

Summary Report

2019 South Asia Hydromet Forum: Pathways for Regional Collaboration



Hydrology and meteorology — hydromet — experts shared information at the second South Asia Hydromet Forum in Kathmandu. The event was hosted by the World Bank, the World Meteorological Organization, and others.

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The second annual [South Asia Hydromet Forum](#) was held in Kathmandu on Nov. 19-21, 2019. All eight nations of South Asia¹ and neighboring Myanmar sent meteorologists, data scientists, hydrology specialists, or technical representatives to exchange ideas about ways to improve weather, climate, and water information services. The forum sought to build momentum for more regional collaboration to protect lives and livelihoods from extreme weather.



Arati Belle, South Asia regional coordinator for the World Bank's Hydromet Early Warning and Climate Services

Hydromet modernization in South Asia

South Asia needs to improve hydrology and meteorology — hydromet — information services because the region is home to one-fourth of the global population and highly vulnerable to weather-related disasters. In the past two decades, half of South Asians were affected by at least one natural disaster such as floods, drought, landslides, and cyclones. Climate change will bring more volatile weather. Much of the region is at risk from hotter temperatures, changes in rainfall patterns, rising sea levels, melting Himalayan glaciers, and deteriorating natural resources linked to climate change, according to the [UN Intergovernmental Panel on Climate Change's Fifth Assessment Report in 2013](#). The changing climate will disproportionately affect the poor — about 40 percent of the world's poor live in or near South Asian transboundary river basins that are already affected by recurrent flooding.

The social and economic costs of such hazards are staggering. Between 1990 and July 2019, a total of 1,000 natural disasters in South Asia affected more than 1.6 billion people, according to the [EM-DAT global disaster database](#). Those same weather disasters killed an estimated 267,000 people and caused US\$127 billion in damages. In just the first half of 2019, a dozen severe floods swept through the region, killing 600. From Afghanistan in the west to Bangladesh in the east,

¹ The World Bank's South Asia region consists of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

floods will cost South Asia an estimated US\$215 billion annually by 2030, according to the World Resources Institute.

South Asia can move faster on the path to resilience by improving access to reliable hydromet information that is tailored to the needs of target communities and sectors. International experience suggests that every dollar invested in strengthening weather and climate services results in benefits of US\$2-10. Hydromet services also help manage risk in weather-dependent economic sectors such as agriculture, transport, and water. Given the transboundary nature of weather, regional collaboration can help improve the understanding of changing weather patterns, devise effective response strategies, lower investment costs, foster technological innovations, and address sustainability challenges of sophisticated hydromet tools.

Development partners

The World Bank has invested in modernizing national hydromet agencies in Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka, and Myanmar. Many other partners also support investments and technical assistance to help South Asian governments develop early warning systems and adopt a service-oriented approach to provide accurate and timely weather information. A complete list of South Asia Hydromet Forum supporters is in **Annex 1** and includes the following:

- Global Facility for Disaster Reduction and Recovery (GFDRR)
- World Meteorological Organization (WMO)
- European Union's South Asia Capacity Building for Disaster Risk Management program
- United Kingdom's Department for International Development and its Program for Asia's Resilience to Climate Change (PARCC)
- Japan International Cooperation Agency (JICA)
- Asian Development Bank (ADB)

The World Bank's program takes a bottom-up approach with investments to provide user-oriented weather information and disaster warning systems. As countries modernize their systems, they face many of the same technical challenges. It was apparent at this year's Hydromet Forum there is a growing understanding among countries that regional collaboration could help them adopt better forecasting models and technology and improve how that information is disseminated.



The Hydromet Forum opened with the lighting of a traditional Nepalese panas, or oil lamp. Left to right: World Bank South Asia Regional Vice President Hart Schafer; Nepal Minister of Energy, Water Resources, and Irrigation Barshaman Pun Ananta; and Secretary of the Ministry of Energy, Water Resources, and Irrigation Er. Rabindra Nath Shrestha.

Objectives

The 2019 Hydromet Forum drew more than 100 weather, water, and technical experts from the eight nations of South Asia and Myanmar. Participants also included development partners and regional groups such as the [International Center for Integrated Mountain Development](#) (ICIMOD) and the [Regional Integrated Multi-hazard Early Warning System](#) (RIMES). A list of participants is in **Annex 2**.

The objectives of the second forum were more specific than those of the first, held in September 2018 at the World Meteorological Organization in Switzerland. Both meetings sought to strengthen regional engagement by bringing together high-level representatives from government agencies and development institutions working on hydromet, early warning, and climate services.

The Kathmandu meeting was significant for a higher degree of ownership and commitment demonstrated by countries in the region. The forum took a major step forward from its original conceptualization in 2018 to active participation by all countries in 2019 panel discussions. This year's meeting benefited from important support from regional organizations, permanent representatives to WMO, and key advisors working in the region who played a prominent role in facilitating sessions. The agenda of the 2019 forum was expanded to include innovative approaches to weather and climate information, and engagement with hydrology experts and key economic sectors. Finally, the 2019 forum ended on a high note by partnering with RIMES to provide a regional training initiative — a high priority expressed by virtually all the countries in the region during forum sessions.

At the 2019 forum, participants were asked to:

1.) Share information, ideas, and innovative approaches to

- improve forecasting skills, especially for high-impact weather events;
- provide hazard information for risk assessments, prevention, response and recovery;
- deliver user-oriented services in key weather-dependent sectors; and
- address common implementation challenges.

2.) Prioritize areas to strengthen regional collaboration.

3.) Discuss pathways to sustain and scale up national and regional efforts to improve the quality and delivery of weather, hydrological, and climate services.

