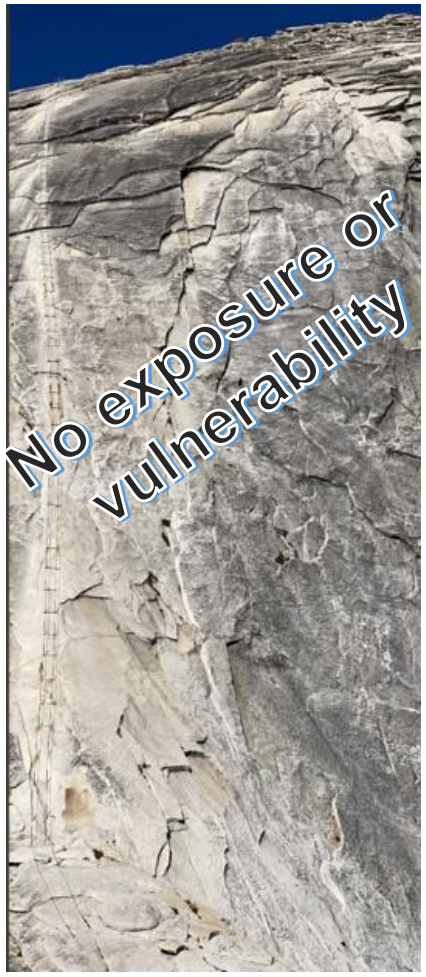
The characteristics and circumstances of a community, system or asset, that make it susceptible to the damaging effects of a hazard. **(UNISDR Definition)**

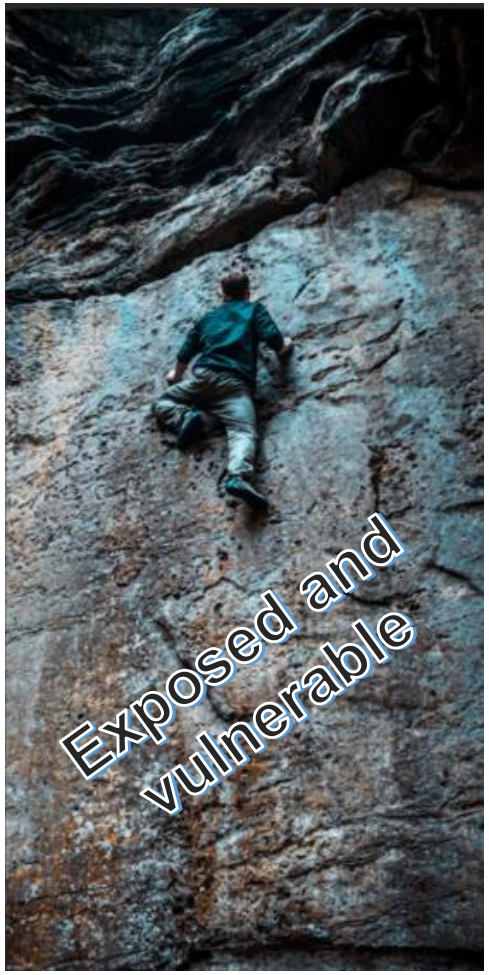
or another way of considering it;

Physical, social, economic, and environmental factors which increase the susceptibility to be impacted by hazards. Vulnerability engages resistance and resilience. **(WMO definition)**

More on Exposure and Vulnerability

Example: Rock climbing





To be vulnerable, you have to be exposed. The act of climbing on sheer rock will always cause exposure, due to the location and activity.

