APEC Climate Symposium 2015
Proceedings

FROM SCIENCE TO ACTION:

THE USE OF WEATHER AND CLIMATE INFORMATION FOR EFFICIENT DISASTER RISK MANAGEMENT

Manila, Philippines

November 2-4, 2015

This document summarizes the presentations and discussions from the APEC Climate Symposium (APCS) 2015, held in Manila, the Republic of the Philippines at the Crowne Plaza Manila Galleria on November 2-4, 2015

Asia-Pacific Economic Cooperation

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Contents

Summary

1. The APEC Climate Symposium 2015 was conducted from November 2-4, 2015 at the Crowne Plaza Manila Galleria, in Manila, the Republic of the Philippines. The meetings of the APCC Science Advisory Committee and the Working Group were also held in conjunction with the event.

2. The event was attended by more than 130 participants from 21 economies – Australia, Cambodia, Chile, China, Chinese Taipei, Indonesia, Italy, Japan, Korea, Papua New Guinea, the Philippines, Peru, Myanmar, Mexico, Nepal, Russia, Thailand, Ukraine, United Kingdom, United States, and Vietnam. The participants included keynote and invited speakers, representatives from National Meteorological and Hydrological Services (NHMSs), government officials, and academics. Experts in disaster management were invited to the conference to discuss the importance of weather and climate information and its use for efficient disaster risk management.

Opening Ceremony

3. The APEC Climate Symposium 2015 opened on Monday, November 2, 2015. The Opening Ceremony began at 9:00 am with Ms. Sangwon Moon, the head of the External Affairs Department at the APEC Climate Center (APCC), opening the ceremony and welcoming everyone to the event. She introduced the guests sitting on the stage. Ms. Moon introduced Dr. Chin Seung Chung, the Director of APCC. Dr. Chung gave his Opening Remarks and spoke about the importance of this event. He concluded his speech by welcoming everyone to the symposium. Dr. Vincent B. Malano, the Administrator of Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), followed with Opening Remarks for the symposium's co-host Dr. Malano. Dr. Malano hoped this symposium will serve as an instrument for more cooperation among APEC nations to achieve the common goal of achieving a disaster free and secure environment. Raymund E. Livboro, assistant secretary of department of Science and Technology of the Philippines, gave a Congratulatory Address on behalf of Sec. Mario Montejo, the secretary of department of Science and Technology of the Philippines. The final Congratulatory Address was delivered by Dr. Bin Wang, Chair of the Department of Meteorology at the University of Hawaii and Co-Chair of the APCC Science Advisory Committee, who spoke about both the work of APCC and PAGASA. The opening ceremony was followed by a gift giving ceremony between APCC and PAGASA.

Session I: Keynote Presentations

4. Session I commenced at 10:00 a.m. and consisted of keynote presentations by two distinguished disaster specialists. The session was chaired by Dr. Hyungjin Kim, the Head of the Climate Research Department at APCC.

5. Undersecretary Alexander Pama, Office of Civil Defense, "Global Perspective-Current Challenges for Disaster Risk Reduction"

Undersecretary Alexander Pama started off by highlighting the danger caused by disasters that the APEC member economies are facing. Most APEC member economies are situated in the Pacific Ring of Fire, which explains the existence of earthquakes, volcanic eruptions, tsunamis and landslides in addition to typhoons and floods. These disasters are becoming more complex, frequent and unpredictable in terms of occurrence, scope and magnitude. Referred to as the "new normal", disasters, which used to be a concern of only a few before, are now the concern of everyone.

People in Asia and the Pacific also face a greater risk of being a victim of disaster impacts. They are two times more vulnerable than individuals in Africa, six times more than those living in Latin America, and 30 times more vulnerable than those in North America and Europe. Through changing temperatures, precipitation and sea levels, amongst other factors, global climate change is already modifying hazard levels and exacerbating disaster risks. An increasing concentration of wealth, accompanied by depressed real wages and cuts in spending on social welfare and safety nets, is expected to lead to growing risk inequality. Sectors and territories without comparative advantages for economic development face increasing risks due to low levels of investment in risk-reducing infrastructure, an absence of social and environmental protection, and rural and urban poverty. Socially segregated urban development in turn generates new patterns of disaster risk. Low-income households are often forced to occupy hazard-exposed areas with low land values, deficient or non-existent infrastructure and social protection, and high levels of environmental degradation.

APEC member economies are also vulnerable as disasters cause disruptions to production and supply chains. They increasingly disrupt the free flow of trade and investments across economies. They present tremendous challenges and serious threats to sustainability and economic growth and development. They lead to serious damages and financial losses. Finally, they result to casualties and claim lives. The Philippines ranked as 2nd country at risk and 3rd as the most exposed. To strengthen the Philippines stance to address the challenges of the "new normal", the Philippine Disaster Risk Reduction and Management Act of 2010 (Republic Act No. 10121) was enacted on May 27, 2010. A new DRRM framework was developed to serve as a conceptual guide to implement DRRM activities across all sectors working within the four thematic areas of Prevention and Mitigation, Preparedness, Response, and Rehabilitation and Recovery.

The framework has its vision for "safer, adaptive, and resilient Filipino communities toward sustainable development." The National DRRM Plan for 2011-2028 outlines programs, projects, and activities covering the four distinct yet mutually reinforcing priority areas with four long term goals focused on Disaster Prevention and Mitigation, Disaster Preparedness, Disaster Response, and Disaster Rehabilitation and Recovery. It is aimed towards strengthening the capacity of both national government and local government units together with stakeholders to build disaster-resilient communities and to institutionalize arrangements and measures for reducing disaster risks.

Climate information and related products are an integral part of risk assessments. The only question is how much lead time is available for these preparations to take place. Fortunately, advances in science and technology makes it possible for longer lead times and more accurate forecasts and projections, which in turn leads to good decision making for preparedness activities with the end goal of saving lives and properties. PAGASA also utilizes the forecasts of various meteorological agencies in the Asia-Pacific to be able to come up with its consensus track. Usec Pama then introduced the example of Typhoon Koppu, Lando, and Ruby. Because the government ensured that the structure, resources, and systems for DRRM are in place including early warning and logistics for disaster preparedness and response, 716,639 individuals were able escape before Typhoon Ruby. This initiative cannot be done by the government alone, no matter how prepared it is, without the willingness and cooperation of the people. In the same way, affected people needs its government to provide the needed structure, resources and systems. The Philippine government, under the stewardship of the National DRRM Council, is bound to continue its effort to further enhance the systems and programs for Disaster Risk Reduction and Climate Change Adaptation.

6. Ms. Feng Min Kan, the United Nations Office for Disaster Risk Reduction for Asia & the Pacific, "Sendai Framework: An Instrument for Climate Change Adaptation at the APEC Climate Symposium 2015"

Ms. Feng Min Kan handled the Sendai Framework, a new framework adopted in March. She provided local, regional, national pictures and suggested how APEC member economies can work together between climate change and disaster communities. During the past decade less people have died. However, there are still disasters that can possibly happen. The average annual local loss is getting bigger. It is related to the loss that one country should bear in long term in the future. The country with more population needs more money to cover the expense. Furthermore, the disaster does not affect only one country at a time. The result happens on a global scale. Then she introduced the example of Toyota, which was damaged by the earthquake. Its shortage of components affected the reduction of production employees. The business suffered from the comprehensive losses. This means that the world is more than ever interconnected. The importance of working together cannot be overemphasized. Then she said about the focus moving from managing disasters to managing risks. The risk

assessment should be done before the development. Through the cooperation between the two communities the disaster can be managed.

The key elements of the framework are local, national, regional and global. The focus has changed from disaster management to disaster risk management, from 'what to do' to 'how to do'. The scope should be widened to increase the action in recovery, rehabilitation and reconstruction. The goal of the Sendai Framework is to prevent new types of disasters and reduce existing disaster risk and thus strengthen resilience. The risk can be monitored from the very beginning to the end. Ms. Kan introduced seven global targets. Mortality, affected people, economic loss, and damage to critical infrastructure should be reduced, while the number of national and local DRR strategies and international cooperation should be increased. There are also thirteen guiding principles with four keywords such as "Responsibility for DRR", "Engagement", "Approach", and "Partnerships". The government cannot manage the disaster alone, it should be handled with individuals including the stakeholders.

