Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries

13-17 September 2021 (Online Platform)

Workshop Report

Dr. R. L. Verma & Partners

Regional Resource Centre for Asia and the Pacific
Asian Institute of Technology
Pathum Thani, Thailand
www.rrcap.ait.ac.th/apn/

Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries

13-17 September 2021 (Online Platform)

Workshop Report

Lead Author

Dr. R. L. Verma
Regional Resource Centre for Asia and the Pacific, Asian Institute of Technology, Pathum Thani, Thailand

Contributors

Prof. Kim Oanh and Dr. Ekbordin Winijkul
Asian Institute of Technology, Pathum Thani, Thailand

Dr. Ittipol Paw-Armart
Pollution Control Department, Bangkok, Thailand

Dr. Hathairatana Garivait
Environmental Research and Training Center, Bangkok, Thailand

Dr. Didin Agustian Permadi
National Institute of Technology (ITENAS), Bandung, Indonesia

Dr. Md Firoz Khan
The University of Malaya, Kuala Lumpur, Malaysia
(now at North South University, Dhaka, Bangladesh)

Ms. Maria Katherina Patdu
United Nations Environment Programme, Bangkok, Thailand

PUBLISHED BY:

Regional Resource Centre for Asia and the Pacific
Asian Institute of Technology
Pathum Thani, Thailand
Email: info@rrcap.ait.ac.th

March 2022

ISBN (e-Book): 978-616-8230-13-8

RECOMMENDED CITATION

R. L. Verma, N. T. Kim Oanh, E. Winijkul, I. P. Armart, H. Garivait, D. A. Permadi, Md. F. Khan, and M. K. Patdu (2022); Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries; Regional Resource Centre for Asia and the Pacific, Asian Institute of Technology, Pathum Thani, Thailand.

DISCLAIMER

FOREWORD

Dr. Naoya Tsukamoto
Director
Regional Resource Centre for Asia and the Pacific
Asian Institute of Technology
Thailand

Increasing air pollution in Asia is causing severe impacts on the environment, human health, and economies of the countries. The majority of the population in Asia is exposed to dangerous levels of air pollutants, emitted from rapid urbanization, industrialization, transport, power generation, and open burning of agriculture residual and municipal solid waste.

Several regional initiatives, such as the Acid Deposition Monitoring Network in East Asia (EANET), the Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia (Malé Declaration), the ASEAN Agreement on Transboundary Haze Pollution, as well as some UN and international organizations, are making efforts to address air pollution issues in the Asian region. This includes capacity building to improve air quality management which is linked to achieving the Sustainable Development Goals (SDGs).

Most countries in Asia are still lacking technical capacities required for efficient management of air quality, including knowledge on cost-effective and technical advances in air quality management. To assist the Asian countries in capacity development on air quality management, the Regional Resource Centre for Asia and the Pacific (RRC.AP), along with partners, is implementing a 2-year project on the "Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for ASEAN Countries" with funding support from the Asia-Pacific Network for Global Change Research (APN).

The first 5-day capacity development workshop on air quality management was organized online in September 2021 in which over 200 participants from 29 countries participated. The workshop covered all the aspects of air quality management. I am happy and grateful to see the large number of participants including policymakers, technical staff, academicians, young researchers, students, and air quality professionals. I strongly believe that the participants had greatly benefited from the workshop in terms of improving their understanding on air quality management. I am pleased to see the detailed report of the workshop which summarized the proceedings and the evaluation from the participants noting their enhanced understanding and knowledge on air quality management.

FOREWORD

Mr. Yoichi Toyama
Director
Asia-Pacific Network for Global Change Research (APN)
Secretariat
Japan

The Asia-Pacific Network for Global Change Research (APN) awarded a grant (CBA2020-01MY-Verma) to the Regional Resource Centre for Asia and the Pacific (RRC.AP) based at the Asia Institute of Technology (AIT), Thailand, for a capacity-building project under its capacity development programme (CAPaBLE). The title of the project was "Capacity Development Program on Air Quality Management and Emission Reduction of PM2.5 for ASEAN Countries". This project responded to the high priority needs of the APN and, specifically, is closely aligned with the priorities of the APN Southeast Asia Subregional Committee (SEA-SRC).

The present workshop report is a compilation of the session outcomes of the capacity building workshop that was held from 13-17 September 2021 and organized by the RRC.AP. We highly acknowledge the support and presence of APN's National Focal Point for Thailand, Dr. Monthip Sriratana, Senior Adviser to the National Research Council of Thailand (NRCP) during the workshop. APN also acknowledges the representation from organizations/networks including the ASEAN Agreement on Transboundary Haze Pollution, the Acid Deposition Monitoring Network in East Asia (EANET), the Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia, and the Asia Pacific Clean Air Partnership (APCAP). Their participation underscores the importance of building capacities of the Asian countries on air quality management and emission reduction strategies.

Rapid economic growth in the ASEAN region faces serious environmental problems, especially air pollution, which is compounded by the increase in traffic in several megacities such as Bangkok, Jakarta, Hanoi, etc.

The programme mainly aimed to build the capacities of the ASEAN member countries on air quality management and emission reduction of $PM_{2.5}$. The 17 prominent experts of the region were invited as lecturers who covered a range of important topics, including air quality monitoring, emission inventory development, air quality modeling, human health and environment impact assessment, and planning skills for emission reduction policies and action plans. The valuable information introduced in the respective lectures has been compiled in this workshop report.

More than 200 participants including policymakers from the national and local governments, technical staff, early career and young researchers from the member countries of the ASEAN and other intergovernmental networks of Asia participated in the 5-day programme and received the certification. It is highly expected that these participants will contribute to the brilliant progress in the field of air quality management at their respective organizations and undertake relevant roles in the near future.

As a network in the Asia-Pacific region that endeavors to strengthen mechanisms to undertake collaborative research, capacity development, and science-policy interlinkages, APN is pleased to support this workshop and sees its contribution to the efforts of air quality monitoring and management in the region. As a strong advocate for action-oriented capacity development, collaborative research, and enhancing science-informed policy and decision-making, APN is delighted to endorse this workshop report, which is expected to serve as relevant and useful documentation of the increasing work related to addressing air pollution, climate change mitigation and emission reduction. We, at APN, hope that fellow researchers, the general public, and policymakers in the ASEAN and other Asian regions will find this workshop report and proceedings useful.

