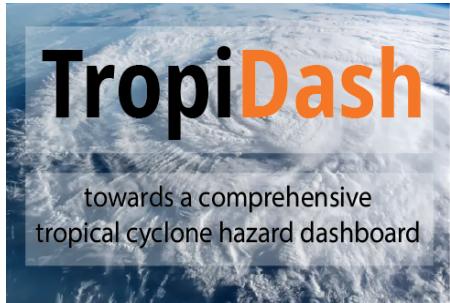


Deliverable 1

Background information acquisition and existing products review



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Introduction

This deliverable is composed of two parts: a context report and a data description report. The *Context report* contains a summary of the current charts and products used for tropical cyclone hazards and the key variables and indicators identified as relevant for tropical cyclones hazard visualization. The *Data description report* contains information about the available data for the project (sources, temporal resolution, spatial resolution, temporal horizon).

With this report we aim to gather together all the information useful for the development of the next step of the project: the platform design. In fact, by analysing the current charts and tools available online we are able to understand the strengths and the limits of the current methods and better implement the structure of TropiDash. The list of key variables and indicators serves the purpose of being a reference about the charts and data we want to include. The data report groups the different possible sources we can access to retrieve the data we need for the realization of plots and charts.

D1.1 - Context report

Current charts and tools available

NASA Tropical Cyclone DashBoard

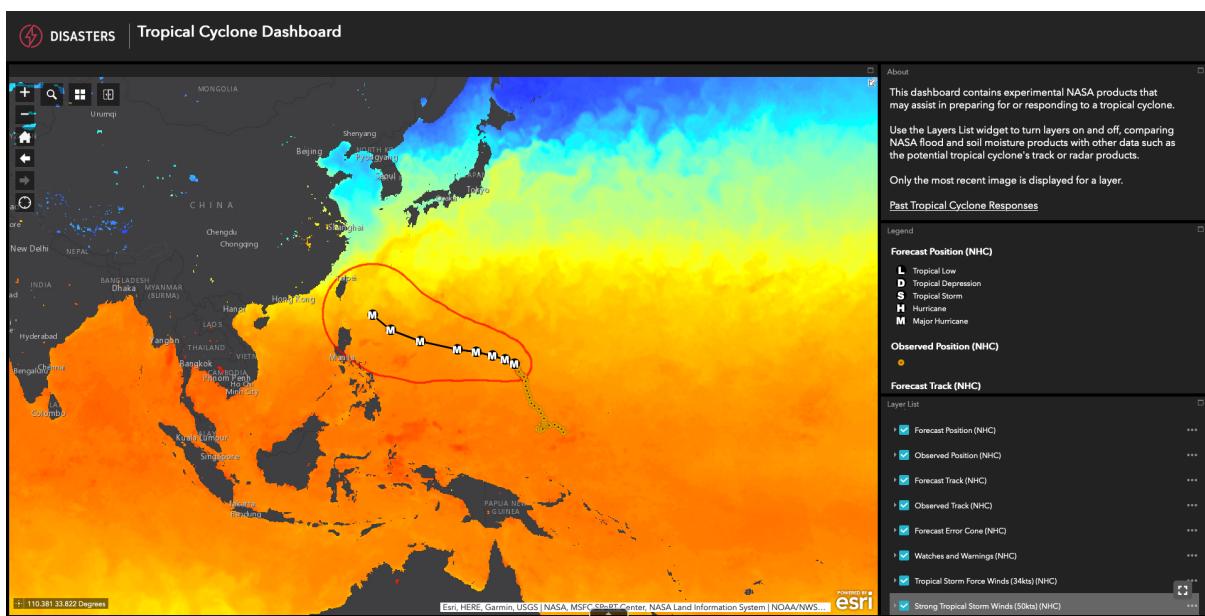
Link

<https://maps.disasters.nasa.gov/arcgis/apps/webappviewer/index.html?id=05318f7ef53e47919ed4fcfe54760a3>

Description

The Tropical Cyclone Dashboard of Nasa is a GIS-based dashboard that contains products and data for assistance in preparing to tropical cyclone hazards. It blends together the cyclone forecast and observations from the National Hurricane Center (NHC), data from the NASA Land Information System (LIS) model and observations from different satellites. The dashboard map covers the globe. More information about the variables contained in the dashboard can be found here

<https://maps.disasters.nasa.gov/arcgis/home/item.html?id=4a016ea21a204db9a5b8faf0983461fe>



Pros

- It contains both relevant real time information and the cyclones forecast
- Has a layer named “Watches and Warning” from the NHC for risk related to cyclones
- In the forecast position they specify the stage of development (Tropical Low / Tropical Depression / Tropical Storm / Hurricane / Major Hurricane)
- Forecast error cone makes it easier to understand the possible development of the cyclone track

Cons

- Not easy to find all the information regarding all the layers
- There too many layers and so a lot of information. This often causes problem in the loading of the platform and the layers and it does not make it easy to understand what is the crucial information
- Also global coverage might slow down the dashboard and global coverage is not needed for tropical cyclones
- All the data are overlaying in just one map, this makes a little bit confusing browsing through different information
- Is not clear why there are some layers/variables since they do not seem useful for a tropical cyclone dashboard
- It's missing a section of general information (spatial resolution, time scale, etc.)
- The forecast is not an ensemble forecast

- There is no possibility to look at the data in the past or in the future and the only forecast you have is about cyclones characteristics

Layers/Variables list

- Forecast position [12hrs temporal resolution]
- Observed position
- Forecast track
- Observed track
- Forecast Error Cone [5 Day Cone]
- Watches and Warnings
- Tropical Storm Force Winds (34kts)
- Strong Tropical Storm Winds (50kts)
- Hurricane Force Winds (64kts+)
- Observed Wind Swath
- Sea Surface Temperature (°C)
- 2 Day Probability Outlook
- 5 Day Probability Outlook
- Radar Base Reflectivity
- Precipitation Accumulation - 30 Minute / 3 Hour / 1 Day
- Flood Detection
- Landslide Nowcast
- Soil Moisture Percentile - (0-10cm) / (0-40cm) / (0-100cm) / (0-200cm)
- Soil Moisture - Top 10cm / Top 2m
- Wind Speed (m/s)
- Black Marble Nighttime Blue/Yellow Composite
- Natural Color Imagery
- True Color Imagery
- GOES Colorized Satellite Imagery
- GOES Infrared Satellite Imagery