Governance for integrating DRR in national adaptation plans include a high level political vision, political will, and commitment. Strong institutional arrangements and coordination mechanism are also needed. It is important to take the time to assess the current policy, institutional and financial arrangements and identify gaps. The government should be clear about the purpose of the risk assessment, the end-users and their needs from the start. Then the definition of the climate-related hazards and consideration of the interaction within a broader risk context is needed. By starting risk assessment, there will be the ways that we can work together. The implementation strategies are also needed for strengthening the policy and institutional framework to enable CCA and DRR integration. People need to monitor, report, and review the process together. From the scientist to the government, stakeholders should have open minds and try to pile up the activities.

7. Session Wrap-up & Discussion

Question: One of the themes that the Philippines have for 2015 is local. It deals with local health and welfare. How is health factor included in the Sendai Framework?

Answer: After the two years of consultation from 2013 to 2014, it came out very clearly that health system, especially hospitals and health centers are not actually functional after disasters. They are not disaster-resilient. So UNISDR set the starting point to save hospitals. It is the process of generating the consideration and needs to invest risk resilient community. Although they are not really in disaster management areas, there is also a need to increase the health personnel. Climate change has increased the patters of infectious [diseases] infecting areas such as Malaysia. Things that have never happened before are now happening because of climate change. As a result, from the perspective of disaster management, the hospitals need to be practical and professional.

Question: Climate change adaptation includes many sectors such as DDR and CCA. These are quite big projects, so could you tell me what were the practical actions that were taken?
Answer: During the second world conference in 2005, people tried to work together and see how they can promote the collaboration between two communities. It was impossible actually – a long, slow process. There are certain areas they can work together as both are the major threats to development. The Sendai Framework addresses a very wide area, requiring every sectors and action. DDR is also a cross-sector initiative. APCC secretariat has used some of UNSDR practices related to climate change and storm management. People should start to look at their environment at their level. In most countries, disaster management is being taken care of by one ministry, and climate change is another ministry. Some included in the environment, the other in the technology. That is why two ministries are focusing on their own, and make slow progress in climate change adaptation. They need to reach out other ministries and learn from stakeholders who have successful cases to actually manage the impact of disaster management. We need to take proactive actions.

Question: What is the action of local government? What were the challenges that you faced?
Answer: We do all these things to protect and save lives. We do this to minimize catastrophe. We have high level of confidence and have progressed a lot. The warnings are not quite reliable. People may not hear the sirens. Beyond saving lives, this involves a lot more. All the sectors can achieve assistance beyond their mandate. The methodology is strongly needed. This is very crucial part of the work. Risk informed policies, strategies, indicators should work together. The Philippine government is trying to get leaders and scientists together.

Question: Integrating DRR into national level is important as well as local and regional level. So could you please give the insight on doing local DRR?
Answer: The link between DDR and CCA is that they came together. We also work with specialized agencies to see to find how to break the traditional point of working. This time we reached out and there are technical agencies to work on to integrate into the national adoption plan. It does not mean you should stay at national level. The action should start with the national guidance but the actual action should be the core of DRR.

Session II: Science and Technology for Forecasting Extreme Weather

8. The afternoon Session of November 3 commenced at 1:00 pm. Session II discussed Science and Technology for Forecasting Extreme Weather and was chaired by Prof. Eric Wood from Princeton University.

9. Dr. Suzana Camargo, Columbia University, "Lessons from Recent Results on Tropical Cyclones and Climate"

Dr. Camargo started off her presentation by describing how tropical cyclones have been traditionally studied by using climate models. Based on findings from some papers, she pointed out that the main drawback of using climate model for tropical cyclones (TC) is that climate simulations have very long time periods and very low horizontal resolution. The study of TC using climate models is a critical issue because tropical cyclones require very high resolution models. People have been looking at climate models since 1970 to observe disturbances similar to TC, and continued to work with low resolution models. However, recently people have started looking at high resolution model to get improvements in describing TC. She then presented results from one study that looked at the effect of climate change under double CO_2 conditions for TC. Under double CO_2 conditions, higher occurrence of very intense storms is likely. She then talked about the use of genesis indices (GI) in TC studies, where higher value of a genesis index represents potential of the occurrence of TC. She presented two examples of how GI can be used to describe TC. The problem with climate change projections using GI is that the indices are based on present climate and cannot be used for future climate change. GI developed using the current climate give more TC activity. She then presented some results on TC activity projections using dynamic downscaling which showed an increase in the occurrence of the most intense TCs and a small reduction of global frequency of future TCs. She also presented some results using regional climate models that showed increase in more intense storms, but not very intense storms, due to the lack of very high-resolution.

When climate models are used for TC studies, these models are diagnosed by looking at TC activity, including seasonal to decadal time scales. TC forecasts and projections are part of seamless prediction approach. With high resolution models, there is significant improvement in the results, but these results are not consistent among all models. In some models very few storms form, but others do a much better job in simulating TC frequency. Recently people have also started using SST (sea surface temperature) anomalies for TC projections. Some models are not able to get the mean number of storms, but are able to capture the response to El Nino and La Nina. This is the basis for many groups to that have started issuing seasonal dynamical forecast in the 2000s. Currently many modeling groups issue dynamical TC seasonal forecasts including ECMWF, FSU, MetOffice, and GFDL. The current TC dynamical seasonal forecasts have good skills over the Atlantic Ocean. Even though the results are much better from these studies, but there are still some issues related to how the models respond to El Nino. For example, most models get the basic reduction of activity in Atlantic right, but the pattern may be different. Even in terms of simulating the intensity, there is a progress by using coupled models, which simulate the interaction between the storms and the ocean. The current state of the art is that a few models are able to simulate the most intense storms, and showed that regional projections are based on spatial pattern of

the SST warming. The latest development in TC studies include producing four week forecasts, and use of decadal time scales for TC predictions.

Overall using a high resolution model helps in producing TC activity but there are several issues that need to be addressed, For example, models have biases depending on convection scheme. Other issues include model parametrization, definition of TC, and tracking, intensity.

10. Dr. Yuriy Kuleshov, Bureau of Meteorology of Australia, "Tropical Cyclone Activity over the Western Pacific Ocean: Impact, Forecasting and Adaptation"

Dr. Yuriy started off his talk by giving few examples of tropical cyclone (TC) impacts on Australia including TC Tracy in 1974 that destroyed 70 % of buildings in Darwin and TC Pam in March 2015 that destroyed almost all infrastructure in Vanuatu in its path. He also talked about typhoon Haiyan in Nov 2013 as one of the strongest TC that killed more than 6300 people and caused an economic damage to the Philippines in excess of 2.86 billion USD. He mentioned that IPCC 2013 report states that climate change will lead to increase in intense TC activity, but there is low confidence in this claim. There is no high resolution data on TC, including historical records. Overall, the number of TCs globally is not projected to increase dramatically.

He then presented the "Climate Change and Southern Hemisphere TCs" International Initiative. This includes high quality TC database for the South Pacific and South Indian oceans covering tracks and intensity. The archive is being extended to the western North Pacific. TC climatology maps that show distribution of El Niño years and La Nina years are also available through this initiative. Data is distributed through a web portal. Data is displayed based on seasons, where the user can zoom-in, analyze cyclones, change color pattern, etc. This portal is useful for analysis of historical storms. Wind field model is also developed – it is more accurate compared to previous models. Another area of research is seasonal prediction of TC using statistical methodology and dynamical approach, but there is still a lot of room for improvement in modeling of TC.

Next, Dr. Yuriy spoke about the International Climate Change Adaptation Initiative (ICCAI) and the Pacific Climate Change Science Program (PCCSP), Pacific Adaptation Strategy Assistance Program (PASAP) and Pacific Climate Change and Adaptation Strategy Assistance Program (PACCSAP) which includes 15 island partner countries. This program's focus is on climate extremes including SST and CO, and ICCAI web page information tools. The Pacific Climate Change data portal currently has records for 92 stations in 23 countries. Users can select a station of interest in the Pacific region, get data, and perform analyses for studying climate extremes. He then talked about the WMO global predictions center for long range forecasts. This portal provides broad scale field and climate drivers. He briefly touched on other tools related to sea surface temperature seasonal prediction, coral risk assessment metrics, and seasonal sea level

prediction. Besides providing the tools, another important component of the ICCAI is capacity building and providing training on how to use these tools.

