



Impact Based Forecasting Working Paper

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This paper is part of the SAHF Regional Approach Document for improvement of hydro-met service delivery in SAHF member countries. The SAHF programme is being funded and guided by the World Bank and technically supported by the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia.



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This paper is part of the SAHF Regional Approach Document for improvement of hydromet service delivery in SAHF member countries. The SAHF programme is funded and guided by the World Bank and technically supported by the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia. The paper is drafted by RIMES experts and does not reflect the views of the World Bank Group.

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Citation

RIMES, 2022. *SAHF Working Paper 03-Impact-based Forecasting*, Pathumthani, Thailand: RIMES.

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ACRONYMS

AI	Artificial Intelligence
AMD	Afghanistan Meteorological Department
ARRCC	Asia Regional Resilience to a Changing Climate
AWLS	All Weather Landing System
BANCCA	Bangladesh National Center for Climate Applications
BMD	Bangladesh Meteorological Department
CAP	Common Alerting Protocol
CARE	Climate Adaptation and Resilience
COMET	Cooperative Programme for Operational Meteorology Education and Training
COSMO	Consortium for Small-scale Modeling
DATAEX	Data Exchange Platform by RIMES
DIANA	Digital Analysis
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSS	Decision Support Systems
ECMWF	European Centre for Medium-Range Weather Forecasts
EWA	Early Warning Advisory
EWS	Early Warning Systems
FFGS	Flash Flood Guidance System with Global Coverage
GCF	Green Climate Fund
GFS	Global Forecast System
GLOF	Glacial Lake Outburst Flood
GTS	Global Telecommunication System
IBFWS	Impact Based Forecast and Warning Services
ICON	Icosahedral Nonhydrostatic
ICT	Information and communications technology
IITM	Indian Institute of Tropical Meteorology
IMD	India Meteorological Department
INCOIS	Indian National Centre for Ocean Information Services
IPCC	Intergovernmental Panel on Climate Change
JAICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
KMA	Korea Meteorological Administration
MME	Multi-model Ensemble
MMS	Maldives Meteorological Service
MOS	Model Output Statistics
NCHM	National Center for Hydrology and Meteorology
NCMRWF	National Centre for Medium Range Weather Forecasting

NMHS	National Meteorological and Hydrological Services
NWP	Numerical Weather Prediction
RADAR	Radio Detection and Ranging System.
SAHF	South Asia Hydromet Forum
SCOPE	South Asia Consortium for data and weather Predictions
SNCCA	Sri Lanka National Center for Climate Applications
SOP	Standard Operating Procedure
SWFP	Severe Weather Forecasting Programme
ToR	Terms of Reference
WB	World Bank Group
WBG	World Bank Group
WG	Working Group
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting

Executive Summary

The IPCC in its Sixth Assessment Report released in mid-2021 indicated that the South Asia weather hazard elements are worryingly intensifying-hotter weather with longer and highly variable monsoon seasons, cyclones, storm surge, floods, droughts, heat and cold waves and glacier melt events continuing to pose serious risks. Rapid economic growth, greater capital stocks, rising population and continued urbanization have enhanced exposure elements in South Asia. To address these increasing climate risks and reduce disasters, actionable hydrometeorological services are crucial for the region. However, there are several challenges currently being faced by the National Meteorological and Hydrological services (NMHSs) of South Asia that hinder the delivery of hydromet services.

With the overarching objective to reinforce national activities leading to a more sustainable program of building state-of-the-art meteorological and hydrological services across the region through a structured and staggered approach under the guidance of the Executive Council (EC), SAHF brings together nine countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan and Sri Lanka. SAHF endeavours to strengthen the key elements of the hydro-meteorological services by leveraging regional collaboration while enhancing national capacities to fully meet user requirements. Among the most immediate and specific priorities are the improved forecasts of extreme events, both in terms of intensity and lead time anticipation, using ensemble prediction systems, impact-based forecasting and user-specific advisory services. There is a necessity to transition from traditional public weather services to impact based forecasting and warning services (IBFs) on a continuum of lead-times that range from hours to decades. This requirement is essential to maintain NMHSs relevance and utility to societies in the face of changing climate and extremes. IBF, therefore, is a priority for NMHSs in the region and is now being actively supported by the World Meteorological Organization (WMO) and other development partners.

While some NMHSs like Bangladesh, India and Nepal has made some progress in the implementation of IBF in sectors such as agriculture, disaster management and water and health, rest of SAHF NHMSs are yet to start the IBF process. Therefore, these beginnings need to be consolidated for more systematic progress towards value addition and operational service delivery in the region. SAHF is ideally positioned to orchestrate this process both during its current phase until end of March 2023 and in longer term through its mechanisms

of Working Group (WG) on IBF under the guidance of SAHF EC. Regional strengths can be beneficially leveraged building on national capacities and experience of good practices.

To begin with, the initial phase until March 2023 will focus on trainings and development of components of the SAHF Knowledge-hub. As outlined in the SAHF CE Working Paper two training modules on IBF shall be implemented. The Knowledge-hub document details the modalities of providing access to ensemble forecasts from global and regional centers, including forecast products available from the India Meteorological Department and the National Centre for Medium Range weather forecasting (NCMRWF), India.

On a longer-term regular capacity requirement assessment shall be carried out by SAHF anchoring/coordinating agency (like RIMES in the present phase). This capacity assessment and feedback from SAHF IBF WG Members will be ongoingly used to build need-based capacity enhancement leveraging regional strengths. Feedback from sector agencies will form the main guidance to steer the prioritization of requirements. It is also envisaged that partner agencies that are working to strengthen IBF capacity will share experience from in country Pilot projects to further strengthen the feedback process. Emerging needs to assess the impacts of coastal hazards and sea level rise for coastal and island states are also to be catered to build guidance for overall resilience building across coastal communities.

1. Introduction

In the last decade about 600 million people have been affected by at least one climate-related disaster of which nearly one-third of the population affected are in South Asia (Germanwatch, 2021). The IPCC in its Sixth Assessment Report released in mid-2021 indicated that the South Asia weather hazard elements are worryingly intensifying-hotter weather with longer and highly variable monsoon seasons, cyclones, storm surge, floods, droughts, heat and cold waves and glacier melt events continuing to pose serious risks. Rapid economic growth, greater capital stocks, rising population and continued urbanization have enhanced exposure elements in SAR, i.e., more people and assets are exposed to hazard events. To address these increasing climate risk and reduce disasters, actionable hydrometeorological services are crucial for the region. However, there are several challenges currently being faced by the National Meteorological and Hydrological services (NMHSs) of South Asia that hinder the delivery of hydromet services. Fragmented modernization efforts that remain financially and technically unsupported beyond project lifetime are one of the main concerns besides the limited regional collaboration.

With the overarching objective to reinforce national activities leading to a more sustainable program of building state-of-the-art meteorological and hydrological services across the region through a structured and staggered approach under the guidance of the Executive Council, SAHF brings together nine countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan and Sri Lanka. SAHF endeavours to strengthen the key elements of the hydro-meteorological services by leveraging regional collaboration while enhancing national capacities to fully meeting user requirements. Among the most immediate and specific priorities are the improved forecasts of extreme events, both in terms of intensity and lead time anticipation, through the use of ensemble prediction systems, impact-based forecasting and user-specific advisory services.

Despite the efforts of the National Meteorological and Hydrological Service (NMHSs) to provide accurate and timely warning information to protect lives and livelihoods in the region from the impacts of hydro-meteorological extreme events, extreme weather events have resulted in adverse impacts due to lack of clarity and relevance to specific decision contexts. Changing vulnerability and exposure profiles due to human habitation and climate change act to amplify impacts. These dimensions necessitate a transition from traditional public weather services to IBFs on a continuum of lead-times that range from hours to decades. This requirement is essential to maintain NMHSs relevance and utility to societies. IBF, therefore, is a priority for NMHSs in the region and is now being actively supported the World Meteorological Organization (WMO) and other development partners.

IBF is not a stand-alone process that can be delivered by the NMHSs. Impact-based forecasting requires collaboration with sector departments who have expertise in the subject area, resources and knowledge of actions and activities that need to be informed to alter decisions that can reduce damages and losses. IBF require data such as demographic data, crowd-sourcing techniques, geographical information systems (GISs), interoperability, and

third-party data integration and usage to deliver impact services that NMHSs cannot do on their own. From the perspective of service users, this would include communities most vulnerable to disasters contributing to the information system. Working closely together, the suppliers of the services and the beneficiaries of those services would provide an integrated, authoritative, unified voice that everyone could resonate with, and in turn could take effective action. Co-development, therefore, lies at the core of effective IBF. The focus of the present regional action is to build the knowledge and skills of NMHSs and the user sectors in developing impact-based forecasting tools and services.

2. Objectives

This WG would be responsible for developing and implementing a strategy to enable South Asia NMHSs to make full use of ensemble prediction and impact-based forecasting (IBF) methods using the latest guidance from WMO, experience of leading centers and successful use-cases demonstrated in the region. This will include developing training materials and drawing on appropriate regional and wider expertise of relevant experts. To begin with the SAHF Training modules implemented through the SAHF Training strategy described in the SAHF Capacity Enhancement Working paper and the SAHF Knowledge Hub being developed will serve as the primary mechanisms to deliver capacity improvements in IBF for the region. This strategy would also leverage ongoing and planned efforts to improve IBF carried out by other development partners and national agencies including academic institutions working in allied subjects. Thus, this working paper has the following objectives:

- To assess the existing capacities of NMHSs, map capacities to generate IBF and prioritize them into efforts, to be addressed during the current phase of SAHF till December 2022 and other needs to be addressed beyond the current phase of SAHF.
- To identify regional components to support IBF systems at national level and to build demand driven IBF services of the SAHF member countries.

3. Approach and Process

As a first step, the Working Groups (WG) for four thematic areas (Numerical Weather Prediction (NWP), Impact Based Forecasting (IBF), Observational Networks (ON), Capacity Enhancement (CE)) of SAHF were established by the SAHF Executive Council. The first WG meeting for the thematic area of IBF was held on 28 June 2021, where preliminary stocktaking of existing capacities and needs of NMHSs was implemented (see Annex 1 for the meeting report). Following this, individual consultations with WG members of each NMHS of SAHF member countries were carried out to have an in-depth understanding of the status in four

thematic areas concerning: existing capacities, available operational systems, gaps in current operational procedures, access to various datasets, challenges faced in sustaining operations, priorities for improvements and availability of human and technical resources (see Annex 2 for the consultation report). Additionally, an online survey was conducted from September to October 2021, which covered not only the WG members but also the staff from the NMHSs working at various levels (see Annex 3 for the survey results). The survey collected information on existing capacities, gaps and needs in the four SAHF thematic areas.

In November 2021, SAHF III was organized that brought together the NMHSs of SAHF member countries, regional partners and experts, international partners and experts, and users in the region to: (i) Showcase regional best practices and approaches in the hydromet and climate services value chain; (ii) Deepen and strengthen SAHF program, including weather, water, and climate services at the national and regional levels; (iii) Share knowledge about innovations and the socio-economic benefits of the value chain for hydromet and climate services as countries invest in new technology over the next decade; and (iv) Discuss and agree on the design of future SAHF activities. The forum identified several needs to improve the capacities of SAHF NMHSs in operational services delivery and recognized capacity development as the backbone for improving services. Thus, SAHF III recommended the need to design and implement a training schedule for SAHF Capacity Enhancement efforts across all components of the information value chain. The needs that were identified and recommended during SAHF III were considered in the stocktaking process. The summary of needs ensued from the SAHF III is given as Annex 4.

