Warnings on Tropical Cyclone for WMO Global Multi-Hazard Alert System

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WMO GLOBAL MULTI-HAZARD ALERT SYSTEM

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ABSTRACT

The World Meteorological Organization (WMO) is planning to implement a Global Multi-hazard Alert System (GMAS) to aggregate official warning information issued by authorities around the world and to serve as a one-stop shop to support the humanitarian organizations of the United Nations (UN), National Meteorological and Hydrological Services (NMHSs) and other global users including the media. It aims to enhance the authority and visibility of NMHSs and other alerting authorities. To aid effective dissemination of warnings to GMAS, the Common Alerting Protocol (CAP) was considered as a standard and robust format to use. In respect of GMAS infrastructure, the World Weather Information (WWIS) and the Severe Weather Information Centre (SWIC) of WMO as well as the WMO Alert Hub now being implemented are identified as core components, among others. The SWIC is being upgraded with GIS capability for displaying authoritative warnings and tropical cyclone (TC) information, and for use as a display platform of GMAS. Apart from warnings from NMHSs, authoritative TC warnings and advisories issued by Regional Specialized Meteorological Centres (RSMCs) and Tropical Cyclone Warning Centres (TCWCs) are also indispensable information for GMAS. As the existing TC warnings and advisories, now more or less in free text format, are not intended for automatic parsing by computer software, it is proposed to make available the TC advisories in a machine-readable format so that TC information can be effectively ingested into GMAS and made available to the UN humanitarian organizations, NMHSs and other global users. In this respect, some enhancement measures to TC advisories are proposed. This calls for active collaboration of Members of the Typhoon Committee in the GMAS project.

Keywords: GMAS, multi-hazard alerts, authoritative warnings, Common Alerting Protocol, RSMC, TCWC

1. Background

Early warnings of weather, water and climate hazards from NMHSs of each country have proved to be very effective in reducing loss of life and property. This has been usefully supported by TC warnings and advisories issued by RSMCs and TCWSs. With increasing impacts from weather, water and climate hazards, there is a need to make available all authoritative warning information for decisions makers in the UN humanitarian agencies and other global users to enable them to plan and take early actions against the hazards. In view of this, the WMO is planning to implement the GMAS with the following objectives:

(i) Provide the UN agencies and humanitarian community with authoritative information and advice to both their operational and longer-term decision making bodies;
(ii) Aggregate authoritative sources of information from WMO Members;
(iii) Strengthen partnerships with stakeholders to deliver warnings to the general public in the most efficacious manner;
(iv) Raise the visibility of NMHS at the national, regional and global levels;
(v) Raise the visibility of the WMO at the UN level;
(vi) Enhance the authoritative voice of Members; and
(vii) Strengthen the Members’ capability and capacity to provide better services.

The Executive Council of WMO at its Sixty-ninth Session (EC-69) approved the vision of GMAS1. A meeting of the Expert Group of GMAS2 was subsequently held in October 2017 to develop a project plan and recommendations

1In this paper, “warning” means official alerts, warnings or advisories issued by NMHSs and other Registered Alerting Authorities, including RSMCs and TCWCs.
for the implementation of WMO GMAS.

2. Benefits of GMAS:

WMO GMAS is expected to bring about the following benefits:

(i) Help to save lives, livelihoods and property through the provision of authoritative information and advice on weather, water and climate hazards to agencies operating at global and regional levels;

(ii) Increased recognition of WMO Members’ products and services;

(iii) Increased sharing and harmonization of hydro-meteorological warnings and hazard products/information among WMO Members;

(iv) Increased focus on NHMSs’ capacity development to provide reliable, actionable and timely warnings;

(v) Improved user decision-making for humanitarian agencies;

(vi) Through quick access to authoritative warning information, better inform the general public, media, tourism sectors and other sectors vulnerable to hydro-meteorological hazards.

3. Proposed GMAS Framework

Figure 1 depicts the proposed schematic of the GMAS Framework. There will be two levels of GMAS information access: one for open access by the general public and another for restricted access by UN agencies, NMHSs and experts providing advices to users. Some existing systems to be leveraged for the development of GMAS are identified in the Figure 1. Among others, WMO’s WWIS and SWIC as well as the WMO Alert Hub now being implemented were identified as core components of GMAS. RSMCs are also key components of the WMO GMAS. As a matter of fact, the strategies of GMAS emphasize, among others, the role of RSMCs in providing guidance to WMO Members, e.g. TC and climate products.