Last part of Dr. Yuriy's presentation focused on effective response to disasters. He spoke about the climate risk early warning system for developing countries. This new initiative will be delivered by 2020. The objective is to provide access to real time weather and climate updates, public information and communications technology, as well as improve risk knowledge and ensure that all arms of the administration are on the same page when it comes to issuing warnings. Pacific countries are most affected by climate change and are urged to lead against complacency.

11. Dr. Eylon Shamir, Hydrologic Research Center, "Vulnerability Assessment of Precipitation Extremes: Water Resources and Disaster Management"

Dr. Shamir's talk was divided into two parts. In the first part, he presented an analysis of the very extreme (unobserved) events and their possible impact on water resources by using the Panama Canal watershed as a case study. The objective of this study was to estimate the very low frequency rainfall events, assess their impact on the canal operation, and estimate the potential for structural damage. He gave a brief description of the Panama Canal watershed and described the methodology that was used to construct extreme event distribution. The methodology includes the analysis of observe extreme events and fitting GEV distribution. These conventional steps were augmented with paleo-climatic flood records, a stochastic weather generator to simulate likely events, and using atmospheric regional model to simulate events that occurred in similar setting and simulating possible synoptic conditions that may lead to extreme events. He then drew a distinction between events that are rare but probable and events that are unforeseen. This distinction between these two categories, which are both in the very low probability spectrum is somewhat arbitrary (assigned to 1000-year return period in this case study). The extreme rainfall events were used as input for a series of models that simulates inflow and water level in Gatun Lake, and estimates the economic analysis of expected loses. The final report was submitted in 20 October 2010. In December 2010, a very large event took place that persisted for six days and caused fatalities and economic damage, and the first ever Canal closure due to a natural event. The event was the largest ever observed (276 mm/24-hr average over the canal watershed 3,300 km^2). He then posed the question: Was the 2010 rainfall event a probable one? When GEV distribution was fitted to the previously observed large events, the 2010 event falls under the category of an unforeseen event (i.e. return period greater than 1000-year). However, when an uncertainty bound is included, for the 95th percentile bound the 2010 event is found to have a 140-year return period. He concluded that it is important to consider the uncertainty bound and we should not rely on the optimal value when the uncertainty is very large. The study was revised to include the 2010 event and the return period of the December event was reduced to 35-year for the 95 percentile bound.

In the second part of his talk, Dr. Shamir presented a PhD study conducted by his colleague Dr. Theresa Modrick that looked at frequently occurring flash flood events with extreme impact. This study looked at about 1000 small mountain basins (~25km^2) and assessed the projected impact of climate change on flash floods frequency in these basins. It is seen that precipitation in Southern California is positively linked to El Nino conditions and streamflow shows an even tighter link to El Nino conditions. The study included a GCM dynamic downscale atmospheric model to force hydrologic-geomorphologic models that compute flash flood occurrence. It was found that the rainfall climatology of the 20th and 21st century is not that different, however, flash flood frequency is clearly projected to increase. This is because of projected increase in rainfall magnitude, increase in event duration, and decrease in number of events. He concluded that investigations of climate change impacts on the frequency of flash floods occurrence must consider the properties that dominate the local hydrologic processes.

12. Dr. Tien-Chiang Yeh, Central Weather Bureau of Chinese Taipei, "Recent Progress of Operational Predicting Typhoon and Heavy Rainfall in Chinese Taipei"

Dr. Yeh started off his talk by giving background information on Taiwan, which is affected by typhoon, heavy rainfall and also drought. In the last 100 years, the temperature in the region has increased by 1.6 degrees, and the temperature increase in the last 30 years is greater than previous years. Similarly, the number of torrential rainfall days has significantly increased in the last 30 years, and the tropical cyclone activity has significantly increased in the last 10 years. He then talked about surface observation facilities including radar network, data from satellite including geostationary, portal orbiting and cosmic, and typhoon surveillance dropsondes. The Central Weather Bureau (CWB) uses multiple models to forecast from short term to long term. Recently the CWB upgraded its system to high performance computing, which can handle processing of greater than 1.3 petaflops. The new global model from CWB has a resolution of 25 km horizontally and vertical layers will have 60 layers. The physics is also modified to include new things. The global forecast model is also improved. The regional/mesoscale forecast model uses ARW-WRF based system that is in operation since 2007. The CWB produces deterministic forecast 4 times a day based on an ensemble from 20 members, which has led to improvements in the regional/mesoscale forecast. The improvement is based on the input from the model development community, collaboration with NCAR and in-house development. When just using the mean value, extreme forecasts have error due to smoothing out of the rainfall extremes during the averaging progress. To improve regional/mesoscale forecast, probability matching method is used. After applying the probability matching, the results improve significantly compared to just an arithmetic mean. There are efforts ongoing on data assimilation. He then showed a tropical cyclone track forecast including errors from three days to 24 hours. Two way nesting improved the Tropical Cyclone Track Forecast. Tropical cyclone rainfall distribution strongly depends on TC

center location so model track error will induce large rainfall forecast error. The ensemble typhoon quantitative precipitation forecast (ETQPF) models use the mean of the EPS cases and helps to assess the uncertainty in rainfall. Short range forecast uses a variety of datasets into the analysis for forecast. Warnings are distribute through short messages, line, CWB app, Facebook, CWB webpage, and through Quantitative Precipitation Estimation and Segregation Using Multiple Sensors (QPESUMS) system. Future work includes data assimilation, model improvement, and better ensembles.

13. Prof. Eric Wood, Princeton University, "Assessing the North American Multi-Model Ensemble (NMME) Forecasts for Seasonal Forecasting and Decision Making over Africa"

Prof. Wood started off his talk by first showing the Global Framework for Climate Services (GFCS) homepage that has a climate service framework. In this framework, climate product is the end result of the process of synthesizing climate science, and climate service is the information prepared and delivered to meet a user's needs. He showed a climate service staircase that includes monitoring and forecasting at the bottom followed by information services, model and data integration, customized products, indicators, management data, and finally management decisions. Next, he presented the framework for drought monitoring and forecasting system. He showed the portal for African Drought and Flood Monitoring and Forecasting system. This project was done for UNESCO in the hope of providing information to local communities so as to achieve water and food security. He presented information services, including web-based services and apps. Customized products include the delivery of drought indicators, soil moisture products, streamflow, etc. He then showed how GFS and Global Precipitation Measurement (GPM) are used to produce soil moisture, streamflow, etc.

Next, Prof. Wood talked about ongoing efforts in improving seasonal forecasts. NMME gives monthly data on Phase 1 and sub-seasonal (daily forecast) in Phase 2. Data integration and applications depend on skillful forecasts. He then presented results from unweighted to optimally weighted forecasts for temperature, monthly precipitation and sub-seasonal precipitation. By using the examples of the West Africa drought in 2000 and the Brazil Floods in 2011, he demonstrated that uncertainty in ensemble weighted mean are more consistent compared to the individual models or just ensemble means. He then showed some of the informatics behind the Princeton's portal. He raised a few interesting questions including, how to make climate information useful for client decision making? Can the information get the data into data centers in ways that are convenient and easy to access by climate product providers? Can the climate service center produce products useful for decision makers? Can the decision makers access the products in an easy, convenient and timely manner? By using an example of soil moisture, he demonstrated how some of the data services are not useful to the end user.