4. Status of IBF in the Region

IBFs in sectors like aviation, agriculture and water have been in operations in most countries of the region in a more traditional framework cast in a rather top-down fashion. Current conceptualization of the IBF process of probabilistic forecasts in a risk-based decision context is well captured in the schematic below.

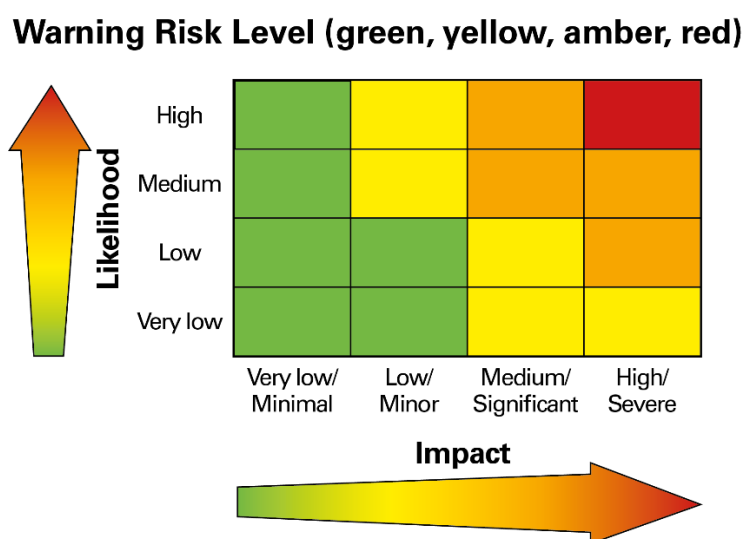


Figure 1: Probabilistic forecasts and risk enabled projection of sector and location specific impacts (WMO, 2020)

In some NMHSs like Bangladesh, India and Nepal progress has already been made with some illustrative examples in sectors such as agriculture, disaster management and water and health. UKMO led Asia Regional Resilience to a Climate Change (ARRCC) project has implemented training and co-development workshops during April 2020 in Nepal and Bangladesh (ARRCC, 2020). These beginnings' need to be consolidated for a more systematic progress towards value addition and operational service delivery in the region. SAHF is ideally positioned to orchestrate this process both during its current phase until end of March 2023 and in longer term through its mechanisms of WG on IBF under the guidance of SAHF EC. Regional strengths can be beneficially leveraged building on national capacities and experience of good practices.

The table below summarizes the overall status of IBF capacities and requirements within NMHSs in the region.

Table 1: Gaps and needs in IBF in the SAHF member countries

Country/NMHSs & current services	Gaps	Needs	SAHF Considerations
<p>Afghanistan/AMD</p> <p>Flash Flood Warning provided through AMD website</p> <p>Warnings issued before 24 hours through media platforms like Facebook and WhatsApp</p> <p>3-day weather forecast issued in AMD website</p>	<p>Forecasts are not skillful/not adequately verified due to the difficult terrain and sparse observational coverage, particularly over the mountainous areas of the country</p> <p>FFGS warnings not consistent, reported to have some uncovered areas where flood events were reported during 2021 monsoon season (JJA)</p> <p>Lack of robust communication mechanism</p> <p>High-altitude areas are prone to extreme weather events like heavy snowfalls & avalanches</p> <p>Availability of skill staff</p>	<p>AMD does not have a media center for broadcasting hydrometeorological information to public</p> <p>Afghanistan does not have EWS for Avalanches in high mountain regions</p> <p>As new staff has been inducted in AMD, trainings at all levels of IBF required</p>	<p>Introduce IBF and train the staff in IBF with emphasis on co-development as a crucial first step of the engagement process – in SAHF IBF training modules</p> <p>Strengthen observations for extreme weather events, particularly in high-altitude areas</p> <p>Develop hydro-met database for impact-based forecasting</p>
<p>Bangladesh/BMD</p> <p>Major stakeholders of BMD are Bangladesh Water Development Board (BWDB) and the Department of Agriculture Extension.</p> <p>Other partners are Tourism, Aviation and</p>	<p>Limited availability of historical data of hazardous weather and climate events and their impacts, access to risk information meta data, high-resolution geo-spatial data</p>	<p>Collaborate with key sector agencies to develop data bases for IBF, consider how the data intensive IBF process can be simplified using accessible satellite-</p>	<p>Implement training based on earlier pilot studies and projects conducted by ARRCC, RIMES and other development partners, Co-development with sector partners for IBF; setting-up automated systems for generating</p>

Country/NMHSs & current services	Gaps	Needs	SAHF Considerations
Ministry of Disaster Management and Relief.	Lack of capacities on IBF, no impact assessment done, no historic data and limited collaboration and coordination among BMD and stakeholders for IBF	based analysis, gridded regional, global data. Need more training for preparing geospatial data to implement IBF;	IBF in agricultural sector – like DSSs being implemented/developed under CARE project
<p>Bhutan/NCHM</p> <p>Flashfloods and riverine floods, windstorms, glacial lake outburst floods (GLOFs), landslides, heavy rainfalls.</p> <p>Dissemination of alerts through email, social media platforms, regular monitoring of glacier lakes and water level monitoring in river basins.</p> <p>Sector agencies - National Environment Commission; Department of Hydropower and Power Systems (DHPS); Department of Disaster Management; Department of Human Settlement; Department of Agriculture; Department of Public Health</p> <p>IBF system not operational. Still in pilot phase- IBF system- not sector</p>	<p>Lack of knowledge about IBF, better Stakeholders' coordination.</p> <p>Data on impacts and vulnerabilities.</p> <p>Gaps in communication and utilization of warnings.</p>	<p>Training on Impact based forecast- risk assessment, implementation of relevant IBF technical tools, real time monitoring and impact and CAP.</p> <p>Understanding of Hazards, Vulnerability, Exposure</p> <p>High resolution topography data, soil data, identifying real time hazards using remote sensing data.</p> <p>Web based applications for IBF.</p>	<p>Implement training and co-development workshop with key sector partners</p> <p>Improve weather forecast accuracy</p> <p>Integrate geospatial data in the impact forecast</p>

Country/NMHSs & current services	Gaps	Needs	SAHF Considerations
<p>specific. Covers agriculture, roads, and transport services.</p> <p>Drought monitoring under development.</p>			
<p>India/IMD</p> <p>Cyclone and associated hazards (wind, storm surge and heavy rains), cold/heat wave, dense fog, thunderstorms (lightning, winds, hailstorm), heavy rainfall, floods (surface flood)/ flash flooding (urban flooding), coastal flooding (low tide/high tide and rainfall epochs), riverine flooding, landslide and land sink and dam burst, severe heat wave, heat health warning systems</p> <p>IBF for 25 cities implemented in monsoon 2020, started computing and assigning colour code for Risk Based Matrix from Exposure and Vulnerability Data collected</p>	<p>Limited access to Geophysical and Socio-economic impact data at district and Sub-city scale. Exposure data collection at district and sub-city is ongoing.</p> <p>Scaling-up to cover all the key sectors and to cover the whole country is a challenge.</p>	<p>Automated systems to be developed on State wise basis down to sub-district level is a crucial requirement. Also, setting-up automated systems based on AI, integrating crowd sourced data and non-conventional data gathering through social media platforms are topics that need support and guidance, including IT support for maintaining DSS.</p>	<p>Knowledge platform support and trainings in AI and non-conventional data gathering</p>
<p>Maldives/MMS</p> <p>Flooding due to torrential rain and swell/tidal waves, thunderstorms, strong winds, rough</p>	<p>Lack of data- aerial data, hazard maps and bathymetry, topography data, vulnerable and exposure data.</p>	<p>Training on Impact based forecast (2).</p> <p>Develop national IBF implementation plan</p> <p>Risk and impact assessment for IBF</p>	<p>Implement IBF training for forecasters</p> <p>Develop national IBF implementation plan, co-development workshops.</p>

Country/NMHSs & current services	Gaps	Needs	SAHF Considerations
<p>seas, tropical cyclones.</p> <p>Refined CAP systems and SWFP guidelines. Web, phone SMS, social media (Community Viber Group, Facebook, Twitter) used for dissemination.</p> <p>Risk maps available.</p> <p>Stakeholders for IBF are National Disaster Management Authority, Water and Sanitation, Red Cross Red Crescent, Atoll and Island Council and Health.</p> <p>CAP operational, and SOP for provision of warnings of extreme weather using colour coding in place.</p>	<p>Lack of Hazard and impact matrix for flash floods.</p>	<p>Assessment of coastal hazards</p> <p>High resolution data for IBF implementation</p> <p>Determining and agreeing on the Impacts of hazards on individual stakeholders</p> <p>Update risk maps for hazards based on all the gaps to be filled</p>	<p>Strengthen access and accusation of high-resolution data for implementation of IBF</p>
<p>Myanmar/DMH</p> <p>Cyclones, heavy rains, floods, strong winds, storm surge, thunderstorms, landslide, high and low temperatures.</p> <p>Issue all forecast and warning on the DMH's Facebook and Website for the Public.</p> <p>Stakeholders for IBF are Agriculture, Transportation, Emergency Services (DDM, MRCS, etc.), Water and Health.</p>	<p>Lack of data for IBF.</p>	<p>Risk map for extreme weather events (heavy rainfall, cyclone, strong wind, Temp).</p> <p>Identify meteorological thresholds (rainfall, temp., wind).</p> <p>Technical assistance to prepare hazard map and risk map.</p> <p>Training on Impact based forecast- risk assessment, implementation of relevant IBF technical tools, real time monitoring and impact, CAP.</p>	<p>IBF training modules to be implemented.</p> <p>Co-development of IBF products with key stakeholder agencies, data for defining impact thresholds</p>

Country/NMHSs & current services	Gaps	Needs	SAHF Considerations
Ongoing efforts to operationalize CAP-SAHANA			
<p>Nepal/DHM</p> <p>Rainfall, flood, landslides, thunderstorms, windstorms, heat wave, cold wave and snowstorms.</p> <p>Key stakeholders are Agriculture, Tourism, Transportation and Disaster</p> <p>Piloting IBF in 16 municipalities of 4 districts in June 2021 under ARRCC UKMet support [Landslide as an impact of heavy rainfall along with other impacts of rainfall – more details requested from DHM WG Member on IBF, trial use of CAP.</p>	Human resource, reliable NWP output, Research and Development, co-ordination and communication of forecasts.	<p>IBF Research- Historical data & Analysis – thresholds</p> <p>NWP reliable forecast data, Real time observation data of the Hydro-meteorological parameters</p> <p>IBF training- risk assessment, implementation of relevant IBF technical tools, real time monitoring and impact, IBF</p> <p>Hazard mapping for all met hazards with thresholds.</p>	Scaling up IBF to the whole country and for all meteorological parameters and for longer lead time (at least a week).
<p>Pakistan/PMD</p> <p>Floods (Urban, Flash, and riverine), GLOF, Thunderstorm, Landslides, Tropical Cyclones, Droughts, Heat Wave.</p> <p>Key stakeholders are Disaster Risk reduction, Agriculture/food, Transport, Power, Tourism</p>	<p>Impact Assessment and</p> <p>Integration of forecast with severe weather events</p> <p>Hazard maps,</p> <p>IBF training- risk assessment,</p>	<p>vulnerability assessments and geotagged historical Hydro-meteorological extreme events. implementation of relevant IBF technical tools, real time monitoring and impact, IBF .</p>	Trainings to support transition from the initial stages for the implementation of IBF. Strategy to acquire geo based historical disaster data

