First BACS Training Dialogue:

Introduction to Climate Services

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21-25 October 2018

Venue: **Bangladesh Meteorological Department (BMD)**

বাংলাদেশ আবহাওয়া অধিদপ্তর

CIMMYT International Maize and Wheat Improvement Center

ICCCAD International Centre for Climate Change and Development

IRI International Research Institute for Climate and Society Earth Institute | Columbia University

Executive Summary

The "Introduction to Climate Services" training was the first of a series organized under the Bangladesh Academy for Climate Services (BACS). The goal of the training was to work with a group of decision makers from a range of sectors related to food security, through the identification of relevant climate information that has the potential to improve their decision-making processes and address some of their climate challenges. The course aimed to engage with the four pillars of climate services: production, translation, dissemination, and use.

Led by a team of interdisciplinary international and local facilitators with ongoing participation from relevant Bangladesh government Agencies and Departments, the BACS Training Dialogue employed participatory and interactive learning methods to equip participants with a basic understanding of climate services to help them identify climate-sensitive decisions within their respective fields. The aim was for participants to be able to better articulate their demand for climate information as well as critically assess the current use of climate information within their field and institution.

The training was met with great enthusiasm and positive feedback. It was successful at creating a bridge between producers of climate information and users. Among the highlights of the week, participants emphasized the great value of being given the opportunity to interact with BMD scientists throughout the week and gain a much better understanding of existing data and how to use it. Through the lectures on the basics of climate science and the participatory tools focused around specific decisions, participants were also able to develop a critical thinking process about the information they need at different timescales, the information available and the limits of science. Many took steps to contact their management to discuss better strategies of integration of climate information, and BMD director offered to provide advice on those strategies if requested.

Background of Bangladesh Academy for Climate Services (BACS)

The Bangladesh Academy for Climate Services (BACS) is co-founded by the International Center for Climate Change and Development (ICCCAD) at Independent University, Bangladesh (IUB), the International Research Institute for Climate and Society (IRI) at Columbia University, the International Maize and Wheat Improvement Center (CIMMYT), and the Bangladesh Meteorological Department (BMD). BACS was born from stakeholder consultations as part of IRI's ACToday project, and IRI's contributions to BACS are supported by the ACToday project. The Academy was born from the need for a trans-sectoral dialogue on the use and understanding of weather and climate information in Bangladesh. It aims to respond to that need by:

- convening trans-sectoral and multi-stakeholder dialogue around the production, translation, dissemination and use of climate information while identifying needs, challenges and opportunities; and,
- developing tailored certification short courses and creating graduate level curricula to train the new generation of weather, climate and sector experts.

Introduction on BACS Training Course

The first week-long training course was held from 21st October to 25th October 2018 at Bangladesh Meteorological Department (BMD). It was an introductory course on climate services with twenty early-to mid-career participants working in fields related to food security and the value chains of food systems, including agriculture and food systems, disaster preparedness and response, infrastructure, public health, or aligned fields. The course created an interactive platform between the participants and the facilitators where the participants got to learn strategies to incorporate climate information into their decision-making processes, including identifying and documenting climate-sensitive decisions, learning the basics of climate science, unpacking specific needs for climate information in their sector, and understanding available products.

Objectives for Participants

The main objective of the course was to explore strategies for incorporating climate services into existing decision frameworks using the four pillars of climate services: production, transfer, dissemination, and use. Other objectives include:

- Identify climate-sensitive decisions within their respective fields and develop an understanding of existing stakeholder/organizational decision-making processes. With this knowledge, participants will be able to articulate better their demand for climate information as well critically assess the current use of climate information within their field/institution.
- Equip participants with a basic understanding of climate, climate services, and available products.
- Learn strategies for beginning/improving use of climate services in existing decision systems using decision-making flowcharts (DMF).
- Become BACS Academicians, and join the BACS alumni network for further collaboration, trainings and engagement.

The training was led by resource persons actively engaged in development of climate services in Bangladesh, including scientists and experts from BACS partners, the Bangladesh Meteorological Department (BMD), the International Research Institute for Climate and Society (IRI) at Columbia University, CIMMYT and ICCCAD.

Day One

Themes: What challenges do I face that climate services can help address? What questions am I currently asking and what climate information am I using to address them? What do I need to know about climate and climate services to address my challenges?

The first day of the training course was themed on understanding the current use of climate information in particular working sector for each of the participants, the challenges associated with climate services and the knowledge they need to have about climate and climate services to address those challenges. The session started with welcome notes from each founding partner, participants' presentation on their homework and the introductory notes on the basics of climate science.

1.1 Welcome Remarks

Mr. Shamsuddin Ahmed, Director, Bangladesh Meteorological Department (BMD) highlighted the important role that climate services play to the various sectors of the national economy. Climate services will help in implementing green technology and services across the country. All the information producers and users of those information currently work in silos. He feels that there is lack of knowledge when it comes to climate information and how to use that knowledge in any specific sector. The idea of having an academy is a great initiative to have this platform where different stakeholders can discuss climate services. He concluded his remarks by thanking all the participants who joined the training course.

Dr. Timothy J. Krupnik, Senior Scientist and Systems Agronomist from International Wheat and Maize Improvement Center (CIMMYT) remarked that the learning from this training course will be from both ends. BMD has a treasure trove of information for applying science to be used for action but translating this information and disseminating to different sectors such as fisheries, livestock, agriculture, construction would make it more accessible and usable. This training course is to benefit people by articulating what they actually need and identifying how the climate information will help their decision-making for any particular action. After this five-day training dialogue, every participant is going to be an ambassador for Bangladesh to carry out climate services along its different sectors. They can take this learning back to their organization.

Mélody Braun, Research Staff Associate, Project Lead of ACToday Bangladesh, International Research Institute for Climate and Society (IRI), The Earth Institute at Columbia University explained that so much information is produced in academic institutions that needs to be linked to users. In Bangladesh in particular, there are so many different initiatives that it's hard to keep track of all climate projects, and know what is available. There is a need for better understanding of climate information and climate services in Bangladesh. Ms. Braun suggested that BACS could be a platform to do just that and to help identify gaps in climate information. Through this course, participants can learn about how to incorporate this knowledge into their working sector.

Dr. Saleemul Huq, Director, International Centre for Climate Change and Development (ICCCAD) identified that production of information is going on but using it properly is the major issue. Under this BACS initiative, the team is trying to address and enhance the effectiveness of climate information and how it can be improved for the users and strengthen the ability to use the information. ICCCAD is involved in many capacity building programs including a one-year MS degree program in Climate Change and Development, as well as short courses on several topics and themes. With this capacity development initiative, ICCCAD looks forward to continuing this relationship beyond the course. He concluded his remarks by stating to think about the ideas on how to do it together and how to carry this huge information to user level.

1.2 Participant Introductions and Presentations

Before the training course, participants were given homework to complete needs assessments and prepare a Decision-Making Flowchart (DMF)[1]. DMFs are a user-centered design tool that provide a diagnostic space to allow for analysis of the opportunities to include climate information data into existing decision-making processes (**Annex II**). In this session, participants introduced themselves and shared their needs, challenges, questions, and what climate information/services they use now and why.