14. Dr. David Robertson, Commonwealth Scientific and Industrial Research Organization, "Ensemble Forecasts of Floods Using Numerical Weather Predictions"

Dr. Robertson started off his presentation by talking about existing forecasting services in Australia that include forecast of flood events by using event models at sub-daily time steps, ad hoc use of numerical weather predictions, and that these services are labor intensive. The desired forecasting should include hydrograph in the time range of 7-10 days, use continuous hydrologic modeling, routinely use the Australian NWP model outputs, quantify forecast uncertainty, and build on existing services. He then presented a portal that showed 7 day streamflow forecast. We should use ensemble forecast because it will allow understanding risk and manage flood risk. He showed the framework for ensemble forecasting framework with 10 components. The forecast system components include observed data, rainfall forecasts, runoff and routing models, hydrological errors and verification. He showed how post-processing is able to remove bias and significantly improve rainfall forecasts from numerical weather prediction models, ensuring forecasts have the right spatial pattern. The hydrologic modeling process includes model calibration, spinning up of the model, producing ensemble streamflow forecasts and updating. The bias in streamflow forecasts produced using post processed numerical weather predictions is significantly lower than when using the raw predictions. Next, Dr. Robertson showed how the ensemble forecast compared to two observed events and said that the overall forecasting of floods still need some work. He talked about assessment of streamflow forecast reliability using Probability Integral Transform (PIT), where there is some ongoing work to improve forecast accuracy by include better rainfall observations, alternative rainfall forecasts, and improvement in hydrologic modeling errors.

Dr. Robertson concluded the talk by asking the participants to consider attending the HEPEX Workshop to ensemble for better hydrological forecasts, which is scheduled for June 6-8, 2016.

15. Session Wrap up & Discussion

Question 2 for Dr. Wood: How can we set up services that deliver? What is it that is missing in a way that we are missing this? How do a build a system and how to sustain that? How do we address the issue of flow of information?

Answer: Prof. Wood let the entire panel address this question. Here are some comments from the panel members. We cannot be very ambitious, and we need to learn from the GFC that has seen some success in developing countries. We need to help communities in data rescue and focus on local or regional climate centers. Experience working with WMO regional forecasting system shows that forecasters at national level are not trained to transfer the information. The problem lies with the institutions and the bureaucracy.

Question 2: Climate services are fundamental and different than from forecast. We cannot use the forecast blindly to covert forecast to climate services. What is important factor in seasonal TC activity prediction? It is possible to use any index in other TC activity time scales?

Answer by Dr. Camargo: There are several genesis indices and the factors vary from index to index including vorticity, humidity parameters, SST and how these variables are combined. They do a good job in climatology, and okay job in seasonality. With climate change, they are not having same projections in counting the storms. We should aim for not using the indices but look at the TC models itself.

Question 3: This question relates to seasonal forecast for TP. PGASA using is statistical method for forecasting TP. Based on your studies, from forecasting model, which models can forecast TP track at seasonal time scales?

Answer: The users are asking a lot and it is not feasible currently do this. In the future, we may be able to provide a general track but right now we cannot do that. At this stage of seasonal prediction of TC, we can say below average or above average. Statistical models do not do well and we should move away from those. In future, we should be able to use dynamic downscaling of climate model to get a general sense of TC tracks.

Question 4: How to do extreme event analysis (return period) including uncertainty? How can we explain this uncertainty to the general public? How to explain uncertainty in rainfall to the public? Do you have any experience related to Panama?

Answer: The whole concept of return period is a complex concept. It is an engineering concept developed for design. It is a difficult to explain, we should not try using this term to general public. Communicating uncertainty is a challenge. In the case of floods, we produce several different forms of some information. Some people get one piece of information and not others.

Question 5 for Dr. Shamir: what was the comment after you submitted the report in October 2010 within the context of the December 2010 event in Panama?

Answer: The take away message is to make sure that you should communicate the uncertainty not just the optimal.

Question 6: Because climate models uses large scale models to compute genesis indices, these are derived from climatology data so they can be applied to seasonal, sub seasonal and decadal time step to apply for Atlantic regions. Why cannot these be used for climate change?

Answer: We found no difference in indices skill for present climatology, but when we apply them to future scenario they have a different response. For example using absolute humidity worked compared to relative humidity. It may not work for other models.

Session III: The Sharing of Best Practices for Climate-Related Disaster Management

16. The morning session of November 3 commenced at 9:00 am. Session III discussed the Sharing of Best Practices for Climate-Related Disaster Management and was chaired by Dr. Paul Gregory, a Seasonal Prediction Scientist at Australian Bureau of Meteorology.

17. **Dr. Royboon Rassameethes, Hydro and Informatics Institute, "Science and Technology Adaptation for Community Water Resource Management"**

Dr Rassameethes introduced the role of the Hydro and Informatics Institute and its role for undertaking and disseminating research and development for agriculture and water resources management in Thailand. The focus of the remainder of the presentation was on how a Community Water Resources Management (CWRM) program has used science and technology to support the improvement of livelihoods of communities.

Dr Rassameethes described several example communities who have been supported to develop plans to improve local water management and subsequent implementation has led to improvements in agricultural productivity and increases in household income. Communities are supported to identify local priorities, develop their skill to collect and analyse data and manage water infrastructure. HAII provides the connections with public and private agencies, pass on knowledge and facilitate community thinking and analytics. Technologies being adopted by communities include GPS, mapping, topography, water charts, water balance analysis, and echo sounders. Communities are also innovatively applying technologies to support implementation of their water management plans, for example using solar cell water pumping.

Outcomes have included the establishment of collaborative networks, transformation of agricultural production from seasonal to year-round production supporting improved food security, active community management of water resources network and infrastructure, improved self-sufficiency with less dependence on government and better organisation and use of data. The success of CWRM program has led to it being progressively expanded throughout Thailand, with 60 main networks and 420 communities participating.

18. **Mr. Hilton T. Hernando, Philippine Atmospheric, Geophysical and Astronomical Services Administration, "Sharing Experiences in the Provision of Weather and**

Climate-Related Information to Regional and Local DRRMC's (Disaster Risk Reduction & Management Council) in the Philippines"

Mr. Hernando provided an overview of the role of Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) in providing weather and climate related information to regional and local councils and discussed the experiences of the flood forecasting and warning office in supporting disaster risk management.

The flood forecasting and warning center is located in the heart of the Pampagamga River Basin. Its primary role is to issue flood advisories and flood bulletins for the Philippines, and to transform weather and climate information from central PAGASA to a form that is locally relevant to Disaster Risk Reduction and Management offices at regional, provincial and municipal levels. Flood advisories and bulletins are localised to regions and issued disaster regional management councils which cascades through to local councils. Information is also provided direct to the public through SMS, Twitter, Facebook etc., but its effectiveness is limited due to difficulties with internet and phone connections at critical times.

In addition to flood warnings, the flood forecasting and warning office also undertakes complementary activities to educate the community about flooding. Relationships are fostered with local governments and communities through local focal points and small groups. Memorial flood level markers have been established to help retain historical context and create institutional and community memory. A School Hydrological Information Network (SHINe) program has been established to support flood awareness and educate the next generation. Flood drills have also been established so that communities know what they need to do when flooding is imminent.

In implementing these programs, PAGASA has learned many lessons related to the communication of weather and climate information to local councils and communities. Those lessons include: each local government has its own personality; if communities are unable to understand the information they are provided, then they are unlikely to act or respond to this information and so trust in the agency and information provided declines; communication is an art; organizations don't learn but individuals do.

19. Dr. Donna Lagdameo, Red Cross Climate Centre, "Participatory and Innovative Ways of Linking Science, Policy and Practice"

Dr. Lagdameo spoke about the role of the Red Cross Climate Centre. The Red Cross Climate Centre is one of 12 Red Cross Reference Centres and was established in 2002 to raise awareness of climate change and climate disasters, and decrease the vulnerability of communities. The key activities are to assist in translating global scientific insights to the local level. The centre identifies actions in short, medium, and long term to prevent hazard, prepare before hazards arrive, and in the long run save lives.

Dr. Lagdameo described some of the many activities the Red Cross Climate Centre undertakes to implement their objectives. Minimum standards for using climate information in disaster risk reduction plans applicable to communities, and national and regional organisations. A forecast-base financing system is being operated in several countries that prepares local agencies before a disaster occurs. Standard operating procedures are initiated once a forecast is issued, for example to release funds for disaster management, rather than waiting until the disaster has occurred. One of the techniques the Red Cross employs in communicating concepts related to climate information is the use of serious games. These games provide a platform that is more effective than PowerPoint presentations as they require active participation and force participants to make internal decisions by processing information that is available. These games have been used with the IPCC, Whitehouse and communities. Dr. Lagdameo demonstrated several of these games during her presentation and many more examples are available on the Red Cross Climate Center website.