Country/NMHSs & current services	Gaps	Needs	SAHF Considerations
Ongoing - Providing IBF for disaster risk reduction			
Sri Lanka/DoM Flood/Flash flood, Lightning, strong winds, drought Key stakeholders include Disaster Management sector, Marine (Fishery, Harbour etc.) Water, Health, and Agriculture Impact based warnings are initiated Availability of Ensemble products Extreme Index Forecast Experienced staff with relatively high academic background	Early warning for costal inundation Knowledge about impact from equatorial waves Automatic Rain Gauge System linked to FFG Single weather threshold for entire country. Specific thresholds for different areas	Developing Impact/Risk tables/Threshold values Improve Forecast accuracy and lead time IBF training- risk assessment, implementation of relevant IBF technical tools, real time monitoring and impact, IBF, GIS, better understanding about meteorological phenomena leading to hazardous weather, more research on case studies.	Trainings for generating risk tables for user sectors

Most countries face similar technical, capacity, resource, and other challenges in their efforts to implement IBF systems for provision of user-oriented hydro-meteorological and climate services. Creating a robust interface with user agencies that enables a process of co-development is an essential first step. This will enable resolution of the crucial bottleneck of lack of sector level data that most NMHSs have conveyed. There are two main requirements that are common to the region for enabling development of robust IBF:

- Requirements expressed towards awareness and trainings on IBF are across the countries of the region. This includes suggested co-development workshops that can help create effective interface with key sector agencies.
- All needed observation, forecast products and socio-economic data including vulnerability and risk information to be collected and collated for building IBF tools and associated service delivery enhancements.

5. Regional Approach to Develop IBF

Impact based forecast entails multi-stakeholder engagement for co-production of user relevant services. This presents an opportunity for providers and users of climate information to exchange data and value-added services, allowing for immediate feedback and decisions made in line with user needs. NMHSs have common requirements to improve their weather forecasting systems and services utilizing ensemble prediction, impact-based forecasting techniques and user-oriented decision-support services. There is a growing understanding of the potential for regional collaboration to address these constraints in operationalizing technologically complex systems and strengthening capacities to enhance service delivery component of the value chain. Regional cooperation is also critical for countries to keep up with rapid advances in technology and data science and progress towards impact-based forecasting. This would transform data into information through tailored services for a wide range of users through fostering collaboration with weather sensitive sector user institutions, academic and research systems across countries.

The SAHF III Annual Session held in November 2021 clearly brought out that forecast based action ensures early response to protect lives, livelihoods, and assets from disasters through preparedness and the need for regular dialogues between users and providers to drive this process. Community outreach is also crucial for strengthening this process. Due the varying capacities of the countries in the region as sustained regional mechanism to support them will ensure effectiveness of investments. Research and development on region and country specific needs is also critical and can be helped by collaboration with academic institutions. Forecasts, early warning systems and alerts need to be integrated seamlessly and sectoral agencies enrolled into using it through a co-development/user interface feedback process to result in changes and individual/ community level actions.

In the initial phase until March 2023 the focus will be on trainings and development of components of the SAHF Knowledge-hub. As outlined in the SAHF CE Working Paper two training modules on IBF shall be implemented. The Knowledge-hub document details the modalities of providing access to ensemble forecasts from global and regional centers, including forecast products available from the India Meteorological Department and the National Centre for Medium Range weather forecasting (NCMRWF), India.

WBG CARE project components like the Regional Data Analytics System (RDAS) will also be used to source data on impacts required for the national IBF process.

6. Action Plan and Timelines for Implementation

As indicated in the previous sections, the initial phase until March 2023 will focus on building of knowledge and skills in IBF through trainings and development of components of the SAHF Knowledge-hub. Table 2 provides the action plan to build knowledge and skills in IBF with current phase of SAHF.

Table 2: Timeline for the implementation of impact-based forecasting training

Title	Training Code	Timeline	Probable Resource	Status
Training to be implemented by RIMES under SAHF				
Basics of IBF	B-IBF-1	Jan 2023	SAHF	Resources available and training dates proposed
IBF for DRR and Agriculture	M-NWP-3/M-NWP-4/ M-IBF-2	Feb/Mar 2023	SAHF	Resources available and training dates proposed
Data policies / Regional Knowledge Platform	E-DM-4	Dec 2022/Jan- Feb 2023	SAHF	Needs consultation to discuss training date and resources

On a longer-term regular capacity requirement assessment shall be carried out by SAHF anchoring/coordinating agency (like RIMES in the present phase). This capacity assessment and feedback from SAHF IBF WG Members will be ongoingly used to build need-based capacity enhancement leveraging regional strengths. Feedback from sector agencies will form the main guidance to steer the prioritization of requirements. It is also envisaged that partner agencies that are working to strengthen IBF capacity will share experience from in country Pilot projects to further strengthen the feedback process. Emerging needs to assess the impacts of coastal hazards and sea level rise for coastal and island states are also to be catered to build guidance for overall resilience building across coastal communities.

References

- Asia Regional Resilience to Climate Change. (2020). *Enhancing capacity for communicating forecasts & early warning in Nepal*.
- Germanwatch. (2021). *Global Climate Risk Index 2021*.
<https://www.germanwatch.org/en/19777>
- IPCC. (2021). *Climate Change 2021: The Physical Science Basis*.
<https://www.ipcc.ch/report/ar6/wg1/>
- World Meteorological Organization. (2021). *WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services (WMO-No. 1150), Part II: Putting Multi-Hazard IBFWS into Practice*. https://library.wmo.int/index.php?lvl=notice_display&id=21994

Annex I – IBF Working Group Meeting Report

Overview

The meeting of the Working Group (WG) I- Impact Based Forecasting (IBF) was held on 28 June 2021, from 1:00 to 2:30 PM Bangkok time (UTC+7) through virtual mode. The agenda and list of participants are provided in [Appendix-1](#) and [Appendix-2](#). The meeting has the following objectives:

To understand and carry out an initial assessment of country-wise existing capacities, gaps and priority requirements in IBF

To appoint co-chairs of WG

To acquaint WG members on the requirements of WG

Opening session

On behalf of RIMES and the World Bank, Mr. Tshencho Dorji, Project Officer, RIMES and chair of the session opened the session of the first meeting of Working Group I-Impact Based Forecasting at 2:30 Bangkok time (UTC+7) on Monday, 28 June 2021. He welcomed the members of the working group and other participants to the meeting. Dr. G. Srinivasan, Chief Scientist, RIMES welcomed the participants on behalf of the Director, RIMES and he thanked the members of the working group for showing enthusiasm in this regional endeavours. He highlighted that Impact Based Forecasting is a relatively new but critical area that NHMSs are forging ahead with. He emphasized the importance of the contribution of WG members in the thematic area through individual and group consultations and survey forms.

Introduction of participants

Mr. Tshencho Dorji moderated the introduction of participants. He highlighted the importance of continued communication and interaction within the WG members to know each other well and taking the works of the WG forward.

Appointment of Co-Chairs

To lead the WG and liaise with the project team of the RIMES, the need for co-chairs of the WG was noted. The delegates from the NMHSs of the SAHF partner countries and members to this WG elected the following delegates as the co-chairs for the WG I- Impact based Forecasting.

- Dr. Zaheer Ahmed Babar, Director, National Weather Forecasting Center, Pakistan (Co-Chair)
- Dr. Shiromani Jayawardane, Director, Weather Forecasting and Decision Support, Sri Lanka (Co-Chair)

Presentation by each WG member

The members of the working group presented their reflections on the TOR of the WG, and the existing capacities, gaps and priorities needs of their countries in impact-based forecasting. The summary of priority requirements of impact-based forecasting in South Asia (SA) are highlighted below:

Establish/strengthen the impact-based forecasting to enhance the delivery of weather and climate information and services

- Capacity building of NHMSs staff in impact-based forecasting (short term and long term training required)
- Development of geospatial hierarchical databases for effective monitoring, warning and management of hydrometeorological hazards
- Improvement of computing and observational infrastructures

- Enhancement of research in weather forecasting and modelling
- Strengthen collaboration and communication with disaster management agencies and other climate-sensitive sectors in each country and among the NMHSs in South Asia.

Table 3: A summary of country-wise priority requirements is tabulated below.

More information on country-wise requirements is provided in their respective presentations provided in Appendix-3.

Country	Priority requirement for IBF
Afghanistan	Introduce IBF and train the staff in IBF Strengthen observations for extreme weather events Develop hydro-met database for impact-based forecasting
Bangladesh	Country-wise impact assessment Capacity building in IBF Implementation of CAP/Meteo Alarm
Bhutan	Introduce and train forecasters in IBF Geospatial web-based to generate impact-based maps and displaying forecast Integration of socio-economic data with weather data for assessing risks and impacts
India	Consultation and feedback from stakeholders on the use of IBF
Myanmar	Develop risk map for extreme weather events Capacity building in IBF Technical assistance to prepare hazard maps
Nepal	Hazard mapping for hydrometeorological hazards Nation wise IBF forecast required Capacity building in IBF
Pakistan	Improve geospatial database for disaster Capacity building in IBF
Sir Lanka	Develop impact/risk table and threshold values Improve geospatial database Capacity building in IBF

Discussion and way forward

Dr. Srinivasan RIMES moderated the discussion session. Following recommendations ensued from discussions for taking the work in IBF forward.

- Share and exchange data in the SA region to meet the IBF needs
- Improve the coordination between stakeholders and NHMSs
- Paradigm shift from hazard warning to impact-based forecasting and warning
- Assessment of stakeholders needs and prioritize their requirements for the development of IBF
- Scaling up existing IBF products available from IMD and others in SA
- Development of a strategy for stakeholder engagement

Appendix 1: Agenda

Table 4: Agenda of Working Group meetings held on 28-29 June 2021

Program	Time (minutes)
Remarks (Moderator)	5
Introduction	5
Appointment of Chair and Co-chair of the Working Group	10
Presentation by each WG member (5 minutes each) <i>Reflections on WG TOR</i> <i>Priority needs of each country based on respective Thematic Areas</i>	45
Discussion and way forward	25

Table 5: Schedule of Working Group meetings held on 29- 28 June 2021

Monday, 28 June 2021	
1:00 pm-2:30 pm (Bangkok Time)	Working Group 1- Impact Based Forecasting
3:00pm-4:30 pm (Bangkok Time)	Working Group 2- Numerical Weather Prediction
Tuesday, 29 June 2021	
1:00 pm-2:30 pm (Bangkok Time)	Working Group 3- Observational Networks
3:00pm-4:30 pm (Bangkok Time)	Working Group 4- Capacity Building

Appendix-2: Participants List

Table 6: Participant list of the IBF Working Group Consultation held on 28 June 2021

WG-1	Dr. Muhammad Abul Kalam Mallik	Bangladesh	mallikak76@yahoo.com
	Mr. Saroj Acharya	Bhutan	sacharya@nchm.gov.bt
	Dr. R.K. Jenamani	India	rjenamani1@yahoo.co.in
	Mr. Ali Shareef	Maldives	ali.shareef@met.gov.mv
	Ms. Chaw Su Hlaing	Myanmar	chawsuhlaing.dmh@gmail.com
	Ms. Shanti Kandel	Nepal	kandelpeace@gmail.com
	Dr. Zaheer Ahmed Babar	Pakistan	zaheer_a_babar@hotmail.com
	Dr. I.M.S.P. Jayawardane	Sri Lanka	Shirojaya2000@yahoo.com
RIMES Team	Dr. G. Srinivasan		srini@rimes.int
	Dr. K.J. Ramesh		kjramesh2607@gmail.com
	Dr. Anshul Agarwal		anshul@rimes.int
	Dr. Itesh Dash		itesh@rimes.int
	Mr. Tshencho Dorji		tshencho@rimes.int
	Ms. Kousalya V Kumar		kousalya@rimes.int
World Bank	Ms. Dechen Tshering		dtshering@worldbank.org

Annex II- Country Consultation Report

Background

South Asia Hydromet Forum (SAHF) is constituted with the vision to strengthen the key elements of the hydro meteorological services at national and regional scale. The forums are dedicated towards evolving collaborative regional strategies to increase the use of ensemble predictions, impact-based forecasting systems and user oriented advisory services. Capacity enhancement shall align to these requirements by adopting a demand and context driven approach that leverages regional actions while meeting the differential needs of the various NMHSs.