ADAM Tropical Cyclone DashBoard

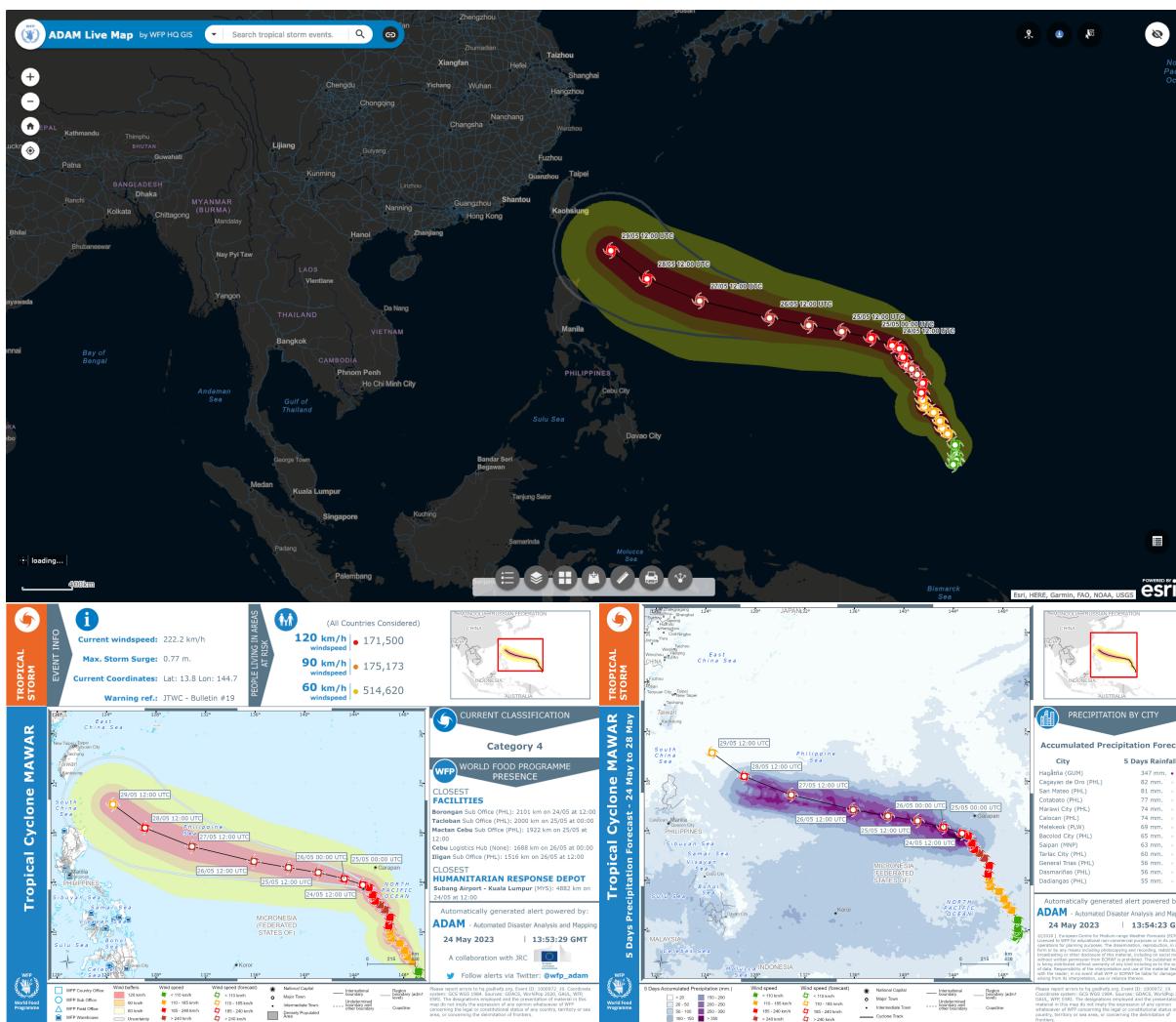
Link

<https://gis.wfp.org/adamlive/>

Description

ADAM is the Word Food Programme (WFP) operational system for humanitarian emergencies. It collects, analyzes and maps geospatial data and socio-economic information. It is operational for floods, earthquakes and tropical cyclones. Its dashboard aggregates relevant, near-real time risk and impact information.

The dashboard is available online with a live GIS map but you can also subscribe to receive Tropical Storms Alerts at this [link](#). When a cyclone is detected the dashboard collects information from different sources, including WFP's databases and the European Commission Joint Research Centre (JRC). The system carries out analysis and provides information about the population likely to be affected, coastal storm surge, wind speeds, and WFP facilities in the area. The result is a standardized dashboard which presents all the information in a simple and digestible format.



Pros

- It allows to download the event layers in various formats containing all or selected features
- If you press on the event inside the GIS platform it opens a pop-up menu with summary information (e.g., maximum wind speed, maximum storm surge, storm status category, alert level, population living in the radius of 60/90/120 km/h winds) and the possibility to download two images, named dashboards, that better visualize wind and rainfall information and a table of population exposure
- The dashboard contains information about population and infrastructure exposure
- Forecast error cone makes it easier to understand the possible development of the cyclone track
- Having a printed image with summary information helps less experienced users to better understand the information
- The storm status and category intensity are immediately clear by zooming on the cyclone track thanks to the different colors utilized for the intensity scale

Cons

- It contains just the essential meteorological information regarding cyclones, probably that is because it has more focus on the impacts

- The data sources are not explicitly specified, especially from which model the cyclone forecast is retrieved
- Despite mentioning storm surges it does not provide more informations regarding it, maybe they are in the flood events which are also analysed by the ADAM System
- No clear plot of the wind speeds radius
- There is no possibility to look at the data in the past or in the future and the only forecast you have is about cyclones characteristics
- It's missing a section of general information (spatial resolution, time scale, etc.)
- The forecast is not an ensemble forecast