FOREWORD

Dr. Monthip Sriratana Tabucanon
APN National Focal Point for Thailand
Senior Adviser, National Research Council of Thailand
Thailand

Air pollution has become a serious transboundary environmental and health problem globally. As APN National Focal Point for Thailand, and having had opportunities to share concerns and ideas with APN colleagues, I believe that air quality and emission reduction of particulate matters, $PM_{2.5}$ in particular, are pressing common concerns of countries to protect the health of people and the planet.

The holistic, transdisciplinary approach to tackling the science and policy issues, as reflected in the comprehensive program content contained in this report, in terms of monitoring, developing emission inventories, modeling flows, impact assessment and policies for mitigation, is responsive to building capacities and competencies of researchers and policymakers. The knowledge gained in this program will benefit participating organizations and society.

I recognize the valuable contribution of this Workshop Report on "Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries". I commend the Regional Resource Centre for Asia and the Pacific (RRC.AP) of the Asian Institute of Technology, with the generous support of the Asia-Pacific Network for Global Change Research (APN), Japan, and all partner individual experts and organizations, for their great efforts towards holding the workshop and producing this report.

FOREWORD

Prof. Mario T. Tabucanon
Emeritus Professor, Asian Institute of Technology
Senior Adviser to the Director
Regional Resource Centre for Asia and the Pacific
Thailand

The capacity development programme on "Air quality management and emission reduction of $PM_{2.5}$ for Asian countries" should be viewed in a broader context through the lens of the interplay of science, policy, and society. Implementation of the UN 2030 Sustainable Development Agenda at the national, sub-national, and local levels requires a strong alliance between the scientific and academic community, the government sector, and the multitude of stakeholders in society. The scientific understanding of the economic, environmental, and social dimensions of sustainability, their inter-linkages, and interrelated emerging issues, are crucial to achieving the Sustainable Development Goals.

The capacity development programme responds to the call for strengthening the science-policy-society interface on air quality management, as well as for the identification of the underlying issues through the well-defined programme modules, namely – air quality monitoring, emission inventory, and modeling, which are in the domain of science; impact assessment on health not only of people but also of ecosystems, which are societal concerns; and mitigation issues, which are policy considerations.

When understanding specialized disciplines, one should be mindful of the holistic, big picture view of the issues, to enable understanding how science advice can better be integrated into the policymaking process for societal benefits. It is imperative to mobilize science, data, and information evidence for knowledge creation and policymaking for the betterment of the quality of life. Profound appreciation goes to the organizers, support and partner organizations, resource persons, and participants for making the programme a reality and for producing this important and beneficial Workshop Report.

ACKNOWLEDGMENT

For funding

This publication is an outcome of the project "**Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for ASEAN Countries**" funded by the Asia- Pacific Network for Global Change Research (APN), under their Capacity Development Programme (CAPaBLE), project reference number: CBA2020-01MY-Verma

For support

The authors would like to thank Dr. Naoya Tsukamoto, Director, Regional Resource Centre for Asia and Pacific (RRC.AP) for his support and encouragement in the implementation of project activities which include organizing the capacity development workshop. Acknowledgment is also to RRC.AP colleagues who had contributed to the success of the workshop, namely, Mr. Bayasgalan Sanduijav and Ms. Sengja Jangmaw for providing IT services and support in the development of the project website; Ms. Charina May Lepiten and Ms. Lakshani Gunawardhana for overall support in the organization of the workshop; Mr. Ric Dennis Canullas for the layout design of the report; and Ms. Nawaphorn Supakarn for providing administrative support to the project.

The authors also appreciate and acknowledge the strong support and valuable contributions from colleagues of the partner organizations, namely, AIT, PCD, ERTC, ITENAS, University of Malaya, and UNEP.

CONTENTS

ANNEXES

EXECUTIVE SUMMARY

Air quality in many Asian countries is deteriorating at an alarming rate due to increasing emissions of air pollutants from rapid urbanization, industries, constructions, traffic, residential cooking, open burning of agricultural residuals and municipal waste, and other activities. Most countries are lacking technical capabilities to manage air quality. Therefore, to build capacities of the Asian countries on air quality management, a capacity building workshop (Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries) was organized by the Regional Resource Centre for Asia and the Pacific and partners during 13-17 September 2021, online. This project has been supported by the Asia-Pacific Network for Global Change Research (APN) under its Capacity Development Programme (CAPaBLE). The participants for this workshop were invited from the member countries of the intergovernmental networks of the Asian region, namely, the ASEAN Agreement on Transboundary Haze Pollution, the Acid Deposition Monitoring Network in East Asia (EANET), the Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia (Malé Declaration), the Asia-Pacific Clean Air Partnership (APCAP), and the APN. An intensive campaign was made on social media to attract a large number of participants from member countries of these networks. As result, a total of 310 participants from more than 30 countries registered for the workshop and about 150-200 participants from 29 countries have participated during the 5-day capacity-building workshop. The participants included policymakers, air quality managers, technical staff, air quality professionals, academicians, young researchers, and students. The workshop was divided into five Modules, namely, (1) Air Quality Monitoring; (2) Emission Inventory Development; (3) Air Quality Modeling; (4) Impact Assessment; and (5) Policy Measures for Air Pollution Mitigation. To cover various aspects of air quality management of the 5 Modules, a total of 18 lectures were delivered by 17 well-known resource persons from India, China, Japan, Hong Kong, Indonesia, Malaysia, Nepal, Philippines, Thailand, United Kingdom, and the United Nations Environment Programme, during the 5-day workshop. At the end of the workshop, a “Certificate of Participation” was issued to participants. Evaluation of the participants was made by providing a set of questions for each topic of the lecture as well as for the whole workshop in order to measure the enhancement of knowledge and understanding of participants on the Modules and the topic of lectures. A total of 159 participants have provided their evaluation feedback. Among 159 participants, 32% were holding Bachelor's degree, while 42% and 26% are Master's and Ph.D. holders, respectively. The majority of participants have rated “5” regarding their knowledge and understanding on all aspects of air quality management (i.e., monitoring, emission inventory, modeling, impact assessment, and mitigation policies) before the workshop, on a given scale of 1-10. Their knowledge and understanding of air quality management were increased to “8” after the workshop. On average, the knowledge and understanding of participants on all aspects of air quality management before the workshop were 5.4±2.1 which increased to 7.9±1.5 after the workshop, with a net

increase of 2.5. The feedback received from participants showed that they had learned a lot from the workshop and were quite satisfied with the contents of the modules and the topic of lectures delivered during the workshop. The order of liking the modules by the participants are as follows: (1) Air Quality Monitoring Module, (2) Air Quality Modeling, (3) Emission Inventory Developments, (4) Impact Assessment, and (5) Mitigation Policy Measures Modules, in descending order. A large attendance of participants from 29 countries could imply that organizing the workshop online was effective and efficient, by having reached a maximum scope with a minimum resources, and can be considered for future events. Also, it provided a way forward for organizing the workshops online in the near future with minimum resources. The online workshop paved the way for interested participants from various backgrounds, such as policymakers, academicians, students, researchers, and technical staff, who may not have the means to attend the workshop in a physical setting. However, for virtual events, it could be difficult to monitor and ensure regular participation on screen. Internet connectivity could also be a big challenge in an online activity. A dedicated website (www.rrcap.ait.ac.th/apn/) was developed for the project where all details of the workshop, including resource materials, were uploaded.