The participants worked with topics spanning agricultural crop production, infrastructure development, WASH (water, sanitation and hygiene) activities, disaster preparedness, new technologies, and information dissemination etc. After presenting their area of work and responsibilities, they presented on the challenges they face in their daily work. They continuously

[1] DMFs were designed by Melody Braun and IRI colleague Andrew Kruczkiewicz in early 2018 to help diagnose decision-making processes related to climate sensitive questions in Bangladesh. The DMF design and related facilitation processes are currently experimental. Testing of the DMF is currently funded by NASA under the COMPAS (Connecting Earth Observations to decision makers for preparedness actions) project.

depend on climate information and services, such as rainfall data and weather forecasts for their activities or the decisions they are taking. But there was a perceived lack of reliable and timely information on weather and climate data and forecasting. They identified challenges when they see conflicting data or when they cannot interpret the previous forecast. Another challenge mentioned by some of the participants is how to communicate the information to local communities, for example: farmers, fishermen, or relief workers. With all these needs and challenges, they shared their DMFs according to the work they do. Most of the participants expressed that they found the DMF exercise critical yet very challenging without initial help and a number of them were unable to complete the assignment beforehand.

As there are many climate and non-climate risks and impediments associated with this sort of work, the participants were mainly keen to understand what type of climate information are available and how to apply that information in their research or working arena. They reiterated that their expectation from the course is to learn how to incorporate climate services into decision-making.



1.3 Introduction to Climate Services

John Furlow, Deputy Director at the International Research Institute for Climate and Society (IRI), The Earth Institute at Columbia University, started with the point that "understanding climate services is important so that people can use the data for better results and decision-making." To define the climate services, there are four pillars: Production, Translation, Dissemination and Use (Annex III).

When generating climate information, it's important to first identify the need for the information. Then, to learn from the past, monitor the present and forecast the future. After generation, climate information needs to be translated by analyzing the data for the user group such as agriculture, public health, disaster, natural resource management or other relevant sectors. After climate information has been translated, it comes to the point to transfer the information, which can be through different formats or media. The transferred climate information then needs to be used in various operational decision-making processes, policies or plans. The whole chain is developed with a group of scientists gathering data from the meteorological services, and then analyzing the data with sectoral scientists so that the sectoral operations flow well. The producers and users of climate information will learn what works and what doesn't from the whole chain. However, if there is no institutional buy-in, the impact of climate services would be very negligible.

1.4 Climate Basics

This session was concentrated on climate science basics, including timescales, spatial scales, and uncertainty. The session was designed to give participants a foundation on climate science and to observe how to use this scientific knowledge further in their respective area of work. The main goal is to create a real understanding of the climate processes that are occurring.

Colin Kelley and **Hannah Nissan,** climate scientists from IRI at Columbia University, started the session with the definition of weather and climate. Here, the participants received a simplified definition of weather and climate.

Weather and climate were discussed looking at different meteorological parameters, for example: temperature, humidity (water vapour), rain / snowfall, sunshine / cloudiness, wind, air quality etc. There are different ways to characterize climate by using different ranges or statistics, and frequency of occurrence of an event. Key interests of these parameters include extremes, thresholds, accumulation of rain etc. During the presentation, the scientists showed the participants a picture of a climate system where there is interaction between air and the water surface and discussed the importance of the surface, atmosphere, surface type, hydrological cycle, carbon balance, energy exchange etc. There are different zones on earth with different climate. The tropics are mostly constituted by water and they receive important radiation and rainfall. The subtropics have a different climate, they are much drier and are having most of the world's deserts. The mid-latitude presents another weather pattern. The weather experienced in these zones is influenced by the sun angle on the surface of the earth. The surface is heated by the sun, but this varies based on the time of the day, season and latitude. They explained that the tropics are hotter than the poles because solar radiations come in a straight line and hit the tropics more directly than the poles. There are seasons in the year because the earth rotates on its axes.

Both scientists then introduced a series of basic principles for understanding how climate works. By using the climate principles, the participants can understand the more complicated systems (weather and climate) and interpret the information. The hottest time of day is when there is a combination of solar heating and heat coming off the land. That's why it is important to know how different surfaces are heated and cooled by the sun. It takes a lot of energy to change the temperature of water – so water tends to stay a similar temperature throughout the year, while land will heat up and cool down more easily. Colin also pointed out what makes the Sahara very different from Bangladesh, though

they are both situated at the same latitude. Thus, he emphasized the importance of cloud formation to influence temperature variation. Also, there are no heat waves in the mountains since air pressure decreases with latitude; air expands at high altitudes, and so temperatures will be colder. The vegetation also has an important impact on temperature, as warm air can hold a lot more moisture than the cold air. Humidity is very important for heat stress because when there is a lot of water vapor already in the air, our sweat doesn't evaporate quickly enough to cool us down. Hot air rises and cold air sinks. Humidity is higher on the surface than higher in the sky. When it is colder, humidity reduces, and the water falls in the form of rain. We have an increase of water in the atmosphere with GHG emissions, but this cannot go up indefinitely. It is part of the water cycle: we have evaporation from water, ocean and land due to moisture in the land, and water drops from clouds, exchange the energy. Indeed, clouds are liquid water drops that fall on earth and start the cycle again. The total amount of water on earth will always stay the same. Water consumption by animals, plants, humans is part of the greater water budget, but this is a much more complicated question. The scientists explained convective rainfall in the tropical regions, large scale rainfall over big spatial scale and orographic rainfall which places in the mountains which various seasons in rainfall.

Participants were given a quiz to answer the primary cause of monsoons, which specified four options. They were divided into groups and asked to collaborate in finding the answer to the question asked. The objective of the quiz was to ensure that the basics of climate science are correctly understood by all the participants, as well as to promote collaboration between the participants for the rest of the course and enable everyone to get to know each other. Colin mentioned that most of responses have some good points, but he stated that the differences between the ocean and the land would be the answer as during summer, the land heats up faster, forces the ocean wind to go higher and then causes the rainfall. But during winter, there is not much of this difference and thus the monsoon circulation is not happening. There is also a need of a specific combination of big amount of water, land and temperature difference. The organization of land and water is what creates the monsoon. So, some places with the same latitude as Bangladesh will not experience the monsoon., because they have a different geographical and space organization of water and land.

In the next part of the presentation, the climate scientists presented on the **Time scale of Weather and Climate Information** where they asked to think about the specific decision they presented in the morning, and the time scale that would be relevant for that decision. They explained the climate variations over many years, using a rainfall graph to show trends over time. For the weather and climate forecasts, they explained different timescales which are: Weather (hours to 10 days), Sub-seasonal (2 weeks to 3 months), Seasonal (3 months to 1 year), Interannual to decadal (1 year to 10 years) and Multi-decadal (10 years to 1 century).

The participants were asked to write down the decision from the DMF on a card and think about the timescale of climate information they thought they needed in order to take that decision. The

facilitators put a timeline on the wall, and the participants were asked to fix their question to the timeline. The facilitators also added that the users might need to look at historical data.

Day Two

Themes: What information is available to answer my questions? What do I need to know to use this information effectively? What are some examples of actions that were enabled by appropriate use of climate information/climate services?

The second day aimed to identify the type of weather and climate information that could be used to help address participant's needs as well as to highlight the concepts that participants need to understand and consider in order to use climate information effectively.

The facilitators presented examples of actions that were enabled by appropriate use of climate information. Different terminologies on climate change, discussed the previous day, had been illustrated again by incorporating local examples led by Mr. Abdul Mannan from the Bangladesh Meteorological Department. In addition, Mr. Abdul Mannan clarified concepts such as water budget, radiation variation, seasonal rainfall pattern, roles of ocean and land surface, cyclone formation, and seasonal changes of climate.

2.1 Weather and climate observations and forecasts

Collin Kelly and **Hannah Nissan** from IRI presented on the weather and climate observations, where Collin started with the note on there is an extensive international system of weather observation and exchange. These observations are coordinated and communicated around the world to help make the best possible forecasts. There are different types of observations, for example: station data, gridded data, remote sensed data (mainly satellites) for getting data. Each has pros and cons that need to be understood when the data are used. Where the station data provides with accurate local information, but the spatial coverage is uneven, and land is also an issue here. Where there is a station and where there is not accuracy will certainly vary, and it is dependent

on topography and time. There are 47 weather stations those are covered by BMD, and they have a goal to reach 260 in number by 2040. On the other hand, gridded data provides nice spatial coverage, but may vary with the local stations. The satellite data provides good spatial coverage, but clouds make it hard to see the earth's surface. Satellite gives us grid data whereas stations gives us point data.