Layers/Variables list

- Forecast position [12hrs temporal resolution]
- Observed position
- Forecast track
- Observed track
- Forecast Error Cone [5 Day Cone]
- Population comprehended in the 60 / 90 / 120 km/h wind speeds radius

NOAA Historical Hurricane Tracks

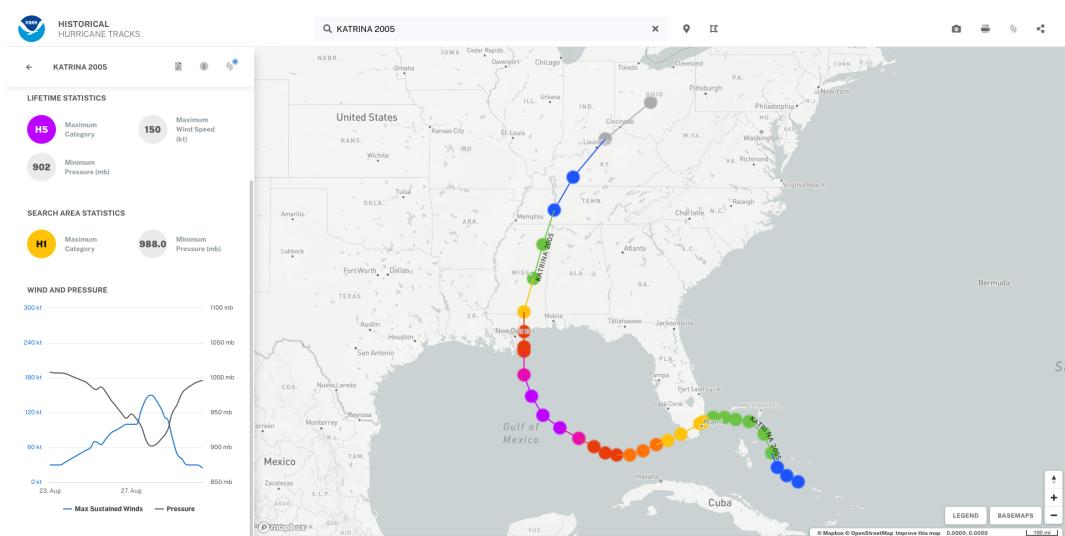
Link

<https://coast.noaa.gov/hurricanes/#map=4/32/-80>

Description

NOAA historical hurricane tracks is an interactive mapping tool to view and analyze hurricane tracks data from the NOAA National Hurricane Center (NHC) HURDAT2 and NOAA National Centers for Environmental Information (NCEI) IBTrACS datasets. The tool allows users to browse through over 13,000 storms since 1842 searching by location, storm, year or ocean basin. Once you have found the storm you are interested in you can connect to the details section. In the section you can find the entire storm track, data about the maximum wind speed and minimum pressure but also links to technical reports and additional details when they are available. The tracks' data are discretized with 6 hrs intervals.

Despite the dashboard only containing historical data and not real time forecasts of current cyclone events, it still has some interesting features for data visualization.



Pros

- User friendly interface that helps better visualizing data
- Summary statistics helpful for a first glance on cyclone characteristics (Max category, Max sustained wind speed, Min pressure)
- Max sustained winds and pressure graph is interactive, if you slide on a specific point of the graph it highlights the correspondent location on the track and vicevers if you slide on one of the cyclone location in the map
- The storm status and category intensity are immediately clear along the track thanks to the different colors utilized for the intensity scale
- A graphic tool allows you to draw polygons on the map to visualize all the cyclone tracks that have passed by the specified region. Another graphic tool allows you to specify a location and visualize all the tracks that have passed inside a specified radius distance from that location.
- By clicking on a location on the track you open a pop-up menu showing a summary of the cyclone at that time step (Date, Category, Max sustained wind speed, Min pressure)

Cons

- The details pan associated to the cyclone does not give more information than the overview pan
- Overall the information provided by the dashboard are very limited, just intensity category, maximum sustained wind speed and minimum pressure
- There is no impact information about the events

Layers/Variables list

- Observed position
- Observed track
- Observed Category
- Observed Max sustained wind speed [kts]
- Observed Min pressure [hPa]

Delft Dashboard - Tropical Cyclones

Link

<https://publicwiki.deltares.nl/display/DDB/Tropical+Cyclone>

Description

Delft Dashboard is a standalone Matlab-based graphical user interface (i.e. GUI) which supports modelers in setting up new and existing models. The Tropical Cyclone toolbox makes it possible to compute the wind field and pressure drop caused by a cyclone providing the track of the cyclone and adjusting some settings.

Pros

- The dashboard is downloadable through [this](#) page as a standalone executable or in a version to be run on Matlab

Cons

- I couldn't understand how to run the executable as intended in the instructions
- The dashboard does not operate online

Layers/Variables list

The dashboard should be able to produce, after having provided the track of the cyclone:

- Wind profile
- Vmax-Pc relation relating central pressure and maximum winds
- Radius of maximum winds relation with pressure drop and latitude

Severe Weather information Centre (WMO)