1. BACKGROUND

In many Asian countries, the air quality is deteriorating at an alarming rate due to increasing emissions of air pollutants from rapid urbanization, industries, constructions, traffic, residential cooking, open burning of agricultural residuals and municipal waste, and other activities. The World Health Organization (WHO) estimated that over 90% of the population globally is getting exposed to higher levels of air pollution that results in premature deaths of over 7 million people every year. Premature deaths are mostly occurring in developing countries including Asian countries. In fact, many Asian cities are among the list of the most polluted cities in the world. The countries in Asia are mostly lagging behind the timeframe of achieving the Sustainable Development Goals (SDGs) linked to improving air quality, including the reduction of $PM_{2.5}$ concentration levels to a level of the Interim Target (IT-1) set by the WHO. Increasing air pollution is not only affecting human health and the environment but also causing a large economic burden on the national health budget of the countries and significant losses in agriculture productivity.

Many Asian countries are lacking technical capabilities to monitor key air quality parameters, including particulate matters (PM_{10} and $PM_{2.5}$) and trace gases (CO, NO_x, O_3, SO_2, etc.). Some countries do not have reliable emission inventories, models/tools to assess the impacts, and effective air pollution mitigation policies. The capacity development programme is necessary to enhance the air quality management capabilities of these countries, leading to an effective policy formulation and sound decision-making. These include policies and actions for emission reduction of particulate matters (PM) and gaseous pollutants and measures to address air pollution issues in the countries. The Asian countries need technical capability and policy support for better air quality management to reduce the impacts of air pollution on human health and the environment.

The Asia-Pacific Network for Global Change Research (APN)'s Capacity Development Programme (CAPaBLE) aims to enhance the capacity of scientists, policymakers, and practitioners to assess global change issues. Through the CAPaBLE programme, APN supports the activities that enhance the capacities of the countries.

The APN, under its CAPaBLE programme and priority thematic area of transboundary air pollution and its impact on human health, provided financial support to the Regional Resource Centre for Asia and the Pacific (RRC.AP) of the Asian Institute of Technology for the "**Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for ASEAN Countries**" project for a period of 2 years, commencing from January 2021. Under this capacity development programme, RRC.AP will organize 2 capacity-building trainings of a duration of one week each for the ASEAN member countries. The first workshop was organized from 13-17 September 2021 (online) for policymakers and technical staff working in pollution

control agencies, and the second workshop will be organized in 2022 for young researchers and early-career scientists.

Designed initially for ASEAN member countries and to be conducted in a physical setting, the workshop was organized online due to the COVID-19 pandemic. Since it was a virtual event, the capacity-building programme had expanded its scope and extended the invitations to other countries in the Asian region. This provided opportunities for more countries of Asia to participate in the capacity-building programme and could benefit from it.

2. PARTNER ORGANIZATIONS

The following organizations are the implementing partners of RRC.AP for this Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for ASEAN Countries:

- School of Environment, Resources and Development of the Asian Institute of Technology (AIT), Thailand;
- Pollution Control Department (PCD), Thailand;
- Environmental Research and Training Center (ERTC), Ministry of Natural Resources and Environment, Thailand;
- National Institute of Technology (ITENAS), Indonesia;
- University of Malaya (UM), Malaysia; and
- UNEP Regional Office for Asia and the Pacific (UNEP/ROAP).

3. OBJECTIVES

The capacity development programme was aimed at building the capacities of the Asian countries to better manage air quality and enhance technical capabilities to support their national efforts for addressing air pollution problems in the countries. As a co-benefit, the capacity development programme would also help in creating awareness and reducing transboundary impacts of air pollution in the region.

The major objectives of the capacity development training programme were as follows:

(i) To enhance understanding of air quality monitoring and analysis including satellite data, low-cost sensors, and Continuous Emission Monitoring System (CEMS) and their uses in air quality management;

(ii) To enhance understanding of the development of emission inventories of air pollutants through “bottom-up and top-down” approaches and introduction of an Emission Inventory Tool, which countries could use to develop emission inventories of air pollutants at the national level;

(iii) To enhance understanding of air quality modeling, such as chemical transport models, source apportionment models, and secondary pollutants formation models and their applications in air quality management, as well as transboundary estimation of air pollution; and

(iv) To enhance understanding of impact assessment of air pollution on human health and the environment and how the impact assessment tools/models can be used in air quality management including formulations of effective emission reduction policies.

(v) To enhance understanding of the emission reduction policies, action plans incorporating co-benefits approaches, mitigation scenarios, strengthening emissions standards, etc.,

4. WORKSHOP PARTICIPANTS

The capacity development workshop was initially proposed to be a face-to-face event covering ASEAN member countries. Due to the COVID-19 pandemic, the workshop was held online, which in effect, presented an opportunity to expand the coverage to all Asian countries.

Photo: *Screenshot of participants*

The main focus was to invite participants from the member countries of the existing intergovernmental networks in the Asian region, namely, the ASEAN Agreement on Transboundary Haze Pollution, the Acid Deposition Monitoring Network in East Asia (EANET), the Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia (Malé Declaration), the Asia-Pacific Clean Air Partnership (APCAP), and the Asia-Pacific Network for Global Change Research (APN).

Policymakers, air quality managers and technical staff working with the pollution control and meteorological agencies, and associated government departments were encouraged to register for the training programme. Additionally, air quality professionals working in various developmental sectors, young researchers, and students who wished

to learn and enhance their capability in air quality management were also encouraged to participate. The invitation was sent to secretariats and national focal points of the intergovernmental networks. The invitation to the workshop was also advertised on various social media (i.e., Facebook, LinkedIn, Instagram, etc.) and other web platforms to attract more participants from the countries.

