**Report of the Joint WMO/IHO Task Team on Volcanic Activity and Safety of Marine Navigation (TT - VASMN)**

Submitted by New Zealand / NAVAREA and METAREA XIV

**SUMMARY**

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|---|---|
| Executive Summary: | The joint session of WWNWS14 and AG-WWMIWS-SubC-1 established a joint task team, to be co-led by the METAREA and NAVAREA XIV Coordinators, to audit existing, readily available, resilient, and robust volcanic hazard information with the objective to provide recommendations and options for inclusion in future MSI products and services. This document reports on the outcomes from the work of the task team |
| Action to be taken: | 7 |
| Related documents: | TT-VASMN TOR; WWNWS14/WWMIWS3 – 3.2.3; NCSR 10/10 |


## 1. Background

1.1. NAVAREA and METAREA XIV submitted an information paper to the joint session of WWNWS14 and AG-WWMIWS-SubC-1, document WWNWS14/WWMIWS3 – 3.2.3 "Volcanic Activity and MSI". This document discussed, inter alia, the potential hazards to marine navigation posed by volcanic activity and the sources of information available to MSI providers.

1.2. Following discussions, the meeting agreed that clarity was needed on the roles and responsibilities of METAREA and NAVAREA Coordinators regarding natural hazards, particularly in relation to volcanic eruptions. In this regard, METAREA and NAVAREA XIV agreed to co-lead a combined METAREA Task Team / NAVAREA Project Team (NCSR 10/10 §14), with the following terms of reference.

## 2. Terms of Reference, Task Team on Volcanic Activity and Safety of Marine Navigation (TT-VASMN)

### Scope

2.1. The task team was established to provide an INF paper on recommendations at the next sessions of the WWNWS/WWMIWS in 2023 and SERCOM session in 2024.

**Aim**

2.2. The aim of the Task Team is to audit existing, readily available, resilient, and robust volcanic hazard information with the objective to provide recommendations and options for inclusion in future MSI products and services via an INF document.

**Specific Tasks**

2.3. The task team was instructed to create an INF paper with recommendations for volcanic hazards to shipping following completion of the following tasks:

- Audit currently available volcanic hazard information from other relevant user groups (such as ICAO),
- Collate applicable sources of volcanic activity and hazard information that are currently freely available (or could be used freely) to Maritime Safety Information (MSI) providers,
- Articulate the potential hazards this activity may pose to the safety of marine navigation,
- Initiate discussions regarding the benefits of developing standard messaging relevant to mariners, and
- Recommend possible methods for ingest and dissemination.

**Membership**

2.4. Invitations to join the task team were extended to all NAVAREA and METAREA coordinators with an interest and expertise in volcanic hazards. The co-coordinators of the task team express our appreciation to these members:

| METAREAs | NAVAREAs |
|---|---|
| METAREA I | NAVAREA I |
| METAREA IV-XII | NAVAREA IV-XII |
| METAREA VI | NAVAREA X |
| METAREA VIII | NAVAREA XIV |
| METAREA X | |
| METAREA XIV | |
| METAREA XV | |

## 3. The work of the Task Team

**Coordinator Task**

3.1. NAVAREA XIV, on behalf of the coordinators, presented to, and facilitated a discussion panel at, the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) 2023 Post-Conference Workshop "Developing the future visions for seamless multi-hazard warning for volcanic eruptions". Link: IAVCEI 2023 (eventsair.com). The following "User Requirements", at the request of the organizers, were provided to focus the discussion following the NAVAREA XIV presentation.

**IAVCEI 2023 – NAVAREA Coordinator User Requirements**

3.1.1. It was noted to the workshop that NAVAREA Coordinators need to provide mariners with timely, reliable and succinct information, informing their decision making to avoid hazards to navigation. To achieve this, NAVAREA Coordinators need:

- *Reliable sources of information* - avoiding multiple sources, if possible, otherwise limiting the number of potential sources
- *Consistent structure* - particularly where there are multiple information sources, consistency in the structure of the information provided is important, and
- *Translation of information into ship-specific intelligence or messages* - Using the sources of quake-generated tsunamis as an example, it was noted that the messages received by NAVAREA coordinators are lengthy and for multiple audiences. Simply repackaging these messages into navigational warnings is not providing the best service to the mariner. Ideally, our warnings contain only the information required by mariners to inform their decision making. Options to achieve this would be either maritime-specific messaging, or guidance from experts to develop agreed and consistent navigational warning templates from the volcanic activity message.