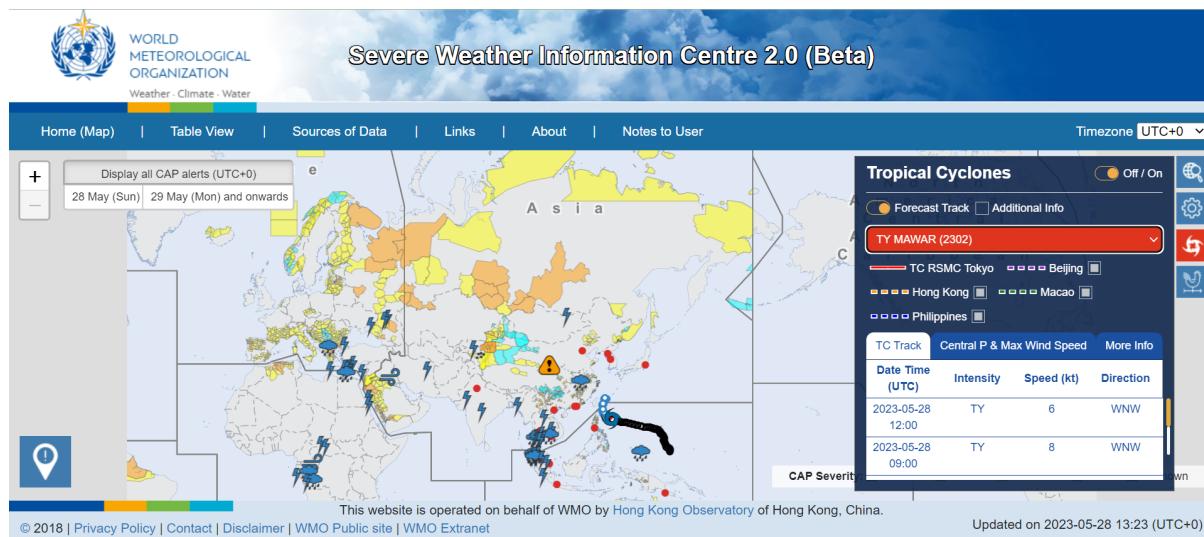
Link

<https://severeweather.wmo.int/v2/>

Description

The Severe Weather Information Centre (SWIC) is a World Meteorological Organization (WMO) website that provides a single and centralized source for the media and the general public to access official warning and information issued by National Meteorological and Hydrological Services (NMHSs) efficiently and effectively.

The dashboard consists of a world map showing severe weather events, based on the Common Alerting Protocol (CAP). Tropical cyclones are shown and have a special view available.



Pros

- The representation of all the severe weather events enables an overview of the current world situation
- The past positions of the tropical cyclone are shown and by hovering on them intensity, speed, wind speed, pressure, radius and gust are shown for each position.
- The source of the tropical cyclone information is provided for each position
- 5 days ahead predicted tropical cyclones positions are provided, along with maximum wind speed, pressure and gust.

- By accessing to the right “tropical cyclones” tab, a graph showing past central pressure and maximum wind speed is shown

Cons

- The view of the map is limited by the two banners above and below the map, which narrow the available space.
- The website takes some time to load. It may be due to the “beta” nature of the dashboard.
- Tropical cyclones are only one of the many instances of severe weather represented, thus the informations on them are only the essential ones

Layers/Variables list

- Position of severe weather events: thunderstorms, severe precipitations, tropical cyclones, gale
- Common Alerting Protocol (CAP) severity overlaid on world countries
- For tropical cyclones:
 - Intensity, speed, wind speed, pressure, radius and gust at each position
- For other events:
 - Precipitation, wind speed

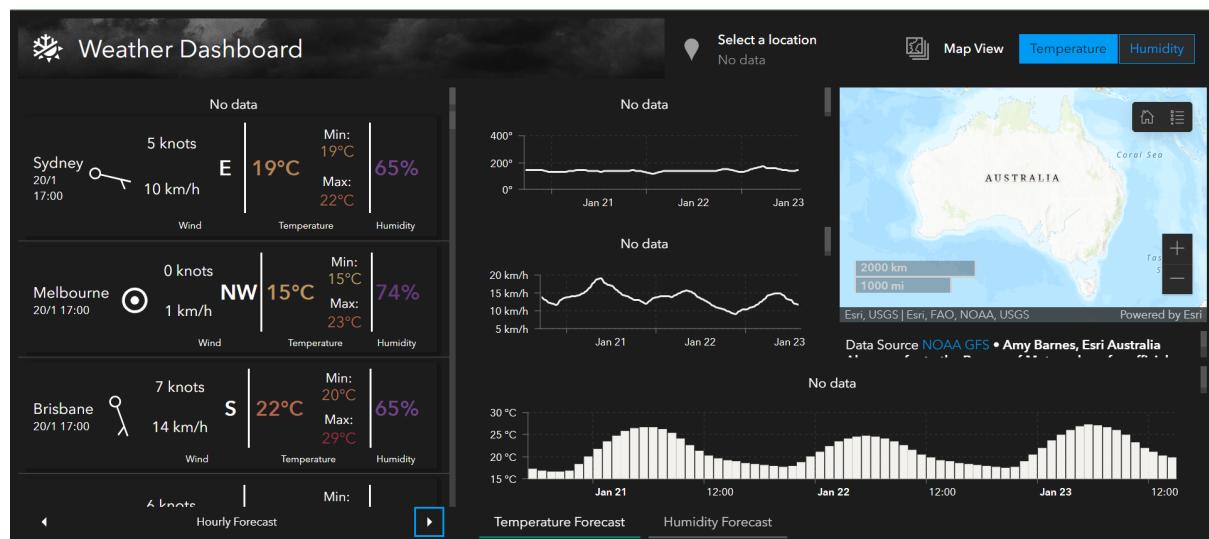
ArcGIS Weather Dashboard

Link

<https://www.arcgis.com/apps/dashboards/737e5317ef7343feb3b859f7757682e0>

Description

This dashboard is a weather dashboard developed on ArcGIS. It shows current and forecasted temperature and humidity data for a selected location.