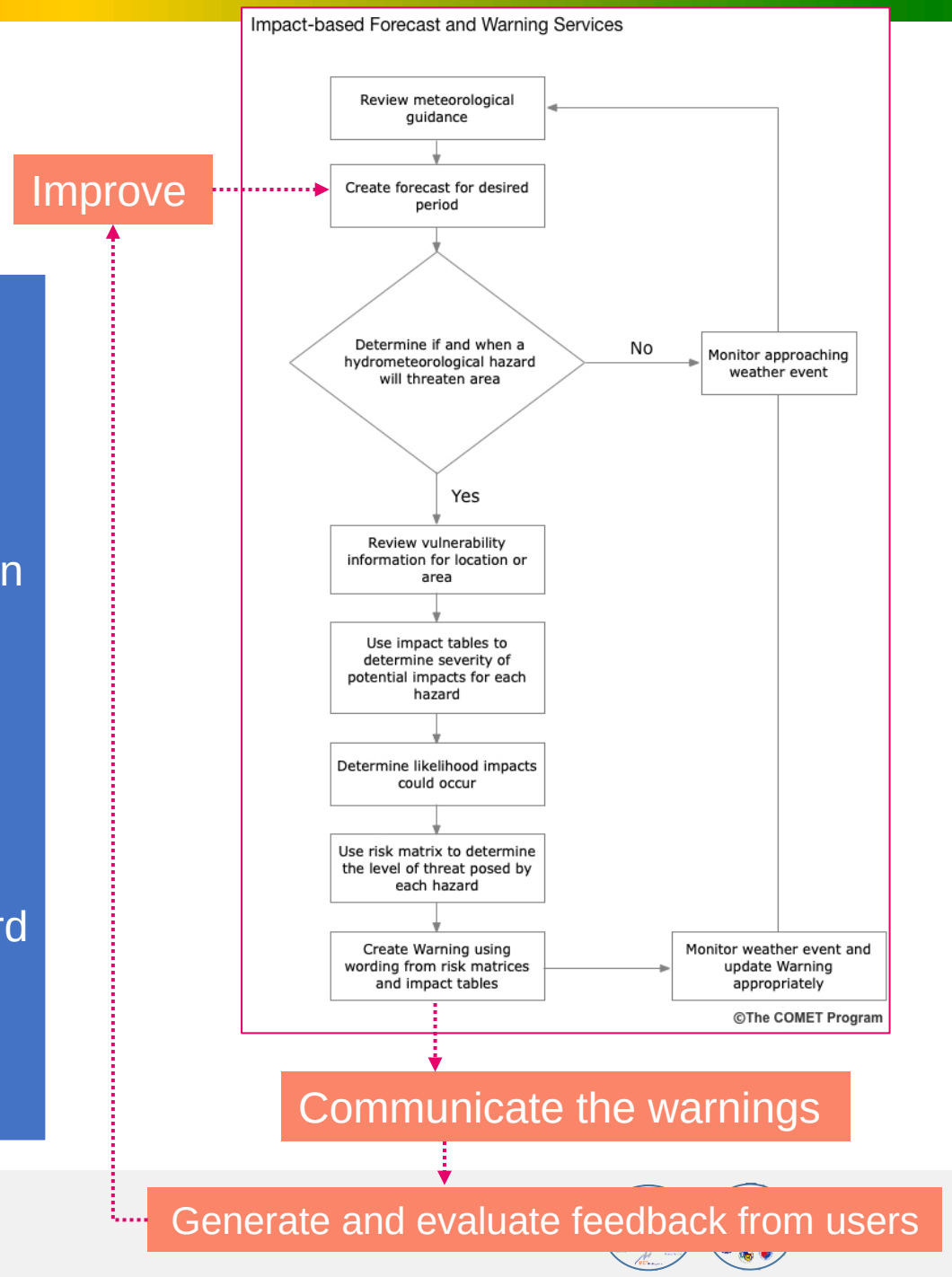
Aim

- To simulate the IBFWS process by going through each step of the procedure

Recap

The impact-based approach consists of nine steps:

1. Review meteorological and hydrological guidance
2. Create forecast for desired period
3. Determine if and when hydrometeorological hazards will threaten an area
4. Review vulnerability information for location or area
5. Use impact tables to determine severity of potential impacts for each hazard
6. Determine likelihood impacts could occur
7. Use risk matrix to determine level of threat posed by each hazard
8. Create Alert Warning using wording from risk matrices and impact tables
9. Monitor weather event and update Alert Warning appropriately



IMPACT-BASED FORECASTING

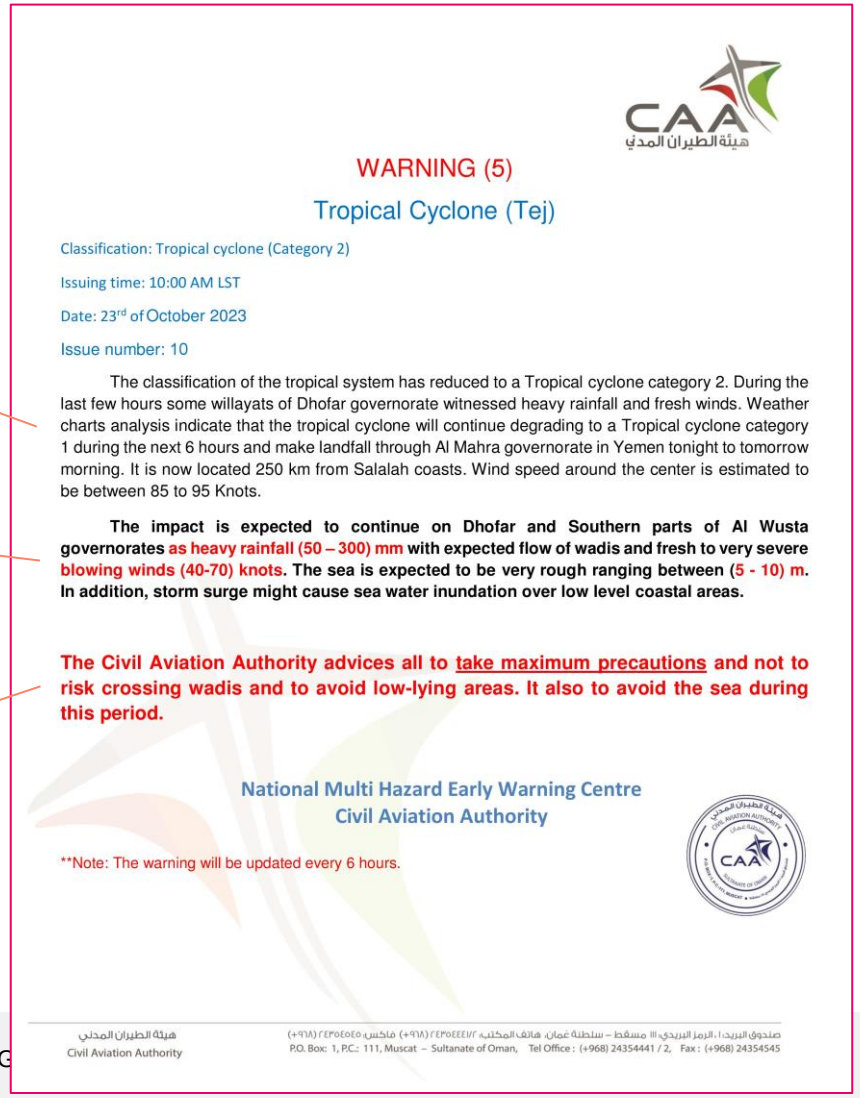
DOST-PAGASA

Simulation Exercise

Feedback on the existing warning

October 23, 2023

- Meteorological conditions
- Areas affected/ Expected impacts
- Recommended Actions



CAA
هيئة الطيران المدني

WARNING (5)

Tropical Cyclone (Tej)

Classification: Tropical cyclone (Category 2)

Issuing time: 10:00 AM LST

Date: 23rd of October 2023

Issue number: 10

The classification of the tropical system has reduced to a Tropical cyclone category 2. During the last few hours some willayats of Dhofar governorate witnessed heavy rainfall and fresh winds. Weather charts analysis indicate that the tropical cyclone will continue degrading to a Tropical cyclone category 1 during the next 6 hours and make landfall through Al Mahra governorate in Yemen tonight to tomorrow morning. It is now located 250 km from Salalah coasts. Wind speed around the center is estimated to be between 85 to 95 Knots.