**Workshop Outcomes**

3.1.2. One of the goals for the members of this workshop was the future development of a single, global, multi-hazard (weather and geo-hazards) and integrated warning system, aligned with WMO's Early Warnings for all (Early Warnings for All | World Meteorological Organization (wmo.int)). While this is out of scope for our Task Team, this is perhaps something WWNWS/WWMIWS could consider engaging with in the future.

3.1.3. Noting that NAVAREAs provide warnings to ships in the shore-ship direction only, one request from the workshop to NAVAREA Coordinators was to create a "feedback loop" in the ship-shore direction. Volcanologists would like to receive observations from ships on volcanic activity, and if possible, samples of any volcanic material. WWNWS members need to consider how/if we could support this.

**Team Tasks**

3.2. Each task team member was requested to:

3.2.1. Collaborate with their relevant METAREA/NAVAREA coordinator to identify sources of volcanic information within respective regions,

3.2.2. Engage with local/regional agencies (E.g., VAACs, state volcano observatories, etc.) identified at task 3.2.1, and

3.2.3. Consider seeking input from professional mariner/s on their assessment of the potential impacts from volcanic activity. It was noted with respect to this task, that the information provided in the paper "Assessing the magnitude of volcanic risk to global shipping" (https://eartharxiv.org/repository/view/4634/) may suffice.

## 4. Task Team Outputs

**Audit/collate applicable sources of volcanic activity and hazard information:**

4.1. All team members were able to identify and connect with sources of volcanic activity and hazard information within their respective regions.

4.2. In most cases, the National Meteorological Services had the most mature relationships, through existing VAAC (ICAO) responsibilities, with the State Volcano Observatories.

4.3. The table in Annex 1 illustrates the information sources identified, and the dissemination processes, in the regions of the members of the task team.

**Broadcast Responsibilities:**

4.4. It was not an assigned task for this team to decide which information provider (METAREA or NAVAREA) should be responsible for broadcasting volcanic activity messages to mariners. However, to ensure the broadcasts are properly coordinated, the team recommends that NAVAREA and METAREA Coordinators in each region understand which MSI provider has designated state responsibility to ensure appropriate coordination and consistency of messages across user groups.

**Articulate the potential hazards this activity may pose to the safety of marine navigation:**

4.5. Mostly taken from the paper noted in paragraph 3.2.3, the potential hazards, while not an exhaustive list, are mapped to guidance text as noted in 4.6 below and described in Annex 2.

**Initiate discussions regarding the benefits of developing standard messaging relevant to mariners:**

4.6. In Annex 2 is a table of *Volcanic Activity to Hazard Mapping Guidance*.

**Recommend possible methods for ingest and dissemination:**

4.7. The methods for ingest will likely be determined by the source providers. For example, NAVAREA XIV has subscribed to Volcanic Ash Advisories from VAAC Wellington and Volcanic Activity Bulletins from the institute for Geological and Nuclear Sciences (GNS). These are received via email in the form of Word or PDF documents, the relevant text of which is copied/pasted into navigational warning templates.

4.8. Dissemination of text-based volcanic activity information that is the subject of navigational warnings should follow the standard WWNWS process. If additional information is provided, including graphics, consideration could be given to including these in web-based or other value-added services.

4.9. Development of technology in the navigational warning space (eNavigation) may provide additional opportunities. The provision of data via S-124, for example, and whether graphics could be included, will depend on the capacity of the delivery systems.

## 5. Future Development:

5.1. Under the International Aviation Volcano Watch workflow from the International Civil Aviation Organization (ICAO) it is expected that most VAACs will be able to produce Quantitative Volcanic Ash Information (QVA) by the end of 2025. QVA, and additional requirements for ash deposition, could lend itself for port/harbour and sea surface ash deposition statements.

5.2. As noted in document WWNWS14/WWMIWS3 – 3.2.3, efforts are under way in the South Pacific to develop a Volcano Observatory Notice to Aviation (VONA) Portal. If developed, the format could be modified to accommodate marine as well as aviation audiences.

## 6. New Zealand Volcanic Activity Exercise:

6.1. New Zealand CAA is planning a volcanic activity exercise for August 2023. These were previously aviation focused, but given our engagement with them on this topic, CAA will include the marine environment so we can work on information sources and access for marine navigational warnings. Noting this exercise will have occurred after the submission of this report, NAVAREA XIV will provide a verbal report on the exercise outcomes at WWNWS 15.