Pros

- The layout of the dashboard is clean and on point: it shows a map of the location and around it 2 smaller and one bigger plots showing variables in that location. On the left a panel make you see the available variables to show with some statistics (min, max, mean value)
- It shows current and forecasted weather data (temperature and humidity)

Cons

- The dashboard is not currently operative. It shows “No data” in all of its plots.
- It is not a dashboard on tropical cyclones, so it doesn’t show any key variable related to tropical cyclone risks or forecast

Layers/Variables list

- Temperature
- Humidity

National Hurricane Center (NHC) Active Tropical Cyclones Panel

Link

<https://www.nhc.noaa.gov/cyclones/?epac>

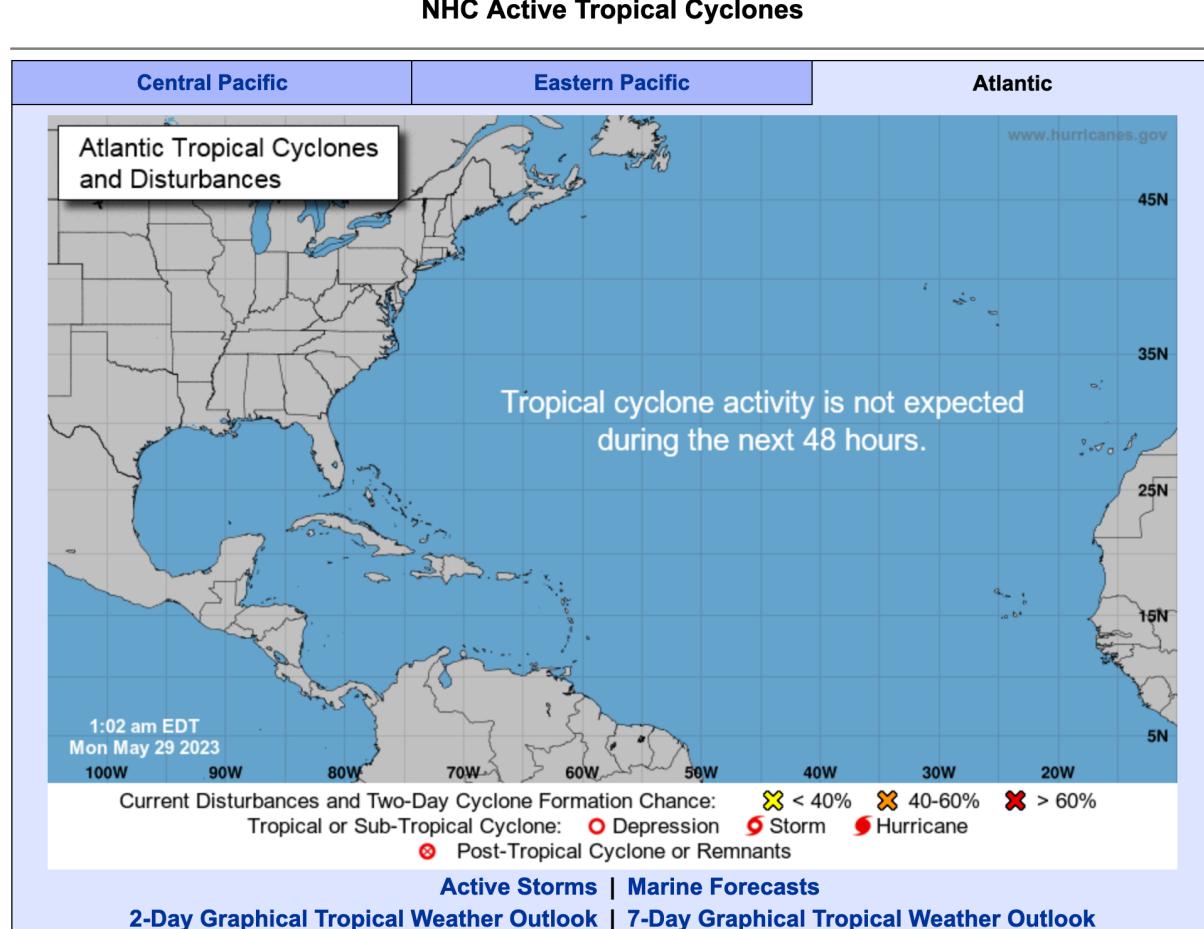
Description

The NHC active tropical cyclones panel is a forecast tool for cyclones event covering 3 regions across 2 basins: the Central Pacific, the Eastern Pacific and the Atlantic. In the panel you can access 4 sections, namely, the Active Storms map, the Marine Forecasts, the 2-day Graphical Tropical Weather Outlook and the 7-day Graphical Tropical Weather Outlook.

The Active Storms map shows the cyclone activity forecasted in the next 48 hours giving an overview of the current disturbances and their chance to develop in a cyclone over the next 2 days. It shows the current cyclone dividing them in 3 intensity categories: Depressions, Storms and Hurricanes. It also shows the remnants and post-tropical cyclones.

The Marine Forecasts section shows the marine graphical composite forecast map every 12 hours for the next 5 days for a set of variables (Wind at 10-30-50 meters, Wave height, Hazards level, High seas and Features), at this link there is a better description of the marine forecast products <https://www.nhc.noaa.gov/marine/forecast/info.php?large>. The forecast it is also splitted in sub-basin maps for each basin.

The 2-day Graphical Tropical Weather Outlook is like the Active Storms map but uses satellite images, while the 7-day Graphical Tropical Weather Outlook is also like the Active Storms map but it consider a 7 days forecast period.



Pros:

- The panel gives a clear overview about the tropical cyclone activity with clear legends and different kinds of map that the user can consult
- The division in basins (and sub-basins) help in a better overview of the event considered
- Each section also contains a text part with discussion about the weather outlook and other products forecasts produced by expert meteorologist of the NHC
- It contains risks information connected with cyclones (High Seas and Hazards) and also Wathces and Warning layer associated with the track evolution of the cyclone
- Archive of past outlooks
- Detailed information of the active disturbances

Cons:

- It covers just a part of the areas affected by tropical cyclone activity around the globe
- Not easy to find source data information

Layers/Variables list:

- 2-day cyclone formation chance
- 7-day cyclone formation chance
- Winds at 10-30-50 meters [kts]

- Wave height [ft and m]
- Forecast position
- Forecast track
- Probable path cone

