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South-East European Multi-Hazard Early Warning Advisory System (SEE-MHEWS-A)

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Introduction

As weather, climate and the water cycle know no national boundaries, international cooperation at a global and regional scale is essential for developments in the fields of meteorology, climatology and hydrology as well as to reap the socio-economic benefits from their application. WMO provides the framework for such international cooperation.

To deliver on its mandate, WMO collaborates with global, regional and national forecasting centres, which form the WMO Global Data Processing and Forecasting System (GDPFS). These include the European Centre for Medium-Range Weather Forecasts (ECMWF), which is both a research institute and a 24/7 operational service. It produces global numerical weather predictions and other data for ECMWF Member and Co-operating States, WMO Member States & Territories and the broader community. ECMWF also manages a number of computing services, including a supercomputing facility and cloud services, for its Member and Co-operating States, providing vital resources for computer modelling of the global atmosphere and ocean and for weather forecasting research and time-critical activities.

National Meteorological and Hydrological Services (NMHSs) work around the clock to monitor the Earth's system and share vital weather, climate and water information worldwide. Their early and reliable warnings of severe weather as well as of climate variability and change allow decision-makers, communities and individuals to better prepare for related risks. Their warnings help save life and property, protect resources and the environment and underpin socio-economic growth. WMO supports the work of these National Meteorological and Hydrological Services, enabling them to meet their international commitments in the areas of disaster risk reduction, climate change mitigation and adaptation, and sustainable development.

Sendai Framework, DRR, Early Warnings, GMAS

The Sendai Framework for Disaster Risk Reduction 2015–2030 recognizes the benefits of multi-hazard early warning systems and enshrines them in one of its seven global targets: “Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030”.

Early warnings are a major element of disaster risk reduction. Such warnings can prevent loss of life and reduce the economic and material impacts of hazardous events, mitigating disasters.

In the context of this presentation and in relation to Sendai Framework for Disaster Risk Reduction, we underline WMO's role in facilitating, promoting and supporting the provision of weather, climate and water-related services, and ECMWF's role in the operational production of weather forecasts on a 24/7 basis. These roles are performed through the application of science and technology in operational meteorology and hydrology to reduce disaster risks and contribute to climate change adaptation, as well as for sectors such as transport (aviation, maritime and land-based), water resource management, agriculture, health, energy and other areas.

The WMO Global Multi-hazard Alert System (GMAS) is poised to substantially increase and enhance the availability of authoritative warnings and information related to extreme and/or potentially high-impact weather, water and climate events – regionally and globally. GMAS is intended to be a highly visible and accessible resource for warnings and a vehicle for

1. Identifying gaps in capability and where capacity development is needed to generate and disseminate these warnings
2. facilitating investments by development partners
3. promoting outreach to those at risk and to decision-makers
4. improving visibility and recognition of national alerting authorities
5. harmonizing and standardizing specific warning parameters; and
6. promoting cross-border cooperation.

To achieve these objectives, GMAS will leverage, strengthen and help sustain national early warning systems (EWSs). One of the prerequisites for successful implementation of GMAS Framework is broadening of the existing WMO Data Policy for international exchange of observed data.

WMO Data Policy

The last decades have seen explosive growth in the demand for weather, climate and water monitoring and prediction data to support essential services needed by all sectors of society as they face issues related to climate change, such as the increasing frequency and intensity of extreme weather, and the cascading implications for e.g. disaster risk reduction, food security and many other applications.

WMO Data Policy must evolve to accommodate areas such as atmospheric composition, oceans, cryosphere and space weather, to help the WMO community to strengthen and better sustain monitoring and prediction of all Earth system components, which in turn will enable all WMO Members to deliver better, more accurate and timely weather- and climate-related services to their constituencies.

With this in mind, WMO Members will consider the adoption of a new *WMO Unified Policy for the International Exchange of Earth System Data* at the forthcoming World Meteorological Congress (Ext-Cg (2021)).

South-East European Multi-Hazard Early Warning Advisory System (SEE-MHEWS-A)

When we look at the practical implementation of WMO GMAS at the sub-regional level, our focus in today's presentation is on the South-East European Multi-Hazard Early Warning Advisory System (SEE-MHEWS-A) – an initiative jointly developed and implemented by WMO, ECMWF and 18 countries of South-East Europe with support from World Bank, USAID, European Commission, and others.

The development of SEE-MHEWS-A, including encouraging results from the demonstration, quasi-operational phase, shows its potential to empower NMHSs of the region to better deliver on their core mandates. Such activities belong to key measures of climate change adaptation options that enable NMHSs to contribute to reaching the Sustainable Development Goals, particularly Goal 13: Take urgent action to combat climate change and its impacts, and Goal 6: Ensure availability and sustainable management of water and sanitation for all.

South-East Europe (SEE) has experienced a significant number of severe meteorological and hydrological hazardous events such as floods, extreme temperatures, severe storms, droughts, wildfires, and landslides. Over the last 20 years, more than 6 000 people lost their lives and over 12 million people were negatively affected by weather, climate, and hydrology related disasters in this region. Furthermore, the total estimated losses and damage from these disasters during this period amounted to over US$ 20 billion.