4. WMO Alert Hub

As mentioned above, the WMO Alert Hub is a key component of GMAS. It is a one-stop back-end engine to aggregate authoritative warnings issued by NMHSs and Registered Alerting Authorities (RAAs), and to disseminate the warnings through publishing of feeds or through push mechanism. The WMO Alert Hub simplifies the access to authoritative warnings by offering an aggregated store for subscription by users over the Internet in standard formats such as Really Simple Syndication (RSS) and Atom Syndication (Atom).

The WMO Alert Hub serves as a centralized source of...
warnings as depicted in Figure 2, and will be considered as a Data Collection and Production Centre (DCPC) within the scope of the WMO Information System (WIS). As part of the implementation of GMAS, the current SWIC will be upgraded to a GIS-enabled platform for visualization of authoritative warnings in CAP format aggregated in the WMO Alert Hub with a view to providing real-time update of warnings to users. The WMO Alert Hub can also be enabled to push CAP warnings to time-sensitive applications and VIP users (such as UN agencies, NMHSs, regional or sub-regional meteoalarm systems, humanitarian agencies, etc.), while other users could acquire warnings from the WMO Alert Hub by subscribing to RSS/ATOM feeds or through the upgraded SWIC website.

The WMO Alert Hub is designed to handle CAP-formatted warnings issued by official and known sources. These sources are limited to the organizations designated in the WMO RAAs. It should be emphasized that the WMO Alert Hub only serves to disseminate warnings to users. The warnings remain as a product originated from NMHSs and RAAs, including RSMCs and TCWCs.

CAP is an XML-based data format designed for exchanging public warnings for all-media and all-hazard communications. It has the following merits and is ideal to serve as a standard for communicating warnings for GMAS:

- **Reduce cost/complexity** - A CAP message sender can activate multiple warning systems with a single input;
- **Facilitate common situation awareness** - Standardized data format of warning from many sources can be easily consolidated to enhance situational awareness, providing a whole picture across all types of local, regional, and national warnings;
- **Consistency** - CAP provides consistency over multiple channels, allowing exact corroboration of warning information;
- **Flexibility** - CAP is useful for multilingual application and can be targeted to special-needs populations; and
- **Breakthrough standard** - Geographic information in a CAP alert allows targeting of users.

As a proof-of-concept, the Hong Kong Observatory (HKO) has established a prototype of alert hub aggregating available authoritative warnings in CAP format issued by worldwide NMHSs. The prototype is developed based on the Filtered Alert Hub project and is operating on cloud computing platform. Figure 3 depicts the basic operations of the prototype alert hub. The alert hub aggregation process can be initiated in two ways: either a publisher posts an immediate notice to the alert hub whenever the relevant

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4Filtered Alert Hub: http://alert-hub.org
news feed for warning is updated, or the alert hub periodically polls the publisher's news feed to check for updates. When the alert hub adds a new warning to its store, it also updates its own news feed. The alert hub may also provide a push service for those who need quick notification of new warnings.

5. A potential standardized scheme for impact-based warning presentation

According to the WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services (WMO-No. 1150), it recommended to create a risk matrix (Figure 4) for an expected hazard by identifying the likelihood (vertical axis) and potential severity (horizontal axis) of the hazard. Since CAP alerts carry essential information about the certainty (likelihood), severity and urgency of a hazard event, this made CAP an ideal candidate for conveying the risk level of hazards to users.

To convey warning message to people who speak and write in different languages is challenging. The lack of a standard in the meteorological and hydrological communities in naming hazard type introduced additional barrier for
people to understand the warnings issued by NMHSs and RAAs. Despite this, there is an international standard on guidelines for colour-coded alerts for use by emergency management community to inform people at risk, viz. ISO 22324.