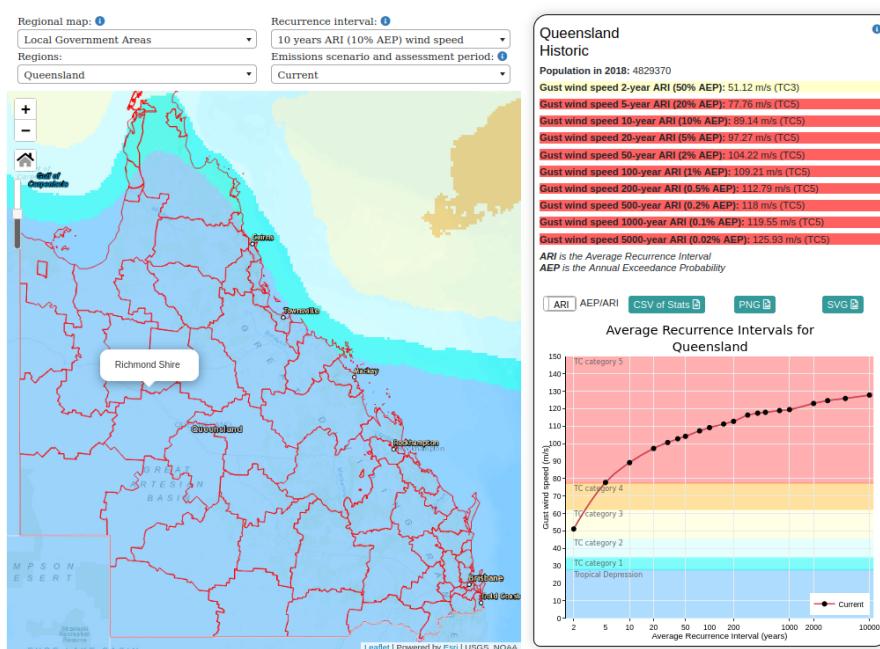
Tropical Cyclone Hazard Dashboard

Link

<https://www.longpaddock.qld.gov.au/qld-future-climate/tropical-cyclone/>

Description

The Tropical Cyclone Hazard Dashboard (TC-) is an online interactive visualisation platform for current and future tropical cyclone (TC) wind hazard to support the Severe Wind Hazard Assessment for Queensland (SWHA-Q). SWHA-Q aims to understand the potential impacts of modelled current and future TCs on population centres and elements of critical infrastructure in Queensland. For the assessment of future TC risk, moderate and high emission scenarios (RCP 4.5 and 8.5 respectively) are considered with two time-slices namely mid-century (2041-2060) and end-of-century (2081-2100). This interactive visualisation platform provides regionalized wind speed hazard for regions and locations over Queensland. It is composed of drop-down menus, maps, plots, and tables whereby users can customise, visualise, and download current and future wind hazard information summarised across Queensland's regions.



Pros

- Layer of emissions scenario: RCP 4.5 and 8.5
- Description of Queensland TC recurrence at regional scale
- Easily to download data and plots as PDF, GeoTIFF, CSV, PNG and SVG
- Value at mouse displayed

Cons

- Only covers small area

- Limited time coverage: only current situation and future projections at 2050 and 2090.
- Limited variables displayed

Layers/Variables list

- Gust wind speed category
- Average Recurrence Interval
- Annual Exceedance Probability

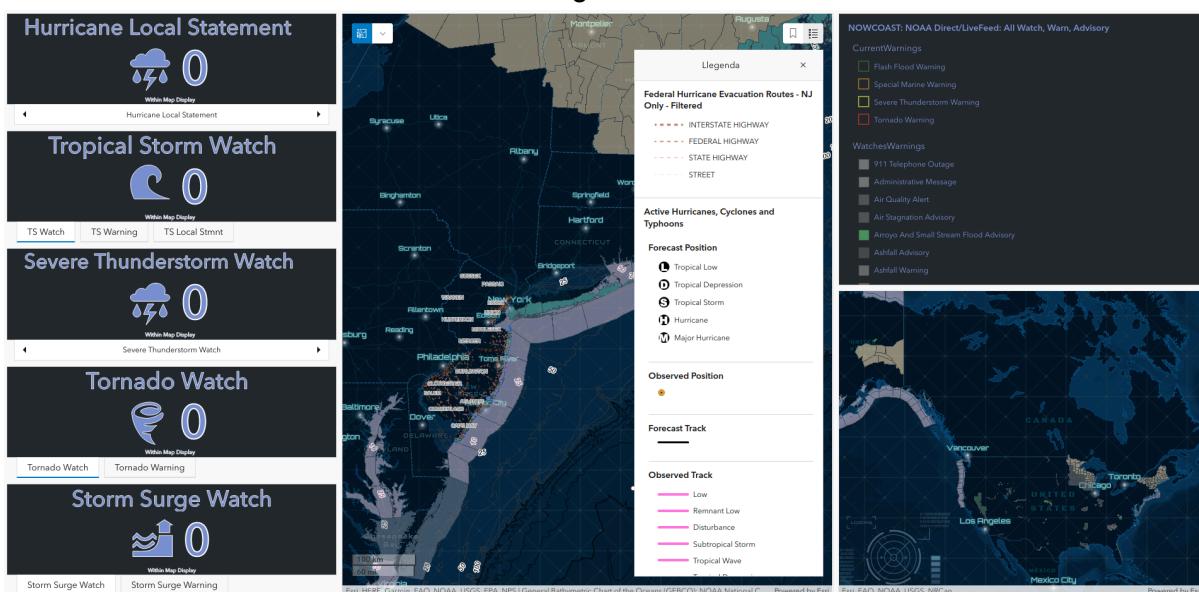
ArcGIS Tropical Cyclone Dashboard

Link

<https://www.arcgis.com/apps/dashboards/016fc4fa9dd74e60a3c23ba920126e80>

Description

Dashboard powered by Esri displaying watch and/or warnings of hurricane, tropical storm, severe thunderstorm, tornado and storm surge in the USA.