The impact is expected to continue on Dhofar and Southern parts of Al Wusta governorates as heavy rainfall (50 – 300) mm with expected flow of wadis and fresh to very severe blowing winds (40-70) knots. The sea is expected to be very rough ranging between (5 - 10) m. In addition, storm surge might cause sea water inundation over low level coastal areas.

The Civil Aviation Authority advices all to take maximum precautions and not to risk crossing wadis and to avoid low-lying areas. It also to avoid the sea during this period.

National Multi Hazard Early Warning Centre
Civil Aviation Authority

**Note: The warning will be updated every 6 hours.

هيئة الطيران المدني
Civil Aviation Authority

صندوق البريد: ١، الرمز البريدي: ١١١ مسقط – سلطنة عمان، هاتف المكتب: ٢/٢٤٥٤٤٤١ (+٩٦٨) فاكس: ٢/٢٤٥٤٥٥ (+٩٦٨)
P.O. Box: 1, P.C.: 111, Muscat – Sultanate of Oman, Tel Office : (+968) 24354441 / 2, Fax : (+968) 24354545

CAA
هيئة الطيران المدني

تحذير رقم (5)

الحالة المدارية (تيج)

التصنيـــــف : إعصار مداري من الدرجة الثانية
وقت الاصدار : العاشرة صباحاً
تاريخ الاصدار : 8 ربيع الأخر 1445هـ
الموافـــــق : 23 أكتوبر 2023 م
رقم الإصـــدار : 10

تراجع تصنيف الحالة المدارية إلى إعصار مداري من الدرجة الثانية، حيث شهدت بعض ولايات محافظة ظفار أمطار متفاوتة الغزارة وهبوب رياح نشطة خلال الساعات الماضية، وتشير خرائط الطقس إلى استمرار تراجع الحالة المدارية إلى إعصار من الدرجة الأولى خلال 6 ساعات القادمة وعبور مركز الحالة المدارية عبر محافظة المهرة بالجمهورية اليمنية خلال هذه الليلة وصباح الغد، ويبعد المركز حالياً عن ولاية صلالة حوالي 250 كم، وتقدر سرعة الرياح حول المركز من 85 إلى 95 عقدة.

ومن المتوقع أن يستمر التأثير على محافظة ظفار والأجزاء الجنوبية لمحافظة الوسطى خلال الساعات القادمة بهطول أمطار غزيرة إلى شديدة الغزارة من (50 -300) ملم تؤدي إلى جريان جارف للأودية والشعاب وهبوب رياح نشطة إلى شديدة السرعة (40 – 70) عقدة. ويكون البحر هائج الموج على سواحل بحر العرب ويتراوح ما بين (5 -10) متر مع احتمال امتداد مياه البحر على المناطق الساحلية المنخفضة والخيران.

وتهيب هيئة الطيران المدني بالجميع ضرورة أخذ أقصى درجات الحيطة والحذر وعدم المجازفة بعبور الأودية والابتعاد عن الأماكن المنخفضة، كما تهيب بعدم ارتياد البحر خلال هذه الفترة.

والله أعلم
المركز الوطني للإنذار المبكر من المخاطر المتعددة
هيئة الطيران المدني

**ملاحظة: سيتم تحديث التحذير خلال 6 ساعات القادمة.

هيئة الطيران المدني
Civil Aviation Authority

صندوق البريد: ١، الرمز البريدي: ١١١ مسقط – سلطنة عمان، هاتف المكتب: ٢/٢٤٥٤٤٤١ (+٩٦٨) فاكس: ٢/٢٤٥٤٥٥ (+٩٦٨)
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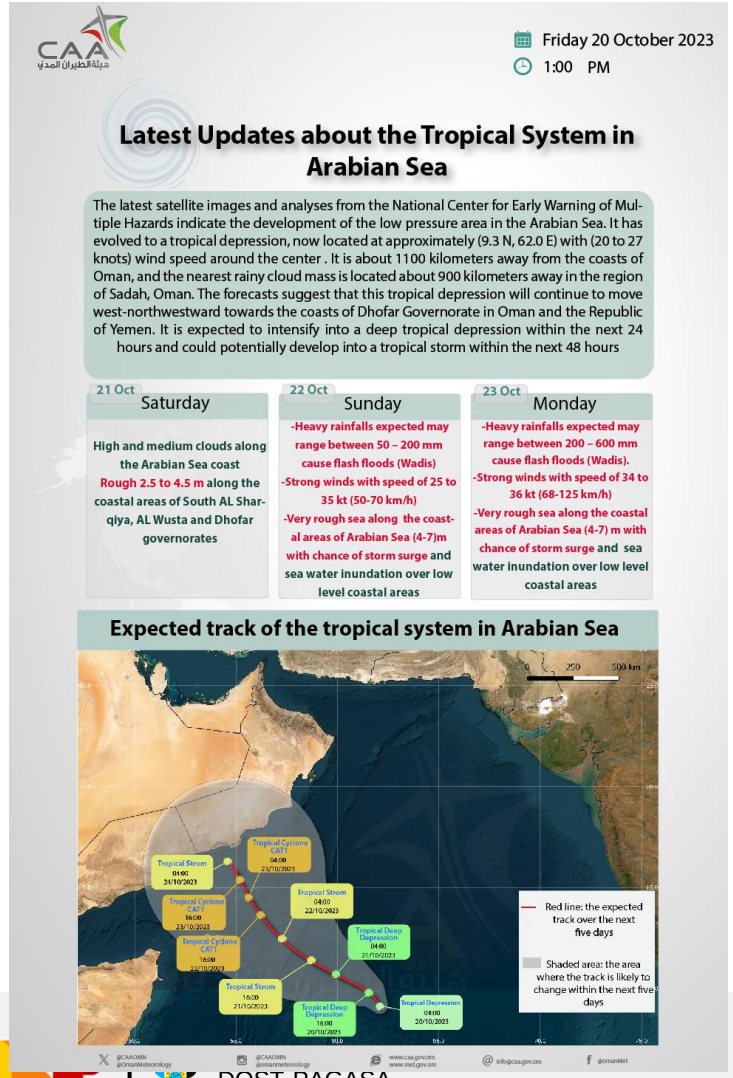
Updates issued