South-East European countries are making an important leap in taking the cooperation to a higher level by joint development and operationalization of their SEE-MHEWS-A forecast system, which aims to strengthen the variety of existing early warning capacities in the region. This system, as sub-regional implementation of the WMO GMAS Framework, aims to provide NMHS operational forecasters with effective, efficient, and easy to apply tools for improved and more accurate forecasting of hazardous events and early warnings and to ensure that national authorities have the best possible information to carry out early actions and make the decision that can mitigate potential impacts of hazardous situations. Countries need to invest on a permanent basis in the further development and maintenance of their hydrometeorological observation infrastructure and in the improvement of the status of their National Meteorological and Hydrological Services (NMHSs). Complementary to these national activities, through international cooperation these countries will achieve better quality of weather and water related information and advisories from jointly owned digital/cloud-based multi-hazard early warning advisory system. The outputs of the system reaching the end-users, principally disaster risk management authorities, will ultimately serve more than 200 million inhabitants in South-East Europe.

The foundation of the SEE-MHEWS-A system is the “Policy on the Exchange of Hydrological and Meteorological Data, Information, Forecasts and Advisories under the South-East European Multi-Hazard Early Warning Advisory System” under which the project countries agreed on the technical and conceptual principles required to promote data, information, forecasts and warning exchanges and interoperability. This data policy will allow access to a large quantity of additional observations, which generally has not been shared neither regionally nor globally, to be input into the system for various applications, such as data assimilation for numerical weather prediction, and verification, hydrological modelling and nowcasting.

The signatories of the Policy provide additional observations to those they routinely share via WMO Global Telecommunication System (GTS). Additional data are collected with the support of Hungarian Meteorological Service under the SEE-MHEWS-A system in the Central Observational Database (CODB) hosted by the ECMWF. Currently, additional observations from approximately 500 stations are being provided regularly by the countries to ECMWF which is approximately 1.5 more than what is available via WMO GTS.

Numerical Weather Prediction (NWP) cooperation is one of the most important aspects in the development of the regional advisory system. During the pilot phase of the SEE-MHEWS-A

implementation in 2018-2022, the NWP teams from Slovenian Environment Agency, Croatian Meteorological and Hydrological Service, Hellenic National Meteorological Service, Israel Meteorological Service and University of Belgrade (Serbia), supported by the ECMWF, have cooperated to set up quasi-operational running of several limited area models. ALADIN, COSMO, ICON and NMM-B models with high-resolution (2.5 or 4 km) are set up for a domain which covers an extended area around South-East Europe, including parts of the Middle East. All these NWP models are run on ECMWF supercomputing facilities and using a portion of computing resources available to all ECMWF Member States. Furthermore, efforts have been put into development and implementation of a verification methodology to evaluate the quality of the produced forecasts. The model outputs will be available for all NMHS-users of the SEE-MHEWS-A, and will be used for other system modules, such as hydrological modelling and nowcasting.

As floods are one of the most devastating hazards in the region, the development of the SEE-MHEWS-A system has a specific emphasis on improving the flood forecasting capacities, especially on transboundary catchments. Hydrological modelling systems have been set-up for pilot river catchments in the region (*Vrbas* in Bosnia and Herzegovina and *Vardar* in North Macedonia). The INCA Nowcasting system by ZAMG (Austria) has also been implemented for *Vrbas* River catchment. Eventually, flood forecasting and nowcasting modules will be extended to cover all critical river catchments in the region. In the future, the modelling framework is expected to include sand and dust and marine/oceanographic modules.

A Common Information Platform (CIP) is being designed in close collaboration with ECMWF to exchange all forecasting data and products from NWP, nowcasting, and hydrological models, together with additional observations. These will be shared across all the countries, based on their agreed data policy. In this respect SEE-MHEWS-A System development will closely follow the concepts and recommendations of the WMO Information System of second generation (WIS 2.0) and strive to reduce the volume of transferred data by bringing the Common Information Platform as close as possible to the forecasting applications, hence computational facilities. During the pilot phase of the SEE-MHEWS-A development, the system is hosted by the ECMWF, using the ECMWF supercomputing facilities and European Weather Cloud resources.

Conclusions

The development of the system is a joint effort between internal and external stakeholders including National Meteorological and Hydrological Services of the region, WMO Regional Specialized Meteorological Centres, European Meteorological Infrastructure organizations, research institutions/academia, European numerical weather prediction consortia, relevant projects, regional and international organizations in the field of disaster risk reduction and WMO. This collaboration effort shows the power and potential of international cooperation which contributes to the optimization of national efforts, both in terms of human power and financial resources. This calls for a dedicated effort to develop a long-term research and development plan for South-East Europe, integrated within relevant pan-European actions. This plan will serve as a vehicle for long-term cooperation under WMO, EU integration in the field of meteorology and hydrology, and improvement of operational practices in all countries of the region.

Implementation of the pilot/demonstration phase of the SEE-MHEWS-A system is done in close collaboration between the WMO, ECMWF and NMHSs of the region. Preparations for the further developments are under way, building on experiences gained in the pilot phase. Lessons learnt from the pilot phase include technical challenges which Global Data Processing and Forecasting Centers and NMHSs

are facing when more observations become available for processing than is presently available via GTS. NMHSs will need to ensure that the observations are performed and shared according to the WMO standards and that the data is quality controlled. Providing support for this will be one of the functions of the Regional WIGOS Centers (WMO Integrated Global Observing System). This role has been partially performed by ECMWF and WMO during this pilot project resulting in valuable lessons learnt that will guide the implementation of the next phase of SEE-MHEWS-A project.

This sub-regional GMAS implementation is an example of how improved collaboration could contribute to better performance of national multi-hazard early warning systems. It shows that a regionally owned advisory system, such as the SEE-MHEWS-A, may improve prevention, preparedness and response and will help us to adapt to climate change and build a more resilient, sustainable future. WMO remains committed to supporting GMAS implementation of such good practices in different parts of the world as needed.

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