Pros

- Shortcut to default configuration
- Two maps are displayed

Cons

- Scarce information about data source and technical aspects
- The spatial area covered is not clear
- Small area
- Values do not show units, are these values indicating probability?
- No indication of time
- Too much watches available
- Only current time

Layers/variables list

Probability of:

- Hurricane local statement
- Tropical storm watch

- Severe thunderstorm watch
- Tornado watch
- Storm surge watch

ECMWF Tools

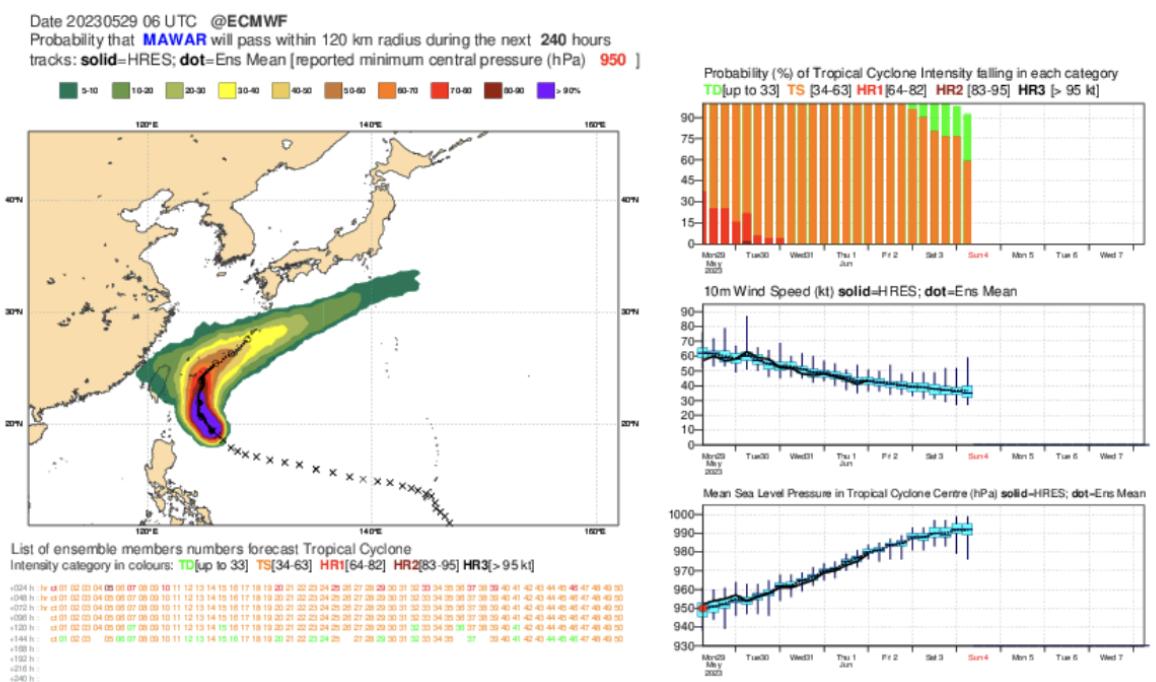
A. Latest tropical cyclone forecast

Link

https://charts.ecmwf.int/products/cyclone?base_time=202305290600&product=tc_strike_probability&unique_id=04W_MAWAR_2023

Description

Dashboard generated automatically whenever a tropical cyclone is observed (reported via the Global Telecommunication System) at the initial time of the forecast and is present in the high-resolution forecast and/or ensemble (ENS).



Pros

- Focus on the area of the cyclone
- Easy to navigate for the different layers, variables are grouped

Cons

- Some information is missing, some cyclones could not be tracked.

- Some labels are not easy to understand

Layers/variables list

- Probability that the cyclone will pass within 120km radius during the next 240h
- Observation tracking
- Individual trajectories for the next 240h
- Probability of tropical cyclone intensity
- 10m wind speed
- MSLP in tropical cyclone centre
- Observation position and strength

B. ECCharts

Link

https://charts.ecmwf.int/products/medium-tc-genesis?base_time=202305290000&layer_name=genesis_td&projection=opencharts_global&valid_time=202306010000

Description

These products are based on tropical cyclone activity throughout the forecast. They are produced twice a day from the ENS, twice a week for the extended range (month ahead) and once a month for the seasonal forecasts. They give an indication of the potential tropical cyclone activity in the coming days, weeks and months.

Pros

Cons

C. Plots and maps

Link

<https://charts.ecmwf.int/?facets=%7B%22Product%20type%22%3A%5B%5D%2C%22Range%22%3A%5B%5D%2C%22Parameters%22%3A%5B%22Tropical%20cyclones%22%5D%7D>

Description

ECMWF provides a number of different plots and maps which show tropical cyclones related variables. They provide:

- Tropical cyclone activity map: shows active tropical storms, cyclones and hurricanes over a global map
- Tropical storm probabilities - Extended range forecast: shows the evolution of existing and potential tropical cyclone activity derived from the ECMWF extended range ensemble

- Errors of tropical cyclone forecasts: shows mean errors in position and intensity of tropical cyclones for ECMWF high-resolution (HRES) and ECMWF ensemble (ENS) forecasts.
- Tropical storm frequency - Extended range forecast: shows 7-day mean frequency of tropical storms and 7-day mean accumulated cyclone energy (ACE).
- Accumulated Cyclone Energy (Verification) – Long Range Forecast – SEAS5: shows the ACE for each of the different cyclone basins, with forecasts, observations and standard deviation.
- Hurricane/Typhoon Number (Verification) – Long Range Forecast – SEAS5: shows the Hurricane Number for each of the different cyclone basins, with forecasts, observations and standard deviation.
- Accumulated Cyclone Energy/Hurricane/Typhoon Frequency – Long Range Forecast – SEAS5: two maps which provide information on the Accumulated Cyclone Energy (ACE) contained within tropical storms/number of tropical storms that are expected to develop and reach “hurricane” or “typhoon” strength that are expected to develop over a six-month period, commencing with the month following that chosen.
- Tropical Storm Standardised Density/Tropical Storm Density Anomaly – Long Range Forecast – SEAS5: two maps which provide information on the actual/predicted anomalies in the “Tropical Storm Density” that are expected over a six-month period commencing with the month following that chosen.