Friday 20 October 2023
1:00 PM

Latest Updates about the Tropical System in Arabian Sea

The latest satellite images and analyses from the National Center for Early Warning of Multiple Hazards indicate the development of the low pressure area in the Arabian Sea. It has evolved to a tropical depression, now located at approximately (9.3 N, 62.0 E) with (20 to 27 knots) wind speed around the center . It is about 1100 kilometers away from the coasts of Oman, and the nearest rainy cloud mass is located about 900 kilometers away in the region of Sadah, Oman. The forecasts suggest that this tropical depression will continue to move west-northwestward towards the coasts of Dhofar Governorate in Oman and the Republic of Yemen. It is expected to intensify into a deep tropical depression within the next 24 hours and could potentially develop into a tropical storm within the next 48 hours

21 Oct	22 Oct	23 Oct
Saturday	Sunday	Monday
High and medium clouds along the Arabian Sea coast Rough 2.5 to 4.5 m along the coastal areas of South AL Sharqiya, AL Wusta and Dhofar governorates	-Heavy rainfalls expected may range between 50 – 200 mm cause flash floods (Wadis) -Strong winds with speed of 25 to 35 kt (50-70 km/h) -Very rough sea along the coastal areas of Arabian Sea (4-7)m with chance of storm surge and sea water inundation over low level coastal areas	-Heavy rainfalls expected may range between 200 – 600 mm cause flash floods (Wadis). -Strong winds with speed of 34 to 36 kt (68-125 km/h) -Very rough sea along the coastal areas of Arabian Sea (4-7) m with chance of storm surge and sea water inundation over low level coastal areas

Expected track of the tropical system in Arabian Sea

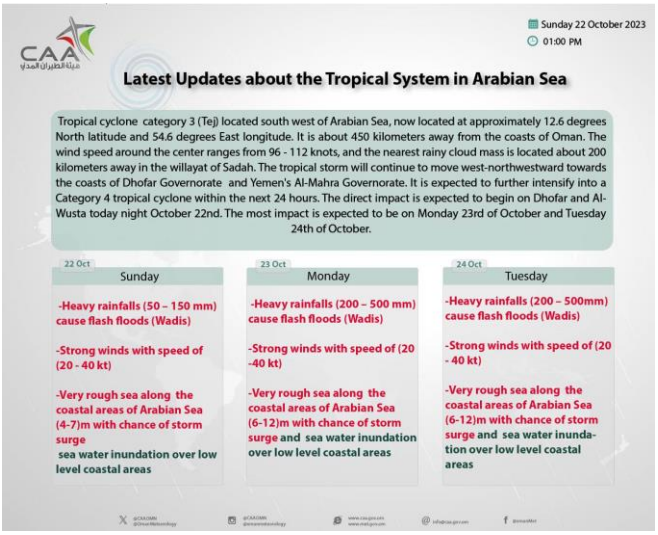
الجمعة ٢٠ أكتوبر ٢٠٢٣م
01:00 ظهرًا

ملخص توقعات الحالة المدارية في بحر العرب

توضح آخر صور الأقمار الإصطناعية وتحاليل المركز الوطني للإنذار المبكر من المخاطر المتعددة إلى تطور الحالة المدارية من منطقة ضغط جوي منخفض إلى منخفض مداري يتمركز في جنوب وسط بحر العرب على دائرة عرض ٩.٣ شمالاً وخط طول ٦٢.٠ شرقاً، ويبعد عن سواحل سلطنة عمان (ولاية سدح) حوالي ١١٠٠ كم، وتقدر سرعة الرياح حول المركز (٢٠ - ٢٧ عقدة) ومن المتوقع تطوره إلى منخفض مداري عميق خلال ٢٤ ساعة القادمة وفرص تطوره إلى عاصفة مدارية خلال ٤٨ ساعة القادمة ومن المتوقع أن يبدأ التاثير المباشر على محافظتي ظفار والوسطى ظهر يوم الأحد ٢٢ أكتوبر واحتمال عبور مركز الحالة بين منتصف ليل الأثنين وصباح الثلاثاء بين محافظة ظفار واليمن (محافظة المهرة)

٢١ أكتوبر	٢٢ أكتوبر	٢٣أكتوبر
السبت	الأحد	الأثنين
تدفق بعض السحب المتوسطة والعالية هائج الموج (٤.٥-٤.٥) أمتار على سواحل سلطنة عمان المطلة على بحر العرب	تدفق السحب وهطول أمطار متفاوتة الغزارة (٥٠-٢٠٠) ملم تؤدي لجريان الشعاب والأودية رياح نشطة (٢٥-٣٥) عقدة هائج الموج (٤-٧) أمتار على سواحل بحر العرب واحتمال إمتداد مياه البحر إلى المناطق الساحلية المنخفضة والخيران	هطول أمطار شديدة الغزارة (٢٠٠-٦٠٠) ملم تؤدي لجريان جارف للأودية رياح نشطة (٣٤-٦٣) عقدة تؤدي لتطاير المواد الغير ثابتة هائج الموج (٦-٧) أمتار على سواحل بحر العرب واحتمال إمتداد مياه البحر إلى المناطق الساحلية المنخفضة والخيران

المسار المتوقع للحالة المدارية في بحر العرب



Sunday 22 October 2023
01:00 PM

Latest Updates about the Tropical System in Arabian Sea

Tropical cyclone category 3 (Tej) located south west of Arabian Sea, now located at approximately 12.6 degrees North latitude and 54.6 degrees East longitude. It is about 450 kilometers away from the coasts of Oman. The wind speed around the center ranges from 96 - 112 knots, and the nearest rainy cloud mass is located about 200 kilometers away in the willayat of Sadah. The tropical storm will continue to move west-northwestward towards the coasts of Dhofar Governorate and Yemen's Al-Mahra Governorate. It is expected to further intensify into a Category 4 tropical cyclone within the next 24 hours. The direct impact is expected to begin on Dhofar and Al-Wusta today night October 22nd. The most impact is expected to be on Monday 23rd of October and Tuesday 24th of October.

