Report of the first Training Workshop on "Impact of air pollution on crops" under the Malé Declaration held in Bangladesh during 15-16 August 2007

Background

Crop impact study was one of the priority areas identified for capacity building under Phase III implementation of the Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia. The first training workshop on "Impact of air pollution on crops" was held in Dhaka and Mymensingh, Bangladesh during 15-16 August 2007. This report summarises the proceedings of the training. The agenda is enclosed as Annexure1.

Participants

Twenty seven participants from seven countries attended the training workshop. They were drawn from the Government agencies dealing with environment, meteorology and agriculture or fisheries. The list of participants and resource persons is given as Annexure 2.

Presentations

Day 1: August 15

Inaugural session

The inaugural session was held at the LGED Bhaban auditorium. Apart from the participants of the workshop, over 50 others participated representing Government, academics, research institutions and media. The occasion was blessed by the presence of Dr. C.S Karim, Hon'ble Advisor, Ministry of Environment & Forests, M/O.Agriculture,M/O.Fisheries & Livestock,Government of the People's Republic of Bangladesh,the chief guest, Mr. AHM Rezaul Kabir, ndc, Secretary, Ministry of Environment & Forests, People's Republic of Bangladesh as the special guest and Dr.Khandaker Rashedul Haque, Director General, Department of Environment, People's Republic of Bangladesh as the chair of the session.

The session started with a recitation from the Holy Quran. Mr. Q S I Hashmi, Deputy Director, Department of Environment, Bangladesh and Project Director in Bangladesh for implementing Malé Declaration, gave the welcome address. Mr. Mylvakanam Iyngararasan, Head, Early Warning, UNEP RRC.AP, Bangkok addressed the gathering, in which he mentioned the background of the workshop in the context of implementing the Malé Declaration. This was followed by an address by Dr.Lisa Emberson, Stockholm Environment Institute – York (SEI-Y), in which the workshop's link to Sida's RAPIDC project and its APCEN network was delineated. The Special Guest, Mr. AHM Rezaul Kabir, then addressed the audience. He brought out the air pollution issues affecting Bangladesh due to rapid urbanization and highlighted the measures taken by the Government to address it, including the conversion of two stroke vehicles to four stroke

and changing fuel to CNG. In this context the Malé Declaration activities and this workshop was very relevant. He also mentioned how Bangladesh is contributing to the implementation of the Malé Declaration. The address by Dr. C S Karim, the Chief Guest, gave a broader view of the issue, taking into consideration Climate Change and air pollution in the form of sustained and accidental releases. For mitigating transboundary air pollution, it is important to identify the pollutants and its origins, for the countries to take action. He mentioned the improvements made in air quality in Dhaka due to policy and technical interventions and went on to highlight the challenges. He suggested the following: the need to install a digital air quality monitor in the city to create public awareness; informal networks of professionals to share information; installation of more monitoring stations in Bangladesh under the Malé Declaration. The Chair of the session, Dr.Khandaker Rashedul Haque, Director General, DoE then took the dias. He briefly touched upon the issues of local and transboundary air pollution issues and stressed the need for regional cooperation for tackling transboundary air pollution. He mentioned how this workshop is relevant in this process and stressed the importance of discussions to map out the solutions. He thanked the Chief Guest, Special Guest, participants, UNEP and SEI for their support for the workshop and wished the workshop success in achieving its objectives.

Technical Session 1

The session was chaired by Prof. Dr. Abdul Hamid, Dept. of Agronomy, Bangobondhu Shaikh Mujibur Rahman Agriculture University. The session started with a round of self introduction and the participants expressing their expectations from the workshop.

After the inaugural session, Mr. Mylvakanam Iyngararasan, Head, Early Warning, UNEP RRC.AP, Bangkok, gave a presentation introducing the Malé Declaration and the progress in its implementation. The Malé Declaration has made considerable progress since its adoption in April, 1998. During Phase I, 1998-2000, a network was established, baseline studies were completed and action plans drawn up. The baseline studies provided valuable information on air pollution management programmes in the participating countries and clearly identified the gaps in the existing monitoring systems. Consequently, a capacity building programme was initiated in February 2002 as part of Phase II implementation, which has made a significant impact at the national and regional level. In Phase III, August 2005 – July 2008, apart from continuing the capacity building activities, the programme has concentrated on impacts assessment; and information for policy making. Phase IV of the programme intends to build upon the foundation laid in the initial phases, and to break new grounds. The presentation is attached as Annexure 3.