Pros

- Below each map or plot there is a clean explanation of what is shown
- On the left of each product there are some toggles to choose the variable to show and for which date

Cons

- Each map and plot is visualized in a different page from the others, making it more difficult to look at them together

Key variables and indicators

The analysis of the existing contents regarding tropical cyclones and weather dashboards has provided us with information about what could be the key variables and indicators to be included in our project. Below you can find a list of all the variables we believe would be important to include in order to have a comprehensive and complete list of products for tropical cyclone hazards visualization. However, the inclusion also depends on data availability which we cannot ensure for all variables and indicators. We grouped the variables and indicators into three main categories to better visualize the list. The distinction in 3 categories might be useful also for the platform design in the next phase of the project.

Cyclone properties

Variable	Observed/estimated	Forecasted
Cyclone position		

Strike probability map / Probable path cone - 5 days		
Cyclone track (past and future)		
Estimated radius		
2-day / 7-day cyclone formation probability		
Max sustained wind speed		
Cyclone intensity category (Disturbance/Storm/Hurricane/Major Hurricane)		
Radius of wind speeds exceeding 35 kts / 50 kts		

Meteorological/Ocean Variables

Variable	Observed/estimated	Forecasted
Wind speed and direction at 10m		
Precipitation		
Rainfall probability of exceeding a certain value (like in the ECMWF tool)		
Mean sea level pressure		
Sea surface temperature		
Wind gust at 10m		
Wave height or Significant Wave height		

Impact variables

Variable	Observed/estimated	Forecasted

Population density		
Coastal areas prone to risk of flooding		
Watches and Warnings or any sort of risk layer (e.g. Common Alerting Protocol)		
High Seas regions		

D1.2 - Data description report

The data description report contains a brief description of open data sources that might be used in TropiDash. Data sources are grouped in *Tropical cyclones related databases* and *Possible Impacts related databases*.

Tropical cyclones related databases

- **Historical hurricane tracks**

<https://coast.noaa.gov/hurricanes/#map=4/32/-80>

This interactive mapping tool is used to view, analyze, and share track data from the [NOAA National Hurricane Center HURDAT2](#) and [NOAA National Centers for Environmental Information IBTrACS](#) data sets. Contains over 13,000 storms since 1842. The storm description includes wind, pressure and category at 6-hour intervals.

- **Open Weather**

<https://openweathermap.org/api>

The One Call API provides the following weather data for any geographical coordinates:

- Current weather
- Minute forecast for 1 hour
- Hourly forecast for 48 hours
- Daily forecast for 8 days
- National weather alerts
- Historical weather data for 40+ years back (since January 1, 1979)

- **Severe Weather Information Centre**

<https://severeweather.wmo.int/v2/list.html>

The [Severe Weather Information Centre](#) (SWIC) is a World Meteorological Organization (WMO) website that provides a single and centralized source for the media and the general public to access official warning and information issued by National Meteorological and Hydrological Services (NMHSs) efficiently and effectively. The website was developed and maintained by the Hong Kong Observatory (HKO). The website began trial run on 10 September 2001 and became operational on 23 March 2005. A total of 21 WMO Members participated in the operation of SWIC.

- **Recent Hurricanes**

<https://data.humdata.org/dataset/recent-hurricanes>

Living Atlas live feed sources for hurricane path, observed path, forecast path, and intensity of tropical cyclone activity (hurricanes, typhoons, cyclones) from the National Hurricane Center and Joint Typhoon Warning Center. It is based on 3 different data sources:

Hurricane and Cyclone App

Active Hurricanes, Cyclones and Typhoons

Recent Hurricanes, Cyclones and Typhoons

Possible impacts related databases

- **Global exposed economic stock**

<https://data.humdata.org/dataset/exposed-economic-stock>

This database includes an estimation of the economic value of the exposed assets, as well as their physical characteristics in urban and rural agglomerations. This information is key to assessing the potential damages from different hazards to each of the exposed elements. The global exposure database is developed at 1 km spatial resolution in coastal areas and at 5 km spatial resolution everywhere else on the globe. It includes economic value, number of residents, and construction type of residential, commercial, and industrial buildings, as well as hospitals and schools

- **WorldRiskIndex**

<https://data.humdata.org/dataset/worldriskindex>

The WorldRiskIndex is a statistical model that provides an assessment of the latent risk of 193 countries falling victim to a humanitarian disaster caused by extreme natural events and the negative impacts of climate change. Based on peer-reviewed concepts of risk, hazard, and vulnerability, it is assumed that disaster risks are not solely shaped by the occurrence, intensity, and duration of extreme natural events, but that social factors, political conditions, and economic structures are equally responsible for whether disasters occur in the context of extreme natural events. Accordingly, both main spheres of disaster risk, exposure, and vulnerability, are treated as equals.

- **World bank open data**

https://data.worldbank.org/?intcid=ecr_hp_BeltC_en_ext

Free and open access to global development data. Data can be accessed through API. Many different socioeconomic datasets with worldwide interpolated data from 1960 to 2050.

- **WorldPop data**

<https://hub.worldpop.org/>

WorldPop develops peer-reviewed research and methods for the construction of open and high-resolution geospatial data on population distributions, demographic and dynamics, with a focus on low and middle income countries.

Conclusion

The results showcased in this report are crucial to the next phase of TropiDash project: Platform Design. In the Context report existing products have been analysed. Many products are available which enable to check tropical cyclones with varying grades of details in the showcased variables. However, no perfect product exists, as they all have been created to fulfil specific objectives. So, the major pros and take-home information found by studying the available products have been gathered in the list below together with some comments:

- Having too many variables makes it harder to understand the dashboard and which are the most important information it can provide

- Lightness and speed of the dashboard in providing maps and show data is crucial to have a good first impression
- Global coverage is important but maybe the dashboard maps could be divided into the different basins of interest
- Summary characteristics for each cyclone position helps in better understanding the data
- Impact layers are necessary to have a quick guess about risks
- Colours for intensity category are helpful for visualization
- Is important to dedicate different plots/charts to variables that cannot be visualized as overlaid to a map
- Increasing complexity of charts as you scroll through the dashboard (only experienced user arrive to the end)

In the data description report available databases for tropical cyclone data and their possible impacts are listed and commented. Good sources of available data have been found and will be considered to be used in TropiDash.