Forecasting the weather is difficult not so much because the atmosphere is complex. To make a good prediction, we need to know the initial conditions of the weather and climate, and how the current state will evolve. So, in these two sources, there remains uncertainties. By generating multiple forecasts, these uncertainties can be addressed. For the initial condition, accurate forecasts beyond about a week become impossible. A very small error can lead quite different outcome. The deterministic forecasts can be unreliable beyond a few days because there is no information about probability. For example: harvesting rice and maize if storm coming by using 7 day forecast. The probabilistic forecast considers likelihood of crossing threshold and different parameters´ forecasting will lead us different decision. Whereas, evacuating village may need high probability of flood, but distributing water bottles for heat wave may not be so critical. As the north has more stations to capture, the northern hemisphere forecast is better than south.

We can make forecasts at different timescales because there are different reasons why the predictions can work. There are trade-offs in lead time versus precision. Longer-term forecasts are less precise, both in space and time, but we gain additional time to prepare and adapt. We can't predict exact timing or location of weather events using climate forecasts. Instead, we look to climate forecasts to give indication of increased/decreased risk of certain conditions over a longer period of time. For example: when to sow cotton, if we consider 1-month lead time, we compromise getting daily forecast as we cannot get that beyond 10 days. At 1-month lead time, we will only get information about general weather conditions over few weeks.

Climate forecasts tell us the probability of conditions over a period of time from 1 week to several months/years, but they cannot tell us when or where events will happen. Hence, the decision-making across timescales is important. One could use sub-seasonal forecast to gather information about what evidence is available and reliable, and monitor weather forecasts, but wait to implement high cost actions until you have a weather forecast that has higher confidence. But measuring accuracy is an exceptionally complicated question. Some forecasting centres produce weather and/or seasonal forecasts for the whole globe. Seasonal forecasts became widespread from about the late 1990s. The standard format is to forecast the aggregate conditions over a 3- or 4-month period.

In summary, Collin and Hannah mentioned that climate information can be based on observed data or forecasts. Accurate weather forecasts beyond about 10 days are impossible. Probabilistic forecasts are important for good decision-making, particularly more than a couple of days ahead. When using a forecast product, we need to always consider how well the forecast compares with observations. After this session, participants get confused on maps interpretation and scale and how to decide, but the facilitators said that this is the purpose throughout this whole week course. When taking the seasonal accuracy, as winter fluctuations are less, the accuracy is better. Understanding past climate data is very useful to take decision if the data is reliable.

In the end part of the presentation, participants asked questions regarding the emergence of salinity issue in the coastal Bangladesh. This is due to the construction of a barrage in the 80's which changed the fresh water movement in the system and resulted in less fresh water flow. This changed the salinity in the region. Thus, this change is not only climate induced: there is also the effect of cyclones, sea level rise etc. but part is also man-made, for example: practicing shrimp farming.

2.2 Introduction to climate and agriculture

CIMMYT led a session on climate services for agriculture in Bangladesh, which included a group exercise on identification of agricultural calendar and discussion around key climate-sensitive decisions to be made and relevant information. **Dr. Timothy J. Krupnik** and **Dr. Carlo Montes** in their presentation on **Introduction to climate and its application to agriculture** gave the participants the basics needed to have the greater picture of how climate is applied to agriculture.

Dr. Krupnik leading the first part of this session by showing a barrel to give an overview of managing the farm and crop requires better understanding of various components that control agricultural productivity which are dependent on climate. However, climate is one of the many factors that control agricultural productivity (biophysics and socio-economic factors need to be taken into consideration as well). When looking at the yield productivity (crop per area), it is to see what are the things that influence it and that can enhance the yield (like the genome), and thus things that reduce the crop productivity (winds, insects, weeds etc). Climate as such is both a yield enhancer and suppressor. Getting to know about this, it is required to understand the various type of photosynthesis. Thus, the amount of sun will affect the photosynthesis which affects how the crops growth and evaporation happens and how much water is needed to maintain the soil water balances. Climate in a region is regulated by different factors and scale, but the plants behavior is due to micro climate. This is important to keep in mind because the micro-climate can be modified around to enhance the yield, but it is also regulated but other larger scales. Moreover, weather station can easily provide information to describe the micro climate in the plant environment. Thus, it is important to have local weather stations.

Dr. Montes started the session with the overview of geographical context of the country, topographic map, quite complex forecast, animation of the land cover and change over the years, where the dominant cover in India and Bangladesh is agriculture land. The he discussed on the annual cycle of precipitation and temperature, monsoon in South Asia. Then he explained on the periodic fluctuation in sea surface temperature (El Niño) and atmospheric pressure (Southern Oscillation) across Bangladesh for precipitation, maximum temperature, minimum temperature. He also explained on the Dipole Mode Index (DMI) and the climate variables to explain the correlation. He explained on the monthly anomalies in precipitation and if the oceanic index is low then precipitation is low in the negative correlation zone, but for Bangladesh there is a positive relation and thus more rain. Additionally, if we take the pre-monsoon index and sea surface temperature we can have an idea of what can happen. There is a correlation pattern, but not so strong. There is a physical explanation for that linked to wind factors and air humidity, stronger wind with more humid and normal air.

Solar radiation, precipitation, relative humidity, wind speed and direction etc affect crop and forage growth. In Bangladesh during monsoon, there is less solar radiation during the drought, and by taking into account this information, one can determine the correct type of rice to plant during that season.

As, the different crops are having different kind of photosynthesis and effectivity depending on the climate and weather condition we can decide which one we can plant.

During the drought, plant regulate their evaporation, but this means a drop-in productivity if a long-term drought. In dry season, the evaporation increases but with a low air humidity, this can cause a potential water stress for plants which can affect the growth of plants. Precipitation affects crop and forage growth, as it is the main source of water, also productivity related to amount of transpired water. Another factors that affect the crops is the insect pest and are much more complicated and highly diverse. The growth of insects is related to the temperature. There are also many other factors which make it difficult to predict outbreak of pest.

Dr. Krupnik also showed the value of climate information on the agro-ecosystem and the agricultural production and livelihood where the significant interannual fluctuations may importantly affect livelihoods.

There he introduced the participants with the "climate smart agriculture" where he brought down three principles on productivity and income enhancing technologies, resilience to climate change and variability and the mitigation of GHGs. As climate services are focusing on transformative actions, we need climate service that allowed farmers to really take actions. Farmers are managing different production enterprises. Without partnership, applied science is just for academic but we need to work together to get the information out for users. For example, if one put climate data into when the farmer needs to transplant its crop, then they can have a better yield productivity. Climate is one thing that they have to think about and if we are giving advices to farmers, we need to keep in mind that they manage also many other things influenced by many other factors. During the field trip, it will be an occasion for the participants to ask more questions and understand where the climate information comes handy for farmers and how it can be integrated in their decision-making process. Additionally, we need to understand what time scale of climate information the farmer needs, as in most situations, they are less concerned about climate change but more about weather and climate variability.

In the open discussion round, participants also wanted to know about the characteristic of an effective agriculture climate service. Here, there is need to consider the gender dimension on getting the climate services, as they do not have the same preferences. This is due to the fact that they do not manage the same type of enterprise, such as: pond and livestock are managed by woman which means that they need another type of climate information that the one that will be used by men for their crop. So, we should be careful about designing a demand driven climate service. Additionally, climate services need to be simple and actionable. Indeed, farmers will not necessarily understand the forecast, therefore, we need to make them understand it by making access to information easier.