Dr.Lisa Emberson, SEI-Y, then gave an overview of the RAPIDC crop project and the provisional risk assessment methodology for crop impacts. During Phase I of the RAPIDC crop project between 1998-2000, case studies were undertaken in different countries, some of which indicated air pollution's impacts on crops in South Asia. During Phase II, between 2000-2004, the Air Pollution Crop Effect Network (APCEN) was established, and protocols were developed for risk assessments. During Phase III, provisional risk assessments were done in Asia and Africa, with a focus on ozone. She then described the methodology of risk assessment and factors that impact its quality. A brief overview of biomonitoring and chemical protectant studies was given and how they

could be done under the Malé Declaration. She concluded by giving a brief of the APCEN network and its activities. The presentation is attached as Annexure 4.

An introduction to the workshop was given by Dr.Patrick Bueker, Stockholm Environment Institute – York (SEI-Y). He explained the objectives of the workshop as to : present the first results of the studies in different countries; introduce and discuss the experimental protocols; exchange experience and knowledge on the subject; and to discuss the future of the crop impacts programme. The presentation is attached as Annexure 5.

Dr.Bueker continued with an overview of ozone bio-monitoring and chemical protectant studies in South Asia. He introduced biomonitoring and differentiated between active and passive monitoring and accumulative and reactive indicators. He mentioned the type of pollutants that could be detected by such methods and the effect parameters used. He then detailed clover bio-monitoring, starting with its advantages, its aims, and the experimental set up required and the schedule of the experiment. He then described the chemical protectant study, its aims; the chemical used (EDU), experiences in using EDU and a brief introduction to the protocol for EDU experiments. The presentation is attached as Annexure 6.

The next presentation by Dr.Bueker focused on the results of two years of bio-monitoring in South Africa as part of the Air Pollution Information Network Africa (APINA). APINA acts as a link between different networks and programmes on air pollution in Africa, including a programme on impacts of air pollutants on crops in Southern Africa. Clover bio-monitoring is being carried out in Mozambique, South Africa and Zambia, and will be joined soon by Botswana, Tanzania and Zimbabwe. EDU study will be started in South Africa. He described the study in South Africa and the results. The results so far show slight injury, most probably due to lower ozone concentration characteristic of that site. Results are awaited from the other countries, which have higher ozone concentrations. The presentation is attached as Annexure 7.

Presentation was followed by discussions. Participants asked why rural sites with less pollution are selected for such studies, if other pollutants are considered for the biomonitoring study and if meteorological parameters and seasons are considered. Rural sites have a higher concentration of ozone and that's why they are chosen. For air pollution bio-monitoring, Clover was chosen due to its unique sensitivity to ozone. This is a simple method to show ozone impacts and more detailed methods may not be practical in South Asian conditions. Meteorological parameters like precipitation and sunlight do affect ozone concentration and they are considered.

Technical Session 2

The session chaired by Dr.Khandaker Rashedul Haque, Director General, Department of Environment, Government of Bangladesh, started with presentations from Bangladesh, India and Pakistan about the preliminary results obtained from studies of assessment of impact of air pollution on crops.

The first presentation by Dr.M.A Salam, Chief Scientific Officer (CSO), Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh described the study being

conducted at Mymensingh. He introduced the air pollution situation in Bangladesh and gave a brief of an Open Top Chamber study he did in Austria, exploring the effect of ozone on the physiology and morphology of rice. In the current study two genotypes of white clover (NC-S and NC-R): one is susceptible to ozone while the other is resistant. Passive samplers were used for ozone monitoring. They followed the prescribed methodology. The monthly mean ozone concentration was between 29 and 35 ppb, which was on the lower side. NC-S showed very slight to slight visual ozone injury symptom whereas NC-R showed no symptom. The ozone susceptible cultivar generally produced lesser biomass than the resistant one at every harvest. He also gave suggestions on potential future projects on Tobacco, Tomato, Mung bean and Potato. The presentation is attached as Annexure 8a and 8b.