It is a unique institutional mechanism involving shared vision, participatory process, openness to innovation, open data sharing and engagement with research institutes and communities for innovation. SAHF is envisioned to be a demonstrable institutional mechanism of the WMO's Hydromet value chain and a best practice to replicate in all other regions globally.

An overarching objective of the **SAHF** is to reinforce national activities leading to a more sustainable program of development of meteorological and hydrological services throughout the region. An important aspect of the forum is **"learning from each other"**; which involves developing solutions to the meteorological and hydrological challenges that are unique to the region. SAHF aims to leverage hydromet capacities within the region to strengthen each other through collaborative regional strategies. SAHF also aims to identify specific fit-for-purpose investments to build technical and intellectual capacity of NMHSs in South Asia to respond to the main users' needs using skills that exist in the region and globally.

Process and Preparation of Consultation

With the overarching objectives and purpose SAHF in place, meetings of the Working Groups (WG) in the four thematic areas were conducted during 28-29 June 2021 from all nine South Asian countries to familiarize WG members with SAHF process, seek initial understanding of each NMHSs' capacities and needs. This consultation with WG members of each NMHS of SAHF countries was carried out to get in-depth understanding of the status in four thematic areas with respect to: existing capacities, available operational systems, current operational procedures, access to various datasets, challenges faced in operations, priorities for improvements and human and availability of technical resources. Also, this consultation aimed to identify the strengths of individual NMHSs which could be a resource for the region.

Table 7: Schedule for consultation meetings with WG members of SAHF countries

Date	Time (Bangkok Time: UTC+7hrs)	Country
10 August 2021	11:00 am- 1:00 pm	Bhutan
	3:00 pm -5:00 pm	Afghanistan
11 August 2021	11:00 am- 1:00 pm	Maldives
	3:00 pm -5:00 pm	Bangladesh
13 August 2021	3:00 pm -5:00 pm	Myanmar

16 August 2021	3:00 pm -5:00 pm	Pakistan
18 August 2021	11:00 am- 1:00 pm	India
19 August 2021	3:00 pm -5:00 pm	Nepal
20 August 2021	11:30 am -1:30 pm	Sri Lanka

The consultation meeting was coordinated and led by the RIMES and the World Bank team involved in SAHF implementation (Table 8). The consultation meeting was attended by the WG members of SAHF four thematic areas from the SAHF member countries.

Table 8: Composition of RIMES and World Bank for the consultation meetings

RIMES	Dr. G Srinivasan, Team leader Dr. K.J. Ramesh, Sr. Advisor Dr. Anshul Agarwal, Technical Expert Dr. Itesh Dash, Technical Expert Mr. Tshencho Dorji, Technical Expert Ms. Kousalya V Kumar, Program Coordinator
World Bank	Ms. Dechen Tshering, WB Expert

Summary of Consultation

The following sections provide a summary of discussions with individual SAHF countries.

Afghanistan

The consultation meeting with Afghanistan Meteorological Department (AMD) was held on 10 August 2021 between 03:30 pm -05:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from Afghanistan Meteorological Department attended the meeting:

- Mr. Nasim Muradi
- Mrs. Tahmina Askari
- Mrs. Kubra Mahmoodi

Table 9: Outlines of consultation meeting between WG from SAHF and Afghanistan

Impact Based Forecasting	Existing Capacities Flash Flood Warning provided through AMD website Warnings issued before 24 hours through media platforms like Facebook and WhatsApp 3-day weather forecast issued in AMD website
	Gaps and Needs GEFS forecasts not skillful over Afghanistan FFGS warnings not consistent, reported to have some uncovered areas where flood events were reported during 2021 monsoon season (JJA) No Media Center or broadcasting of weather information on television

	High altitude areas need to be focused on as they experience heavy snowfalls and avalanches
Numerical Weather Prediction	Existing Capacities 3 days forecast through AMD website in 3 languages Aviation Briefing Department Upper Air Station-1(Kabul Airport) METCAP+ connected to GFS model
	Gaps and Needs High resolution modelling MME and High-Resolution models required. GFS resolution is weak No operational WRF/LAM models being run at AMD
Observational Networks	Existing Capacities 25 synoptic stations (6 stations connected in GTS); 6 AWS stations Observations are shared between stakeholder on request Work on data sharing policy ongoing Weather stations in high elevation
	Gaps and Needs Generation of TAF reports and other aviation met forecasts Lack of stations in all provinces Other agencies and govt departments may have observational networks that need to be assessed, mapped and included in a future strategy for observational networks.
Capacity Building	Existing Capacities Online Trainings
	Gaps and Needs Trainings in Synoptic Division Basic synoptic training to carry out interpretations Communication Systems

Others Matters

- Online trainings are hardly possible because of limited resources a laptops/computers and poor internet connectivity. In addition, current civil the ongoing situation makes the situation worst for attending online trainings.
- Prefer to receive face to face trainings at regional training center in India or other similar venues.

Bangladesh

The consultation meeting with Bangladesh Meteorological Department (BMD) was held on 11 August 2021 between 03:00 pm -05:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from BMD attended the meeting.

- Dr. Muhammad Abul Kalam Mallik
- Dr. Md. Abdul Mannan
- Mr. Md. Abdul Matin
- Mr. S. M. Quamrul Hassan

Table 10: Outlines of consultation meeting between WG from SAHF and Bangladesh

Impact Based Forecasting	<p>Existing Capacities Thunderstorm, Cyclonic Storm, Storm Surge and Fog Forecasting Access to risk information as static data Heat Wave Forecast Pilot IBF project on Fog being conducted under ARRCC Work Package 1</p>
	<p>Gaps and Needs Event wise assessment of impact Lack of impact data Assessment of IBF Improve forecast accuracy Linking risk information with early warning and forecasting Access to risk information as meta data Increase lead time Listing of different indicators for vulnerability, exposure, examples of how the data intensive IBF process can be simplified using satellite-based analysis, gridded regional, global data. [This may help scaling up pilot initiatives]</p>
Numerical Weather Prediction	<p>Existing Capacities WRF model GFS Model JMA Model [Storm Surge]</p>
	<p>Gaps and Needs Advanced Storm Surge Model Test run for boundary forcing Probabilistic forecasts Institutional bias correction of models</p>
Observational Networks	<p>Existing Capacities 57 synoptic observations 5 RADAR system [conditions not good; 2 RADARS non-functional, 3 partially functioning, JAICA replacing 2 RADARS] AWS/AWLS [Lack of maintenance and communication concerns] Rain Gauge 8 lighting sensors Satellite data reception – HIMAWARI-CMA FY and KMA Under World Bank projects – 35 AWS, 65 Agromet stations and 125 automatic rain gauges being added</p>

	<p>Gaps and Needs</p> <p>Lack of manpower in synoptic stations Satellite observation system [to be received from JMA] Common lighting observation system BMD has been conducting induction trainings at both senior and Class 2 levels. For the last 2-3 years such trainings have not been conducted as no new recruitments are being done at BMD.</p>
<p>Capacity Building</p>	<p>Existing Capacities</p> <p>New Recruits: WMO affiliated 1 year training [Administrative problems in new recruitment] All staff has basic knowledge in Linux operating system Refresher courses [Not conducted for past 5 years] WB Supported Project-Trainings in Marine meteorology, climatology, disaster management and ICT In house trainings IMD training in association with UK Met Office</p>

Other Matters

- Frequent trainings are necessary to keep update of evolving science in weather and climate.
- Integration of all RADARs in South Asia under one system is required

Bhutan

The consultation meeting with National Center for Hydrology and Meteorology (NCHM) was held on 10 August 2021 between 11:00 am -01:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from NCHM attended the meeting.

- Mr. Saroj Acharya
- Ms. Monju Subba
- Mr. Jangchup Choephyel Dorji
- Ms. Ugyen Tshomo

Table 11: Outlines of consultation meeting between WG from SAHF and Bhutan

<p>Impact Based Forecasting</p>	<p>Existing Capacities</p> <p>IBF system not operational. Still in pilot phase (details required to be furnished) [IBF system- not sector specific. Covers air culture, roads, and transport services.] Dissemination of alerts through website, email, social media platforms Regular monitoring of glacier lakes (15) Water level monitoring in river basins Drought Monitoring Platform [Not Operational] ICIMOD Flash Flood Guidance system (SAFFG)</p>
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	<p>Gaps and Needs Lack of knowledge about IBF Stakeholders' coordination Data on impacts and vulnerabilities Gaps in communication and utilization of warnings Web based applications for IBF There has been loss of lives due to extreme weather events</p>
<p>Numerical Weather Prediction</p>	<p>Existing Capacities WRF models</p>
	<p>Gaps and Needs Data Assimilation Medium Range Forecasting & Extended Range Forecasting System (ERFS) access to NCMRWF in addition to IMD Nowcasting-Aviation Forecasting Verification /Hydrological models being used for IB</p>
<p>Observational Networks</p>	<p>Existing Capacities Automatic weather station Water level stations Normal Forecasting- WRF Model Output+ Guidance from IMD + Thai Surface Charts Satex software for Satellite data – with analysis for RBG channels</p>
	<p>Gaps and Needs Network covering northern part of the region Training of new staffs in AWS/AWLS; as senior staff have left Calibration setup – (lab for pressure, temp and RH) Upper air observations and RADAR station Internships in instrumentation (3 months basic) GTS Data: To be able to represent at least 1 region and utilize 5-6 weather stations Dense observational network required</p>
<p>Capacity Building</p>	<p>Existing Capacities Virtual Training from WMO, IMD and RIMES on Seasonal Operational Services and Nowcasting</p>
	<p>Gaps and Needs Trainings in Nowcasting/Aviation Data Assimilation Short/Long Range Forecast Introductory training on IBF Hydrological IBF Introductory Training on Flood Forecasting Introductory Training in Glacio-Hydrological Modelling & glacier and mass-balance studies, snow mapping Upper Air Observations RADAR Installation Calibration and Instrumentation Network Design Satellite Image Processing Finance, Human Resource and Procurement ICT</p>

	<p>Short-term trainings; secondment training for six months and one-year (attachment)</p> <p>Academic long term – degree courses: Aeronautical Meteorology Electronics and Communication Glaciology Instrumentation</p>
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Other Matters

Past Trainings:

- 3 months training for new recruits including two months of theory sessions and 1 month of respective department technical training.