As a result of an extensive advertisement, a total of 310 participants from more than 30 countries had registered for the capacity-building workshop. However, about 200 participants from 29 countries of Asia and other parts of the world have actually participated in the capacity-building workshop. Participants included policymakers, air quality managers, and technical staff working in pollution control and meteorological agencies of the countries; air quality professionals from various organizations including international organizations, NGOs, private sectors; and academicians, young researchers, and students affiliated to various academic institutions in Asia.

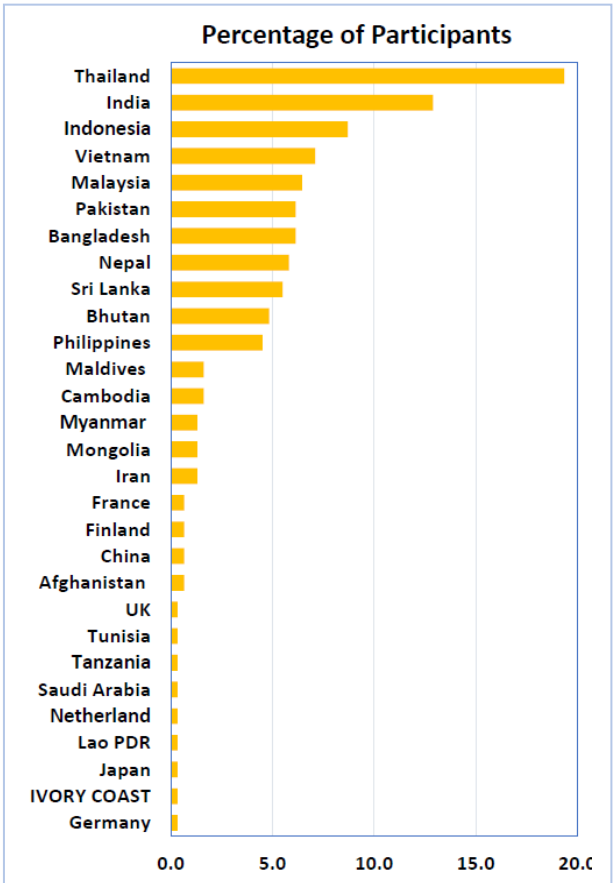


Figure 1: *Percentage of participants from Asian countries and other parts of the world*

As can be seen in Figure 1, the participants from Thailand (about 19%) and India (about 13%) were large in the workshop, followed by Indonesia (about 9%), Vietnam (about 7%), Malaysia (about 6.5), and Pakistan, Bangladesh, and Nepal (each about 6%) and other Asian countries. Some participants from Europe, Central Asia, and African countries also participated in the workshop.

On the first day of the training workshop, more than 200 participants had participated, while during the rest of the four days of the training workshop, there were about 150-200 participants each day.

Figure 2 shows that the young researchers and students were among the largest groups who had participated in the training workshop, representing 43% of the total participants; followed by policy-makers, air quality managers, and technical staff (about 30%) who deals with air quality management in their countries; and then academicians (about 16%) including faculty members who are involved in teaching and research at academic institutions; and about 12% were air quality professionals working with private sectors, international organizations, UN organizations, NGOs and other developmental sectors.

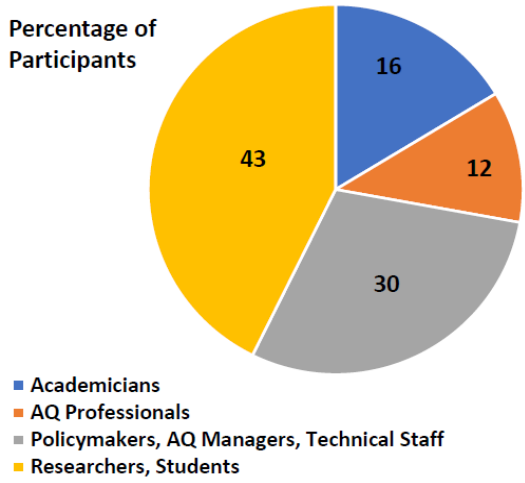


Figure 2: *Percentage of participants from various categories.*

The participation of large numbers of young researchers and students indicated that the interest in learning about air quality management has been increasing among the young researchers and students. Eventually, they are intending toward making their career in the field of environment, particularly, in air quality management which is a good indicator for the countries.

5. WORKSHOP

5.1 Agenda

The capacity-building workshop [**Capacity Development Program on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries**] was organized from 13-17 September 2021, on an online platform. Annex 1 illustrates the agenda of the workshop. The programme was divided into five Modules, namely, Air Quality Monitoring, Emission Inventory Development, Air Quality Modeling, Impact Assessment, and Policy Measures for Air Pollution Mitigation. The workshop covered one module per day, with various presentations from well-known resource persons from India, China, Japan, Hong Kong, Indonesia, Malaysia, Nepal, Philippines, Thailand, United Kingdom (UK), and the United Nations Environment Programme (UNEP). Annex 2 showed a promotional poster of the workshop. The poster included the workshop programme agenda with photos of the resource persons and a brief overview of their presentations. It also included photos of other speakers who delivered remarks during the opening session of the workshop. Annex 3 provides a short introduction of the resource persons. A “Certificate of Appreciation” was given to each resource person after the workshop.

A dedicated website (www.rrcap.ait.ac.th/apn/) was developed which included all details of the workshop.

5.2 Workshop Modules and Proceedings

The workshop started with the Welcome Remarks by Dr. Naoya Tsukamoto, Director, Regional Resource Centre for Asia and the Pacific – Asian Institute of Technology (AIT RRC.AP), Thailand; followed by the Opening Remarks of Dr. Monthip Sriratana Tabucanon, Senior Adviser to the National Research Council of Thailand, Former Director of ERTC, and Former Deputy Permanent Secretary at the Ministry of Natural Resources and Environment, Thailand; and Mr. Yoichi Toyama, Director, Asia-Pacific Network for Global Change Research (APN) Secretariat, Japan. Prof. Mario Tabucanon, Senior Advisor, AIT RRC.AP, also delivered the Remarks.

Dr. Naoya Tsukamoto, in his welcome remarks, mentioned that air pollution continues to be a serious global concern and challenge. It is taking a heavy toll on health and the quality of life. It has impacted the Asian region the most, with many Asian countries identified as among the topmost polluted cities in the world. The Air Quality Life Index revealed that the change in the life expectancy of people due to the impacts of air pollution is more in the Asian and African countries where the level of air pollution is high. He stressed that there is an urgency to address air pollution issues. More enhanced, collective, and collaborative efforts and actions among all sectors and stakeholders are necessary to improve air quality. He happily informed that over 200 participants are participating in this capacity-building workshop which was a good sign that more and more people are now interested and encouraged to contribute to the solutions of the persistent problem of air pollution.