Several participants said the Hydromet Forum is helping them keep up with rapid advances in technology and move toward impact-based forecasting that gives an estimate of the severity of the forecasted weather event so emergency workers can prepare for the impact. Early warnings of severe weather are most effective when tailored for stakeholders to help them understand the information and how to act on it. Innovative communication technologies can help vulnerable communities better access such information.

Structure and sessions

The 2019 event included formal sessions, networking opportunities, and a field trip to Nepal's hydromet operations. An agenda for the three-day Hydromet Forum is in **Annex 3**.

Day 1 (Nov. 19) focused on high-level speakers from South Asia to explore identified priorities for regional training and joint activities. Country representatives shared their views.

Day 2 (Nov. 20) focused on service delivery and technological innovations including the use of remote sensing, geo-spatial, and other tools to provide more reliable and timely information. One session was devoted to encouraging participants to share a top priority for collaboration.

Day 3 (Nov. 21) visited Nepal's National Agricultural Research Council, which produces forecasts tailored for farmers, and the Department of Hydrology and Meteorology to learn about Nepal's experience modernizing its hydromet services (see photo on right).



Outcomes

Forum participants agreed on a dozen specific steps to support four areas of collaboration:

1.) Raise the profile of the South Asia Hydromet Forum.

- Prepare an analytical/strategic report about regional collaboration;
- Deepen relationships among hydromet agencies through technical meetings;
- Increase communications among regional forecasters;
- Expand engagement and dialogue with stakeholders in key sectors; and
- Continue to hold an annual South Asia Hydromet Forum flagship event that has clearly defined objectives.

2.) Launch a regional capacity building initiative for training and technical assistance.

- Offer forecaster skills building and strategic staff planning for management.
- Identify the optimal number of weather observation system density in each country and the region.
- Encourage national hydromet agencies to develop impact-based forecasting that uses clear language and actionable messages targeted at key sectors.
- Focus on multi-hazard early warning systems.
- Prepare a progress report of each country's modernization efforts, set targets, and measure improvements over time.

3.) Create a regional hydromet information portal for forecasters to exchange information.

- Identify a real-time mechanism for operational support of forecasters.
- Hold monthly meetings for national forecasters to learn more about Numerical Weather Prediction models that forecast temperature, wind, and other variables.

4.) Improve communications among Hydromet Forum members.

- Harmonize standards, data sharing formats, and technical specifications throughout the region to reduce the procurement process burden.
- Support national hydromet agencies as they develop policy frameworks.
- Harmonize data standards and data sharing formats for clear communication among national hydromet agencies.
Set common technical specifications throughout the region to reduce the procurement process burden.

The remaining pages of this report summarize the sessions held at the 2019 Hydromet Forum.

Session 1: Pathways for Regional Engagement

Chair: John Roome, World Bank Regional Director, South Asia

Panelists:

- David Rogers, International Advisor to the South Asia Hydromet Forum (former Chief Executive of UK Met Office)
- Markus Repnik, Director (WMO)
- Laxman Singh Rathore, International Advisor to the South Asia Hydromet Forum (former Director General of India Meteorological Department)
- Arati Belle, Regional Coordinator for Hydromet Early Warning and Climate Services, World Bank
- A.R. Subbiah, Director, Program Unit, Regional Integrated Multi-hazard Early-warning System (RIMES)

The private sector is demanding more and better weather information to cope with erratic rainfall and extreme weather. Farmers, the tourism industry, and even small businesses such as wedding planners need timely and reliable weather services. Sharing data analytics, knowledge, and infrastructure can help countries provide better services.

Speakers said the [Regional Integrated Multi-hazard Early-warning System for Africa and Asia](#) — or RIMES — is an existing vehicle that can help promote regional collaboration in South Asia. Created after the deadly 2004 Indian Ocean tsunami, RIMES is a UN-registered entity based at a university in Thailand. It offers a portfolio of services such as weather observations data, monsoon forums, and training, and already provides back-up support for Bangladesh's 10-day weather forecasts. A major strength of RIMES is its nonpolitical and impartial approach in supporting forecasters. "We have no personality or identity of our own," A.R. Subbiah said, because RIMES operates invisibly behind a nation's existing agencies. RIMES has a track record of connecting scientists, institutions, and communities to develop early-warning systems. The RIMES governing council has recommended a capacity building program to help South Asia develop more weather forecasters, he said.



Markus Repnik (left), David Rogers (middle), and John Roome (right).

The [World Meteorological Organization](#) is acting to help South Asian countries develop more reliable weather information products. WMO is experimenting with a [Country Support Initiative](#) in

Myanmar and other nations. “We want to ensure that the combined knowledge and expertise of our members worldwide is provided in a way that other members can absorb it, as well as development partners,” WMO’s Markus Rupnik said. An ambitious “one-stop shop” is being developed to offer basic advisory services to countries for free, and more sophisticated services at cost. “We hope to have the doors open early next year,” Rupnik said.

Laxman Singh Rather said South Asian weather forecasters need informal and regular contact to share knowledge and information. A monthly video or audio conference call is one option, he said, as well as a website portal or social media platform. “We need to develop a mechanism for more frequent discussions,” he said. Currently, the only tool for regular contact among forecasters is the annual [South Asian Climate Outlook Forum](#) (SASCOF), which prepares a consensus outlook for the monsoon season.



Several panelists observed that better weather data, models, and forecasts are not enough. Forecasts must be clearly communicated using language that stakeholders will easily understand.. Weather messages should be written from the user’s point of view to help them take action. “At the end of the day, the systems, the data, the information can all be improved. But it’s how the people use it and engage with it that matters,” said Arati Belle (left photo).

For example, the UK Met Office several years ago adopted a user-focused approach that included regular conversations with users to better understand their needs. That transformed the Met Office “into a service organization that people can trust and believe in,” David Rogers said. “Fundamentally, we’re forecasting risk in the aviation sector, agriculture sector, and other sectors,” he said. “We have to have the language of the end user... If we don’t have people in our institutions who understand those sectors, we can’t do a good job of communicating.”