22 Oct	23 Oct	24 Oct
Sunday	Monday	Tuesday
-Heavy rainfalls (50 – 150 mm) cause flash floods (Wadis) -Strong winds with speed of (20 - 40 kt) -Very rough sea along the coastal areas of Arabian Sea (4-7)m with chance of storm surge sea water inundation over low level coastal areas	-Heavy rainfalls (200 – 500 mm) cause flash floods (Wadis) -Strong winds with speed of (20 -40 kt) -Very rough sea along the coastal areas of Arabian Sea (6-12)m with chance of storm surge and sea water inundation over low level coastal areas	-Heavy rainfalls (200 – 500mm) cause flash floods (Wadis) -Strong winds with speed of (20 - 40 kt) -Very rough sea along the coastal areas of Arabian Sea (6-12)m with chance of storm surge and sea water inundation over low level coastal areas

الأحد ٢٢ أكتوبر ٢٠٢٣م
01:00 مساءً

ملخص توقعات الحالة المدارية في بحر العرب

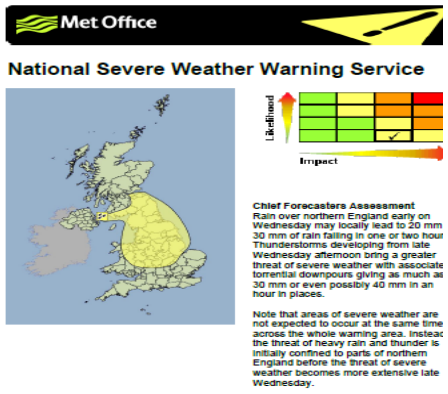
الإعصار المداري (تيج) من الدرجة الثالثة يتمركز جنوب غرب بحر العرب على دائرة عرض ١٢.٦ شمالاً وخط طول ٥٤.٦ شرقاً، ويبعد مركز الإعصار المداري عن سواحل سلطنة عمان حوالي ٤٥٠ كم، وتقدر سرعة الرياح حول المركز بحوالي (٩٦-١١٢) عقدة وتبعد أقرب كتلة سحب ماطرة مصاحبة حوالي ٢٠٠ كم (ولاية سدح)، مع استمرار تحركها غرب شمال غرب نحو سواحل محافظة ظفار والجمهورية اليمنية الشقيقة (محافظة المهرة) مع فرص تطورها إلى إعصار مداري من الدرجة الرابعة خلال ٢٤ ساعة القادمة . ومن المتوقع أن يبدأ التاثير المباشر على محافظتي ظفار والوسطى ليل اليوم الأحد ٢٢ أكتوبر وستكون ذروة الحالة المدارية يومي الإثنين والثلاثاء

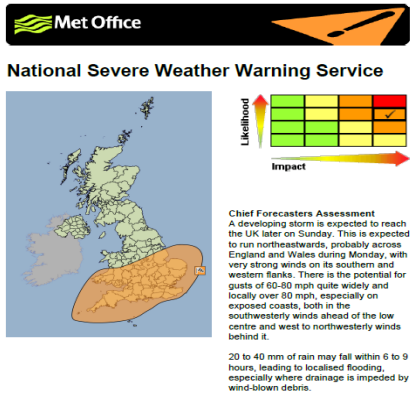
٢٢ أكتوبر	٢٣ أكتوبر	٢٤أكتوبر
الأحد	الأثنين	الثلاثاء
تدفق السحب وهطول أمطار متفاوتة الغزارة (٥٠-١٥٠) ملم تؤدي لجريان الشعاب والأودية رياح نشطة (٣٠-٤٠) عقدة تؤدي لتطاير المواد الغير ثابتة ارتفاع موج البحر (٤-٧) أمتار على سواحل بحر العرب واحتمال إمتداد مياه البحر إلى المناطق الساحلية المنخفضة والخيران	تدفق السحب وهطول أمطار غزيرة إلى شديدة الغزارة (٢٠٠-٥٠٠) ملم تؤدي لجريان الشعاب والأودية رياح نشطة (٤٠-٧٠) عقدة تؤدي لتطاير المواد الغير ثابتة ارتفاع موج البحر (٦-١٢) أمتار على سواحل بحر العرب واحتمال إمتداد مياه البحر إلى المناطق الساحلية المنخفضة	تدفق السحب وهطول أمطار غزيرة إلى شديدة الغزارة (٢٠٠-٥٠٠) ملم تؤدي لجريان الشعاب والأودية رياح نشطة (٤٠-٧٠) عقدة تؤدي لتطاير المواد الغير ثابتة ارتفاع موج البحر (٦-١٢) أمتار على سواحل بحر العرب واحتمال إمتداد مياه البحر إلى المناطق الساحلية المنخفضة

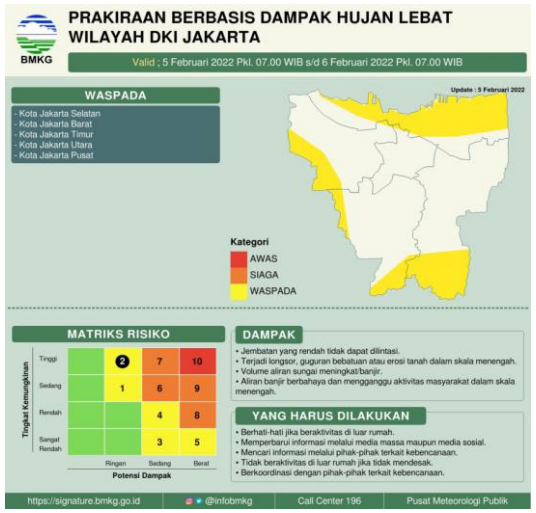
How can the warnings be improved?