Other constriction for decision making: lead time. Dr. Krupnik shared in detail the concept of lead time which is the amount of time required not to just get information but to decide on changing the decision / behaviour due to the information received. If a farmer in Patuakhali growing mung beans and harvest for march, he needs to keep in mind that the bean plants are really sensitive to heavy rainfall. This means if there is a storm, he will lose his crops. Hence, he wants to know when does the heavy storm comes so that he can go to the field to harvest. Additionally, harvesting is a hard work and it is not done by only one person, and demand times. Hence, he needs some time to organize his harvesting activity. Here also a point is that, if one goes too far in time with his climate information prediction, the accuracy of the predictions goes down. Thus, we need to take into account not only the gap between the forecast event but also the time for actions.

2.3 Examples of climate services applications in agriculture

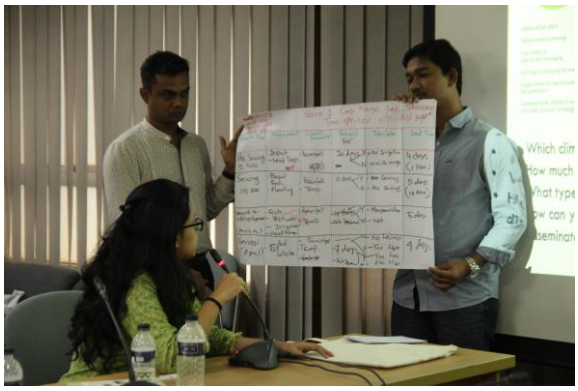
While talking about the examples of climate services applications in agriculture, **Dr. Krupnik** and **Dr. Montes** gave an overview on how the farmers in South Asia are supplying food to over more than 1.8 billion people from less than 15% of the world's agricultural land. The decreasing farm size is reducing crop production, and there are many climate challenges associated with it also. Scientists are generating a lot of data but translating climate information for action should be demand driven. There is always a common problem of designing and delivery of the climate services, such as in agricultural sector. Before the designing, there is less participation, poor need assessment, lack of coordinator among various stakeholders, and most importantly poor user-friendly product or information. That's why, when it comes to the crucial role to deliver that service or information, we need the institutions to take that forward. They showed several agricultural climate services examples from different web portal and literatures.

They shared an example of the blight disease that affects lentils in Meherpur. However, lentil is a highly profitable crop with very high risks. But with the use of forecasting data and model called "stempedia", the scientists can tell you when it is useful to apply the chemical against the disease, so the product is not washed of by rain and you do not lose money but also when to put less of it, so it is also better for the general environment. The work is ongoing, and they are making the maps and trying to validate the model in different geographic area with different solar radiation, humidity, precipitation and temperature etc. to see the progress on how the model works.

There is walked regarding the Program for Advanced Numerical Irrigation (PANI) which is to use some mathematical models and daily observation of the weather to determine when to irrigate. They are targeting to redesign the work to use forecasting from BMD. As such, when we take a picture with the phone of the crop, we want to know how much leaves have grown and temperature and understand how we can have the evaporation for a good plant growth. Additionally, water table depth also contributes to the growth of crop. All that information will be on the phone and with the BMD forecast, this will allow you to tell when to irrigate or not (7 days in advance). Also, we have to keep in mind that each soil is different and have a different water holding capacity. This capacity is due to the function of the soil composition. We also need to incorporate that into our model.

For designing a new climate service, using climate information for improved decision-making is necessary, but there is need to see if the farmers agree with the information, as the farmers know when the crop is water stress, but it is good to know when the rainfall will come. There is need of training and capacity building for the farmers to make them understand the climate information. DAE is leading a training which take the farmers to the training before the crop seasons, so they can understand the climate conditions of their location and make better decision. With PICSA, they are putting climate information into the training. Here the facilitators talked about coping with crop loss and agricultural crop insurance.

Then they are given a group exercise to imagine and think that "you are a farmer and grow a particular crop. We want you to think about all the management decision you have to do before, when crop is established during harvest and after the harvest. What are the management decision to do? Thus, decide on a crop and what management decision you are making during the time , where do you grow it (location has a really important influence on crop growth) etc. Then circle the decision management that are climate sensitive and explain why. Further, list down which climate variables will influence the crop management and growth. Finally, write down what kind of climate information can farmers benefit, forecast or past information and time that farmers need (think also of the lead time)." Then four groups were formed in total.



Day Three

Themes: How do I build my capacity to incorporate climate information into my decision-making? How to identify and address hurdles to implementing climate services?

On the third day of the training, the facilitators brought in outside guests working on different pillars of climate services. Using questions identified in the Decision-Making Flowcharts (DMFs), participants were asked to identify and address the hurdles of incorporating climate information into their decision-making processes. Participants were asked to stick each decision card onto one of the four pillars of the room, representing the four pillars of climate services: production, if they thought the their challenge was that the information they need does not exist; translation, if they believe that information exist but is not currently understood or understandable; dissemination, if they think the information exists in the right language and format, but is not accessible to them; and finally use, if they have access to the right information in the right format but still are not able to use it, for other reasons. Outside guests were kindly asked to listen to the identified challenges, and then try to offer suggestions and solutions based on their own experience.

Participants were later given opportunities to redraft the DMFs with facilitator support.

3.1 World Café Session

In the World Café session, 20 participants were divided into five groups, rotating to each of the 5 stations where guests were sitting. Each group had 10 minutes with each guest to ask questions and discuss their initiatives on climate services.

One station was led by **Mrs. Rahana Sultana**, Agricultural Economist, Department of Agricultural Extension (DAE), Ministry of Agriculture who mainly discussed on the Participatory Integrated Climate Services for Agriculture (PICSA) which is a component of the USAID funded Climate Services for Resilient Development (CSRD) project. After giving a brief introduction about the PICSA approach, she added that PICSA aims at enabling the farmers in choosing crop, livestock and livelihood options most

suitable to the individual farmer's circumstances. To do these, farmers use tools such as, resource allocation map, crop calendar, historical climate information, livelihood options matrix etc. Agricultural extension staff are training the farmers to use these tools. The project has been successfully implemented in several African countries and Bangladesh is the first country in Asia. Currently DAE staff are experimentally working with the farmers of 20 Union Parishads of 20 Upazilas of the 5 districts of Bangladesh. Bangladesh Meteorological Department (BMD) provides the historical climate information and DAE disseminates these to the farmers before, during and after the season. The farmers will take the decision, the whole design is participatory. The impact analysis of PICSA hasn't been done yet, but CIMMYT plans on conducting one later. The historical information of temperature and rainfall will be provided to the farmers as climate information, but there are some barriers associated with introducing this approach in Bangladesh. In the local level farmers' community, they are unwilling to accept anything new, and also, they are unwilling to come to the field schools without any financial benefit.

The next station was led by **Md. Abdul Mannan**, meteorologist from Bangladesh Meteorological Department (BMD) where the participants enquired for weather data related questions and the expert responded on the availability, possibility, authenticity of weather data by BMD. The participants mentioned about their requirement of getting the local specific weather information for their insurance crop products. But the expert replied that, to get local specific weather information, automatic weather stations are required to set up at all the locations of the country. However, it is not possible to install weather stations at all locations at village level because BMD doesn't have enough manpower for the maintenance of the weather station and it requires skilled employments to handle and maintain it. Moreover, space is an issue for setting up the weather station. In some Upazilas, there is no place close to the Upazila office to set up the station, but they are looking forward to installing more weather stations in public spaces in the future.

