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Climate Change Downscaling Approaches and Applications Training Programme

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ABSTRACT: Climate change projections provide an important basis for development of future climate change adaptation strategies. However, since projections of future climate are very much subjected to assumptions made in the models, parameterization, model complexity, societal and economic development trends, etc., there are tremendous uncertainties in the projected future climate. The University Network for Climate and Ecosystems Change Adaptation Research (UN-CECAR) academic programme developed a set of training modules on Climate Projection Downscaling Methods in 2011 to inform the current status of methodologies, uncertainties and the appropriate use of projections. The modules provide training on two approaches to dynamic and two approaches to statistical downscaling methods, risk assessment and estimation of climate change impacts on floods and rice production. This third training was organised from 9–20 November 2012, at the Asian Institute of Technology, Thailand, in partnership with the Asia Pacific Network for Global Change Research (APN). Seventeen lecturers from ten institutions participated in the delivery of training for 48 participants. A new staggered approach was adopted to accommodate the high number of participants by dividing groups into two and staggering the programme by one day. Participants demonstrated high level of competency and could benefit from the training programme. A number of participants requested the use of the materials for their institutional capacity development activities.

KEYWORDS: *climate change impacts, downscaling, training programme, flood, rice production*

Introduction

The University Network for Climate and Ecosystems Change Adaptation Research (UN-CECAR) is a network of universities and research institutes in the Asia-Pacific region that collectively develops research and education programmes on climate change adaptation, ecosystems change adaptation, and sustainability. United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) coordinates and supports the activities of UN-CECAR and acts as a repository for education programmes and research outcomes.

Through a series of workshops, UN-CECAR academic programme developed a set of training modules on Climate Projection Downscaling Methods and Applications in 2011 with the following specific objectives:

- To provide an overview of science of climate change and downscaling.
- To provide practical training in downscaling methods to derive weather and climate projections from global to local scale.
- To assess impacts of climate change on flood and rice production and practical training in using impact models in conjunction with Geographical Information Systems for adaptation planning.

Course Design

The downscaling programme was designed as two independent but interlinked courses. The first course deals with producing future weather series at local scale by downscaling global climate projections and the second course deals with using this information to assess impacts and design adaptation strategies related to flood mitigation and rice production.

Course I

Course I is composed of the following modules: (a) Science of climate and climate change modelling; (b) High resolution climate projections using physically based models; (c) Downscaling using statistical methods; (d) Selection of global models based on modelling skill; (e) Bias correction for extremes and for total rain; and (f) Risk assessment and extreme events.

» *Dynamic downscaling*

In this module, two different approaches to obtaining high-resolution climate projections are introduced. In the first approach, the National Center for Atmospheric Research (NCAR) introduces the nested modelling approach, where Weather Research and Forecast (WRF) model is applied progressively with increasing spatial resolution to smaller nested regions starting from the global model output to downscale model's global predictions to local scale. The session introduces the importance of validating climate model outputs using local observations and participants confirm the improvement of projections obtained from downscaling.

As a second approach, the Meteorological Research Institute (MRI) of Japan 20-km Atmospheric General Circulation Model is introduced where the model does not simulate ocean process, but uses the outputs from other models and observations as the boundary conditions, making it possible to model the whole world at 20-km resolution (Kitoh et. al, 2009). For many applications no further downscaling is required. The participants could get hands on training to use the 'grads' suite of tools to assess model output data and compare with observed climate variables at any location of interest.

» *Statistical downscaling and selection of GCM*

In the statistical downscaling procedure, a model is constructed for a local climatic variable such as rainfall or temperature from a number of variables from GCM predictands. Participants constructed such models using time series data of ground observation and GCM

projections. Selection of a particular GCM for a given region is an important issue due to the large differences in future climate simulated by different GCMs. University of Tokyo, Department of Civil Engineering, introduced a selection method based on model skill in reproducing major climatic signals of the past.

» *Bias correction*

Two different approaches to bias correction are introduced in this training. In the first approach, provided by the University of Tokyo, participants perform correction for extreme rainfall, normal rainfall and no rain days of GCM output by using observed areal average rainfall for 1981–2000. For the extremes, 20 annual maxima were fitted with Lognormal, Gumbel distributions with Weibull, Hazen and Cunnane plotting positions for choosing the best-fit distributions for the observed rainfall.