Prof.Madhoolika Agrawal,Department of Botany, Banaras Hindu University, India, gave a presentation on the "Use of ethylenediurea (EDU) as a research tool in assessing the impact of ambient ozone on plants". She gave introduction to tropospheric ozone, its formation and its impacts on plants. The EDU study conducted in Varanasi on mungbean and Wheat plants was then detailed, starting with an introduction to EDU and its usefulness for assessment of impact on crops. At appropriate dosages, EDU has the property to provide protection to different crops from ozone injury. She stressed the need for a dose-response study before suggesting the correct dose. The methodology used for the study was then explained, before going into the results. The studies proved that EDU can be successfully used for assessments of impact on crops, though there are challenges in developing countries such as lack of continuous electricity and non-availability of monitoring equipments. The presentation is attached as Annexure 9.

Prof.Razi Abbas Shamsi, Department of Botany, University of the Punjab, Lahore, Pakistan, then presented the findings from the clover bio-monitoring and EDU experiment in Pakistan. He introduced the site, and the methodology used for the bio-monitoring, all which followed the protocol given. He described the problems he faced in establishing the plants. In his first attempt, the NC-S did not survive, while NC-R survived. The opposite happened in the second attempt. The EDU study assessed the growth and yield response of Spinach and Mung bean to ozone. The ozone levels were high at about 81 ppb. He then gave the experimental set up used for the EDU and the results. He explained the effect of EDU on: leaf injury; dry weight; growth; reproductive growth; and seed yield. There was difficulty in establishing the cuttings. Though the ozone injury symptoms were not well marked and the results were inconclusive, especially in the case of mung bean. He analysed the factors responsible for the difficulty in establishing the plants and he also suggested a revised schedule for the study in 2008. The presentation is attached as Annexure 10.

This presentation was followed by discussions. Participants raised question about impacts of EDU on humans. The impacts are not significant since EDU has limited use mainly for experimental purpose. Moreover, there will be no EDU left after each experiment.

Technical Session 3

The third Technical Session was chaired by Mr. Mylvakanam Iyngararasan, UNEP RRC.AP. This session was devoted to the experimental protocols developed for clover biomonitoring and for EDU studies and was led by Dr.Bueker. He first gave an introduction to the experimental requirements and site set up, as well as the schedule of the experiment. He then went page by page through the two protocols and the participants had the opportunity to clarify doubts about the procedure mentioned. Some of the clarifications asked were on: the composition of the soil and the use of local sand and soil; need to sterilize the soil; use of slow release fertilizer; and scoring system for plant injury. Based on the comments and discussions the protocols are being revised. The presentation is attached as Annexure 11. The draft protocol on clover bio-monitoring is attached as Annexure 12 and the protocol for chemical protectant studies is attached as Annexure 13. An article on "Growing Stock Clover Plants" by Felicity Hayes, CEH Bangor, U.K was also distributed and is attached as Annexure 14.

Day 2: August 16

The next days session was held at the Bangladesh Agricultural University (BAU), Mymensingh, which is around 2 hours drive from Dhaka. On arrival, the participants and resource persons were given a warm welcome by the team at BAU.

Technical Session 4

The session started with a recitation from the Holy Quran. A welcome address was given by Prof. Dr. M. A. Baten, Head, Department of Environmental Science., BAU and Dr. M M Rahman, Head, Department of Agricultural Chemistry, BAU, introduced the participants. The session was chaired by Prof. Dr. M. A. Sattar, Department of Environmental Science., BAU and had distinguished guests on the dias: the Chief Guest, Prof. Dr. Musharraf Hossain Mian, the Honorable Vice Chancellor, BAU; Special Guest, Engg. H. S. M. Faruque, Director General, Bangladesh Water Development Board, Ministry of Water Resources; and Special Guest Dr. M. A. Hamid, Director General, BINA, Mymensingh.