20. Ms. Lucy Harman Guerra, CARE Peru, "Enhancing Resiliency in Peru: Climate Related Disaster Management"

Ms. Guerra spoke about her experiences with climate related disaster risk reduction and management in Peru and the role of CARE Peru. Peru has 100 life zones that face multiple hazards, including geological and hydro-meteorological hazards that climate change are making worse. Peru has a national risk management policy that seeks to build a culture of prevention and enhance resilience capacities by mainstreaming disaster reduction and climate change adaptations to specific locations. The policy seeks to understand location-specific risks and treat them within a nationally consistent risk management system. The policy looks very like the Sendai framework, but was approved beforehand. Importantly, resources exist to support the implementation of risk management. There are strategic alignment policies and plans between government and the private sector, and different sectors and institutions. The policies are trying to change from emergency response to one of risk management to avoid or mitigate disasters. CARE Peru supports community based adaptation through policy advocacy and local participative assessments.

Ms. Guerra highlighted an example of the Glacier Retreat Project in Peru. Peru has 70% of the world's tropical glaciers and climate change is causing them to retreat. The project is seeking to improve adaptive capacity and disaster risk reduction of affected communities in partnership with national organizations, universities, and other partners. One glacier has retreated ~1km in 45 years and in the process created a lake that is immediately above a city of more than 500,000 people, leaving the city vulnerable to lake failure. Community based adaptions have been developed using local knowledge and perceptions of risk established through ethnographic studies that investigated how people understand and perceive climate change, how locals understand risk, local

practices, and oral studies. Research was needed to develop a knowledge base to support decisions. Early warnings systems were developed and their implementation was supported by drills to practice what needs to be done and posters so people know how to respond. Risk maps were developed to understand how risks have changed, and these were translated from GIS to hand-made maps to support communities understanding the risks they face. Some of the challenges faced included building the bridge between traditional knowledge and western science. It is necessary to tailor the responses to specific life zones. Communities have always been living with risk, but how climate and weather is changing is a baffling experience for most people. The poor tend to be the most vulnerable to disasters and therefore disaster risk reduction and climate change adaptation, is a way of reducing poverty.

Ms. Guerra concluded by outlining the lessons that have been learned by CARE Peru in enhancing the resilience of communities. These lessons have included that the implementation of disaster risk management needs to be based on local people's involvement and community ownership of risk management strategies is critical. Developing trust in relationships between scientists and the community is essential for collective work and ownership of results. Communication is a key tool and successful implementation needs to engage the mass media. The perception of risk doesn't lead to action to manage the risk and there is a need to also pass on awareness of responsibility and solutions and be practical about risk management. To advocate in policy processes there is a need for evidence based on pilot experiences.

21. Ms. Susan Asam, ICF International, "Addressing Gaps in Availability of and Access to Climate Information in Climate-Related Disaster Management"

Ms. Asam briefly introduced ICF International and subsequently spoke about some of the barriers to the use of climate information for climate-related disaster risk management and some short and long-term solutions to overcome the barriers.

ICF International is a global consulting company having 5000 employees in more than 70 offices around the world. They have been working on climate change projects since 1981 and in international development since 1985. Their relevant work involves assisting in disaster preparedness, including building climate change into preparedness thinking.

Building community resilience to climate change often requires data. However there are many barriers to the improved use of climate data in disaster management. These barriers are related to the access, availability, and the usability of data. Access to data can be limited by lack of technical skills or internet access, cost, and non-digital records. Data availability can be limited by a lack of investment in data collection, conflict which creates gaps in data, difficult and remote geography and dispersed rural populations which lead to sparse observation networks. Data usability can be limited by

a lack of capacity to use data, poor data quality, a lack of human and computer resources to process data, and limited trust between data suppliers and information users.

Short-term solutions to data limitations may include combining data from different sources into a merged product, using non-traditional data sources such as ship and aircraft data or newspaper records, using indigenous knowledge, data interpolation, and using reanalysis products. Longer-term solutions to address the barriers to investment in observation networks, particularly in data sparse regions, includes fostering collaboration between information providers and users. Increasing the accessibility of data may involve solutions such as improving the capacity and tools to access, navigate and download data, improving internet access, digitizing paper records, and quality control of existing data. The usefulness of data can be enhanced by making products that are available in more readily usable formats, listening to users about their data needs, developing practical guidelines on what types of information are available in data sparse regions and how to use them, and developing decision support tools that facilitate the translation of complex information into more easily accessible and useful formats, such as maps and other visualizations.

Ms. Asam concluded with some example projects undertaken by ICF International where data availability was potentially a barrier but alternative solutions were identified that reduced the dependence on climate data. A simple climate data processing tool was developed for the US Department of Transport that translated CMIP climate change projections to simple maps of indices relevant to transport with visualizations that included features that helped solidify the information. This addressed a barrier where climate change science is complex and policy makers can't be expected to read the scientific literature to maintain their knowledge. Another example Ms. Asam described related to the development of climate-resilient infrastructure in developing countries, specifically Mozambique. Here they were seeking to understand current and future flooding risk in a region that had only 3 years of local data. They combined data from local and more distant stations to extend available records. The main outcome from this work was a simple screening tool to support climate change adaptation that provided an assessment of downstream vulnerabilities, and was not paralyzed by lack of data.

22. Dr. Paul Gregory, Bureau of Meteorology of Australia, "Best Practices for Climate-Related Disaster Management: Australian Experience"

Dr. Gregory spoke about the role of the Bureau of Meteorology in Australia and the types of climate information and services the Bureau provides to support disaster management. Australia is the driest inhabited continent and faces many climate risks and impacts from bushfires that can impact urban areas in the south and east to catastrophic cyclones and flooding in the north.

Dr. Gregory showed a short video of the Seasonal Climate and Water Outlook that the Bureau produces each month. The outlook includes an analysis of recent conditions, including rainfall deficiencies and temperature anomalies, the factors driving climate, and seasonal forecasts of rainfall, temperature and streamflow anomalies, tropical cyclones and chances of bushfire. The outlook is a collaboration between the climate and water divisions of the Bureau. Dr. Gregory described how the October 2015 outlook was updated two weeks after it was issued in response to significant changes to the seasonal forecasting model predictions as a result of changing conditions in the Indian Ocean. He also highlighted that while many users find the outlook video useful, it is reliant on high bandwidth internet infrastructure and therefore is not accessible by many potential users. In addition to the material presented in the Outlook video, many other products are available on the Bureau's website, including numerous summaries of past conditions and seasonal outlooks covering a range of temporal and spatial resolutions. Briefings are provided to government departments and ministers, and extensive media engagement occurs with over 500 media interviews each year. Infographics and videos have been developed to support increasing the awareness of the general public.

The current climate outlooks are generated using the couple ocean-atmosphere model, POAMA. Over the coming years, the UK Met Office model will be adopted for seasonal climate forecasting and outlooks will be updated at weekly to fortnightly, and be issued for a wider range of forecast variables.

The goal of the Bureau's Climate Information Group is to be "Australia's trusted and authoritative source of climate information and advice for governments, industries and communities to assist them management climate risk and opportunities." They also participate in international collaborations, including acting as a global seasonal forecast producing center for the WMO, participating in climate and ocean support program for the Pacific and tropical cyclone panel.

The Bureau of Meteorology is establishing a disaster management program by building new service capacity and investing in social science to support forecast and warning services. There is also a national level review of disaster warnings and information, by the Australian and New Zealand Emergency Management Council, with fire and emergency services wanting greater responsibility.

23. Session Wrap Up & Discussion

In general, social scientists are sometimes engaged to support the dissemination of complex climate related information. The Bureau of Meteorology, Thailand Hydro and Agro Informatics Institute, Red Cross Climate Centre, ICF International have all used social scientists to some extent, but not necessarily widely.

Key factors that have supported longer-term sustainability of programs and services include finding the right leadership and coupling with the right local researchers,

committees, and agencies. These elements have been key to the success of the SHINe program run by PAGASA in schools and in Thailand.

A range of strategies are being used by different institutions and sectors to manage the impacts associated with the El Niño – particularly the current strong El Niño. The Red Cross is monitoring conditions, translating information to a usable form for local agencies and updating management and contingency plans. CARE Peru is connecting information, providing specific information for local conditions communicated through the mass media, including describing how families can make use of the potentially positive conditions in Peru. In the US, states have created hazard mitigation plans, but the private sector has no specific plans. In the Philippines, PAGASA have held regional fora in river basins and described the possible risks and hazards end users may face.