Dr. Monthip Sriratana Tabucanon, in her opening remarks, mentioned that air pollution has become a serious transboundary environmental and health problem globally and air quality and emission reduction of particulate matters, $PM_{2.5}$ are pressing common concerns of countries to protect the health of people and the planet. The transdisciplinary approach to tackling the science and policy issues in terms of monitoring, developing emission inventories, modeling flows, impact assessment, and policies for mitigation are responsive to building capacities and competencies of researchers and policymakers. She affirmed that the knowledge gained in the programme would benefit participating organizations and society.

Mr. Yoichi Toyama, in his opening remarks, mentioned that rapid economic growth in the ASEAN region faces serious environmental problems, especially air pollution, which is compounded by the increase in traffic in several megacities such as Bangkok, Jakarta, Hanoi, etc. He informed that the APN awarded a grant to RRC.AP, for a capacity-building project under its Capacity Development Programme (CAPaBLE), which responded to the high priority needs of APN, specifically, the priorities of the APN Southeast Asia Subregional Committee (SEA-SRC). Mr. Toyama acknowledged the representation of organizations or networks including the ASEAN Agreement on Transboundary Haze

Pollution, the EANET, the Malé Declaration, and the APCAP. A large number of participants underscores the importance of building capacities of the Asian countries on air quality management and emission reduction strategies. He stated that APN is pleased to support this workshop and had seen its contribution to the efforts of air quality monitoring and management in the region.

Prof. Mario Tabucanon, in his remarks, mentioned that the capacity development programme on air quality management and emission reduction of $PM_{2.5}$ for Asian countries should be viewed in a broader context through the lens of the interplay of science, policy, and society. He further said that the capacity development programme responded to the call for strengthening the science-policy-society interface on air quality management, as well as for the identification of the underlying issues through the well-defined programme modules. The air quality monitoring, emission inventory, and modeling are in the domain of science; the impact assessment on health not only benefits the people but also the ecosystems, which are societal concerns; and the mitigation issues, which are policy considerations. He stated that it is imperative to mobilize science, data, and information evidence for knowledge creation and policymaking for the betterment of the quality of life.

All speakers emphasized the need for capacity building among Asian countries on air quality management and emission reduction strategies for solving air pollution problems in the countries. They hoped that the workshop would build significant capacities of the participants on air quality management and emission reduction of air pollution.

MODULE 1: AIR QUALITY MONITORING (DAY 1)

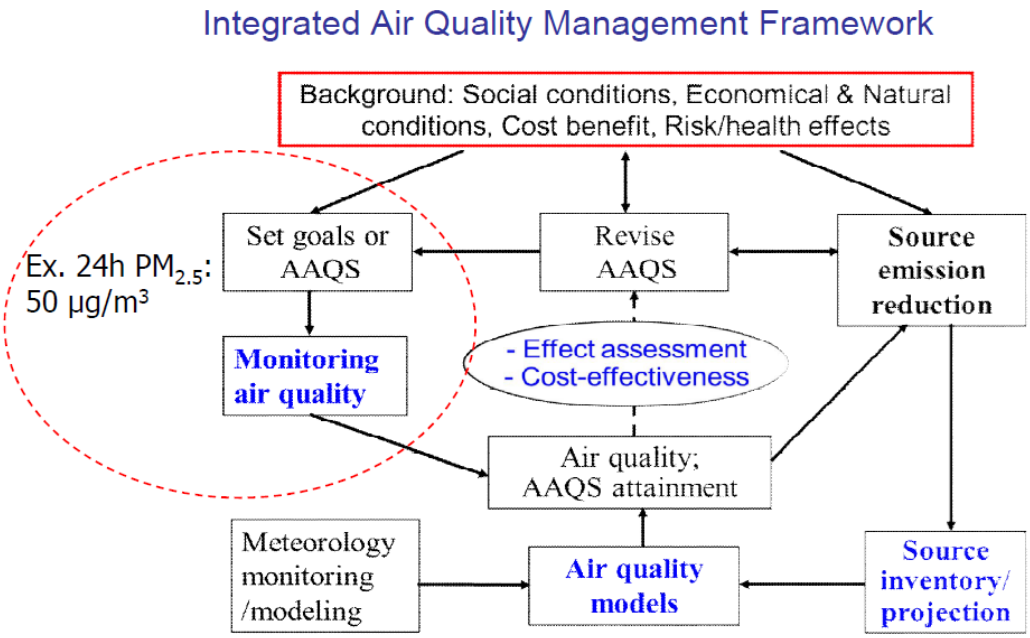
The Air Quality Monitoring Module covered the details of air quality monitoring and analysis including monitoring methods, instruments, calibrations, etc. This module also covered air quality monitoring by satellites, low-cost sensors, and the Continuous Emission Monitoring System (CEMS). There were 4 presentations to cover the scope of the Air Quality Monitoring Module. The presentations along with the video of the session had been uploaded to the Resource Materials section of the website (http://www.rrcap.ait.ac.th/apn/Pages/Resource-Materials.aspx). The summaries of each presentation of the Air Quality Monitoring Module are given below:

P-01: Overview of air quality management and air quality monitoring programmes

Expert: Prof. Kim Oanh, Asian Institute of Technology, Bangkok, Thailand

Prof. Kim Oanh's presentation was focused on integrated air quality management, the roles of air quality monitoring in air quality management, the status of air quality monitoring in Asia countries, and designing the ambient air quality monitoring programme. She mentioned that emissions of air pollutants from natural and anthropogenic sources caused detrimental impacts on human health, climate, and agriculture production. Air pollution is causing about 6.67 million deaths annually in the

world, mostly in the Asia-Pacific countries wherein about 92% of the population is getting exposed to a higher level of air pollution.



Air quality management requires systematic and reliable information on the status and trend of pollution. Air quality programmes may include ambient air monitoring, source emission monitoring: mobile vs. stationary, personal exposure monitoring, and indoor air quality. In the world, only 49% of countries produce air quality data in some capacities. In the Asia-Pacific region, 26 out of 41 countries have official air quality monitoring stations and about 30 countries have real-time data.