Panelists urged the group to focus on specific ways of promoting collaboration within South Asia. “We have the mechanisms in place, like RIMES. We have the willingness to cooperate with each other. We’re making investments,” Rogers said. To sustain the momentum, a regional mechanism has to provide the glue to make collaboration work. “If not us, then who is going to do it?” John Roome said. “The people who can turn this into a reality are in this room.”

Key Messages

- High quality data is the foundation for all weather models and forecasts.
- Forecasts must be clearly communicated and include actionable language.
- National governments must take ownership of a regional mechanism to make collaboration work in South Asia.

Session 2: Lessons from Ongoing Programs in South Asia

Chair: Saraju Kumar Baidya, Director General, Nepal Department of Hydrology and Meteorology

Panelists:

- Abdoulaye Harou, Chief of Data Processing and Forecasting Systems, WMO
- David Corbelli, International Development Manager, UK Met Office
- Alice Soares, International Advisor to the South Asia Hydromet Forum

Panelists described hydromet improvements now underway in Myanmar and Nepal with international support, along with UK Met Office and WMO assistance to modernize forecasting throughout the region.

The WMO in 2010 launched a [severe weather forecasting demonstration project](#) in South Asia to help nine nations² keep up with rapid developments in weather prediction science, tools, and early warning systems. The project trains forecasters to produce earlier and more reliable warnings for hazardous weather by using [Numerical Weather Prediction](#), which combines current weather data



with mathematical models of the atmosphere and oceans to calculate weather probabilities. Assisted by UK Met, the project held a week-long training session for forecasters in November 2019. Abdoulaye Harou said the project uses a three-tier forecast process that cascades information from global weather prediction centers to regional meteorological centers to national meteorological centers.

Abdoulaye Harou

The WMO is also using a regional [flash floods guidance system](#) to train South Asian forecasters. Forecasters combine hydrological models, radar and satellite-based rainfall estimates, and local

² The WMO's South Asia project involves nine countries: Bhutan, Bangladesh, India, Maldives, Myanmar, Nepal, Pakistan, Sri Lanka and Thailand.

conditions to calculate the probabilities of flash floods. Harou said WMO will soon adopt a higher resolution model to improve flood predictions. The model — known as Quantitative Precipitation Forecasts — estimates the amount of rain, snow, or ice expected to fall in a defined period of time, and amounts can vary widely within small areas. Harou said the model will be upgraded from its current 9 km resolution to a 3 km resolution in 2020.

The UK Met Office is working in four South Asian countries via the [Asia Regional Resilience to a Changing Climate](#) trust fund, which is supported by the UK Department for International Development and administered by the World Bank. UK Met is focusing on the most vulnerable countries of Afghanistan, Bangladesh, Nepal, and Pakistan. Work is into three areas: impact-based weather forecasts, seasonal climate outlooks, and future climate change projections. David Corbelli said lessons learned during the program's first year included the need to provide seamless integration of short-, medium-, and long-term forecasting services. He said donors must improve coordination among themselves to identify what national agencies need and to organize training. Corbelli also said more data and monitoring networks are needed for early warning systems for the Ganges, Brahmaputra, and Indus river basins.

Myanmar's hydromet modernization has been challenged by limited financial resources and skills. Alice Soares said the department initially wanted to run its own global forecast model but adopted



a less ambitious approach based on the skills of its staff. A key step was establishing a legal framework that gave the [Department of Meteorology and Hydrology](#) authority to regulate all hydromet activities and set standards. The framework has also fostered engagement among the public, private sector, and academia, she said.

Alice Soares (left), Abdoulaye Harou (middle), David Corbelli (right).

Key Messages

- National hydromet agency forecasters need training and a support network to build confidence using complex prediction models; technical support coordinated by partners that includes operational training and knowledge exchange
- Hydromet forecasters understand the importance of establishing a reliable, trusted national agency that demonstrates
- Managing hydromet modernization projects is easier with a combination of a systems integrator and international or national advisors.
- In addition, there are other challenges/lessons learned that were discussed: (i) a combination of systems integrator with international and national advisors prove to be a good way to manage projects; (ii) Met agencies have made progress but more is required

for them to position themselves as a reliable, national agency that requires the attention and funding from Finance to sustain these services; (iii) NMHSs are increasingly partnering with private sector to help unlock potential of more timely and accurate services (eg. Telecom);

Session 3: Prioritizing Regional Collaboration

Moderators: Laxman Singh Rathore and David Rogers

Panelists:

- Muhammad Hanif, Chief Meteorologist, Meteorological Department (Pakistan)
- Saraju Kumar Baidya, Director General, Department of Hydrology and Meteorology (Nepal)
- Mrutyunjay Mohapatra, Director General, India Meteorological Department
- Abdul Muhsin Ramiz, Director, Meteorological Services (Maldives)
- Karma Dupchu, Director, National Center for Hydrology and Meteorology (Bhutan)
- Shamsuddin Ahmed, Director, Meteorological Department (Bangladesh)
- Dulari Gangani Fernando, Deputy Director, Department of Meteorology (Sri Lanka)

National hydromet agencies described what they need to deliver better services. The wish lists ranged from more computing power to maintenance of radar technology to weather sensors installed on nuclear power plants.

Pakistan — Regional data sharing is urgently needed to warn the public about flash floods, a frequent threat to Pakistan and its neighboring countries. Muhammad Hanif called for the creation of a “joint transboundary early warning system” with three password-protected sites for countries to share real-time data. One site would capture data from Pakistan and Afghanistan; another for India and Nepal; and a third for Bhutan and Bangladesh.