Existing Trainings:

- New recruits: 2 days orientation programme and 1 week of technical orientation

Requirements and Preferences:

- Short Term Trainings and Knowledge Sharing Culture [With monitoring and evaluation]
- Secondment/ Internship [3 months or more]
- Institutionalization of mandatory training for freshers

NMHS Strength:

- Accurate Data Dissemination in GLOF as a result of past experience and importance given to the aspect.
- Glaciology
- Training structure for consideration:
- Basic Modules – for induction level forecasters and instruments/communication
- Short-term (face-to-face) & Follow-up and pre-training online modules
- Specialized modules – face-to-face short-term – example Satellite data analysis
- Secondment and advanced training modules – 3 months/six-months/one-year
- Academic programs- masters and PhD in climate science

India

The consultation meeting with India Meteorological Department (IMD) was held on 18 August 2021 between 11:00 am -01:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from IMD attended the meeting.

- Dr Udhay Kumar Shende
- Dr. Somenath Dutta

Table 12: Outlines of consultation meeting between WG from SAHF and India

Observational Networks	Existing Capacities Calibration of AWS units, now being done at regional level after trainings 50 doppler RADARS data is being used to generate a high-resolution mosaic Can extend training support in various aspects
	Gaps and Needs Integration of observational networks from different agencies – not complete – at present some State Govt data is being received, private sector entities Upper air system – needs improvements
Capacity Building	Existing Capacities Several WMO compliant training courses are being organized and announced through WMO Global Campus platform for meteorological training.
	Gaps and Needs Trainings in India can extend support through RTC IMD, Pune Only limited numbers of participants/trainees from South Asia NMHSs

Maldives

The consultation meeting with Maldives Meteorological Department (MMS) was held on 11 August 2021 between 11:00 am -01:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from IMD attended the meeting.

- Mr. Ali Shareef
- Mr. Ahmed Rasheed
- Mr. Ibrahim Humaid
- Ms. Shaheema Ibrahim

Table 13: Outlines of consultation meeting between WG from SAHF and Maldives

Impact Based Forecasting	Existing Capacities Refined CAP system SWFP guidelines
	Gaps and Needs Coastal hazards
Numerical Weather Prediction	Existing Capacities WRF models Operational HPC- Wave Watch 3
	Gaps and Needs Capacity to support HPCs in long term High resolution run in WRF with data assimilation

Observational Networks	Existing Capacities INCOIS model Integration of all existing MMS system [AWS systems and NWP products] Mobile application improvement Rainfall data and ocean state data for fisheries Marine weather forecast for sea transportation Utilization of products from ECMWF, WMO and IMD
	Gaps and Needs Ocean observations Ocean current data Ocean current forecast for save and rescue Costal Hazards Datasets for visualization
Capacity Building	Existing Capacities Local trainings Basic and advanced courses in IMD Forecasters-Foreign Trainings Basic instruction package
	Gaps and Needs Introductory and middle level training in observational networks Introductory and middle level training in IBF and for forecasters Certification [required for eligibility for promotion] Refresher course in marine observations Improve manpower

Other Matter

Training Priorities:

- Virtual trainings are sufficient and necessary to maintain learning culture among the NMHS professionals.
- List of training in the last 3-5 years to be provide by MMS

Country Priorities:

- Marine Observations
- Ongoing Projects
- WMO-Hydromet Diagnostic Project
- GCF Project

Myanmar

The consultation meeting with Department of Meteorology and Hydrology (DMH) was held on 13 August 2021 between 03:00 pm -05:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from DMH attended the meeting.

- Ms. Chaw Su Hlaing,
- Dr. Tin Mar Htay,
- Ms. Waitoe Aung,
- Ms. Han Swe,

Table 14: Outlines of consultation meeting between WG from SAHF and Myanmar

Impact Based Forecasting	Existing Capacities IBF in initial stage Water Level Forecast Flood Hazard Map-Hydrology Department Seismic Hazard Map- Hydrology Department Meteo LAN- EWA 2 threshold value
	Gaps and Needs Utilizing hazard data for issuing warning Hazard map for extreme rainfall, heat hazard and others
Numerical Weather Prediction	Existing Capacities WARF model Marine Forecasting- INCOIS Model, IITM Model Storm Surge- IITM Model, JMA Model Daily weather Forecast AgroMet Forecast Aviation Forecast Agricultural Forecasting Seasonal Forecast
	Gaps and Needs Nowcast Wave Model- Sea condition forecast and Marine Forecast 3 days forecast at district level Utilization of ECMWF and other global data for NWP models
Observational Networks	Existing Capacities WMO Projects-AWS Stations RADAR Stations 3 Doppler Weather Station 121 Synoptic Stations 40 Water Level Stations DIANA System- Himawari Data Two JICA Projects- Calibration
	Gaps and Needs Integration of Observational Networks- Common Integration platform
Capacity Building	Existing Capacities Past Training: Storm Surge Training Planned Trainings: COMET Training for forecasting, ON Marine Training UK Met- Aviation Training Climatology Training Meteo LAN system
	Gaps and Needs Training on Induction Training Threshold Value Calculation Issuance Of Warning

	Doppler Weather Training Aviation Forecasting Training Hydrological Forecasting Trainings General Barometer Calibration Phasing out plan for old systems Limited Human Resource Strengthening institutional capacities
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Nepal

The consultation meeting with Department of Hydrology and Meteorology (DHM) was held on 13 August 2021 between 03:00 pm -05:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from DHM attended the meeting.

- Ms. Shanti Kandel,
- Mr. Rajudhar Pradhananga,
- Mr. Suman Kumar Regmi
- Mr. Shiva Nepal,

Table 15: Outlines of consultation meeting between WG from SAHF and Nepal

Impact Based Forecasting	Existing Capacities Piloting IBF in 16 municipalities of 4 districts in June 2021 under ARRCC UKMet support [Landslide as an impact of heavy rainfall along with other impacts of rainfall – more details requested from DHM WG Member on IBF] Flash Flood Guidance System (Utilizing high resolution products)
Numerical Weather Prediction	Gaps and Needs IBF Research- Historical data & Analysis – thresholds Improving Reliability of NWP System- Hourly and Weekly Verified products of NWP system Rainfall, Wind and Temperature
Numerical Weather Prediction	Existing Capacities FMI- Older version of WRF WRF- 4.1.2: 4 times a day (Resolution 9 km) ECMWF products (ECMWF products better than GFS)
Numerical Weather Prediction	Gaps and Needs Forecast Verification System Data Assimilation Optimization and customization of NWP Model Products for Aviation and Transportation Nowcasting Medium Range Forecast (Demand for Agriculture Sector) Ensemble Forecast Products Planning for Ensemble Prediction System [Meso Scale] Single Platform for all products to facilitate forecasters

Observational Networks	Existing Capacities 1 RADAR (2 under installation) 100 AWS (90 working)-PPCR Work on scanning strategy and data sharing Glacier Monitoring System – 6 AWS att high altitude other stations for Glacier mass-balance in collaboration with ICIMOD 2 upper air stations are being planned with Govt Nepal funds
	Gaps and Needs Glacier and Snow Monitoring Section
Capacity Building	Existing Capacities Refresher trainings for forecasters [1-2 years one] On the job training
	Gaps and Needs Trainings on Forecast Verification Modification and learning in IBF Manpower: Increase number of forecasters No induction trainings at present, only on job attachment – plans to restart this year.

Pakistan

The consultation meeting with Pakistan Meteorological Department (PMD) was held on 16 August 2021 between 03:00 pm -05:00 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from PMD attended the meeting.

- Mr. Sarfaraz
- Dr. Zaheer Ahmed Babar
- Mr. Nadeem Faisal
- Dr. Jehangir Ashraf Awan

Table 16: Outlines of consultation meeting between WG from SAHF and Pakistan

Impact Based Forecasting	Existing Capacities Ties with National disaster management authority, province disaster management authority and district DMA Weather Advisory-Information on identified impacts Flood Forecasting Division-Lahore Robust system for riverine flooding Flood Forecasting updated through website, fax, emails, and WhatsApp messages Weather Forecast Guidance System- Responsive and Robust [Ongoing]
	Gaps and Needs Impact Assessment Integration of forecast with severe weather events
Numerical Weather Prediction	Existing Capacities Two new Doppler Radars 90+ Weather Stations METCAP+

	COSMO Model and ICON Model GFS Model downscaling JMA Model
	Gaps and Needs Numerical Modelling General processing of numerical models Assimilating various available data for forecasts Validation of NWP models
Observational Networks	Existing Capacities Access to ECMWF data Surface Observations GLOF project- 2 nd phase
	Gaps and Needs Dense Network Better Ground Observations Better Radiosonde Observations Upper Air Observations
Capacity Building	Existing Capacities Trainings in Initial Meteorology Courses and other introductory courses Product Interpretation-JMA
	Gaps and Needs Trainings in IBF and NWP Trainings in data modelling, climate modelling, model validation and data assimilation Mechanism for refresher courses Improved computational capacities [ICT Infrastructure] Human resources lacking

Other Matter

NMHS Strength:

- Training Capacity, Regional Training Institute

Sri Lanka

The consultation meeting with Department of Meteorological (PMD) was held on 20 August 2021 between 11:30 am -01:30 pm (Bangkok time: UTC+7hrs). Following WG members of SAHF WG from DM attended the meeting.