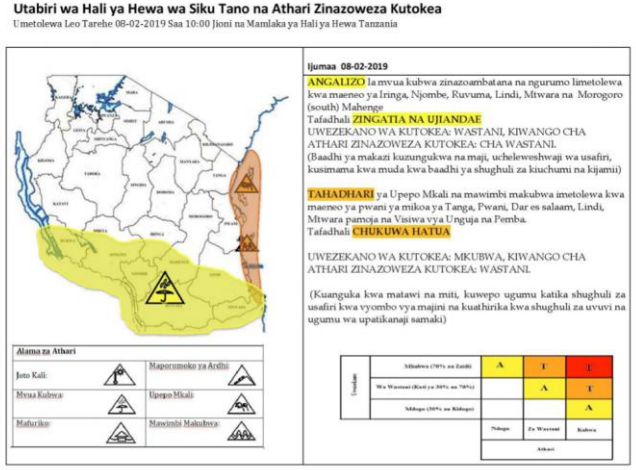
- What did you like about this warning? What are the good points about it?
- What would you like to improve on it? Wording, format, length?
- What platform is most suitable to communicate message?

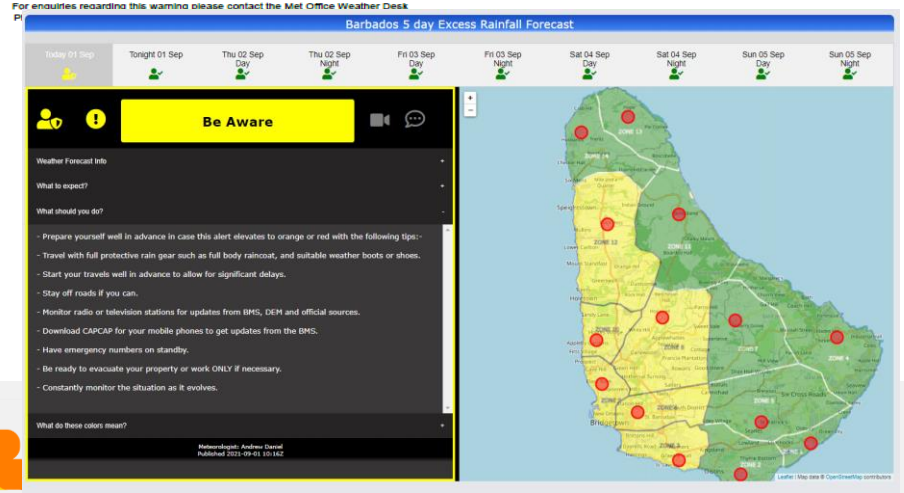
Warning messages and visualization

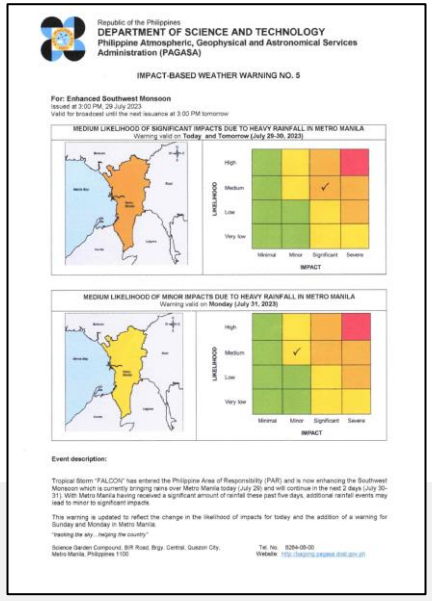


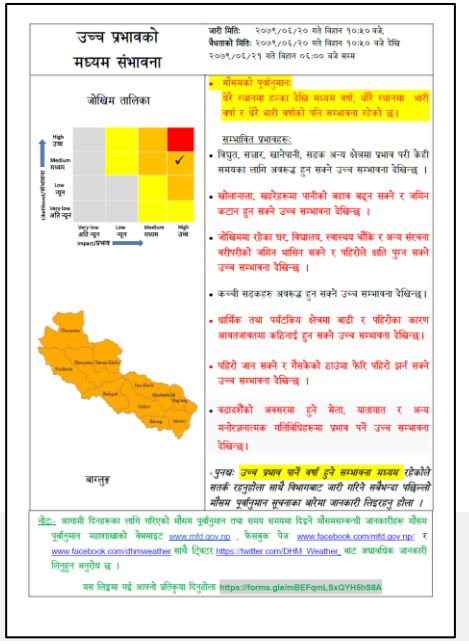












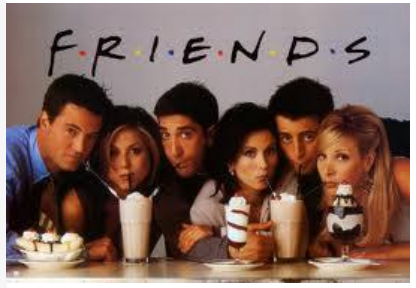
How would you visualize the previous warning into an IBF warning?

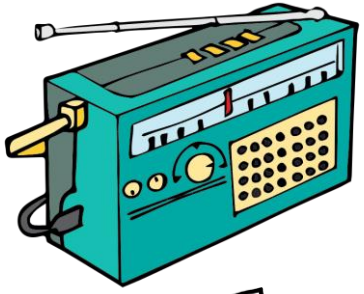
Communicate the Warning

- How will warnings be issued (distribution methods)? You may use different methods for different customers
- Who will receive them (customers)?

(Please list down the methods and the customers who will receive them)

Methods of disseminating warnings





Discussion of Outputs

Evaluate, execute and communicate decisions

- Where to disseminate decisions and call to action?
- Role of media?