One important query coming from most of the participants was, if they need information from one specific locality and that area doesn't have any weather station, then from which station they should consider the weather data. There are two ways that the users of the climate information can collect data. Either, they can look to collect data from the nearest weather station to their locality or they can collect data from the few closest weather stations and take the average value, which also the expert believes to be a more reliable method to use. The expert also pointed out that there is less error in the data collecting from the manual stations than the automatic weather stations (AWS), as sometimes the sensor at the AWS doesn't work properly. AWS is a new technology and it is still going under various experiments; hence the area coverage is not as defined as it is for manual weather stations. For the data usage from satellite stations, there is need for calculation for identifying the deviation from the point of satellite to a particular location, and programming-based software skills area needed for calculating the data points. One added information on that note was, the area coverage of one BMD weather station for wind speed is 50 square km. To find out the wind speed during the day, one must work on previous day's data (historical data) to measure the deviation of wind speed to explore if they want to work with crop damages by the wind. After the round by round interactive discussions, some of the organizations are really interested in working closely with BMD in future. Later in the training, IRI and BMD announced that they would start working together in January 2019 on the development of a merged station and satellite dataset to improve coverage and access to good quality data in places not covered by weather stations. The initiative, called Enhancing National Climate Services initiative (ENACTS) has been successfully implemented in several African countries and would be implemented for the first time in Asia.

The third station was directed by **Colin Kelley,** Associate Research Scientist, International Research Institute for Climate and Society (IRI), Earth Institute at Columbia University. The IRI Climate and Society Maproom is a collection of maps and other figures that monitor climate and societal conditions at present and in the recent past. The Global Maproom is publicly available, whereas the National Maprooms are available to those with granted access. There are various ways to define criteria to illustrate information on the maps differently, for example: via timeframe and thresholds (above or below) as well as different maps that display international temperatures, rainfall, and seasonal forecasts etc. The Bangladesh Maproom is under development and is expected to be completed within 6-8 months (June 2019), it will use ENACTS data with BMD provided station data. BMD owns the Bangladesh Maproom and as such, they can be responsive to the needs of users with integration support provided by the IRI. Maprooms are interactive and users can receive forecasts according to their needs. Information can also be refined with dialogue/feedback with BMD. Because the Bangladesh Maproom is still under development, there is an opportunity to customize data and ensure that the map room contains sufficient detail for users' needs. Providing feedback and evaluation to the nationally responsible unit helps ensure that the data is useable.

Another station was led by **Dr. Mazharul Aziz**, Project Director Department of Agricultural Extension (DAE), Ministry of Agriculture where the discussion with the different group participants was on mechanism of delivering the climate information at the grassroot level. Here, the expert mentioned that, the generated information from PICSA will be analysed by key expert organizations on this sector and then translated by various government institutes to make the information usable for farmers. The project will have lead farmers who are representing individual group of 30-40 farmers will receive the information directly in their mobile applications as text messages through the webportal. The data will also be available in the Upazila Parishad Board, and there will be a system of collecting and updating the information in the national database. The system will be automated and will be linked with the existing infrastructure. As there will be a database of lead farmers, the lack of manpower won't be a problem. In addition, every Union Parishad will have a manual board containing the previous and following 7 days weather forecasting data. For the mechanism to be effective, the message will be in Bangla as text and voice and all the selected lead farmers are able to read and write. Lead farmers will disseminate to their neighbouring farmers. 30% of those lead farmers will be female. The farmers would also give feedback whether the information is helpful or not which ensures a two-way communication method. This system will be effective during both normal and emergency situation.

The fifth station was led by **Arifuzzaman Bhuiyan** from Flood Forecasting and Warning Centre, Bangladesh Water Development Board (BWDB. He started by saying that informing adaptation to people will reduce societal risks to the current climate and help manage future risks in the face of coming climate change. But this would require much closer linkages between the wide-spectrum of applications communities focused on climate impacts, adaptation and vulnerability and the nation's science-based climate observations and modeling programs. BWDB undertakes different projects to support the country's weather, water and climate information infrastructure, strengthening both the supply of hydro-meteorological data, information and services and delivery to sectors and communities while laying the foundation for strengthening resilience at the regional level. He said that high inflow from Ganges, Brahmaputra and Meghna (GBM) basins associated with the intense rainfall is the source of flood in Bangladesh. Flood Forecasting and Early Warning (FFEW) is the mandate and responsibility of Bangladesh Water Development Board (BWDB) and Flood Forecasting and Warning Center (FFWC) under BWDB has been carrying out this responsibility since 1972 and operational on 7-days a week during monsoon (May to October). FFEW system started with few hours lead time has been upgraded up to 5-days with reasonable accuracy. At FFWC numerical Hydrodynamic model is

used for generating water level (WL) forecast upto 5-days at 54 points on 29 rivers based on real-time observed WL of 83 and rainfall of 56 stations with boundary estimation on daily basis. Main challenge of this system is the boundary estimation is the limited upstream data of the transboundary rivers, obstacle for increasing lead-time for FFEW. The satellite based upper catchment data may overcome this limitation. But there is a new approach in FFEW in Bangladesh where boundary estimation becomes possible using JASON-2 observed WE data of the Transboundary rivers. There is scope of further development of this system along with increase of lead time.

3.2 Climate Services of Bangladesh Meteorological Department (BMD)

Mr. Abdul Mannan, Meteorologist, Bangladesh Meteorological Department (BMD) presented on the **Climate Services of BMD** where he mentioned that Bangladesh has a sub-tropical monsoon climate characterized by wide seasonal variations in rainfall; moderately warm temperatures and high humidity. The climate of Bangladesh with detailed seasons, periods and weather events were presented. BMD is mandated by the Government to monitor asses and issue all kinds of forecasts and warnings for all extreme events to Government and public, and also to supply and facilitate the applications of climate data and information to the government and private agencies for planning and performance of socio-economic activities. BMD maintains a network of observational facilities to collect different types of meteorological data, also with many technical equipment. The issue of warning with these data required forecasting. BMD issues regular forecasting in the morning, afternoon and night as weather summary or weather forecast for Bangladesh, Dhaka, Chittagong and Chittagong Hill Tracts, Chittagong-Sandwip, for farmers, fishing trawlers, navigation. Apart from these, there is also a list of severe/special forecasts. At every airport also, there is meteorological department. Every flight needs to have the clarification from BMD. They do follow up until the event takes place.

After this, Mr. Mannan explained the warning dissemination system of BMD. Also, he mentioned about the BMD weather app where the information on location specific current weather, forecasting and warning, latest radar and satellite imageries. Recorded rainfall and temperature in the recent past could be accessible and displayed. There are many weather and climate related hazards in Bangladesh where the nodal agencies for monitoring and assessment of these natural hazards are BMD and flood forecasting and warning centre of BWDB. They take the guidelines from the Standing Orders on Disaster (SOD) for deciding on the warning parameters. BMD issues different spatial and temporal dimension of forecast for different group of users and stakeholders.

At the end of his presentation, he showed the BMD website to the participants and facilitated the procedures for getting data from there. He also introduced the participants to the very recent development of service facilities in the website.

Day Four: Field Trip to Singair Upazila, Manikganj

Themes: What can I learn about climate services from examples in the field? How can I reinforce course learning through practical examples?

On day four, the participants were taken to Singair Upazila, Manikganj to experience real-world learning and gain insight into how climate sensitive decisions are being taken on the ground. The field trip is an important part of the training, it not only helps to improve social capital and networking between participants, but also it is a way to turn participants into facilitators and apply the learning objectives of the course.