Muhammad Hanif (left), Saraju Kumar Baidya (right)

Nepal — Nepal is struggling to manage the growing frequency of extreme weather events that trigger deadly landslides and lightning strikes. In 2019, Nepal recorded its first tornado in history and the hydromet department “wasn’t prepared for this,” said Saraju Kumar Baidya. Nepal recently began issuing 3-day weather forecasts, but the forecasts need to be more accurate with longer

lead times for the public to find shelter, he said. Another priority is to address data gaps in the Himalayan region so computer forecasting models are more accurate.

India — Under the WMO's severe weather forecast demonstration project, the India Meteorological Department is South Asia's regional center for severe weather, providing 5-day forecasts to neighboring countries and forecaster training. Mrutyunjay Mohapatra said he would like to see a password-protected website with real-time weather data to forecasters along with hydromet research and training. "The days are gone when we could simply say, 'rain will occur,'" Mohapatra said. "Instead of what the weather will be, our focus is now on what the weather will do." But to provide comprehensive impact-based forecasts, India needs a geospatial platform and geophysical information, he said.

Maldives —The island nation has difficulty maintaining and calibrating its sole weather radar, purchased in 2007. Abdul Muhsin Ramiz said the equipment stopped working after just six months, and extra funds had to be obtained to get the radar back in operation. Training is another challenge. "Even though we get training, it is difficult to know how to use it in the field," Ramiz



said. Clearly communicating weather forecasts to target stakeholders is a high priority. "We are trying to reach the public in language they can understand," he said, which means color-coding forecasts in white, green, yellow, and red. He proposed creating a regional inventory of weather experts, by technical expertise, so countries can help each other when extra resources are needed.

Abdul Muhsin Ramiz (left), Karma Dupchu (right).

Bhutan — The nation's complex topography makes impact-based forecasting a challenge, and the reliability of weather forecasts needs to be improved, said Karma Dupchu. "We have come a long way in the past 10 years," he said, adding that Bhutan understands the upstream-downstream linkages in river basins and shares river data with India. Dupchu said he would prefer to see more investment in the WMO's existing regional initiatives and platforms rather than the creation of new ones.

Bangladesh — As recently as five years ago, Bangladesh had remote weather stations where a lone staffer recorded rainfall data on paper forms and mailed them to the central hydromet office days or weeks later. Today, the public expects the same data to be available immediately, said Shamsuddin Ahmed, adding that Bangladesh recently started a pilot program posting real-time data online. It's not just the public that is demanding more. The central government wants



forecasters to explain how weather affects various economic sectors. "They are asking how hydromet can contribute to the enhancement of the national economy" and how it supports the UN's sustainable development goals, Ahmed said. To protect major infrastructure from severe weather, Bangladesh should install location-specific sensors in places such as nuclear power plants. To collect accurate nationwide data, Ahmed said he needs guidance on the optimal number of weather observation stations in Bangladesh, country of 56,000 square km.

Another challenge is running forecast models that require data from ocean buoys. "Without this information, our models will not be as accurate as they could be and people may not trust us," he said. Other needs include sharing transboundary river water levels for more accurate flood forecasts, training forecasters to interpret and clearly communicate information, and developing South Asia regional benchmarks to help each country set priorities.

Shamsuddin Ahmed (left), Mrutyunjay Mohapatra (right)

Sri Lanka — Improving the accuracy of weather predictions is a top priority for Sri Lanka, the region's second-highest disaster prone country. The varied terrain means one part of Sri Lanka can be flooded while another area remains drought-stricken, said Dulari Gangani. One of the country's priorities is to obtain data from the European Centre for Medium-range Weather Forecasts.



Dulari Gangani

Key Messages

- Hydromet agencies want guidance on the optimal number of automated weather stations needed to capture reliable, national data for computer models.
- Weather information is most effective when customized for various audiences such as senior government leaders or farmers. Messages should include actionable information.
- Hydromet services save lives and protect a nation's infrastructure and economic growth.

- A way should be found to share transboundary river data, a historically sensitive issue for political leaders. Hydromet agencies need accurate downstream and upstream river data to have a complete picture of flash flooding risks and issue early warnings to the public.
- World Bank is significantly supporting the region with planned or ongoing investments in hydromet and early warning in Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka (South Asia) and Myanmar (East Asia) among other countries.

Session 4: Advances and Solutions for Service Delivery

Chairs: Mrutyunjay Mohapatra, Director General of India Meteorological Department, and Shamsuddin Ahmed, Director of Bangladesh Meteorological Department.

Presenters:

- Stephan Siemen, Head of Development Section, Forecast Department, European Centre for Medium-range Weather Forecasts
- Abhishek Modi and Karan Agarwal, Google Asia
- Giriraj Amarnath, International Water Management Institute
- Michael Souffront, Aquaveo

High-tech tools are being developed to improve accuracy in predicting floods and other extreme weather. Hydromet agencies can obtain access to software packages and selected data instead of investing in computing power and huge datasets that are hard to handle.

The [European Centre for Medium-range Weather Forecasts](https://cds.climate.copernicus.eu) was created to address difficult research problems in weather forecasting that no single country could tackle on its own. In



Stephan Siemen (left), Abhishek Modi (right)

addition to weather forecast services, the centre has supercomputers and a vast archive of historical datasets. It works closely with the WMO and national hydromet organizations to offer training, set standards, and provide software packages and open-source data. Stephan Siemen said the centre can help national hydromet agencies by doing the modeling that requires significant computing power to analyze large datasets. It also offers post-processing of data, interpolation, visualization, and a tool that allows non-domain users to build climate change apps at <https://cds.climate.copernicus.eu>.