P-02: Low-cost sensor-based air quality monitoring networks

Expert: Prof. S. N. Tripathi, Indian Institute of Technology, Kanpur, India

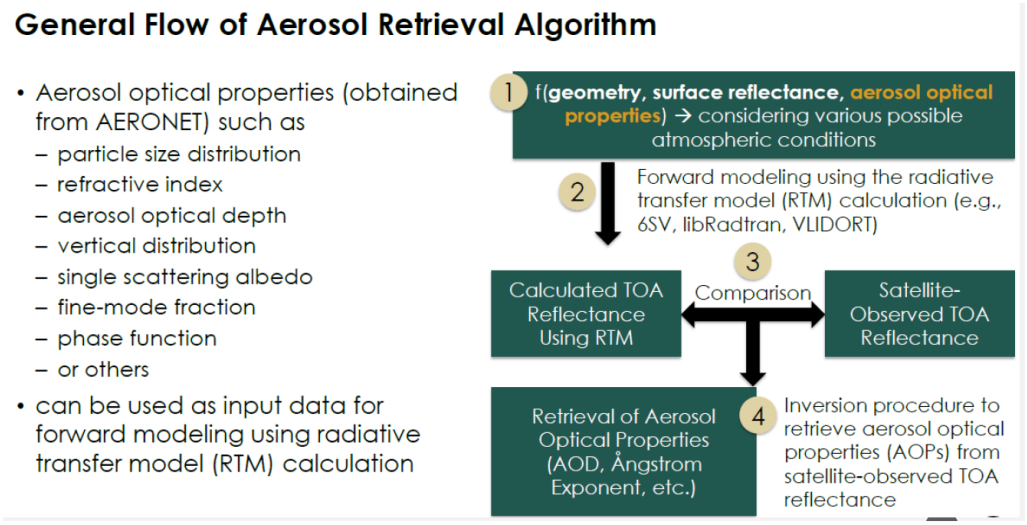
Prof. Tripathi highlighted the opportunities with Low-Cost Sensor (LCS) technologies available for air quality monitoring solutions including the cost of sensors and societal and citizen applications. He mentioned that the market of LCS is growing significantly and may reach up to 2.5 billion, 1.7 billion, 6.5 billion for PM2.5 sensors, gas sensors, and end-to-end monitoring solutions, respectively, by 2025. China and India are expecting to dominate the LCS market in Asia. Prof. Tripathi is extensively working on air quality monitoring using the LCS. The following figure shows a network of LCS of his study.

His recent work showed that the air quality data measured by the LCS has a good agreement with the AQ data measured by traditional instruments and those simulated using the air quality models. Prof. Tripathi concluded that the scientific validity (R2) of LCS technology is in the acceptable range and can be used in the evaluation and assessing the effectiveness of clean air programmes and action plans. LCS is reliable and cheaper for air profiling of cities, identification of hotspots, prioritization of activities, and mitigation measures. Detail description of LCS-related air quality is given in the PPTs uploaded to the workshop website.

P-03: Air quality monitoring using satellite remote sensing

Expert: Prof. Muhammad Bilal, Nanjing University of Information Science and Technology (NUIST), Nanjing, China

The outline of Prof. Bilal's presentation included satellite remote sensing products, MODIS aerosol products (Dark Target and Deep Blue), visualization and spatial mapping of MODIS aerosol products (NASA World View and GIOVANNI), MODIS Data Processing (MCTK), validation of MODIS aerosol products, simplified merge scheme (SMS), and simplified aerosol retrieval algorithm (SARA). He mentioned that there are multiple remote sensing instruments in the space which provide regular observations of nitrogen dioxide (NO2), sulfur dioxide (SO2), formaldehyde (HCHO), carbon monoxide (CO), ammonia (NH3), and ozone (O3). The following figure shows a general flowchart for aerosol retrieval algorithm:



Particulate matters can be estimated using satellite aerosol optical depth (AOD). AOD is a measure of absorption and/or scattering of light by aerosol particles in the atmosphere. It is available from multiple remote sensing sensors (e.g., MODIS, VIIRS, MISR, etc.) with 10 km spatial resolutions. Prof. Bilal mentioned that satellite data can be viewed and downloaded from the NASA websites: https://worldview.earthdata.nasa.gov/ (worldview) and https://giovanni.gsfc.nasa.gov/giovanni (spatial maps). He also showed a step-by-step procedure to plot the spatial maps and download the data. Details of air quality monitoring using satellite remote sensing are given in the PPTs uploaded to the workshop website.

P-04: Continuous Emission Monitoring System (CEMS)

Expert: Dr. Sirakarn Leungsakul, Department of Industrial Works, Ministry of Industry, Thailand

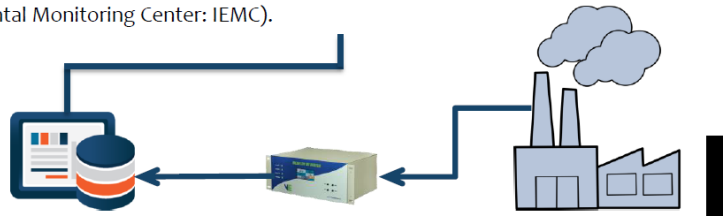
Dr. Sirakarn's presentation on CEMS included a history of CEMS implementation in Thailand, requirements for CEMS, and the process for CEMS implementation. She mentioned that CEMS required a sampling system, analyzer, and data acquisition, as shown in below flowchart:

CEMS components consist of

1. Sampling system
2. Analyzer
3. Data acquisition

Factories located inside the Industrial Estate Area shall submit emission monitoring data to IEAT Data Center (Environmental Monitoring & Control Center: EMCC).

Factories located outside the Industrial Estate Area shall submit emission monitoring data to DIW Data Center (Industrial Environmental Monitoring Center: IEMC).



Industries located inside the industrial area need to submit emission monitoring data to the Environmental Monitoring & Control Center (EMCC) data center. While industries located outside the industrial area need to submit emission monitoring data to the Industrial Environmental Monitoring Center (IEMC) data center. CEMS compliance includes IEAT requirement, EIA and factory permit condition, and voluntary monitoring. The benefits of CEMS are self-monitoring for process optimization and early warning, better compliance, reducing pressure from the community utilizing information disclosure, gaining trust from the community, and increasing communication effectiveness.