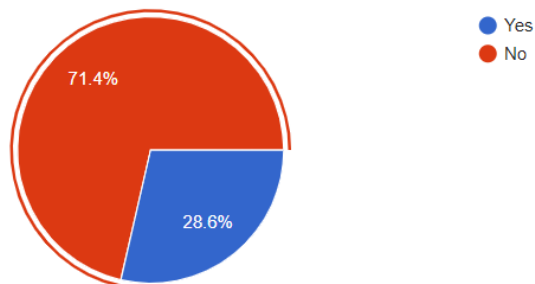
- Dr. I.M.S.P. Jayawardane,
- Mr. Chana Rodrigo,
- Mr. Meril Mendis,
- Mr.A.G.M.M. Wimalasuriya,
- Mr.A.L.K. Wijemanna,
- Mr.T.P.N. Peries,

Table 17: Outlines of consultation meeting between WG from SAHF and Sri Lanka

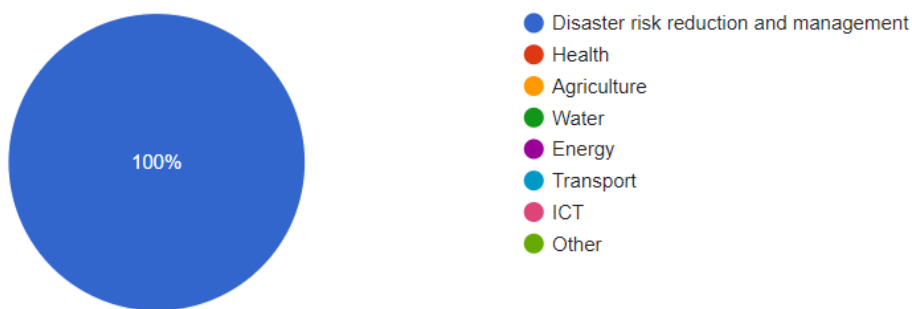
Impact Based Forecasting	<p>Existing Capacities Flash Flood Guidance Warning depended on thresholds</p>
	<p>Gaps and Needs Early warning for costal inundation Knowledge about impact from equatorial waves Automatic Rain Gauge System linked to FFG Single weather threshold for entire country. Specific thresholds for different areas.</p>
Numerical Weather Prediction	<p>Existing Capacities Utilizing ECMWF Forecasts Data from INCOIS ECMWF ecCharts Standard Verification for 24 hours</p>
	<p>Gaps and Needs Customization requirements Verification for ocean products Verification of upper air temperatures and temperature data. Verification of ocean model data</p>
Observational Networks	<p>Existing Capacities Two new Doppler Radars[Yet to be installed] One radiosonde observation station Pilot balloons- 4 stations Lighting detection system- Chinese Government [Experimental State]</p>
	<p>Gaps and Needs Weather Buoys Real time data for thunderstorm and lighting forecast [Automatic Rain Gauges-Expansion of real time data network] Integration of Automatic Rain Gauges</p>
Capacity Building	<p>Existing Capacities Trainings in Basic Meteorology [New Recruits] On the job training [New Recruits]</p>
	<p>Gaps and Needs Trainings in Marine Meteorology [Introductory] NWP [In three levels]- Verification, Data Processing, and Data Model Processing. RADAR Meteorology Maintenance of Observational Network [On the job training] Equatorial and Tropical Meteorology Data Analysis and Programming Support for Marine Products</p>

Annex III- Survey Response

1. Do you provide Impact Based Forecasting on a operational basis?



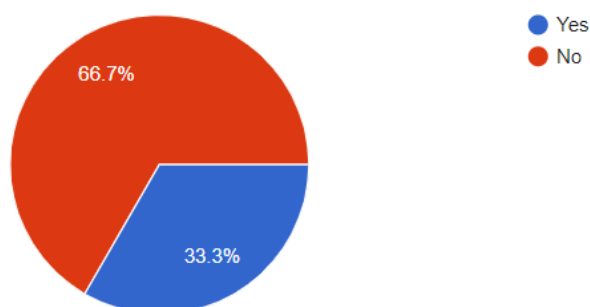
2. If yes, state the sectors you provide IBF(Check all that apply)



3. If other, please specify

- water, health, Agriculture, Marine
- We are piloting IBF as a trial starting from this monsoon season with the support from UKMET office under ARRCCC program.

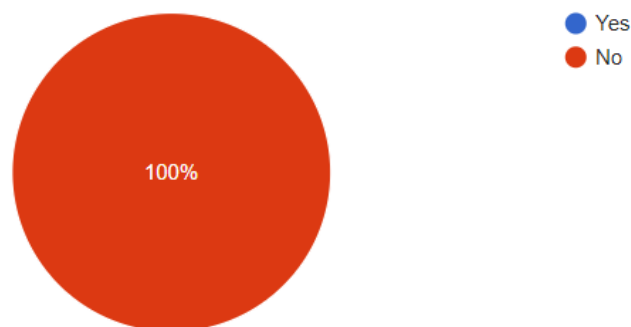
4. If you are providing IBF services, are you complying to the WMO guidelines?



5. If no, what are the challenges in confirming to the WMO guidance in providing IBF services?

- Need the technologies for making of Hazard Map and Risk Map for different Meteorological events, Archiving of Exposure and Vulnerability Data, Human Resources (No GIS and Remote sensing experts)
- Human resource, reliable NWP output, Research and Development, co-ordination and communication of forecasts
- Lack of data. Like Aerial data, Hazard maps and bathymetry/topography data, vulnerable infrastructure of the island.
- Need more coordination between Met Department and other agencies which are related to weather impacts
- Lack of capacity building, no impact assessment done, no historic data and no collaboration and coordination among BMD and stakeholders.

6. Do you have high resolution geospatial data for IBF applications?



7. If yes, please provide a detail list.

- NO

8. If no. what is your future plan?

- Integrate some of the available geospatial data such as LULC, DEM, Population data, etc to understand risk.
- Need to develop GIS based tools
- First we would like to get the training such as GIS and Remote Sensing training which apply back for having geospatial data for IBF applications
- It would be useful to have a high resolution geo spatial data for IBF verification and application.
- Get assistance and help through regional and global partnership. Do risk and impact assessments.
- In planning stage
- Need more training for preparing geospatial data to implement IBF.

Data Requirements

9. What are the common hydro-meteorological hazards that your country experiences?

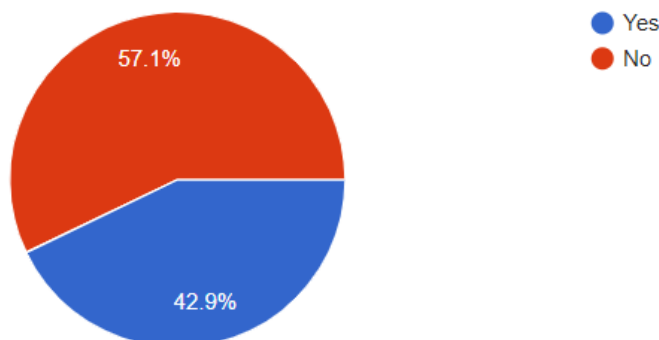
Please provide a list.

- Common hazard:
 - Landslides
 - Flash flood and riverine flood
 - Windstorm
 - GLOF
- Flood/Flash flood, Lightning, strong winds, drought
- Cyclone, Heavy Rain, Flood, Strong Wind, Storm Surge, Thunderstorms, Landslide, High Temperature and Low Temperature
- Common Hydro-Meteorological hazards are- Rainfall, flood, landslide, thunderstorms, windstorms, heat wave, coldwave, snowstorms, etc.
- Flooding due to torrential rain and swell/tidal waves, thunderstorms, strong winds, rough seas, Tropical Cyclone.
- Floods (Urban, Flash and riverine), GLOF, Thunderstorm, Land slides, Tropical Cyclones, Droughts, Heat Wave
- Tropical Cyclone, monsoon depression, thunderstorms, storm surges, heavy rainfall, heat waves, cold waves, prolonged duration of Fog, high wind, tornado and drought.

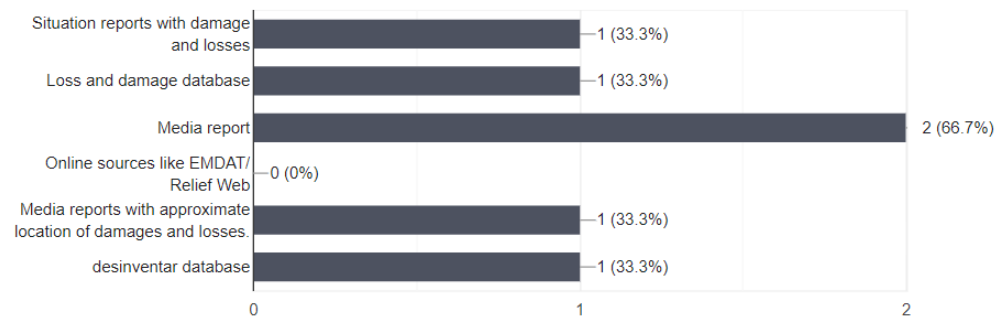
10. Which is the most common hazard in your country that should be prioritized?

- Flash flood and landslide
- Flood/Flash Flood
- Heavy Rain and Cyclone
- The most common hazard that should be prioritized are- Heavy Rainfall, landslide, thunderstorms, Flood, windstorms, heat wave, coldwave, snowstorms, etc. They all contribute for the loss of lives and properties in Nepal.
- Torrential rain, strong winds, thunderstorms, rough seas, swell/tidal waves
- Floods
- Extreme temperature conditions, cyclones and Thunderstorms accordingly

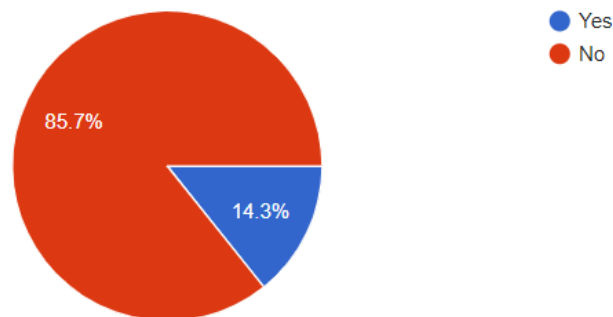
11. Do you have access to geotagged historical data of hydro meteorological events of the country?



12. If Yes, indicate which ones do you have access to:



13. Do you have access to detailed vulnerability and exposure information relevant to the common hydromet hazards in your country?



14. If yes, please specify the source and type of information

- NCHM does not have concrete vulnerability and exposure map. However, have some data to analyze vulnerability.
- Our agency has access to river network data.
- Population statistics, road network, and LULC are collected by the relevant government agency/department.

15. Please briefly mention the data requirements to help enhance or initiate IBF in your organization

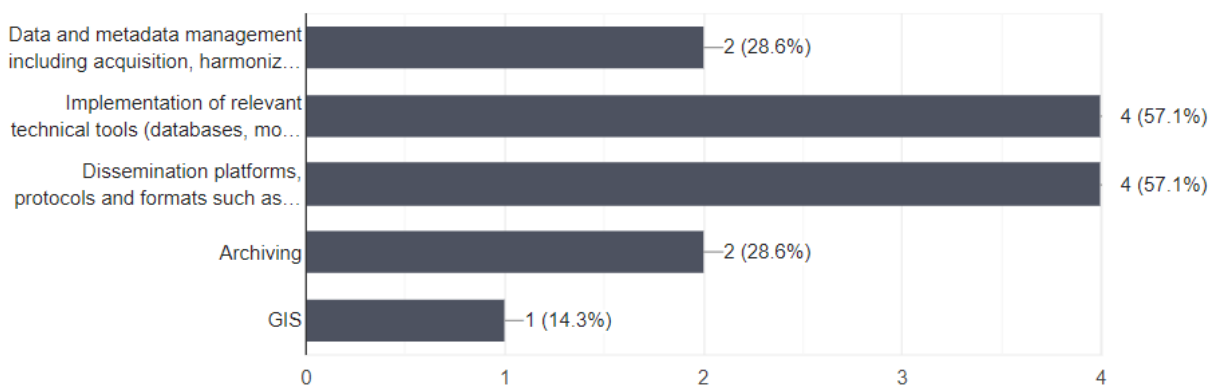
- High resolution topography data, soil data, identifying real time hazards using remote sensing data.
- Historical data regarding impacts of hazards , Exposure and Vulnerability data
- Hazard threshold (Historical data for Heavy Rain and Temperature are ok but we don't have archiving data for other hazard such as strong wind, storm surge, thunderstorms, etc)
- Historical data on disaster impacts
- Aerial Data, Hazard maps, topography/bathymetry and vulnerable infrastructure of the Islands
- We would be needing Hazard maps, vulnerability assessments and geotagged historical Hydro-meteorological extreme events
- NWP reliable forecast data, Real time observation data of the Hydro-meteorological parameters
- EVENT WISE ECTOR IMPACTS DATA

16. Please mention five priority sectors in order of their respective importance you would like to cover under your institutional framework to provide service in the near future.