Google has launched a [flood forecasting initiative](#) that uses the company's vast amount of global data and its machine-learning expertise to issue early warnings about flooding. In pilot testing in India's Patna region, the initiative's flood forecasts have a 90 percent accuracy rate, Karan Agarwal said. Google combines satellite images showing elevations with a 1-meter resolution with rain measurements on the ground. The company applies a hydraulic model of river flooding to calculate the probability of flash flooding. The pilot has so far sent more than 100,000 flood alerts to smart phones, reaching 2 billion people, Agarwal said. Each alert includes a map showing where there is some risk of flooding, greater risk, and greatest risk.

Satellite-based rainfall data can be combined with actual rain data on the ground to help forecasters predict floods. Three satellite products – GSMaP, TRMM, and GPM_L3 – are as accurate as rain measurements on the ground, said Giriraj Amarnath. The International Water Management Institute's [hydromet optimization tool](#), which has elevation maps and 30 years of rainfall variation data, strengthens hydrological simulations. The group's other tools include:



Giriraj Amarnath

- A set of climate screening products, now being created with support from the Asian Development Bank, to map individual hazards such as landslides and rising sea levels.
- [South Asia Drought Monitoring System](#), which combines satellite data and ground measurements to assess drought damage to crops.
- [South Asia Drought Early Warning System](#), a project with Indian Institute of Technology.
- [Sri Lanka Climate and Food Security Bulletin](#), a project with the UN World Food Program.
- [Index-based Flood Insurance](#) using models and satellite images to predetermine flood thresholds.

Flood forecasting is more accurate when computer models include data about streamflow, the volume of water moving through natural channels, said Michael Souffront. [GEOGloWS, a new global streamflow forecasting tool](#), uses data from the European Centre for Medium-range Forecasts to provide 10-15 days of lead time before flooding. Nepal is using the product, which includes an animated sequence showing the probability of watersheds at risk of flooding.

Key Messages

- Sophisticated computer models to predict weather probabilities use large datasets that require substantial computing power and forecaster training.
- Hydromet systems can help disaster risk managers prevent, prepare, and respond quickly to extreme weather.
- High-tech tools are important in weather predictions, but nations should not lose sight of practical solutions in building resilience among local communities.

- The private sector has tested innovative ideas to help protect life and property, and national agencies can strategically collaborate with them.

Session 5: Reaching Users and Sectors with Specialized Services

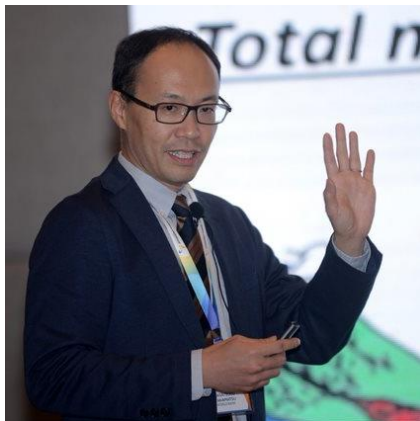
Chairs: Imran Jamil Shami, Joint Secretary, Pakistan Aviation Division, and Karma Dupchu, Director, National Center for Hydrology and Meteorology (Bhutan)

Presenters:

- Masatsuga Takamatu, World Bank
- Naresh Shakya, Department of Roads, Nepal
- Dorji Gyeltshen, Department of Roads, Bhutan
- Mazharul Aziz, Project Director, Bangladesh Agro-Meteorological Information Systems
- Jim Anderson, Chairman, Association of Hydrometeorological Equipment Industry
- Satyagopal Korlapati, former Tamil Nadu Additional Chief Secretary and Relief Commissioner

Landslides and lightning strikes are among the weather hazards that require special hydromet tools. Forecasts customized for farmers can help them prepare for severe weather and maximize crop production.

Landslides are among the most difficult hazards to manage because of uncertainties in predicting



Masatsuga Takamatu

where and when they will occur. Masatsuga Takamatu said risk is determined by land topography, the amount of hill cutting for roads and houses, and extreme weather or earthquakes. The susceptibility of an area to landslides can be assessed and mapped with high-resolution geographical information and land use data. The map is also useful for slope protection measures and to inform planning for future roads and zoning. Local disaster agencies should clarify who is responsible for landslide warnings, and understand the limits of such warnings,

Most of Nepal's 71,000 km of roads pass through hilly or mountainous terrain subject to soil erosion, landslides, and falling rocks. The government's slopes stabilization plan ranked critical slopes based on whether it needs immediate rehabilitation, regular inspections, or biannual inspections. A slopes database holds a risk analysis, consequences of road failure, rain data, maps, and soil investigation reports.

Naresh Man Shakya (far left)



Bhutan is using tilt sensors and rain data to monitor the threat of landslides and close sections of the nation's 18,000 km of roads when the risk rises. Climate-proofing roads with better design, construction, and maintenance is a high priority because the cost of monsoon-related road damage has doubled over the past decade. Dorji Gyeltshen said Bhutan is trying to anticipate danger based on the risk, likelihood, and consequences of the failure of a road. Data from tilt sensors and rain gauges is transmitted to [ArcGIS](#), a mapping and analytics program that helped Bhutan establish an early warning system based on continuous heavy rain of at least 180 mm or one-hour rainfall of at least 50 mm. The warning system will be expanded in the future.

Dorji Gyeltshen



Bangladesh's hydromet modernization project developed [special agromet advisories](#) in 2019 for farmers in each of the nation's 64 districts. Twice-weekly advisories help protect farmers from crop



losses during severe weather. Mazharul Aziz said the advisories suggest specific actions farmers can take to manage pests, treat crop diseases, and prepare for severe weather. Advisories are delivered to farmers via smart phones and special display boards and kiosks at rural offices. The agromet project is planning demand-driven advisories for livestock, poultry, and fish producers and helping farmers understand and use climate information.