(Please list down actions to be taken based on the level of expected impacts)

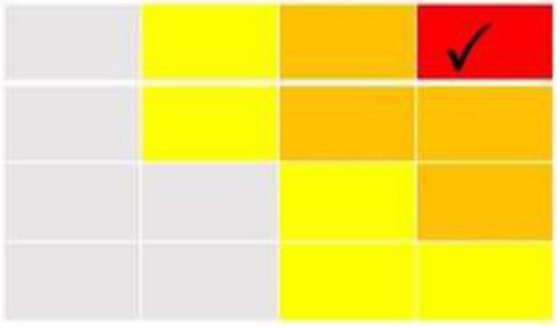
Examples from the Philippines

Medium Likelihood of High (Severe) Impacts **RAIN**

Suggested response:

- Public address to inform residents of possible Pre-emptive or Forced-Evacuation to designated safe area
- Activation of Incident Command System/ Incident Management Team, Emergency Operations Center, Response Clusters and BDRRMOs
- Convene groups that are in-charge with specific sectors to prepare for the impacts
- Preparation of temporary communication (portable and base radios), powerline (Gensets) and water purification system
- Maintenance and review of alternative temporary shelter (ATS)
- Preparation of amphibians / rubber/fiberglass boats with OBM and other rescue vehicles, if available
- Planning of rerouting schemes for vehicles
- Recommendation for some suspension of classes and work in government to LDRRMC
- Continuous coordination with barangays, volunteers and other stakeholders
- Submission of reports to higher authorities

High Likelihood of High (Severe) Impacts **WIND**

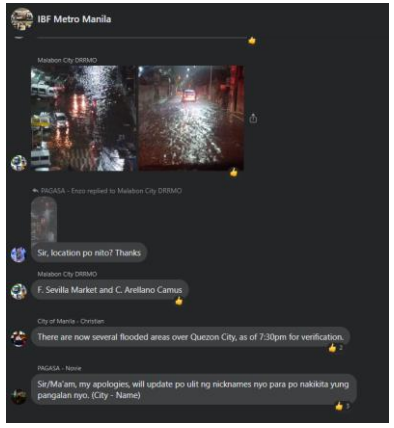


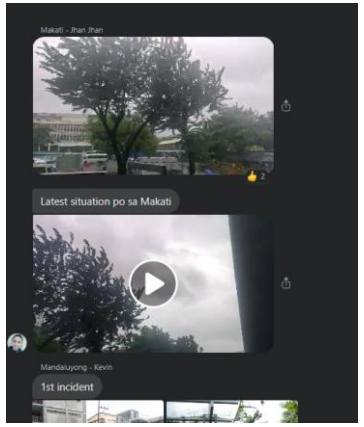
Suggested Response:

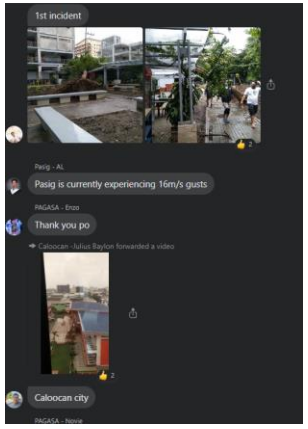
- Keep monitoring for updates.
- Check the latest tropical cyclone wind signals from PAGASA.
- **EDUCATION:** Students, faculties, and staff of schools/universities are strictly advised **NOT TO VENTURE** as the surroundings will be too dangerous.
- **POWER AND COMMS:** Prepare generators and flashlights for possible power interruption. Charges batteries of phones and another comms backup.
- **STRUCTURES:** Stay away from light/old structures that could be destroyed by severe wind. Evacuate if necessary.
- **TRANSPORT AND ENVIRONMENT:** If possible, do not venture outside as the surroundings will be dangerous for life and property.
- **COASTAL:** Stay away from coastal areas. Evacuate to higher grounds.
- **LIFE:** Follow the safety instructions from your local officials and your emergency responders.

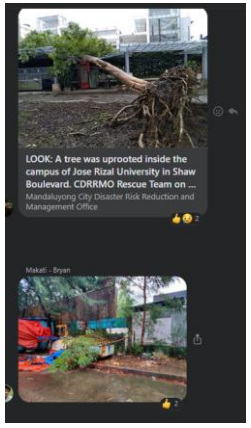
Discussion of Outputs

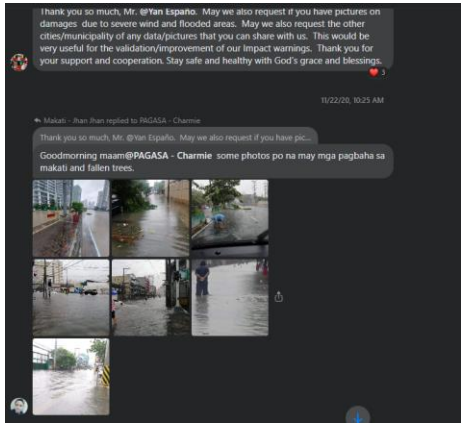
Observation of Hazards
Actual Impacts experienced