Dr.Lisa Emberson was invited to give a presentation on an overview of crop impact assessments. She briefly explained how air pollution impacts crops and about different pollutants and their impacts. She then explained the objectives of the RAPIDC project, the methodologies used and why bio-monitoring and EDU based studies were chosen for the Malé network.

Prof.Madhoolika Agrawal, India, gave an overview of air pollution and its impacts on agriculture in India. She introduced the sources and types of air pollution in India and presented their trends. She then introduced the major approaches used in air pollution research such as survey oriented field studies, long term field studies, and artificial exposure studies. She then described long term and artificial exposure studies done by BHU and presented their results. The studies helped in concluding that air pollution does impact the yield and quality of crops and that ozone poses the greatest threat. She also stressed that the impacts varies depending on species and cultivars, meteorological conditions and air pollutant combinations. The presentation is attached as Annexure 15.

In the next presentation, Dr.Patrick Bueker introduced the experimental protocols developed for clover biomonitoring and for chemical protectant studies and over wintering requirements. He briefly described the experimental requirements and site set up, the schedule of the experiment and the methodology followed for visual injury assessment. Dr.Bueker briefly touched upon the importance of data management. He explained how it could be recorded, how to ensure quality control of data, how to do statistical analysis of data and reporting requirements. He also mentioned about overwintering requirements.

Prof.Razi Abbas Shamsi, University of the Punjab, then presented the findings from the clover bio-monitoring and EDU experiment in Pakistan, which has been summarized earlier. The presentation is attached as Annexure 10.

The Bio-Monitoring Results from Bangladesh was then presented by Mr. Md.Towhidul Islam, Ph. D. student, Department of Environmental Science, BAU. He introduced tropospheric ozone, its impacts on crops, and study results and experiences from various countries. The objectives, the methodology and the preliminary observations from the study at Mymensingh were then presented. The plants showed slight injury symptoms and reduction in biomass with higher ozone levels. The presentation is attached as Annexure 16a and 16b.

During the ensuing discussions, there were suggestions to conduct such studies in more areas to identify hot spots and the existing Malé monitoring site at Khulna was suggested as a potential site. Correlating visible injury levels to ozone concentrations was found to be a challenge, which could be resolved if ozone could be monitored frequently. Dr.Lisa Emberson then led the group on brief discussions on the future plans for the project.

The session ended with addresses by the Special Guests,the Chief Guest and the Chair. Dr. M A Hamid, highlighted food security issues in Bangladesh and how researching on the impact of ozone is important. He also stressed development of ozone resistant crop varieties as the cheapest means for reducing negative impact of ozone. Engg. H. S. M. Faruque, contrasted the impacts of stratospheric and tropospheric ozone and stressed the rapid increase in tropospheric ozone. He discussed mitigation of ozone and suggested studies on different crops. In his address, Prof. Dr. Musharraf Hossain Mian, introduced BAU and its activities. He explained how these types of studies is pertinent, while human activity is impacting the delicate balance in the environment. He wished better collaboration between scientists/researchers. The Chair, Prof. Dr. Sattar, then thanked the resource persons and the participants and suggested that the experiment be expanded to other parts of the country and stressed the need to maintain quality of research.

Before departing to Dhaka, the participants and resource persons visited the green house and the experimental site at Mymensingh, where the resource persons further clarified the finer points of the experiment.

Next Steps

It was suggested that the experiments be continued in the existing sites and additional countries initiate such studies. The difficulty in establishing the clover cuttings was widely discussed. As a temporary solution, cuttings were provided by SEI to the participants from Sri Lanka, Pakistan,

and Nepal. There were suggestions that the experiment be initiated at Khulna in Bangladesh. The protocols need to be revised with suggestions received.

Training Workshop Experience and Evaluation

There was active involvement of the participants in the workshop and emphasis was given to explain the practical aspects of the subject. On the last day of the workshop, an evaluation form was filled in by the participants. The summary of the responses is given in Annexure 19. The participants were in general satisfied with the training. The main suggestion from them was to carryout the experiment with some local crop varieties and EDU test as well for better understanding of the impact of ozone on crops.