The second method of bias correction was introduced in the UNU, where first the rain frequency is corrected by truncating daily precipitation based on the non-exceedance of observations. Then, the intensity is corrected by mapping the cumulative distribution function (CDF) of the truncated series to the CDF of the observed series. The Gama distribution was used to map the observed as well as GCM data sets, and a hands-on exercise used MRI 20 km data sets to verify the methodology.

» *Risk assessment, extremes and rainfall-intensity-duration-frequency (RIDF) curves*

The risks and extremes session conducted by the United Nations University starts with definitions of risk, hazard and vulnerability and move to a discussion on resilience and extreme events. Climate change modifications to extremes and challenges are then introduced with special focus on; non-linear relation between extreme events and losses and infrastructure design implications under climate change uncertainty.

Course II

» *Impacts on flood magnitude*

The main emphasis of the training is on the appropriate use of future climate projections flood impact assessment. In general GCM data are not precise enough to make applications for urban flood analysis. The example selected was flood inundation in an urban area, which is located in the downstream area of a 2500 km^2 catchment. The modelling is carried out using a hybrid approach, where the inflow to the urban area is first estimated using a hydrological model and then this input is used in a hydro-dynamic model to compute the inundation (Herath et. al, 2003). For such applications, the 20 km^2 spatial resolution of the MRI data provide important input of rainfall with adequate spatial distribution in the mountainous upper catchment.

» *Impacts on rice production*

In the rice yield production stream, first an introduction to rice yield modelling is provided with a detailed description of the DSSAT model and its application to rice yield simulation. Then exercises are provided to set up the model to a case study and to calibrate and validate the model. An application is conducted where total rice production under different soil groups and rice varieties in a region are estimated. Then, future yield under climate change for these combinations are carried out. Finally, using GIS tools, appropriate spatial distribution of rice varieties to be planted in the region is determined according to given adaptation constraints.

» *Risk communication*

On the last day, a special session on communicating climate information was conducted by the Institute for Social and Environmental Transformations (ISET). The main objective of this interactive session was to engage the participants in appropriate roles for and communication of climate information in various stages of adaptation and resilience planning. The participants were given a number of climate change impact scenarios and were asked to develop a framework for planning and communicating an adaptation strategy.

Participants

Forty-eight applicants were selected based on their background and relevance to the programme. The composition of the selected participants is shown in Figure 1 that shows a good distribution among researchers and practitioners.

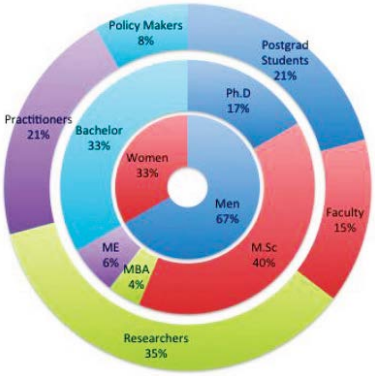

Figure 1. Composition of the participants.

Training Outcomes

The training proved to be an appropriate platform for interaction of researchers and practitioners as well as building teams and connections among various sectors in the Asia-Pacific countries. It is hoped that the participants will continue to build on these networks to develop joint programmes in the future associated with planning for climate change.

At the end of the programme, all participatns produced group reports for both course I and course II. For course I, the reports were a reflection on the training received during the course. For course II each stream produced results of the group activity in modelling and impact assessement related to case studies. In the following section, two group reports are introduced as samples of student submissions.

» *Group report sample: IDF curve derivation*

Intensity-duration-frequency (IDF) curves are essential in the conventional design of urban drainage infrastructure. Due to non-stationarity brought about by the climate change, the IDF curves derived from past data are no longer valid for future and it become necessary to derive them from the climate projections provided by the GCMs. One of the major difficulties here is the lack of high time-resolution (small time step) rainall observations in many part of Asia required for bias correction. During the training, application of simple scaling theory to address this issue was introduced (Mishra and Herath, 2011). The Singapore team used this method to (a) demonstrate that simple scaling theory holds for rainfall maxima in Singapore; and (b) used the method to assess the changes to IDF curve using MRI 20 km^2 data.