Contrasts were also made between the responses of the "global north" and "global south" with respect to climate change. The global north is more concerned with climate change mitigation while the global south is more concerned with adapting to climate change. Lessons are being transferred between the north and south by organisations that undertake work across boundaries, such as the Red Cross and ICF International.

Session IV: The Effective Use of Climate Information for Efficient Decision Making and DRR Operations

24. The afternoon session of November 3 commenced at 2:00 pm. Session IV discussed the Effective Use of Climate Information for Efficient Decision Making and DRR Operations and was chaired by Dr. Jane Rovins, CEO of Disaster Reduction & Resilience Solutions, Limited.

25. Dr. Jane Rovins, Disaster Reduction & Resilience Solutions, Limited, "Integrated Risk Assessments: Making Science Usable"

Dr. Jane Rovins spoke about the way to make the science usable. She said it needs connectivity between science and applications in practice. The way people do business should change, as they work in a complex environment. The disaster resilience cannot be handled without making all those connections come together. The only difference between hazards and disaster is people. The process of analyzing hazards and vulnerability should be taken care of. The plans should be updated to reflect hazard profiles. There are some pieces that are more useful in practice and some are more useful for science/in academia. Technical inputs and local knowledge are one of the most overlooked pieces. Then she introduced several examples such as the Tonga risk reduction plan and Sendai Framework. She highlighted that the stakeholders include those who are possibly unexpected groups who have key knowledge. Sendai Framework signers will need to report out as to what they are doing. She explained what each

members of the society should do. Whole communities can disappear after an event; business continuity is critical. Outlets where you can start to bring in supplies again. Media need to be people's friend, need to understand science, and need to work with people before events.

She said, for someone who accepts the risk, monitoring and reviewing will do. If not, they should identify the ways to prevent and manage risks. Programs and projects are often the best way to manage risks. The model sometimes misses peaks in projections, so it needs to be better. The calibration can be improved with remote sensing applications. Force model to use observations can be supplied by scientist to try to reduce uncertainty. They can also look at other models to develop an uncertainty bound. Sharing, running and visualizing models on the web is important. The model should be published and shared so that anyone can use it. It does not mean the data is given up. In this way, regardless of quality of topographic data sets, the users can still get good flood hazard map. Even if don't have the best data set, there are tools to use what's available. Hydrology and hydraulic modeling at the same time allows a better result. The soil map can be used to develop floodplain mapping if the data needed is not enough. Social Media information can be used to track drought.

26. Dr. Maksym Guysev, International Centre for Water Hazard and Risk Management under the auspices of UNESCO, "Using Drought Indicators for Disaster Risk Management – A case study of Dam Infrastructure in the Pampanga River Basin, the Philippines"

Dr. Guysev studied five Asian river basins where dam infrastructure is the main source of water supply. Agriculture is the main economic activity. The region was exposed to severe droughts in the past. One of them was Pampanga River Basin in the Philippines. The dams provide irrigation and water supply. Characterizing drought is not easy. Natural drought is a water deficiency from normal conditions. It is slow propagation of water shortage in water cycle. Anthropogenic water use is needed to identify water scarcity. In this process, a set of standardized indices used by WMO can be used. Many countries have adopted these indices. They can determine the most extreme droughts when arraying droughts across time. Droughts can happen without having socio-economic drought. The standardized indices can be combined with NDVI. It can use this data for drought risk reduction activities. Data can be used as monitoring tool to determine where water should be released. Using indices for climate change assessment is highly recommended. The full set of standardized indices can provide useful info about natural and socio-economic droughts for disaster risk reduction activities. Combined use of NDVI and standardized indices can give a spatial list of drought affected areas. Indices are applicable for drought monitoring for various users and may be investigated with daily input parameters. Full set of standardized indices can be computed using simulation results for the disaster risk impact assessment under climate change.

27. **Dr. Weihua Fang, Beijing Normal University, "Development and Applications of a Typhoon Catastrophe Model-Open Cyclone"**

Dr. Weihua started by saying that different people have different definitions of risk. So to share the opinions, people need to understand where, when, how often, how strong risks are. General framework for risk assessments is accepted in academic circles. Risk quantification can be quantitative, semi-quantitative, or descriptive. The database can be developed with hazards, exposure data, and loss data. Broad risk maps (e.g., typhoon, drought, multi-hazard) based on historical data are hard for communities to use. They are better for central government planning. Then he introduced several examples of available models in different countries. The government would like to have an open and transparent model. The components of a catastrophe (cat) model are stochastic event module, hazard module, vulnerability, and risk. Insurance industry first used just historic data; then loss calibrated probabilistic models; now new generation numerical model. The cost of computation is decreasing**.** Hurricane Andrew caused 16 insurance companies to go out of business. In cat modeling, it is critical to capture the tail of distribution. A cat model has to combine empirical data with expert judgment. Historical track covers 62 years, while stochastic event set covers 620 years. Statistical characteristics match for both. Local roughness effects due to land use are modeled. Vulnerability is fragility curves developed by component based Monte Carlo simulation. Empirical vulnerability curves are developed for residential, commercial, industrial, buildings, contents. The cat model can be applied to storm surge hazard assessment, developed evacuation maps, and weather index-based insurance

28. **Dr. Sugiura Ai, UNESCO, "Hydro-Meteorological Data and Modeling for Flood Forecasting and Leading to Better Response for Flood Management in Indus river basin in Pakistan, a JICA Funded"**

UNESCO has strong science program. UNESCO actions for disaster reduction have long-term goals. Dr. Ai showed the example of Pakistan mega-floods of [August] 2010. The height of 18m affected many people. Some places remained inundated until December. She showed the table showing areas recorded above designed capacity. As a result, Pakistan established National Disaster Management Act, including established a Commission and national plan. It is a multi-disaster plan that is the national official policy. It contains early warning system plan, human dimensions plan, and 10 interventions with budget of $774m. It includes the processes for who needs to alert regarding floods.

Dr. Ai then analyzed what the missing points were in 2010. The area that flooded was not modeled. The flood devastated areas which had no inundation experience in the past. UNESCO sent a team of flood management experts and then Japan donated money to start a program for flood early warning. The program was set out set out to address issues identified as missing. IFAS (Integrated Flood Analysis System) flood forecasting

system use satellite data. It shows the river discharge, water level, rainfall distribution. There were challenges. The precipitation data showed very big uncertainties. The gauge network was insufficient. It cannot differentiate between snow coming down and snow already settled on ground. Pakistan government is now using the developed version of the tool. It is a developed platform that Pakistan shares with other countries. There established media center to broadcast nationally forecasts.

29. Ms. Lesley Jeanne Yu Cordero, the World Bank, "A Smarter Way of Managing Disaster Risks-The Use of Science and Existing Weather and Climate Information"

Ms. Cordero showed the destruction from two typhoons, Sendong and Pablo, earthquakes, and Typhoon Hayan that killed 6201 people. The Philippines is the 8th most exposed country to the disasters. It conducted catastrophe risk assessment and established a risk resiliency program which cost $1.9 billion.

World Bank is also integrating disaster risk financing and disaster risk reduction. Those works include preventing creation of new risks, reducing existing risk, preparing for next disaster, managing residual risk. The World Bank is focusing on integrating risk projects and programs to include rehabilitation in recovery efforts. It includes risk-informed development planning and investment programming. With the belief that different experts can interact and work together, the World Bank is updating building code. Technical assistance is aiming to institutionalize lessons learned with each event. It aims to incorporate science-based findings and modeling results. This assistance includes helping local government units on how to use maps and how to define areas of low, medium, high risk. Vulnerability assessment and risk reduction for priority cultural heritage assets is also in the process. The experts are working on adopting a method that can be scaled up. Disaster risk financing and insurance would be soft triggers for local governments who want to develop catastrophe risk pool.

Disaster risk management is the combination of many elements. Risk assessment, from asset to well-being losses are combined. The provinces are screened to prioritize investments. Project benefits are measured in well-being terms. Ms. Cordero showed a table of project benefits which shows that the project benefits are found to be 4x investment in Maguindanao but only 1 for 1 in Bulacan. The policy changes as a tool are used to balance prevention with ex post support.