## 7. Action requested of the Sub-Committee:

7.1. The WWNWS-SC is invited to:

7.1.1. Agree that the Task Team has fulfilled its obligations under the Terms of Reference;
7.1.2. Recommend NAVAREA/METAREA Coordinators engage within their regions to further develop their procedures in this space, if necessary, considering the examples from the members of the task team when developing their procedures, and update the Sub-Committee as appropriate;
7.1.3. Note the outcomes from participation at the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) 2023 Post-Conference Workshop "Developing the future visions for seamless multi-hazard warning for volcanic eruptions";
7.1.4. Consider the request from volcanologists at the IAVCEI workshop, for NAVAREA Coordinators to create a "feedback loop" in the ship-shore direction, providing volcanic activity observations from ships to the volcanology community;
7.1.5. Encourage NAVAREA and METAREA Coordinators, if volcanic activity is likely to pose a hazard to navigation in their areas of responsibility, to consider the guidance in the *Volcanic Activity to Hazard Mapping Guidance* at Annex 2, and
7.1.6. Note the report in general.

**ANNEX 1**

**Regional Information Sources and Processes**

| Region | Information Sources | Marine Navigational Warning Process |
|---|---|---|
| NAVAREA/METAREA I | VAACs/British Geological Survey/State Volcano Observatories | Warnings broadcast by NAVAREA |
| NAVAREA/METAREA IV-XII | VAACs/US Geological Survey/State Volcano Observatories | Warnings coordinated between METAREA and NAVAREA. NAVAREA broadcasts warnings but volcanic information is included in the Synopsis of METAREA forecasts. Volcanic Ash Warnings (and Advisories) are included as Headlines in the METAREA forecasts. |
| NAVAREA/METAREA VI | VAACs | Noted as a new item for discussion between METAREA and NAVAREA. |
| METAREA VIII | VAACs | Warnings broadcast by METAREA |
| NAVAREA/METAREA X | VAACs/ US Geological Survey/State Volcano Observatories/Joint Australian Tsunami Warning Centre | Warnings broadcast by NAVAREA |
| NAVAREA/METAREA XIV | VAACs/Geological and Nuclear Sciences Limited/State Volcano Observatories | Warnings broadcast by NAVAREA |
| METAREA/NAVAREA XV | VAACs/National Geology and Mining Service/State Volcano Observatories | Warnings broadcast by NAVAREA |

## Specific Example – NAVAREA/METAREA XIV

In September 2022, the eruption of Home Reef volcano, Tonga, was reported by the Tonga Geological Services to Tonga National MSI Coordinator and the Volcanic Ash Advisory Centre (VAAC) Wellington, New Zealand.

METAREA XIV, in their role as VAAC Wellington, issued a Volcano Observatory Notice for Aviation (VONA). See figure 1.

The Tonga National MSI Coordinator issued a Coastal Warning, which was also sent to the NAVAREA XIV Coordinator. NAVAREA XIV Warning 202/22 was issued. See figure 2.

**VAAC WELLINGTON – TONGA METEOROLOGICAL SERVICE**

**VOLCANO OBSERVATORY NOTICE FOR AVIATION (VONA)**

| Item No | Element | Content |
|---|---|---|
| 1 | **Message title** | **VOLCANO OBSERVATORY NOTICE FOR AVIATION-VONA** |
| 2 | **Issued**: | 20220913/0359Z |
| 3 | **Volcano:** | Home Reef |
| 4 | **Current Aviation Color Code**: | **YELLOW** |
| 5 | **Previous Aviation Color Code**: | **GREEN** |
| 6 | **Source**: | Tonga Geological Services |
| 7 | **Notice Number**: | 22/02 |
| 8 | **Volcano Location**: | 18.992°S, 174.775°W |
| 9 | **Area**: | Vava'u Group |
| 10 | **Summit Elevation**: | 10 metres above sea level (ASL) |
| 11 | **Volcanic Activity Summary**: | First eruption detected by VOLCAT at 1:39am local time Saturday morning 10th Sep 2022. (Figure 3)<br><br>First high resolution image of the island captured by Sentinel 2 satellite at 12:59 pm, 10th Sep 2022, 11 hours and 20 mins after the initial eruption, which was available only 3 days after. (Figure 4)<br><br>Home Reef has re-emerged above the sea in a stubby formation covering 3,850square metres with a 70m diameter. (Figure 4)<br><br>Fumarolic activity is ongoing releasing gas into the atmosphere at 1km above sea level. (Figure 2 & 4). |
| 12 | **Volcanic Cloud Height**: | Gaseous Volcanic Cloud detected at 1km. (Figure 2)<br><br>Source of height: – NOAA-20 VIIRS |
| 13 | **Other Volcanic Cloud information:** | - |
| 14 | **Remarks**: | Home Reef has re-emerged above sea level with ongoing thermal activity and island building.<br><br>Advice Mariners to travel 5km away from Home Reef until further notice. |
| 15 | **Contacts**: | Tonga MET Services (+67635123/+67635009)<br>E-mail: metstaff@met.gov.to |
| 16 | **Next Notice**: | A new VONA will be issued ASAP depending on new information observed and received. |