In the field, the participants met with district officers and sub-assistant agricultural officers who work with farmers, as well as about 30 farmers involved in crop, livestock and aquaculture production. Farmers gathered at the Upazila office auditorium and were divided into 5 different groups of around 10 members in each group. Each group consisted of 6 farmers and 4 training participants, with consideration to gender balance. In addition, a block supervisor was tagged with each of the groups to help in facilitating the group discussion between the farmers and participants. Participants asked questions to the farmers considering the objectives provided before to the field visit. The discussion helped them to understand what sort of weather and climate information farmers and DAE are currently getting, and how they use the information.

The participants were asked to identify 2-3 climate sensitive decisions the farmers need to take, what sort of climate and weather information they need, and how the climate information should be communicated. During the group discussion, the farmers mentioned that if they could get the weather forecasting report 7 days ahead of their harvesting time it would help them select the suitable date of harvesting. Thus, they could potentially avoid loss of production. The farmers do not follow probabilistic forecasting, rather they go along with their plans. They do not count probability unless it is really deterministic forecasting. The forecasting doesn't always match with the reality always, but as it does sometimes, they prefer to check information. If the forecasting warns them of having rainfall for next 3 days, then they do not execute their plan of sowing seeds the next day. They occasionally check whether the forecasts come true or not, and based on that, they review the decision. The DAE staffs mentioned that farmers have consensus on seasonal behavior where they rely more on their knowledge on weather and climate. When a forecast is not on the same alignment as their previous experiences, their trust of the forecast goes down. The farmers mainly rely on their gut feelings. The farmers mentioned that if they have decided to sow seeds, the timeline for getting the information is 15 days in advance, as it would be beneficial to allow them to prepare. For receiving the forecasts, they mainly follow the television on a regular basis. But they report that the data they get from the

television are not reliable, so rather they consider more the information they get by using mobile applications.

In the end, the farmers mainly mentioned that as their agriculture is highly dependent on rainfall, area specific rainfall information could be more useful. The information dissemination can be done by using the microphones from the mosques of their locality. On their mobiles, getting Bangla messages on weather forecasts is always helpful in this regard. The takeaway from the field trip was that participants would be able to present their decision-making flowcharts incorporating the knowledge from the field which reinforces the learning from the course through practical experiences. We were later informed that some farmers from that group called BMD the following week to ask for the weekly forecast in order to plan for their week.

Day Five

Themes: What can I do with what I have learned? How have my decisions changed?

The objective of the last day was to provide participants an opportunity to demonstrate comprehension of the course content through presenting a selection of the DMFs and providing the space to identify constraints, risks, tolerance to uncertainty, and temporal components of climate information and decision-making processes.

After each DMF presentation, participants were asked to join in a "Headline News" exercise giving headlines describing a) a success story around that DMF (the reward- where the use of climate information lead to a successful outcome) and b) a misuse of the DMF (the risk- where reliance on climate information had a negative and unintended consequence), repeated with different themes to explore different perspective and opportunity costs. The headline news provided the opportunity to introduce potential negative impacts of a decision due to the uncertainty associated with climate information, and ways to avoid or be prepared for such potential outcomes. Throughout the DMF presentations, the participants and facilitators discussed lessons learned and additional considerations. The afternoon session ended with each participant providing feedback from the week, including what 'ah-ha moments,' and identifying how participants planned to use the learning of the training during their daily work. Participants also completed a course evaluation survey.

Concluding Remarks

Mr. Shamsuddin Ahmed, Dr. Saleemul Huq, Ms. Melody Braun and Dr. Timothy J. Krupnik shared their remarks by thanking everyone and shared their thoughts on including the participants as BACS alumni. This training dialogue will be happening n every year from now with the feedback. There will be follow-up workshop with this year's participants after six months on how they are integrating the learning from this course. The training course was ended with Certificate Ceremony and dinner with government officials, donors and everyone involved with the training.

Survey

Pre and Post Course Assessment

Participants completed self-evaluations before and after the training to assess the skills and knowledge attained throughout the duration of the training. Topics assessed were 1) Basic scientific understanding of weather and climate including timescales of information; 2) Knowledge of currently available weather and climate information products, services, and tools; 3) Definition of climate services; 4) Ability to identify climate-sensitive decisions within the participant's organization/field; and 5) Strategies for beginning or improving use of climate services in existing decision systems in the participant's organization/field.

Survey results demonstrated that entering the training, there was a huge range in some knowledge and skills. Participants entering the training had zero to expert level understanding of weather and climate information and ability to use climate services to inform decision-making. There were low to medium responses across the board regarding knowledge of currently available climate services, and the definition of climate services.

The training resulted in increases in knowledge and skill for all topics covered. The biggest gains were in knowledge of currently available weather and climate information products, services and tools, likely related to the hosting of the training at BMD and BMD's strong participation throughout the course. The lowest gains were in the ability to identify climate sensitive decisions in their field, likely reflecting widespread challenges in this area throughout climate service development in Bangladesh and beyond.

The suggestions from participants came out as to be more specific sector based for all professionals so that everyone from different sectors, backgrounds and levels be benefited through the course. Participants would encourage more activity related training rather than having basic presentations.
The field option can be in a more climate vulnerable area so that the participants can learn from the vulnerable community on how they are integrating climate services into their day to day decision making. They also asked for organizing a follow-up event so that the participants can share on how they are integrating the learning from the course to their work area and working sectors.

Annex I: Training Course Agenda

Pre-course Homework

Participants must each prepare a short 8-minute presentation for the first day to define their needs, initial climate sensitive challenges of interest to them, and describe current use of climate services using decision-making flowchart (needs assessment, DMF template, examples and guidance will be provided). *Homework will be requested in early Oct when participants are selected, and should be submitted to BACS by Oct 15 for review before the start of the course.*

Agenda

DAY 1: OCT 21 @ BMD		
Themes: What challenges do I face that climate services can help address? What questions am I currently asking and what climate information am I using to address them? What do I need to know about climate and climate services to address my challenges?		
Date and Time	**Topic**	**Team Members**
9:00-12:30 hrs	• **Welcome** • **Introduction, expectations** • **Participant introductions and presentations.** Participants introduce themselves, and then using needs assessment and DMF prepared as homework, share their needs, challenges, questions, what climate information/services they use now and why (8 min each).	Leads: BACS team
12:30-13:30	Lunch Break	
13:30-17:00 hrs	• **Climate basics.** Use challenges defined by participants as examples to introduce basics of climate science, including timescales, spatial scales, and uncertainty. • **Intro to four pillars of climate services:** production, translation, dissemination and use. • **Daily takeaways**	Leads: IRI

DAY 2: OCT 22 @ BMD		
Themes: What information is available to answer my questions? What do I need to know to use this information effectively? What are some examples of actions that were enabled by appropriate use of climate information/climate services?		
Date and Time	**Topic**	**Team Members**
9:00-12:30 hrs	• **Daily recap** from prior day • **Timescales of information.** Introduction of products available for each timescale (weather, seasonal, etc) Discussion of uncertainties at each timescale, key considerations in using these types of information	Leads: IRI/BMD/CIMMYT
12:30-13:30	Lunch Break	

13:30-17:00 hrs	• **Intro to climate and agriculture.** Agro-climatology, appropriate lead time and spatial scale in agricultural climate services • **Example climate service applications in agriculture.** Monsoon onset analysis and planting schedules, disease forecast early warning systems, practical examples of information dissemination networks for farmers, current examples of dissemination pathways to farmers • **Climate information lightning rounds** (2-minute presentations of products by each provider) and **World Cafe** (providers sit at booths and participants rotate between booths every ten minutes) • **Daily takeaways**	Leads: CIMMYT, other invited guests

DAY 3: OCT 23 @ BMD		
Themes: How do I build my capacity to incorporate climate information into my decision-making? How to identify and address hurdles to implementing climate services?		
Date and Time	**Topic**	**Team Members**
9:00-12:30 hrs	• **Daily recap** from previous day, unpack questions about previous day sessions • Discuss role of **boundary organizations** in developing and supporting climate services between users and producers, eg. DAE/CSRD forecast based agro-advisories • **Hurdles and bottlenecks** to implementing climate services along all four pillars, and how to overcome them.	Leads: CIMMYT/IRI, with support from BMD, ICCCAD
12:30-13:30	Lunch Break	
13:30-17:00 hrs	• **Participants update challenges in their decision-making flowchart (DMF)** if needed, flag questions and add information on hurdles and strategies to overcome them, prepare for final day presentations. • Participants report back on DMF updates, using **"Headline News"** activity. • **Daily takeaways** for participants • **Instructions for field day**	Leads: CIMMYT/IRI, with support from BMD, ICCCAD

DAY 4: OCT 24 @ MANIKGANJ - FIELD DAY **Leave BMD by 7am, return at 7pm (40km away, 2 hour drive each way)**
Themes: What can I learn about climate services from examples in the field? How can I reinforce course learning through practical examples?