30. Session Wrap Up & Discussion

Question: I really want to go one step further to the impacts. I want to take information collected on exposure and vulnerability and then forecast impacts for risk assessment and insurance. In Pakistan, how are you going to take next step? Are you just trying to improve the flood forecast? How are you going to translate the information into 'What do I do?' or 'where should I go?'

Answer: Yes, we put the information on the flood hazard map. The databases being used by different people cannot be lined up.

Question: What are the difficulties on determining risk transfer strategies?
Answer: We look at pooling certain percentage of provinces, so that we could leverage capital markets. World Bank will act as a reinsurer in this instance. National government is also looking at providing cost sharing for some of the poorer municipalities.

Question: How is social vulnerability being assessed?
Answer: In cat model, the data is structured from models and insurance industry. Non-structured data such as indigenous knowledge sometimes has a conflict of interest with central government. This data may be underestimated. We need rigorous quality control processes. Capacity is very hard to quantify, especially regarding social vulnerability, which has so many variables. If zooming into local level, people are used to nuisance flooding in one area and not another. As it is hard to compare, bringing local knowledge and communities into the conversation is critical and may be part of the solution on how to assess social vulnerability.

Question: Do you get the data directly from model or do some bias correction
Answer: The data is bias-corrected. Using local data for bias correction was found to be much better. Using the reference period for assessing climate change may be important in seeing change.

Question: Do you use only one station in assessing drought or surrounding as well? Can use SBI for drought forecast?
Answer: We did not use any other station data. Other stations had very short time series. Yes, could use SBI for forecasting precipitation.

Session V: Wrap up and Panel Discussion

31. The Panel Discussion and Wrapping-Up Session on November 4 commenced at 9:00 pm. The session was chaired by Dr. Bin Wang from the University of Hawai'i.

32. Session II Wrap Up

There were 4 presentations that concerned typhoons and cyclones. Dr. Camargo said that the models really need fine resolution. Her presentation was based on the genesis indices. Dr. Kuleshov said tropical cyclone has four or five there was consistency between the times of projections. Dr. Shamir talked about two case studies. He showed an example of southern California. Dr. Yeh talked about Typhoon in Chinese Taipei. As the island is in the path of many typhoons, figuring out how to get improved forecast at

vulnerable society is necessary. Prof. Wood talked about the climate service. It should be prepared and delivered to meet a users' needs. He introduced the monitoring and forecasting system for local communities which is web-based. He insisted that all the data services should be developed and improved continuously to be useful to the end user. Dr. Robertson talked about ensemble forecasting. The forecast is being done by numerical forecast systems. So the development of the system is needed with spatial patterns which are being challenged by extreme rainfalls.

33. Session III Wrap Up

Dr. Paul Gregory categorized whole participants' presentations with keywords; community, trust, communication, bridging the gap, action/inaction, infrastructure issues, have a changing climate risk assessment, success. Dr. Resmikis Royboon talked about grassroots project involving local project not just top-down way but also community innovation. Dr. Hilton gave a presentation on community-based disaster management. He said people who are impacted by disasters should engage. Dr. Lagdameo focused on community. She showed there are tools to understand the concepts of hazards. One of them is to use the idea of playing games so that all the people can participate. Ms. Guerra said community-based risk management makes people understand what to do in disasters. Ms. Asam focused on pre-planning and building climate resilient community. Dr. Gregory said engagement is not just pushing. It is more based on local community process.

34. Session IV Wrap Up

A couple common themes came out during the session, such as typhoon modeling, managing a risk etc. What needs focus is the way to communicate. For better communication, the data should be more accessible. The developing countries lack data, and policy makers have limited time and budget. Not only looking physical phenomenon of the hazard but also looking at the overlapped similarity between disaster and development is necessary. Dr. Jane Rovins said to analyze the hazard, both technical inputs and local knowledge should be considered together. The tradition that passes down generation to generation should never be overlooked. The data should be easily recognizable and open. Dr. Merwade started off by describing the flood damages in the U.S. He said flood modeling and mapping should be high resolution flood simulation at large scale. At the same time, development of low cost technologies should be handled. Dr. Gusyev said a full set of the standardized indices can provide useful information about natural and socio-economic droughts for disaster risk reduction activities. Dr. Fang started off by defining 'risk'. He said landing intensity at county level is done by modeling potential intensity over the sea considering SST, outflow temperature, wind shear, etc. Dr. Ai introduced the flood risk reduction in Pakistan from institutional point of view. The components of the Pakistan flood project include augmenting of flood forecasting and hazard mapping capacity, building knowledge platform for sharing transboundary and community data. Ms. Cordeo said there are four

factors we must consider in managing disaster risk. She suggest the prevention is the key in designing a disaster management strategy. The most important thing is key indices in regional area.

35. Panel Discussion: Prof. Bin Wang, Prof. Erik Wood, Dr. Suzana Camargo, Dr. Paul Gregory, Dr. Jane Rovins, Dr. Wei-Sen Li, Dr. Ilwon Jung

Dr. Wei-Sen Lee started off by giving observations by a disaster manager. He pointed out that there is a difference between the climate change research and disaster management. Disaster mangers have only one answer because they are not projecting future. They want to project next week, comparing to 20 years projection. So from the project facilitator to regional leaders, working as one group is necessary to reduce the disaster management. Dr. Lee said EPWG will support the background and it will collaborate with another working group for safe and sustainable development. Dr. Lee also pointed out the importance of founding one organization which will be in charge of disaster management so that every key stakeholder can gather by the one institution.

Dr. Suzana pointed that the topics that speakers brought were actually about communication. Another part of the issues was funding – clear funding. Unless there is enough funds it is hard to start work and get people from all around the world. So the need to improve the communication from the diverse field arise.

Dr. Ilwon Jung said disaster management is to make decisions to take actions. Disciplinary research should be made for regional local scale. Developing platform for decision making, and unstructured data and sharing customization for disaster management is needed. Dr. Jung also pointed that we should learn from the worst case. Even though there are reliable climate information, we also have learn from what we have paid. We can identify existing gaps and research priority, which is one of the best way to utilize the information.

Dr. Rovins said the development should make the tradition sustainable at the same time. Those two pieces should go together.

Prof. Wood said we should not go back to the day we were. Most communities and government believe that the rehabilitation is to build the way it was, but actually it is not. We need to have the foresight that it is not real.

Dr. Rovins said that if we get better little each time then the damages are minimized with the early warning system and the other preparedness we have to minimize – not the way it was because it will be damaged again. So little by little we have to bring it in better way.

Dr. Lagdameo compared the time management between the response team and the

planning team. Normally when you are in responding side of the problem, you have to take action very quickly but on the planning side it is not very urgent. However, climate change is just obvious and there is big north-south difference. Loss and damages are not as seen as important because the effects are not being seen.

Dr. Antonio Navarra said we need a new way to think of the relationship between social and natural science. Investigating scientists themselves is needed to have one conversation on current situation.

Dr. Merwade said there is a lot of concern on climate data. He suggested APEC Climate Center can develop some directions as there is no playing government as far as I know.

Dr. Jung explained the Korean case, where there is some consensus in the seasonal precipitation change although it includes a lot of uncertainty. Korean researchers worry about more frequent droughts and floods. APCC is focusing on downscaling and impact assessment and as a result published open data focusing on east-south Asia using dynamical downscaling skills. APCC tries to identify the uncertainty since there is many uncertainty in the future projection.

Dr. Li added by saying we should also think about the way to influence the audience. Politicians want the problems to be solved urgently, but that is not how disaster management is done. So we should persuade the public so that the political leaders will think about that. He also highlighted the importance of pre-disaster recovery, which is the prevention in advance before another disaster happens. Although recovery is a very complicated issue, the leadership of all the communities should be involved.

Ms. Cordeo said people in media tend to forget rehabilitation. We have to translate the language for the people and decision makers. By changing the mentality of media, the issues and the model of rehabilitation can be discussed.

Dr. Rogers said no matter how much we prepare, if we miss one of the steps from time, early warning, financing, than the society is not resilient.

Dr. Maksym Gusyev said from the local knowledge we can actually build the group knowledge. The goals will be made from local levels to country level, and ultimately to global.