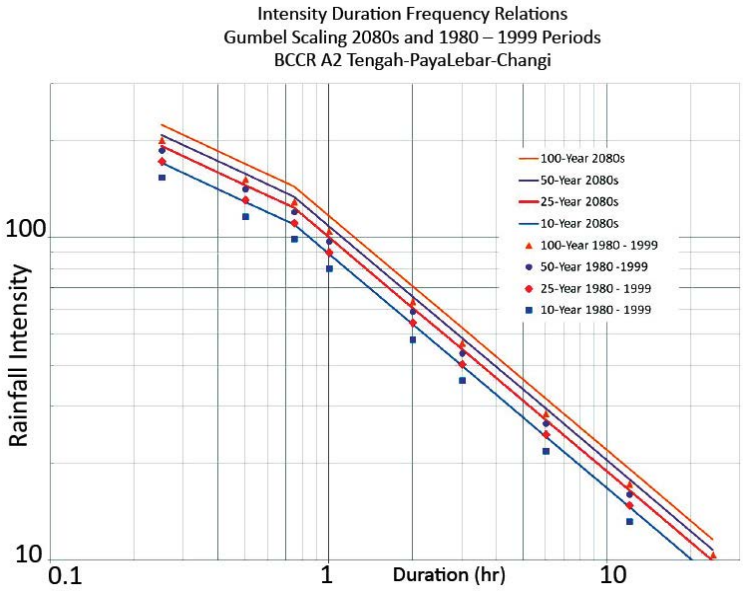

Figure 2. Comparison of current and future IDF curves.

The results obtained (Figure 2) shows that there is significant increase in rain intensities for all durations, and that 1:25 year current intensities (1980-1990) corresponds to 1:10 year probabilities by 2080's.

» *Group report sample: Rice yield estimation*

Some of the main parameters that affect rice yield for a given climate are the rice variety, soil type, fertiliser applicaton rate and irrigation management. Using the DSSAT simulation software, participants were trained on how to model rice yield under different future climate scenarios for different combinations of the above parameters. The assignment for the group was to select rice varieties for future climate under certain quantatitave constraints without incurring an economic loss to farmers at current price levels.

Summary

Representatives from the National Center for Atmospheric Research (NCAR), USA, the Japan Meteorological Research Institute (MRI), Japan, The University of Tokyo, Japan, the Indian Institute of Technology (IIT), India, the Asian Institute of Technology (AIT), Thailand, the University of Philippines, the Institute for Global Environmental Strategies (IGES), Japan, the Institute for Social and Environmental Transitions (ISET), UK and the Institute of Meteorology, Hydrology and Environment (IMHEN), Viet Nam, worked with UNU in developing the modules. The APN funded the present course delivery. The Ministry of Environment, Japan supported the course development as a collaborative activity of IGES and UNU.

A novel staggered training approach was used to accommodate the large number of participants for the training. For half the group, lectures were conducted from 9–13 November; and for the second group from 10–14 November. Each lecturer delivered the same contents on successive days, keeping the overall programme hosting costs low. The participants were requested to evaluate different aspects on a scale of 6 levels; excellent, very good, good, fair, poor and very poor. The overall impression was very good, with all evaluations generally in the range of excellent to good. The combined evaluation for both courses I and II are shown in Figure 3.

It is clear that there is a great demand for updated knowledge on downscaling and using climate change projections. If sufficient financing can be secured it is worthwhile to organise this programme in different countries annually. In order to make these materials readily used by the global community, it would be useful to organise a workshop for the trainers, so that they can conduct the programme at different institutes either locally or regionally.