Mazharul Aziz

Member companies of the [Association of the Hydro-meteorological Industry](#) (HMEI) have helped India's Odisha and Karnataka states reduce lightning deaths. Jim Anderson said that Odisha, for example, had more than 1,200 casualties from lightning strikes in 2015-17. [Earth NetWorks](#), an HMEI member, installed six additional lightning sensors in Odisha in 2017 to provide map-based alerts that predict lightning 30-45 minutes in advance. Alerts are disseminated through WhatsApp, Facebook, and text messages. The company also operates 14 siren and strobe light warning systems in the most lightning-prone blocks.

Jim Anderson



Tamil Nadu's successful emergency alert system is being adopted by the Indian Meteorological Department for nationwide use. The Tamil Nadu System for Multi-hazard Potential Impact Assessment, or [TNSMART](#), engages with users from state- to village-level and uses [RIMES](#) to



ensure technical support, said Korlapati Satyagopal. TNSMART combines historical data, maps, and current weather to predict flooding and hazardous weather. The tool operates on several levels, sending smartphone alerts to the public and helping disaster response managers plan effectively. Alerts identify the level of risk in each district (very high, high, medium, or low) and the mobile app lets citizens send distress messages to TNSMART, which are forwarded to nearby emergency workers.

Satyagopal Korlapati,

Key Messages

- High-resolution GIS maps can help manage the risk of landslides but they remain difficult to predict because of contributing factors such as soil erosion and residential or commercial development on slopes.
- In mountainous areas, governments can prioritize key roads and use tilt sensors and rainfall to indicate when risks are higher.

- On-ground lightning sensors can generate smartphone alerts 30 minutes in advance of lightning strikes to save lives.
- A multi-hazard alert system should be easy for the public to understand and have features that help disaster managers plan and preposition recovery supplies.

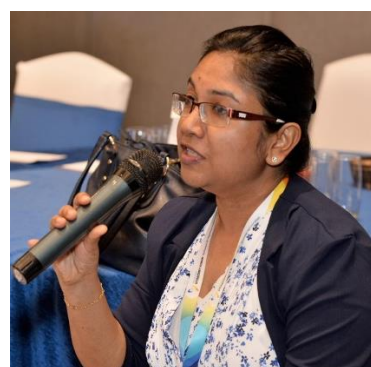
Session 6: Bringing It Together for Regional Collaboration

Arati Belle of the World Bank and Abdoulaye Harou of the WMO asked all participants at this session to identify pathways and priorities to move forward. Each participant mingled with at least two people from other countries to exchange ideas about collaboration priorities.





The ideas were next shared and discussed with the entire group.



What next?

Forum participants discussed and agreed on the following regional collaboration priorities:

1.) Raise the profile of the South Asia Hydromet Forum.

- Prepare an analytical/strategic report about regional collaboration;
- Deepen relationships among hydromet agencies through technical meetings;
- Increase communications among regional forecasters;
- Expand engagement and dialogue with stakeholders in key sectors; and
- Continue to hold an annual South Asia Hydromet Forum flagship event that has clearly defined objectives.

2.) Launch a regional capacity building initiative for training and technical assistance.

- Offer forecaster skills building and strategic staff planning for management.
- Identify the optimal number of weather observation system density in each country and the region.
- Encourage national hydromet agencies to develop impact-based forecasting that uses clear language and actionable messages targeted at key sectors.

- Focus on multi-hazard early warning systems.
- Prepare a progress report of each country's modernization efforts, set targets, and measure improvements over time.

3.) Create a regional hydromet information portal for forecasters to exchange information.

- Identify a real-time mechanism for operational support of forecasters.
- Hold monthly meetings for national forecasters to learn more about Numerical Weather Prediction models that forecast temperature, wind, and other variables.

4.) Improve communications among Hydromet Forum members.

- Harmonize data standards and data sharing formats for clear communication among national hydromet agencies.
- Set common technical specifications throughout the region to reduce the procurement process burden.
- Support national hydromet agencies as they develop policy frameworks.

How?

To accomplish the priorities, Hydromet Forum participants agreed that RIMES should play a central role as an intergovernmental mechanism to coordinate hydromet collaboration.

RIMES is also needed to serve an administrative function for the planned work. The proposed role of RIMES will be discussed at a January 2020 meeting of a subcommittee of the RIMES Council for South Asia.

The forum also identified the following resources for regional hydromet collaboration:

- Regional and global expertise from WMO, Global and regional centers (ECMWF, NCEP, UKmet, JMA etc.), RSMC (IMD), Regional Institutions such as RIMES, IWMI, ICIMOD and others, as well from development partners
- The South Asia Hydromet Forum expert group, comprised of technical representatives from South Asian countries and key partners, to support national decision makers.
- South Asia Hydromet Forum Executive Council (including heads of NMHS and User Sector Representatives)



Session 7: Bringing It Together for Regional Collaboration – How Can Development Partners Help?

Chairs: Markus Repnik, WMO, and Vladimir Tsirkunov, World Bank.

Panlists:

- Archana Shukla, UK Department for International Development
- David Corbelli, UK Met Office
- Michael Ernst, US AID
- Donna Lagdameo, Red Cross Red Crescent Climate Center
- Ram Prasad Bhandari, Japan International Cooperation Agency
- Mandira Shrestha, International Center for Integrated Mountain Development
- Moctar Aboubaca, World Food Program
- Joseph Intsiful, Green Climate Fund

The discussion began with Hydromet Forum participants creating an online word cloud about what they expect from development partners. Panelists responded to the word cloud and shared views about how their organizations can better support South Asian nations' hydromet modernization work.



From left: David Corbelli, Moctar Aboubaca, Mandira Shrestha, Joseph Intsiful, Michael Ernst, Donna Lagdameo, Ram Prasad Bhandari, and Archana Shukla:

Markus Rupnik shared with the group the World Meteorological Office's newly created [Alliance for Hydromet Development](#) as part of the WMO's work on climate change. The alliance brings together development, humanitarian, and climate finance groups to close the investment gap in national hydromet services by 2030. The South Asia region, Rupnik said, may be selected to test how the new principles of the alliance are put into practice. The alliance plans to use private sector expertise and establish benchmarks to track progress in expanding hydromet services.