36. Dr. Chin-Seung Chung, the Director of the APEC Climate Center, concluded the symposium with a speech reiterating the main points of the symposium while showing deep gratitude to everyone for their active participation.

ANNEX: APEC Climate Symposium 2015 Participants List

No	Nation	Organization	Title	Name
1	Australia	Bureau of Meteorology	Dr.	Yuriy Kuleshov
2	Australia	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Dr.	David Robertson
3	Australia	Bureau of Meteorology	Dr.	Paul Gregory
4	Australia	APEC Secretariat	Mr.	Alex Rogers
5	Australia	Australia National University	Prof.	Stuart Mark Howden
6	Cambodia	National Committee for Disaster Management, Council of Ministers	Mr.	Ponleu Rath Phlang
7	Chile	Direccion Meteorologica de Chile	Dr.	Engique Osvaldo Garrido Segovia
8	China	The United Office for Disaster Risk Reduction (UNISDR)	Ms.	Fang Min Kan
9	China	Beijing Normal University	Prof.	Weihua Fang
10	Chines Taipei	Central Weather Bureau	Dr.	Ming-Ying Lee
11	Chinese Taipei	Central Weather Bureau	Dr.	Tien-Chieng Yeh
12	Chinese Taipei	National Science and Technology Center for Disaster Reduction (NCDR)	Mr.	An-Hsiang Wang
13	Chinese Taipei	National Science and Technology Center for Disaster Reduction (NCDR)	Mr.	Tsung-Jung Lee
14	Chinese Taipei	National Science and Technology Center for Disaster Reduction (NCDR)	Ms.	Chu-Ying Kung

15	Chinese Taipei	National Science and Technology Center for Disaster Reduction (NCDR)	Ms.	Yi-Chen Chen
16	Chinese Taipei	National Science and Technology Center for Disaster Reduction (NCDR)	Dr.	Jung-Lien Chu
17	Chinese Taipei	National Science and Technology Center for Disaster Reduction (NCDR)	Mr.	Sean Lam
18	Chinese Taipei	National Science and Technology Center for Disaster Reduction (NCDR)	Dr.	Wei-Sen Li
19	India	University of Purdue	Dr.	Venkatesh Merwade
20	Indonesia	State Ministry of National Development Planning (BAPPENAS)	Ms.	Aruminingsih Sudjatma
21	Indonesia	Indonesian Meteorological Climatological and Geophysical Agency (BMKG)	Mr.	Marjuki
22	Italy	Euro-Mediterranean Centre for Climate Change	Dr.	Antonio Navarra
23	Japan	United Nations Education Scientific and Cultural Organization (UNESCO)	Dr.	Sugiura Ai
24	Japan	Japan Meteorological Administration	Mr.	Yasuhiro Matsushita
25	Korea	Asia Development Bank	Dr.	Younguk Kang
26	Korea	Pukyong National University (PKNU)	Prof.	Jaiho Oh
27	Korea	Korea Meteorological Administration (KMA)	Dr.	Byung-Kwon Park
28	Korea	APEC Climate Center (APCC)	Dr.	Chin-Seung Chung
29	Korea	APEC Climate Center (APCC)	Dr.	Yeongsin Kim
30	Korea	APEC Climate Center (APCC)	Dr.	Hyungjin Kim

31	Korea	APEC Climate Center (APCC)	Ms.	Sangwon Moon
32	Korea	APEC Climate Center (APCC)	Dr.	Ok-Yeon Kim
33	Korea	APEC Climate Center (APCC)	Dr.	Ilwon Jung
34	Korea	APEC Climate Center (APCC)	Dr.	Sunkwon Yoon
35	Korea	APEC Climate Center (APCC)	Dr.	Wooseop Lee
36	Korea	APEC Climate Center (APCC)	Dr.	Daeha Kim
37	Korea	APEC Climate Center (APCC)	Ms.	Suhee Han
38	Korea	APEC Climate Center (APCC)	Ms.	Inja Jeon
39	Korea	APEC Climate Center (APCC)	Ms.	Jiyoon Lee
40	Korea	APEC Climate Center (APCC)	Mr.	Gyeongseok Jo
41	Mexico	National Center for Prevention of Disasters (Centro Nacional de Prevencion de Desastres, CENAPRED)	Dr.	Lucia Guadalupe Matias Ramirez
42	Myanmar	Relief and Resettlement Department, Ministry of Social Welfare, Relief and Resettlement	Mr.	Than Soe
43	Papua New Guinea	Milne Bay Province	Mr.	Steve. Tobessa
44	Papua New Guinea	National Weather Service (PNGMET)	Mr.	Samuel Maiha
45	Peru	CARE	Ms.	Lucy Harman Guerra
46	Peru	Servicio National de Meteorologia e Hidrologia del Peru (SENAMHI)	Mr.	Luis Alfaro

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48	Philippines	Department of Science and Technology	Sec.	Mario Montejo
49	Philippines	Department of Natural Defense	USec.	Alexander Pama
50	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)	Mr.	Hilton T. Hernando
51	Philippines	Red Cross Climate Center	Dr.	Donna Lagdameo
52	Philippines	World Bank	Ms.	Lesley Jeanne Yu Cordo
53	Philippines	Office of Civil Defense	Mr.	Marlon Henson Obligado
54	Philippines	Global Footprint Network	Mr.	Philip Fullon
55	Philippines	Integrated Micro-Electronics INC.	Mr.	Frederick Blancas
56	Philippines	Integrated Micro-Electronics INC.	Mrs.	Rowena Guilalas
57	Philippines	Integrated Micro-Electronics INC.	Mr.	Sherwin Nones
58	Philippines	Asia Development Bank	Dr.	Anil Pokhrel
59	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Dr.	Flaviana Hilario
60	Philippines	Department of Science and Technology	Dr.	Carina G. Lao
61	Philippines	National Security Council, Office of the President	Ms.	Adelwisa M. Merjudio
62	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Ms.	Rosalina G. De Guzman

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75	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Alvin G. Pura
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88	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Ms.	Edna L. Juanillo
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92	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Alan Binalayo
93	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Roque Adora
94	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Alvin Cleofas

95	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Edwin Paguia
96	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Jhonlerry Sumabong
97	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Aaron Chester Cruz
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101	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Ronaldo T. Bihalayo
102	Philippines	Philippine Atmospheric, Geophysical and Astronomical Services Administration	Mr.	Roger C. Cuenos
103	Philippines	Reviewers TV	Mr.	Pedro Uchi
104	Philippines	Reviewers TV	Mr.	Oscar Abunyawan
105	Philippines	TV 5	Ms.	Patricia Mgngune
106	Philippines	TV 5	Ms.	Beverly Nativilad
107	Philippines	TV 5	Mr.	Chris Piogrid
108	Philippines	TV 5	Mr.	Joan Alatiit
109	Philippines	RTVM-APCMOC	Ms.	Vaegueline Amanzona
110	Philippines	RTVM-APCMOC	Mr.	Jerome Geronime

111	Philippines	RTVM-APCMOC	Mr.	Job Pelago
112	Philippines	RTVM-APCMOC	Mr.	Darwin Gernale
113	Philippines	UNTV	Mr.	Rey Pelayo
114	Philippines	UNTV	Mr.	Roberio Alvadez
115	Philippines	Philippine Daily Inquirer	Ms.	Helen Flores
116	Russia	Voeikov Main Geophysical Observatory	Dr.	Vladimir M. Kattsov
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122	UK	BBC	Mr.	Fergus Nicoll
123	UK	BBC	Ms.	Vivienne Nunis
124	Ukraine	International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHARM)	Dr.	Maksym Gusyev
125	USA	University of Hawaii	Prof.	Bin Wang
126	USA	Columbia University	Dr.	Suzana Camargo

127	USA	Hydrologic Research Center	Dr.	Eylon Shamir
128	USA	Princeton University	Prof.	Eric Wood
129	USA	ICF International	Ms.	Suan Asam
130	USA	Disaster Reduction & Resilience Solutions, Ltd.,	Dr.	Jane Rovins
131	USA	I.M. SYSTEMS GROUP	Mr.	Vance Hum
132	USA	Global Footprint Network	Ms.	Pati Poblete
133	USA	Naval Post graduate School	Prof.	Chih-Pei Chang
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