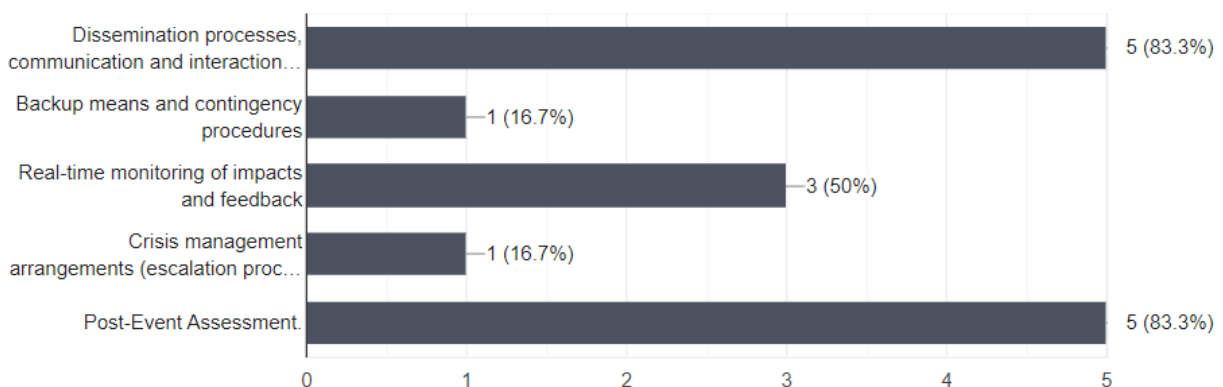
- Department of Disaster Management, Hydro-power sector, Ministry of Agriculture, Department of Road, Civil Aviation authority
- Disaster Management sector, Marine (Fishery, Harbour etc) Water, Health, and Agriculture
- Agriculture, Transportation, Emergency Services (DDM, MRCS, etc), Water and Health
- National Disaster Management Authority, Water and Sanitation, Red Cross Red Crescent, Atoll and Island Council, Health.
- Disaster Risk reduction, Agriculture/food, Transport, Power, Tourism
- Landslide, Flood, Agriculture, Tourism, Transportation
- agriculture, livestock, Fisheries, tourism and transportation

Human Resource Capacity

17. Please select from below the technical and functional features of forecast and warnings for IBF which can be supported by your organization's human resource



18. Please select from below the operational features of forecast and warnings for IBF which can be supported by your organization's human resource

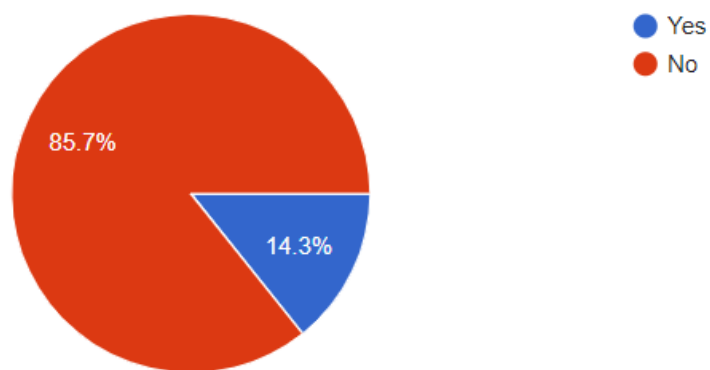


19. Please mention other relevant IBF aspects such as HR support that are specific to your country

- Training on Impact based forecast.
- Understanding of Hazards, Vulnerability, Exposure.
- Currently we issue all forecast and warning on the DMH's Facebook and Website for the Public.
- Training and High resolution data.
- HR support, technical support, Financial Support.

Common Alert Protocols

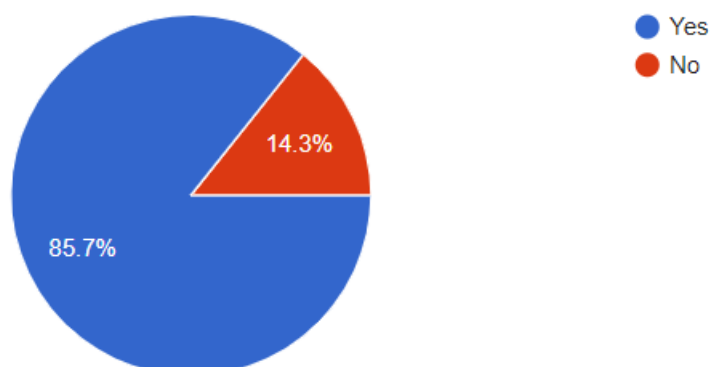
20. Do you use common alert protocols for warning services/ early warning services?



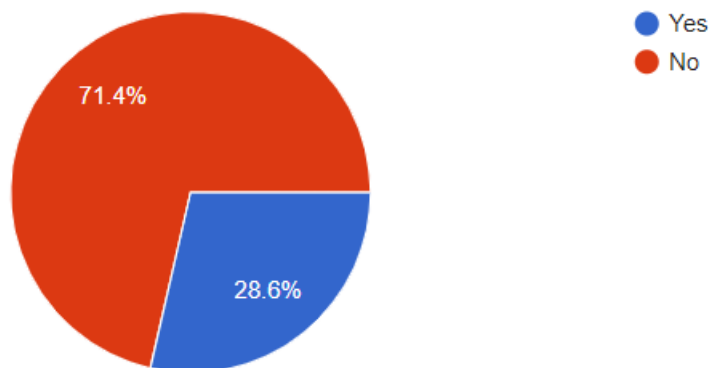
21. If yes, please describe the alert platform that you use

- xtml
- Web, phone sms, Social Media (Community Viber Group, Facebook, Twitter)
- we are using CAP in trial phase which is under our workstation

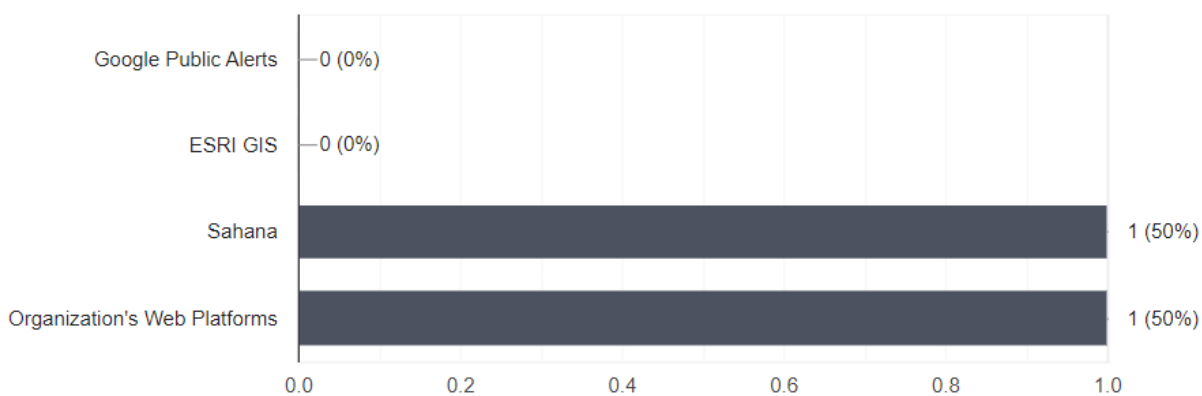
22. Has your organization held any training in CAP-enabled alerting?



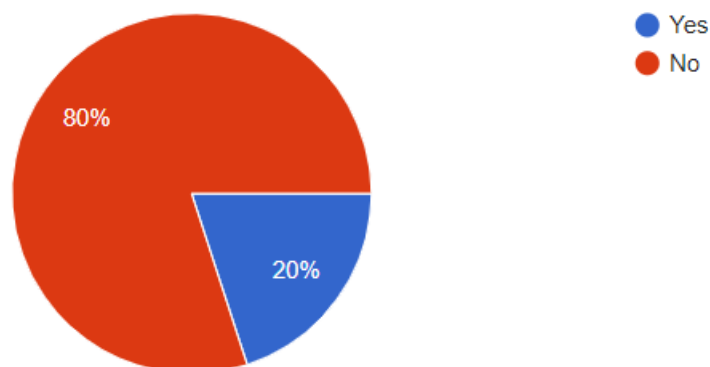
23. Is your source of alerting information in CAP format that is enabled using CAP-enabled products and services?



24. If yes, please mention the CAP enabled products and services used (Check all that apply)



25. Do you have access to mapping tools to support interactive generation of CAP alerts?



26. If yes, please specify the mapping platforms used

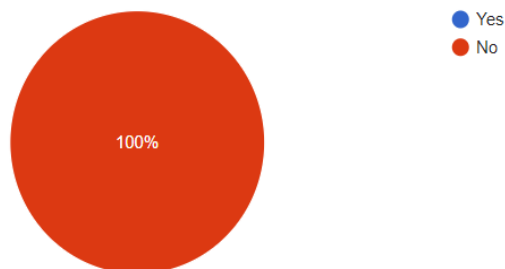


27. Please briefly mention challenges(if any) in incorporating CAP enabled alert system in your organizational infrastructure

- lack of capacity.
- Different Warning authorities for different hydro meteorological hazards
- Unified CAP platform unavailable, not integrated with CAP platform of home ministry, only able to use through email and API. CAP is in trial phase and not in operational till now.
- NO INFRASTRUCTURE, NO INTERDISCIPLINARY CORDINATION AND LACK OF CAPSITY BUILDING

Risk and Vulnerability Matrices

28. Are sectoral risk and vulnerability matrices available?



29. If no, what are the challenges in constructing sectoral risk and vulnerability matrices?

- Lack of Capacity.
- Lack of detail data and information.
- No defined threshold for warning.
- Hazard threshold, Vulnerability and exposure data
- Collection of information , data nd creation of exposure and vulnerability maps, Human resource,
- Lack of vulnerability data. Need to do risk and impact assessments
- LACK OF CAPASITY BUILDING

Long Term IBF Strategy

30. Please provide your views on current challenges and how to plans for future Impact Based Forecasting

- Challenges:
Lack of Data and tool/model to provide ACCURATE location impact forecast.Threshold level for warning.lack of experience and capacity.

Future plans: Improve weather forecast accuracy. Integrate geospatial data in the impact forecast.Provide training to forecasters and officers.
- issues regarding Data sharing and insufficient institutional collaboration, increasing trend in hazards, insufficient real time information
- Current challenges are the Human resource, data base management, reliable and medium range NWP output with ensemble forecasting and Data Assimilation. Communication of forecasts, post event analysis, etc.
- In decision-making process more understanding is needed in issuing IBF and selecting the appropriate thresholds for various receivers which requires linking specialized knowledge from various stakeholders, such as forecasters and local emergency management practitioners and responders.
- We are in the initial stages for the implementation of IBF. The most challenging thing is to have the geo based historical disaster data .
- FIRSTLY CAPACITY BUILDING, SECONDLY, PREPARE DATABASE BASED ON HISTORIC EVENTWISE IMPACTS AND THIRDLY, IMPROVEMENT OF FORECASTING

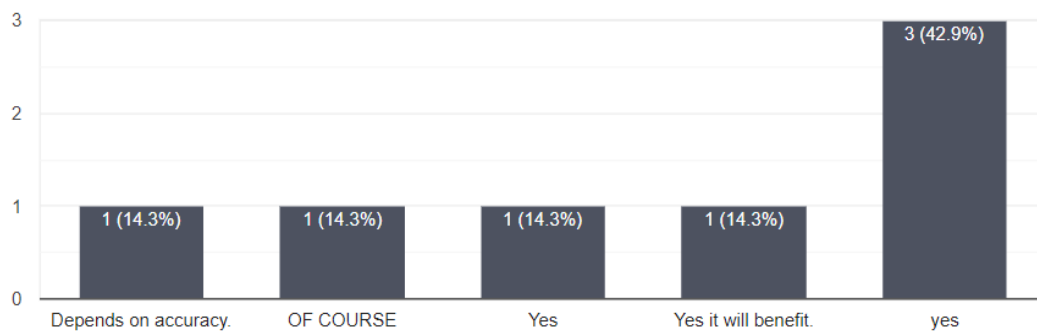
31. How can regional initiatives contribute to improve IBF capacities in the region?