From left: Ram Prasad Bhandari, Archana Shukla, Vladimir Tsirkunov



From left: David Corbelli, Moctar Aboubaca, Mandira Shrestha, Joseph Intsiful, Michael Ernst, Donna Lagdameo, Ram Prasad Bhandari, and Archana Shukla:

Conclusion and Next Steps

The forum's outcome included a continued commitment to regional collaboration and priority actions, the development of a South Asia Hydromet Forum action plan to be presented at the RIMES Council in January 2020, and re-convening for a third SAHF to further the regional dialogue and the resilience-related agenda.

The Hydromet Forum website (<https://www.worldbank.org/en/events/2019/11/19/south-asia-hydromet-forum-ii#3>) has been updated with the forum agenda, speaker bios, presentations, and photos. Participants expressed satisfaction with the organization of the event, materials shared by speakers, opportunities for networking, and the field trip to two Nepal agencies involved in hydromet work.



From left: Faris Hadad-Zervos, Nepal Country Manager for the World Bank, and Saraju Kumar Baidya, Director General of Nepal's Department of Hydrology and Meteorology, during field visit to the DHM.

Appendix 1: Hydromet Forum Supporters

(in alphabetical order)

European Union's South Asia Capacity Building for Disaster Risk Management
Global Facility for Disaster Reduction and Recovery (GFDRR)
International Center for Integrated Mountain Development (ICIMOD)
International Water Management Institute (IWMI)
Japan International Cooperation Agency (JICA)
Red Cross Red Crescent Climate Center
Regional Integrated Multi-Hazard Early Warning System (RIMES)
UK Aid Asia Regional Resilience to a Changing Climate (ARRCC) and
Program for Asia's Resilience to Climate Change (PARCC)
UK Met Office

USAID
World Bank
World Food Program
World Meteorological Organization



Appendix 2: 2019 Hydromet Forum Participants





Appendix 3: 2019 Hydromet Forum Agenda

November 19, 2019, Day 1 – Hyatt Kathmandu Regency Hall

Coffee and Registration 9.30 - 10.00 am: Corridor outside Regency Hall

Opening Ceremony 10.00 – 11.00 am

- › Welcome Address – Er. Rabindra Nath Shrestha, Secretary of Ministry of Energy, Water Resources and Irrigation
- › Lighting of the Panas by Mr. Barshaman Pun “Ananta”, Honorable Minister of Energy, Water Resources and Irrigation, and Mr. Hart Schafer, Vice President, South Asia Region, World Bank
- › Opening Remarks – Mr. Hart Schafer, Vice President, South Asia Region, World Bank
- › Statement from Secretary General of the World Meteorological Organization, delivered by Mr. Markus Repnik, Director, WMO
- › Opening Statement – Mr. Barshaman Pun “Ananta,” Honorable Minister, Government of Nepal

Group Photo 11.00 - 11.15 am: Garden outside Regency Hall

Coffee Break 11.15 - 11.30 am: Corridor outside Regency Hall

Pathways for Regional Engagement

This session will include a discussion of ongoing efforts in the modernization of weather and climate systems and services in the region. Following the outcome statement from SAHF I, a particular focus will be on operationalizing regional priorities supported by the development of a regional capacity and information initiative.

Presentations (15 mins)

Session 1: 11.30 am – 12.30 pm

**Chair: John Roome,
Regional Director,
South Asia, WB**

[Arati Belle, Regional Coordinator for WB's SAR Hydromet Early Warning and Climate Services](#)

[Dr. A.R. Subbiah, Director, RIMES, Program Unit](#)

- › SAHF and the Regional Hydromet Capacity and Information Initiative

Panel Discussion (45 mins)

Markus Repnik, Director, WMO

Dr. A.R. Subbiah, Director, RIMES, Program Unit

Dr. David Rogers, International Advisor, SAHF (Former Chief Executive of UKMet Office)

Dr. Laxman Singh Rathore, International Advisor, SAHF (Former Director General of Indian Meteorological Dept, IMD)

Arati Belle, World Bank

- › Visioning for hydromet services in South Asia

Lunch 12.30 – 1.30 pm: Garden Area outside Regency Hall

Highlighting Lessons from Ongoing Programs in SAR

This session will highlight some of the lessons from ongoing regional efforts and draw on assessments for hydromet capacity related needs.

Session 2: 1.30 – 2.30 pm

Chair: Christoph Pusch, Practice Manager, WB

Presentations (12 mins)

[Abdoulaye Harou, Chief, Data Processing and Forecasting Systems, WMO](#)

[David Corbelli, International Development Manager, UKMet Office](#)

[Alice Soares, International Advisor, SAHF](#)

Severe Weather Forecasting Demonstration Project (SWFDP)

Highlights of Needs Assessment

Hydromet Modernization: Lessons from Myanmar

Coffee/Tea Break 2.30 – 2.45pm: Corridor outside Regency Hall

Moderated Discussion on Prioritizing Regional Collaboration

This session will include a panel discussion among the representatives from agencies providing weather, water and climate services. This session is focused on hearing voices from the different countries, with a view to elicit discussion on information sharing, mechanisms for collaboration and specific country needs.