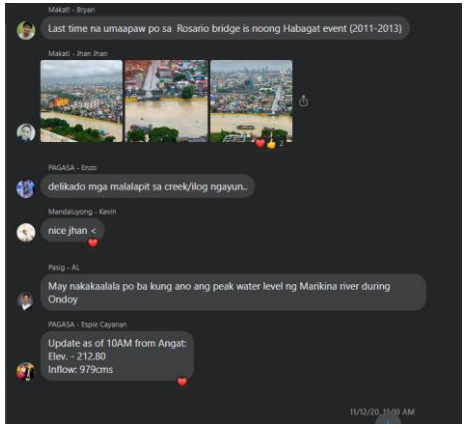


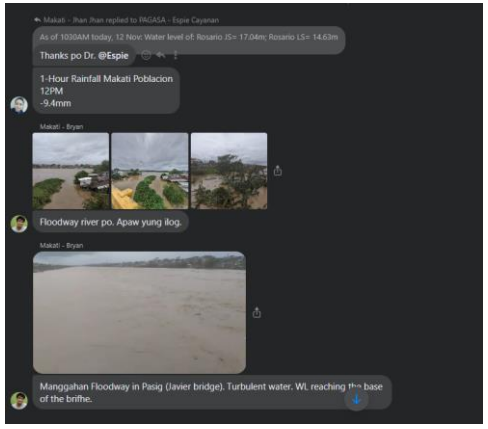


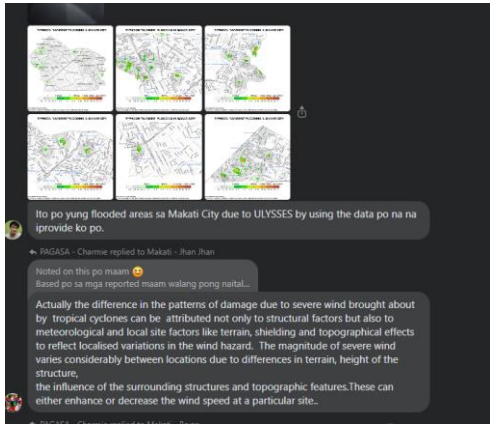












Evaluate actions taken

- Staff of National Center for Emergency Management (NCEM) and stakeholders with Directorate General of Meteorology

Warnings verification:

- Evaluate actions taken – does it match the event that occurred?
- Collect and record impacts data- what to collect?

- How are impacts data being reported?
- Where are impacts data stored?

Impact Data Requirements

Precise Location

- Finest spatial resolution possible
- Scales match to warnings issued

Event date and duration

- Ability to link impacts with driving hazard
- Hazard, Impact, and report dates important

Impact Severity

- Using same classification as warning
- Impacts aggregated
- Accuracy in severity classification > precision of individual impacts

Defining ‘Events’ in Impact Data

Identify Hazard

Hazard type

Hazard subtype

Cascading hazards

Associated/ secondary hazards

Timing of Hazard

Hazard start

Hazard duration

Hazard end

Expected lags between hazard and impacts?

Location of hazard

Where did hazard occur

What is hazard footprint

Differences in timing of hazard by location?

Feedback mechanism

- How would you collect feedback?
- Are there existing mechanisms in place?

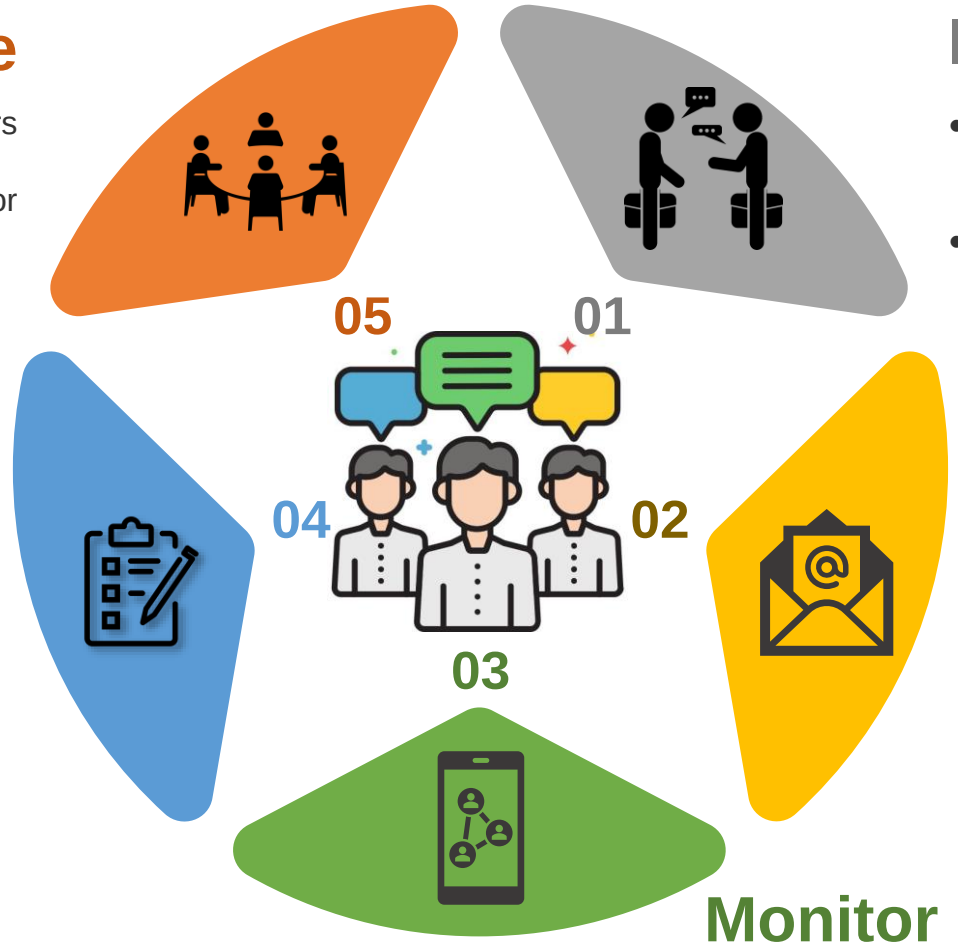
Ways of obtaining feedback…

Face to face

- Conversations with particular customers or groups of customers
- defined intervals where services or products are reviewed
- FGDs

Informally

- always be open to feedback at any time
- can also be really useful - and often very honest



Online surveys or forms

- surveys sent to specific customers
- poll on social media
- only takes people a couple of seconds to engage

Create specific feedback areas/routes

- particular mailbox or email address or online form
- Needs to be monitored

Monitor social media activity

- Immediate feedback

Discussion

Do you have any questions?

Would you have something like these?

What do you like about this approach to warnings?

Do you think this approach would be useful for your country?

What would you need to change?

Thank you very much for your attention!

"tracking the sky…helping the country"

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