- Develop a guidelines/tool to integrate risk and forecast data for impact warning.
- Provide support on capacity building (Internship).
- sharing knowledge, experience , and best practces
- Exchange of information and knowledge, co-ordination and support among the countries in the region, technical and financial support may contribute to improve IBF capacities in the region.
- May help to increase the accuracy and confidence in IBF
- Mutual exhchange of Knowledge and experience will be most beneficial.
- THROUGH TECHNOLOGY AND KNOWLEDGE TRANSFER, CAPCITY BUILDING AND GIVING GUIDELINE

32. Can ensemble forecasts and probabilistic inference integrated with vulnerability and exposure data help meeting user expectations and requirements for Impact-Based Forecasts (IBFs)?

- yes
- Yes, past hazards data integration into the model will be increasing it's accuracy.
- Yes
- yes, This is one of the necessity for implementing IBF in operational phase.
- Yes it can help
- DEFINITELY

33. Will IBF be beneficial for your country's demographics and requirements in long-term?

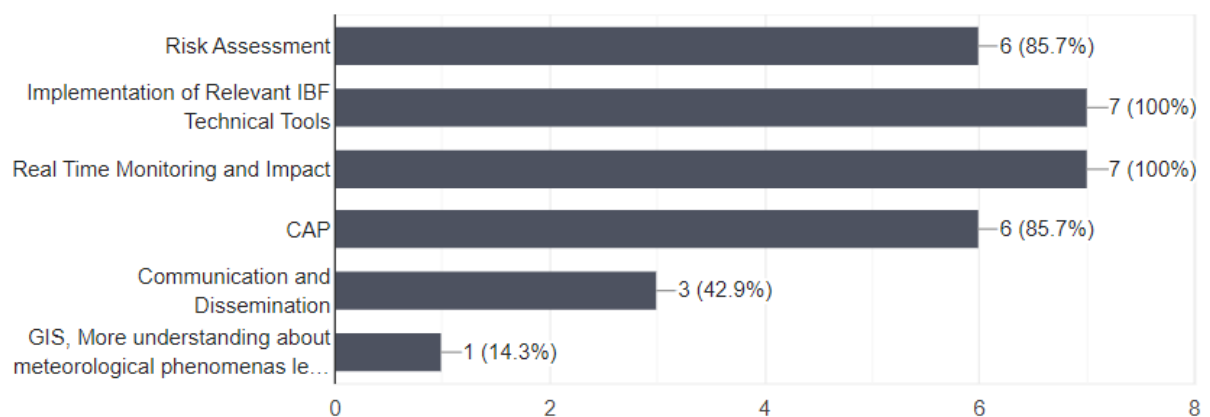


34. What are the specific challenges to developing impact-based monitoring capabilities and databases to capture impact information that are specific to your country?

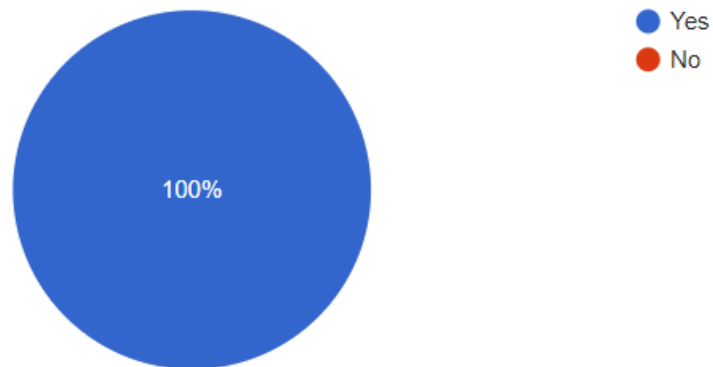
- Lack of tool to detect impact at remote area.
- High spatial variability of impacts, Data (insufficient), Data (Sharing problems) , No common platform for data integration
- Technology and Human Resources to be well perform those tasks, Partnerships and collaboration related departments
- Reliable communication tool and mechanism, awareness, integrated data base, remote area,
- Challenges in accessing the islands and communication.
- All the information is present at different places. The challenging thing is to bring under one roof
- capacity BUILDING

Training Requirements

35. Please select areas where IBF training is required



36. Will cross-training between NHMS professionals and partners on specific requirements and procedures of IBF be useful?



37. Any other specific requirements for IBF work?

- Without accurate weather forecast, it is difficult to provide impact forecast.
- Sufficient Human resource with Financial and Technical support
- RELEVANT IBF TECHNICAL TOOL

Annex IV- SAHF III Outcome

OUTCOMES

SAHF participants unanimously acknowledged SAHF as a vital & ongoing process in the South Asia region that would remain relevant in the future as well so as to strengthen and support the hydromet service delivery capacities of SAHF countries.

The forum agreed that:

1. **The changing landscape of real time observing system networks and forecast data acquisition** for monitoring, detection, and early warning of multi-hazards requires efforts to enhance actionable weather and climate services to protect lives & yield economic benefits.
2. **Collaborative efforts and resources are necessary** to tailor forecasts for key user sectors as per country's needs by generating a suite of useful indices to assist forecasters as well as for value addition towards sectoral applications. Enhancing observing systems- both terrestrial and upper air- in critical gap areas such as mountainous regions and oceans along with innovative mechanisms for their establishment and operation is a key need along with public-private sector engagement centred around NMHSs.

The Forum agreed on several tangible priorities to be undertaken in a time-bound manner as part of an Action Plan with measurable targets. The key outcomes of the Forum are listed below;

Driving the early-warning information value-chain with impact-based Forecasts:

1. Pool collaborative efforts and resources to post-process and tailor forecasts for different sectors and country requirements
2. Generate a range of useful indices that both assist forecasters as well as add value to users' situations within sectors
3. **IBFs offer opportunities for an integrative approach** towards better delivery of hydromet services. Such context oriented forecast information would lead to suitable decision support tools co-developed with sector/ line departments such as agriculture, water resources and fisheries, public health which would benefit them.
4. All SAHF countries would establish an institutional framework to connect NMHS and sector institutions for co-production of IBF services integrating geospatial and socio-economic data with real-time weather data and its exchange for improved IBF, development of Decision Support Systems (DSSs) for risk informed development.

Improving weather and climate forecasts:

5. To synergize efforts and to leverage global and regional strengths, **set up a South Asia Consortium for data and weather Predictions (SCOPE)**, a regional collaborative mechanism blending both cutting-edge technological advances and conventional techniques potentially enabled by SAHF regional cloud computing, storage, and networking services infrastructure with investment by pooling of resources. All efforts

in this endeavor would leverage significant commitment from institutions and partners collaborating with countries in the region. SCOPE would focus on post-processing data blending conventional MOS techniques, ensemble probabilistic forecasts, high-resolution regional domains for specific country clusters within the region and modern approaches like AI/ML to exploit all the forecast data and observational data to bring best science approaches for the generation of relevant forecast products and derived indices tailored to a range of users.

6. Focus on forecasting weather and climate extremes - tropical cyclones, severe thunderstorms & lightning, heavy rainfall events and heatwaves
7. Prioritize specific national requirements that are also common to sub-regions like marine & coastal services focusing on coastal hazards, shoreline management, mountain meteorology and similar requirements
8. Create knowledge repositories to support high-quality operational weather and climate forecasts

Observational Networks (OBN):

9. Improve observations in critical gap areas such as mountainous areas, upper-air networks and oceans along with innovative mechanisms to establish and maintain OBN.
10. **Establish a robust Regional Data Exchange mechanism** for rapid exchange of observational data and forecast products and significantly strengthen South Asia's overall extreme weather and climate services through a systematic increase in expansion of critical observing system networks.
11. Setup mechanism to lead to utilization of the additional data in forecasting systems, post-processing, and above-all value-addition for better hydromet services.
12. Enhance assimilation, leading to improved high-resolution forecasts and also better verification, evaluation, and downscaling.

Capacity Enhancement:

13. **Capacity development is the backbone for improved services**, and SAHF III sought to design and implement a capacity development calendar across all components of the information value-chain.

Agreed Action Plan & Targets

The forum identified and agreed on several tangible priorities to be undertaken in a time-bound manner as a part of an action plan with measurable targets. The table below outlines the priorities and action plans that were agreed upon. Feasibility, resources required, and a phased approach will be initiated to implement the agreed action plans within the current phase of the SAHF project and beyond.

Priority	Targets	Time Frame	Considerations for implementation
Enhance observations & integration into forecasting	1. NHMS-ECMWF and RIMES - Data Exchange Platform to be scaled up.	6- 9 months	Mechanism of feedback for improving medium range skill (3–5-day lead) of extreme weather prediction will be established using country level data for performance evaluation.
	1.2 Real-time data exchanged within the region: 15% improvement		RIMES data exchange platform is already operational. Countries will be pursued to meet the targets.
	1.3 Historical observation data: 20% improvement.		Historical data of extreme events for past 5-years will be used - to evaluate global severe weather forecasts - show value of additional data improving past country level severe weather predictions
Address user needs through tailor-made products leveraging collective strengths	2.1: Forecast Accuracy: 10% improvement -		By using real time data from countries for continuous assimilation at 3Km grid scale for SAHF countries NWP needs
	2.2: Establish SAHF Regional Cloud computing, storage, and networking services infrastructure with investment by pooling of resources Through scaling up existing DATAEX Platform to acquire, host and share new and additional global and regional digital ensemble prediction products		Under SAHF implementation knowledge platform will be operational within 1 year. This can be further enhanced based on a feasibility study to implement 2.2

IBF- An integrating approach for better service delivery	3.1: National institutional mechanisms involving User Sector institutions established on lines of BANCCA (Bangladesh), IRU (India) & SNCCA (Sri Lanka) for co-production of Services in all other 6 SAHF countries	1 Year	Initial steps to be taken to interface with relevant sectoral partners. Other follow up activities to be pursued beyond the current SAHF implementation
	3.2 IBF/DSS implemented for at least 3 sectors – Agri, DRM and Water	2 Years	Initial steps to be taken to interface with relevant sectoral partners. Other follow up activities to be pursued beyond the current SAHF implementation
Capacity development is the backbone	4.1 At least 30% of the NMHS operational staff trained	2-3 Years	All necessary efforts to be taken in working group activities and continue beyond current SAHF implementation
	4.2 At least 20% Staff of user sector institutions trained	2-3 Years	All necessary efforts to be taken in working group activities and continue beyond current SAHF implementation