Panel Discussion (90 mins)

Session 3: 2.45 – 4.15 pm

Moderators: Dr. Laxman Singh Rathore; Dr. David Rogers, International Advisors for SAHF

• Mr. Sayed Reza Mousawi, Director, Meteorological Department, Afghanistan

• Mr. Shamsuddin Ahmed, Director, Meteorological Department, Bangladesh

• Mr. Karma Dupchu, Director, National Center for Hydrology and Meteorology, Bhutan

• Dr. Mrutyunjay Mohapatra, Director General, IMD

• Mr. Abdul Muhsin Ramiz, Director, Meteorological Services, Maldives

• Mr. Saraju Kumar Baidya, Director, Department of Hydrology and Meteorology, Nepal

• Dr. Muhammad Hanif, Chief Meteorologist and Project Director, Meteorological Department, Pakistan

• Ms. Dulari Gangani Fernando, Deputy Director, Department of Meteorology, Sri Lanka

Collaboration on extreme weather:

Information sharing needs and mechanisms

Products and information that can be shared

Operational aspects during severe weather

Training needs (regional, sub-regional)

Reception and Dinner 6.30 pm: Corridor and Garden outside Regency Hall

November 20, 2019, Day 2 – Hyatt Kathmandu Regency Hall

Session 4: 9.00 – 10.45 am

Advances and Solutions for Service Delivery – using data, technologies and remote sensing for forecasting

This session will highlight innovative approaches to forecasting and decision support.

Chairs: Dr. Mrityunjay Mohapatra, Director General, India Meteorological Department, IMD; Mr. Shamsuddin Ahmed, Director, Bangladesh Meteorological Department, BMD	<i>Presentations</i>	
	Dr. Stephan Siemen, Head of Development Section, Forecast Department, European Center for Medium Range Weather Forecasts (25 mins)	Advancing Global NWP through collaboration
	Dr. Amarnath Giriraj, International Water Management Institute (IWMI) (20 mins)	Innovations and lessons on Hydromet –IWMI experience
	Michael Souffront, Aquaveo (15 mins)	Global streamflow forecasting
	Abhishek Modi and Karan Agarwal, Google Asia (15 mins) Email: abhishekmodi@google.com and karanagarwal@google.com	Flood forecasting using remote sensing
Coffee/Tea Break 10.45 – 11.00 am: Corridor outside Regency Hall		
Reaching Users – Linking Communities and Sectors with Specialized Services <i>This session will discuss the good practices and innovative initiatives in the delivery of hydromet and climate services in various sectors with a focus on reaching communities and users including early warning, agriculture and transport.</i>		
Session 5: 11.00 am – 12.30 pm Chairs: Mr. Imran Jamil Shami, Joint Secretary, Pakistan Aviation Division; Mr. Karma Dupchu, Director, National Center for Hydrology and Meteorology, Bhutan	Dr. Satyagopal Korlapati, Former Additional Chief Secretary and Tamil Nadu State Relief Commissioner, India (20 mins)	TN SMART: Multi-Hazard Decision Support System for preparedness, response, recovery and mitigation
	Dr. Mazharul Aziz, Project Director, Bangladesh Agro-Meteorological Information Systems Development (15 mins)	
	Masatsugu Takamatsu, WB; - Dorji Gyeltshen, Bhutan Department of Roads; and - Naresh Shakya, Nepal Department of Roads (25 mins)	Delivering advisories to farmers in Bangladesh for resilience
	Jim Anderson, Chairman, Association of Hydro-Meteorological Equipment Industry (15 mins)	Weather and landslides: case studies
		Private sector services
Networking Activity 12.30-1.00pm: Regency Hall		
Lunch 1.00 – 2.00 pm: Garden Area outside Regency Hall		
Bringing it together for Regional Collaboration – SAR on action planning <i>This session will follow the discussion from Session 3 toward an agreed upon action plan that identifies pathways and priorities for regional collaboration</i>		
Session 6: 2.00 – 3.00 pm Moderators: Arati Belle, WB; Abdoulaye Harou, WMO	Senior Representatives of Meteorological, Hydrological and User Sector Agencies	Action planning areas of regional collaboration and modalities to enhance communication among SAHF
	Dr. A.R. Subbiah, Director, RIMES Program Unit	SAHF Regional Initiative Next Steps
Coffee/Tea Break 3.00 – 3.15pm: Corridor outside Regency Hall		

Session 7: 3.15 – 4.15 pm Chair: Markus Repnik, Director WMO; Vladimir Tsirkunov, Lead Specialist, WB	Bringing it Together for Regional Collaboration – How can Development Partners Help? <i>This session will allow for an exchange of views with development partners engaged with SAR countries on using SAHF to better align hydromet and climate services-related support.</i>	
	Archana Shukla (DFID); David Corbelli (UKMO); Michael Ernst (USAID); Donna Lagdameo (Red Cross Red Crescent Climate Center); Ram Prasad Bhandari (JICA); Mandira Shrestha (ICIMOD); Moctar Aboubaca (WFP); and Joseph Intsiful (GCF)	Discussion to align and build on ongoing and planned Development Partners' activities, such as training and capacity development
Session 8: 4.15 – 5.00 pm Chair: Er. Rabindra Nath Shrestha, Nepal Secretary of Energy, Water Resources and Irrigation, Faris H. Hadad-Zervos, Country Manager, World Bank	Closing	
	Forum Voices (open mic)	
	Closing Remarks, Director General of DHM, GoN	
	Vote of Thanks, Arati Belle, World Bank	

November 21, 2019, Day 3 – Nepal Hydromet Visits

9.00 am	Congregate for transport outside Hyatt main entrance and travel to sites.
10:00 am – 10:45 am	NARC Building: Presentation on Agro-Advisory Bulletins and Agriculture Management Information
10:45 am – 11:15 am	Q/A Session and Discussions (30 mins)
11:15 am	Leave for DHM, Babarmahal, Kathmandu
12:00 pm – 1:00 pm	Lunch at DHM
1:00 pm – 2:00 pm	Presentation by DHM on Hydromet Modernization in Nepal (30 mins)
	Q/A Session and Discussions (30 mins)
2:00 pm – 3:00 pm	Tour of the DHM Building
3:00 pm	Return to Hyatt