MODULE 2: EMISSION INVENTORY DEVELOPMENT (DAY 2)

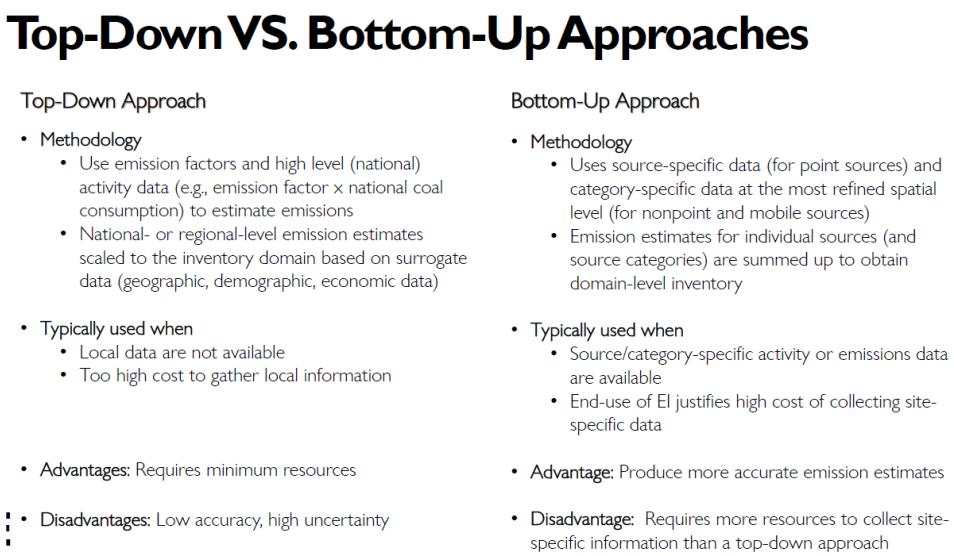
The Emission Inventory Development Module covered the development of inventories of air pollutants through "bottom-up and top-down" approaches. The Emission Inventory Tool was introduced which countries could use for the compilation of emissions of air pollutants. There were 3 presentations to cover the scope of the Emission Inventory Development Module. The presentations along with a video of the session have been uploaded in the Resource Materials section of the website (http://www.rrcap.ait.ac.th/apn/Pages/Resource-Materials.aspx). The summaries of each presentation of the Emission Inventory Development Module are given below:

P-05: Overview of emission inventory development process and emission factors

Expert: Dr. Ekbordin Winijkul, Asian Institute of Technology (AIT), Thailand

Dr. Winijkul defined emission inventory as a comprehensive listing of the emission sources of air pollutants in a geographic area during a specific period. The purpose of emission inventory is to obtain systematic information on the category and distribution of sources, amounts, and types of pollutants to identify major sources, cost-effective control strategies, permitting emissions fees, tracking emissions, modeling, design

monitoring program, and public awareness. In developing countries, about 60-80% of air pollutants are emitted from mobile sources and other sources including cooking emissions, open burning, and industries. Two approaches are adopted in developing an emission inventory, namely, bottom-up and top-down, illustrated as follow:

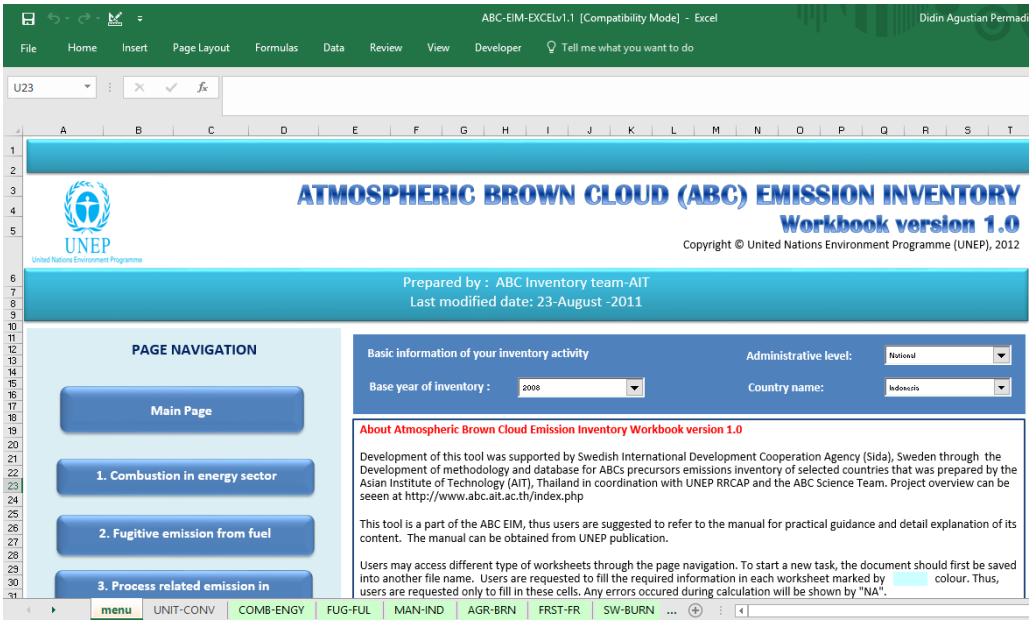


The presentation and video of the session had been uploaded to the workshop website.

P-06: Emission Inventory Tools

Expert: Dr. Didin Agustian Permadi, National Institute of Technology (ITENAS), Bandung, Indonesia

The outline of Dr. Parmadi's presentation included emission inventory basics and processes, emission inventory tools, emission inventory models, and uncertainty analysis. There are several tools are available for the development of emission inventories. Among them, the following tool is prominently used in the development of emission inventories.

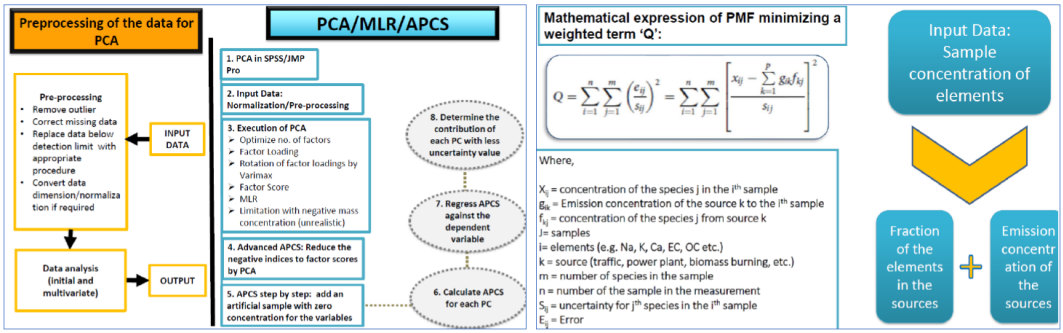


It is an excel-based tool developed in the Atmospheric Brown Cloud (ABC) project. More descriptions about the tools and examples of emission inventories are given in the PPTs uploaded to the workshop website.