Figure 5 depicts a potential scheme to standardize the presentation of impact-based warnings with the application of CAP and ISO 22324. CAP standard provides essential information about the urgency, severity and certainty (USC) of a hazard event. The proposed approach is to assign hazards to various levels of USCs of CAP, and then provide visualization on the CAP alerts by mapping the severity of CAP to colours based on ISO 22324 standard. Through the adoption of the standardized scheme, the display platform can increase the effectiveness of delivery and use of official alerts issued by NMHSs and RAAs.

6. Enabling CAP in SWIC and WWIS

The WMO SWIC website was set up to provide a centralized source for effective access of official warnings provided by NMHSs as well as advisories issued by RSMCs and TCWCs. Apart from TCs, the SWIC website also provides official observation data for heavy rain (including snow), thunderstorm, gale, fog, cloudiness and rain. On the other hand, the WWIS was established as a centralized source for official weather observations, weather forecasts and climatological information for selected cities supplied by NMHSs worldwide. By January 2018, WWIS provides official weather information for 2123 cities. A total of 135 members are providing forecasts for 1993 cities while 169 members are providing climatological information for 1957 cities.

Both SWIC and WWIS are identified as core components
of the GMAS. They will serve as centralized platforms to display authoritative warnings issued by NMHSs and RAAs in CAP format on a GIS-based map. Both websites are being upgraded to enable the display and dissemination of CAP-formatted warnings. It should be noted that before SWIC can be enhanced as described above, it is essential that NMHSs and RAAs be encouraged to adopt CAP format for their warnings and disseminate these warnings to the WMO Alert Hub for use on the upgraded SWIC. Figure 6 shows a mock-up of the upgraded SWIC. The WWIS will likewise be upgraded to become a centralized platform for official weather observations as well as authoritative forecasts and CAP-formatted warnings provided by NMHSs around the world (Figure 7).

It is expected that enhancement of SWIC and WWIS to enable the aggregation, display and sharing of warnings in CAP format from NMHSs and RAAs around the world will serve to uphold the authoritative voice of NMHSs and RAAs.

7. Tropical cyclone warnings and advisories

Apart from warnings issued by NMHSs, TC warnings and advisories issued by RSMCs and TCWCs are also indispensable information for users and should be made

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**Fig. 7.** Mock-up of the upgraded WWIS website to incorporate WMO Members’ warnings in CAP format
available to GMAS and the upgraded SWIC. Currently, TC information available on the SWIC website included current and past positions of TCs on a fix map display while the associated warning advisories as well as forecast are provided as hyperlinks. Enhanced with GIS capability, the upgraded SWIC website is intended to display comprehensive TC information including forecast positions, intensity and other relevant parameters, and disseminate the information in standard format to users. One of the challenges in upgrading SWIC to support GMAS is that the existing TC warnings and advisories issued by some RMSCs and TCWCs are in free text format and are not ready for parsing automatically by machine. Thus essential TC information including analyzed and forecast positions, intensity and other relevant parameters cannot be extracted from the current TC warnings and advisories in a reliable way for use on the upgraded SWIC and for use on other applications.

Currently, BoM disseminates TC advisories in CXML format while RSMC Tokyo of JMA provides TC advisories in CAP format on an experimental basis. Both formats are machine-readable and facilitate the re-use of the data by GMAS and other applications. In this connection, it is recommended that RSMCs and TCWCs provide TC advisories in machine-readable format to GMAS so that TC information in their respective responsible areas can be made available to GMAS for use by the UN humanitarian organizations, NMHSs and other global users.

8. Conclusion

Tropical cyclones are amongst the most destructive weather systems on the earth. The associated hazards such as storm surge, heavy rain and high winds affect many people and cause huge economic loss around the world every year. In addition to accurate forecast, effective dissemination of warnings to users is very important in reducing the loss of life and damages. GMAS is a WMO global platform aggregating authoritative multi-hazard warnings issued by NMHSs and RAAs, including RMSCs and TCWCs. The NMHSs / RAAs contributing to GMAS will be recognized as the only authoritative source of multi-hazard warning information. It is highly desirable and essential for RSMCs and TCWCs to make available their TC advisories in machine-readable format to ensure the effective delivery to GMAS to use by members of the public, media, relevant UN agencies, humanitarian organizations, governments and other relevant stakeholders.

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