Figure 1

NAVAREA XIV WARNING 202/22
SOUTH PACIFIC OCEAN - TONGA
HOME REEF
CHART T / NZ 82
1. UNDERWATER VOLCANIC ACTIVITY REPORTED IN VICINITY 18-59.55S 174-46.44W AT 140330 UTC SEP 2022.
2. HOME REEF HAS RE-EMERGED ABOVE SEA LEVEL. MARINERS ARE ADVISED TO MAINTAIN A MINIMUM DISTANCE OF 2NM FROM HOME REEF
NNNN

Figure 2

**ANNEX 2**

**Volcanic Activity to Hazard Mapping Guidance**

| Volcanic Activity | Hazard to Ships | Warning Text |
|---|---|---|
| Pumice rafts | Blocks seawater cooling systems, overheating engines | "BLOCKAGE OF SEAWATER COOLING SYSTEMS POSSIBLE" |
| Gas emissions (sub-sea) | Impact to instruments on the ship's hull. E.g. Echo sounders, speed logs | "GASSES MAY BE CORROSIVE TO HULLS AND ASSOCIATED INSTRUMENTS" |
| Explosive surtseyan (shallow water) eruption | Physical damage to, or destruction of ship | "EXTREMELY HAZARDOUS TO SHIPS AND PEOPLE" |
| Pyroclastic flows (speeds of hundreds KM/h, temperatures hundreds of degrees C) | Heat and impact damage, ship stability | "EXTREMELY HAZARDOUS TO SHIPS AND PEOPLE" |
| Tephra (from ash to larger objects) | Loss of stability, navigational data, engines, abrasion/corrosion damage<br>Loss of visibility<br>Hazardous to people | "ASH CAN BE CORROSIVE, EFFECT STABILITY, NAVIGATIONAL SYSTEMS AND BE HAZARDOUS TO PEOPLE"<br>"LARGE OBJECTS EXTREMELY HAZARDOUS TO SHIPS AND PEOPLE |
| Sulphur dioxide | Potential corrosion<br>Hazardous to people | [As per Gas Emissions above] |
| Tsunami | Dependent on depth of water. Loss of stability, etc. | "VESSELS ALREADY AT SEA SHOULD REMAIN WELL OFFSHORE AND AT DEPTHS OF 100 METRES OR MORE WHILE THIS WARNING IS IN EFFECT. CREWS OF VESSELS IN HARBOURS AND ESTUARIES MUST CONSIDER EITHER IMMEDIATE RETURN ASHORE OR MOVE TO DEEPER WATER."<br>"UNUSUALLY STRONG AND HAZARDOUS CURRENTS AND UNPREDICTABLE SURGES ARE EXPECTED NEAR THE SHORE. THE SEVERITY OF CURRENTS AND SURGES WILL VARY WITHIN A PARTICULAR COASTAL AREA"[1] |

[1] Text in this cell taken from New Zealand Coastal Warning template for earthquake generated tsunamis

**ANNEX 3**

## Reference Links

Volcanic Ash Advisory Centres
https://www.ospo.noaa.gov/Products/atmosphere/vaac/other-vaacs.html

Maritime Impacts of Volcanic Eruptions: A Guide for the Prudent Mariner
https://ocean.weather.gov/volcano/

Volcanic Ash and Ashfall
Volcanic Ash and Ashfall (weather.gov)

"Assessing the magnitude of volcanic risk to global shipping"
https://eartharxiv.org/repository/view/4634/