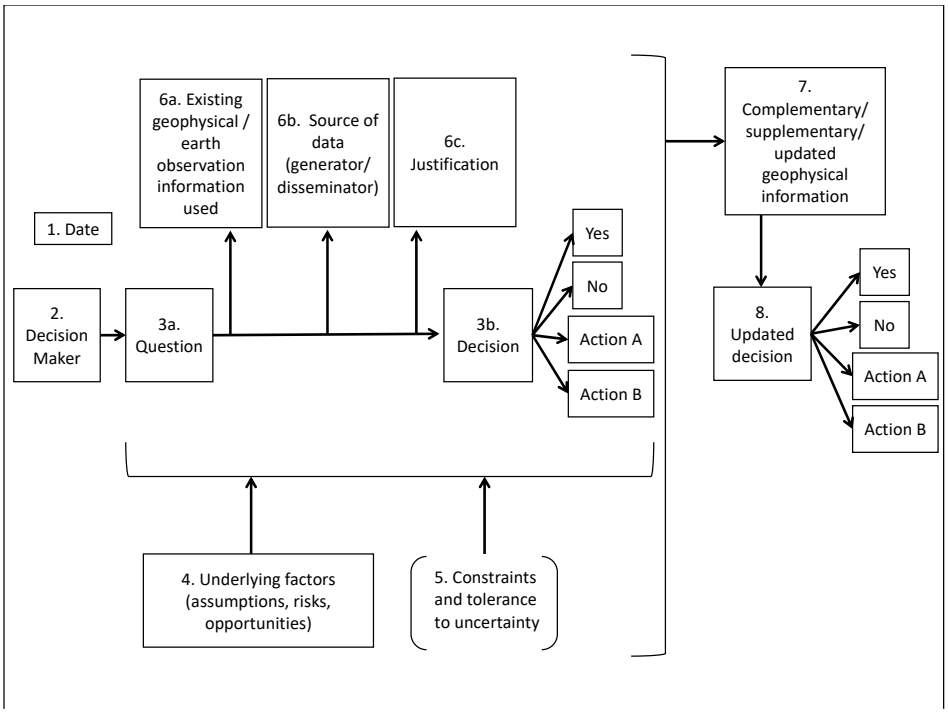
Date and Time	Topic	Team Members
9:00-12:30 hrs	• **Introduction** to climate service context for field component • Participants practice jointly designing decision making flow chart (DMFs) with field organization representatives (DAE ag extension and farmers) in small groups	Leads: BACS team
12:30-13:30	Lunch Break	
13:30-17:00 hrs	• Participants present DMFs generated in field with local representatives • **Site tour** • **Daily takeaway**	Leads: BACS Team

OCT 25 @ BMD – DAY 5		
Themes: What can I do with what I have learned? How have my decisions changed?		
Date and Time	**Topic**	**Team Members**
9:00-12:30 hrs	• **Recap week's learning,** discuss remaining questions, lessons learned • **Participants presentations** of their own revised DMFs, and how they will apply what they have learned after the course (5 min each)	Leads: BACS team
12:30-13:30	Lunch Break	
13:30-16:00 hrs	• **BMD response** to participant presentations • **Participant feedback** on the week, input on further BACS activities • **Closing remarks** by organizers • **Closing speech** by BMD	Leads: BACS team
Evening Program	• **Certificate Ceremony** • **High Level Dinner** with government officials, and all involved with the training	

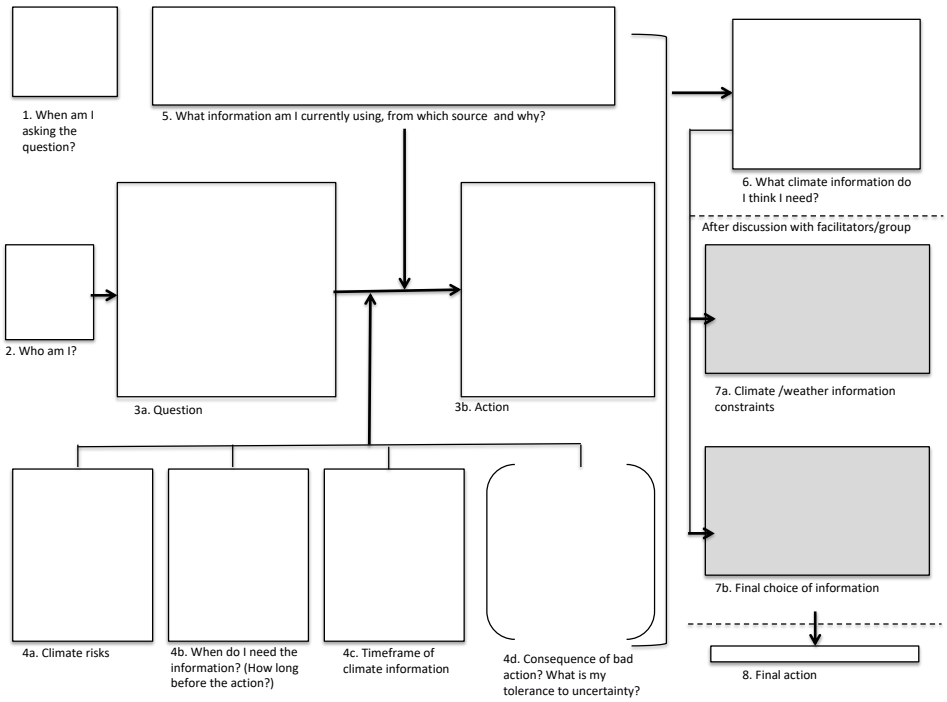
Annex II: Template of Decision-Making Flowchart

DMFs were designed by IRI's Melody Braun and Andrew Kruczkiewicz in early 2018 to help diagnose decision-making processes related to climate sensitive questions in Bangladesh. The DMF design and related facilitation processes are currently experimental. Testing of the DMF is currently funded by NASA under the COMPAS (Connecting Earth Observations to decision makers for preparedness actions) project.