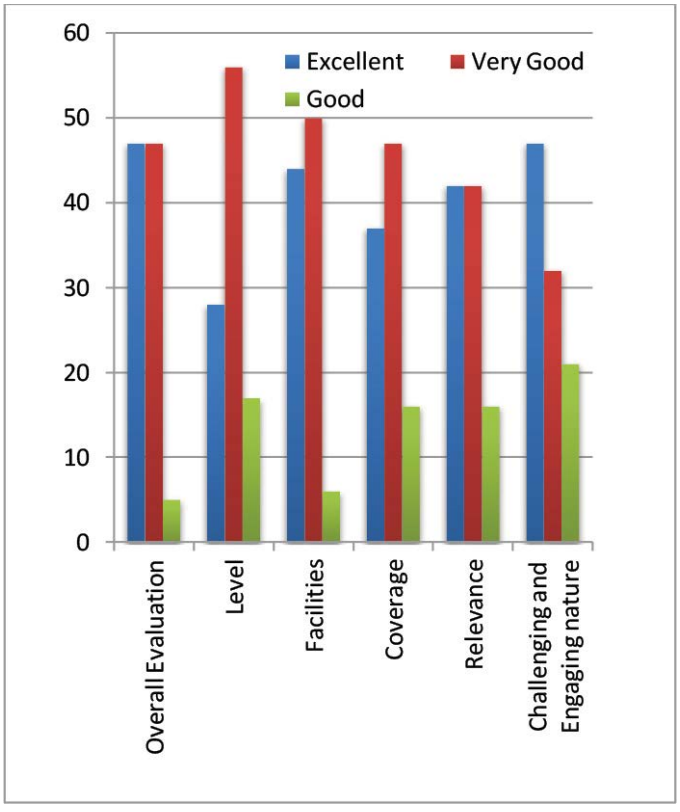

Figure 3. Sample of course evaluation.

References

Chang Chian Wui, Lee Zhang Er, Charoenkit Sasima, Noimunwai Watcharapong, Panpeng Jirawat, Sengkhammy Bounyaseng (2012) Report for the Training Programme on Climate Change Downscaling Approaches and Applications (CCDAA) GIS-Geoinformatics Center, Asian Institute of Technology, Bangkok, Thailand 9-20 November 2012, Course Flood, Group – 3

Dhage Pradnya, Rajwade Yogesh, Satapathy Sushree and Singh Ankita (2012) Report for the Training Programme on Climate Change Downscaling Approaches and Applications (CCDAA) GIS-Geoinformatics Center, Asian Institute of Technology, Bangkok, Thailand 9-20 November 2012, Course 2: Impact on Rice Production, Group - 2

Herath, S., Dutta, D. and S. Wijesekera, S. (2003). A coupled river and inundation modeling scheme for efficient flood forecasting, Geoinformatics,Vol. 14, No. 1, JSGI, pp.37 -41

Herath. S. and S. H. Teh (2012) "Handbook and Proceedings of First Training on Climate Change Projections and Downscaling: Approaches and Applications", CECAR series No. 8, UNU-ISP.

Kitoh, A., T. Ose, K. Kurihara, S. Kusunoki, M. Sugi and KAKUSHIN Team-3 Modeling Group (2009) Projection of changes in future weather extremes using super-high-resolution global and regional atmospheric models in the KAKUSHIN Program: Results of preliminary experiments. Hydrological Research Letters, 3, 49-53.

Kubota, T., S. Shige, H. Hashizume, K. Aonashi, N. Takahashi, S. Seto, M. Hirose, Y. N. Takayabu, K. Nakagawa, K. Iwanami, T. Ushio, M. Kachi, and K. Okamoto (2007) Global Precipitation Map using Satellite borne Microwave Radiometers by the GSMaP Project: Production and Validation, IEEE Trans. Geosci. Remote Sens., Vol. 45, No. 7, pp. 2259-2275.

Mishra, B.K. and Herath, S. (2012): Investigating potential climate change impacts on rainfall intensity duration frequency curves in Kathmandu, Nepal, Proceedings of 11th International Symposium on New Technologies for Urban Safety of Mega Cities in Asia, October 10-12.

Mizuta, R., K. Oouchi, H. Yoshimura, A. Noda, K. Katayama, S. Yukimoto, M. Hosaka, S. Kusunoki, H. Kawai and M. Nakagawa, 2006: 20-km-mesh global climate simulations using JMA-GSM model – mean climate states –. J. Meteor. Soc. Japan, 84, 165-185.

Swain D. K., and Thomas D. 2010.Climate Change Impact Assessment and Evaluation of Agro-Adaptation Measures for Rice Production in Eastern India. Journal of Environmental Informatics, 16(2):94-101.

Swain D. K. and Yadav A. 2009. Simulating the Impact of Climate Change on Rice Yield Using CERES-Rice Model. Journal of Environmental Informatics, 13(2):104-110.

PROJECT INFORMATION

Title:	UNU-CECAR/UNU-ISP/APN Training Programme on Climate Change Downscaling Approaches and Applications
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