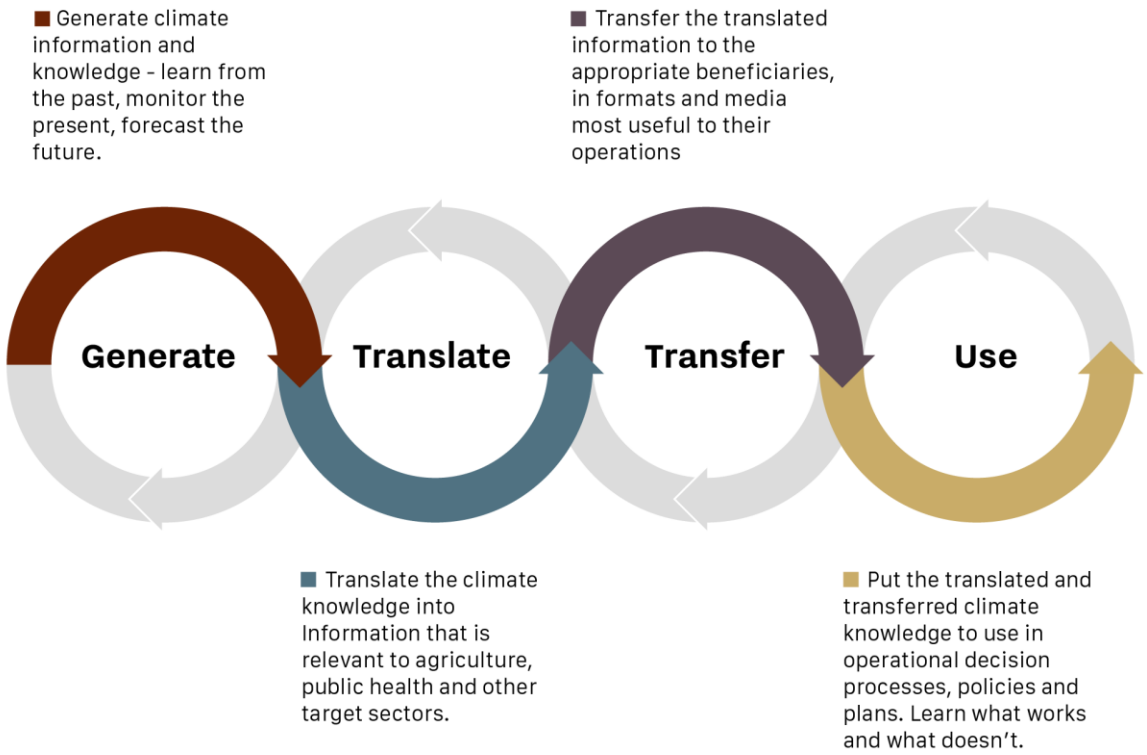
a) DMF for Homework



b) DMF for Final Presentations



Annex III: Four Pillars of Climate Services (IRI).



Annex IV: List of First BACS Training Dialogue Participants

Sl. No.	Name	Organization	Designation
1	Persia Nargis	IOM	Senior Program Support Assistant at Needs and Population Monitoring Unit (NPM)
2	Golam Morshed Rokon	CIMMYT	Agricultural Development Officer
3	Md. Imran Nizami	iDE	Manager-Marketing and Research, SanMarkS
4	Md. Abdullah Al Ahad	iDE	Manager-Technical Design
5	Md. Ariful Hauqe	iDE	Field team Leader - SanMarkS Khulna hub
6	MHM Mostafa Rahman	WorldFish, Bangladesh & South Asia Office	Environment Specialist
7	Dr. Md. Kamrul Islam	Cotton Development Board, Ministry of Agriculture	Senior Scientific Officer
8	M. M. Abed Ali	Cotton development Board, Ministry of Agriculture	Senior Scientific Officer
9	Md. Bodrud-Doza	BRAC	Senior Officer, Grants Making and Innovation, Climate Change Programme
10	Hossain Ishrath Adib	Practical Action, Bangladesh	Head of Programme Implementation

11	Lamiya Mahpara Ahmed	StartFund Bangladesh	Analyst- Start Fund Bangladesh
12	Smriti Tagdira Naznin	Syngenta Foundation for Sustainable Agriculture, Bangladesh	
13	Md. Azim	Syngenta Foundation for Sustainable Agriculture, Bangladesh	
14	Md. Shobug Hossain	Syngenta Foundation for Sustainable Agriculture, Bangladesh	
15	Anupam Mazumdar	Syngenta Foundation for Sustainable Agriculture, Bangladesh	
16	Shekhar Chakraborty	HEKS	Project Officer, Climate Change Project HEKS/EPER
17	Papia Rahman	PRAGATI INSURANCE LIMITED	Deputy Managing Director
18	Shammi Akter	Department of Meteorology, Dhaka University	Lecturer
19	Sayed Monjurul Hoque	RTIP-II Project; LGED	Regional Environmental Specialist
20	SK Shamshul Alam Kamar	Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Rahmatpur, Barishal-8211	Scientific Officer (Agricultural Engineering)

Annex V: List of Facilitators and Organizers

Sl. No.	Name	Organization	Designation
1	Colin Kelley	IRI	
2	Hannah Nissan	IRI	
3	John Furlow	IRI	
4	Dannie Dinh	IRI	
5	Melody Braun	IRI	
6	Geneva List	IRI	
7	Timothy J. Krupnik	CIMMYT	
8	Sk. Ghulam Hussain	CIMMYT	
9	Fahmida Khanam	CIMMYT	
10	Iqbal	CIMMYT	Project Manager
11	Md Zihadul Abedin	CIMMYT	Intern
12	Suraiah Khan	CIMMYT	
13	Dr. Carlo Montes	CIMMYT	Agricultural Climatologist
14	Maamun	CIMMYT	
15	Md. Shahidul Haque Khan	CIMMYT	
16	Saleemul Huq	ICCCAD	Director
17	Dr. Feisal Rahman	ICCCAD	Research Coordinator
18	Tasfia Tasnim	ICCCAD	Research Associate
19	Md. Robeul Awal	ICCCAD	
20	Md. Fahad Hossain	ICCCAD	

21	Ashraful Haque	ICCCAD	Intern
22	Anne-Laure Pilat	ICCCAD	
23	Sherpard Zvigadza	ICCCAD	Visiting Researcher
24	Makame Mahmud	ICCCAD	Assistant to Director
25	Mr Shamsuddin	BMD	
26	Md. Abdul Mannan	BMD	
27	Md. Bazlur Rashid	BMD	Meteorologist
28	S.M. Quamrul Hassan	BMD	
29	Md. Farique	BMD	OA
30	Md. Sajjad Hossain	BMD	Senior Com. Engineer
31	Md. Gias Uddin	BMD	
32	Md. Rashidul Islam	BMD	Caretaker
33	Md. Muzammel Haque Tarafder	BMD	Deputy Director (Eng.)

Annex VI: List of Invited Guests for the Closing Remarks

Sl. No.	Name	Organization	Designation
1	Dr. N Chattopaddhay	DAE, Ministry of Agriculture	
2	Dr. Mazharul Aziz	DAE, Ministry of Agriculture	Project Director
3	Rahana Sultana	DAE, Ministry of Agriculture	Agricultural Economist
4	Arifuzzaman Bhuiyan	FFWC, BWDB	
5	Palash Kumar Debnath	GED	Assistant Chief
6	Mithu Sarker	ECSDI	
7	Dr. Syed Md. Zainul Abedin	www.connecttask.com	Owner
8	Laskar Muqsudur Rahman	FAO	Senior Forestry Officer
9	Tapas Ranjan Chakrabarty	Oxfam	PC
10	Shamunul Islam	ERI	Manager
11	Dr. Nurun Nahar	Programming Division	Deputy Chief
12	Dr. Shameem Hassan Bhuiyan	ADB	Consultant
13	Dr. Farida Perveen	ADB	RS-GIS Specialist & Team Leader
14	Md. Aminul Moven	Syngenta Foundation for Sustainable Agriculture (SFSA)	Insurance Project Manager, SFSA-AIS/ Country Director
15	Hasin Jahan	Practical Action	Bangladesh Country Director
16	Mehedi Al Amin	Dhaka Tribune	
17	Mahmud Hossain Opu	Dhaka Tribune	