P-07: Source apportionment of emissions of air pollutants

Expert: Dr. Md Firoz Khan, University of Malaya, Kuala Lumpur, Malaysia

Dr. Khan introduced chemometrics and its application in air quality management. Chemometrics is a combination of air quality monitoring, chemical analysis, pattern recognition, and source identification. Application of chemometrics includes measurements from the chemical system, real-time decision making, information extraction, calibration and validation, modeling and prediction, classification, and visualization. For source apportionment, 2 receptor models are normally used, namely, PCA/Absolute Principle component Score (APCS) and Positive Matrix Factorization (PMF). A framework of both models are given below:



The PPTs with details of source apportionment models are on the workshop website.

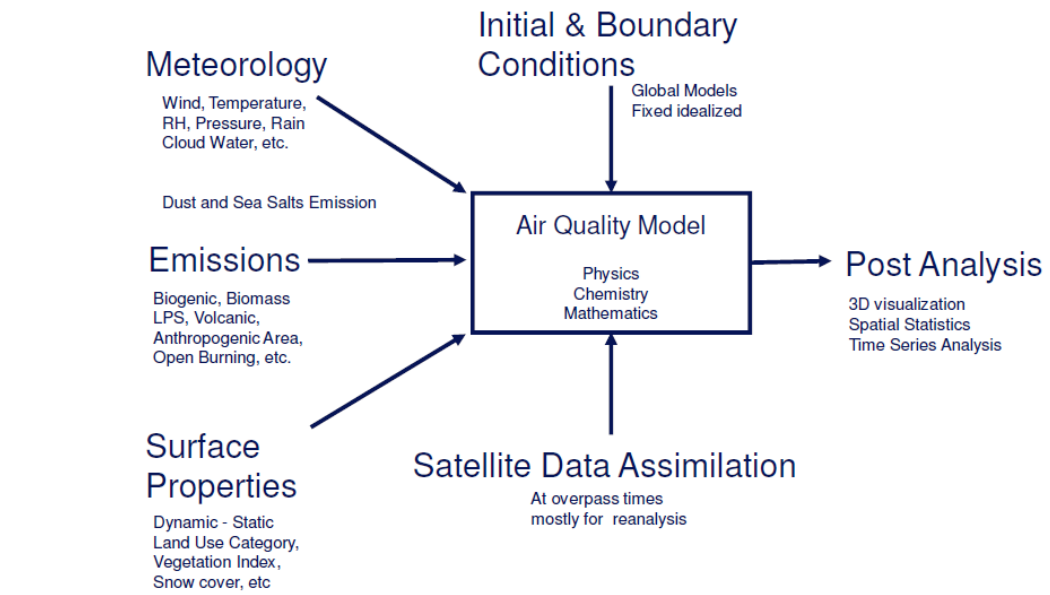
MODULE 3: AIR QUALITY MODELING (DAY 3)

The Air Quality Modeling Module covered the details of air quality modeling including basic information of Chemical Transport Models (CTMs), Source Apportionment Models (such as PMF CMB), and secondary pollutants formation models and applications of these models in air quality management. There were 3 presentations to cover the scope of the Air Quality Modeling Module. The presentations along with a video of the session had been uploaded to the Resource Materials section of the website (http://www.rrcap.ait.ac.th/apn/Pages/Resource-Materials.aspx). The summaries of each presentation of the Air Quality Modeling Module are given below:

P-08: Overview of air quality modeling

Expert: Dr. Bhupesh Adhikary, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

Dr. Adhikary presented nomenclature of models used in atmospheric chemistry, namely, chemistry-climate models (CCM), chemistry general circulation models (chemistry GCM), and chemical transport models (CTM). The air quality models, such as CTM simulate the behavior of pollutants in the real world considering the complexities including physics, chemistry, geography, meteorology, and emissions. Air quality models help to understand the roles of different meteorological/chemical drivers influencing observed pollutant behavior, provide a link between emission sources and observation, study past/present/future scenarios, and provide support in decision-making. Following is the data flow chart of CTM:

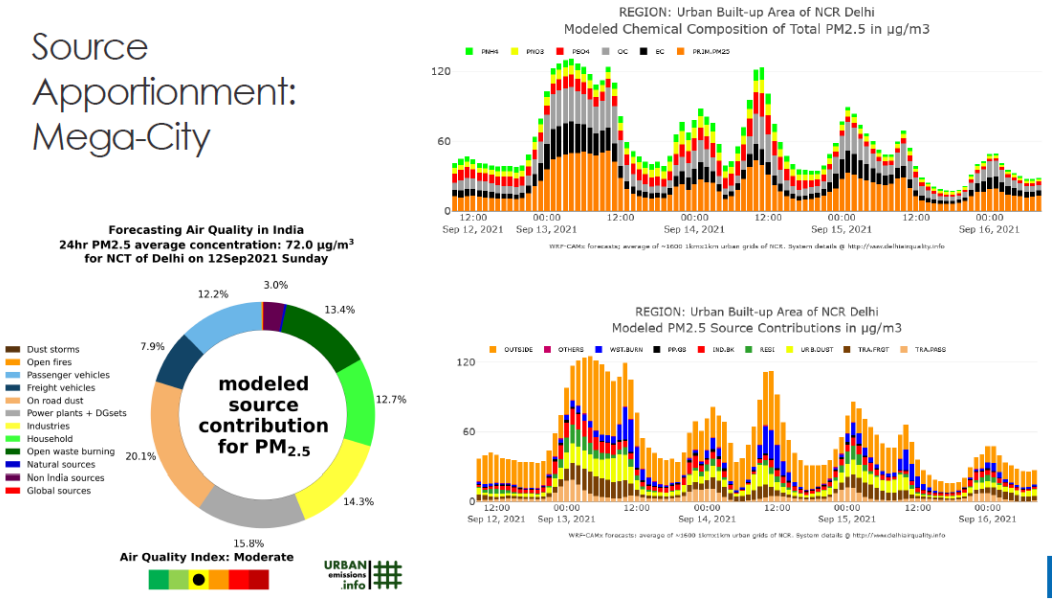


PPTs of the presentation which includes details of air quality modeling are uploaded on the workshop website.

P-09: Applications of chemical transport and photo chemical models in air quality management

Expert: Dr. Bhupesh Adhikary, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

Dr. Adhikary presented the applications of chemical transport and photo chemical models in air quality management. The applications of chemical transport models (CTM) include temporal, horizontal, and vertical distribution of air pollutants; mixing and transport (sectoral and regional) of air pollutants; deriving concentration of air pollutants combining model simulations with observations (e.g., deriving PM2.5 concentrations using satellite AOD and observations); improving emission inventories (inverse modeling); source apportionment; air pollution forecasting; impact assessment; and decision-making support. An example of air quality modeling for source apportionment is given below:

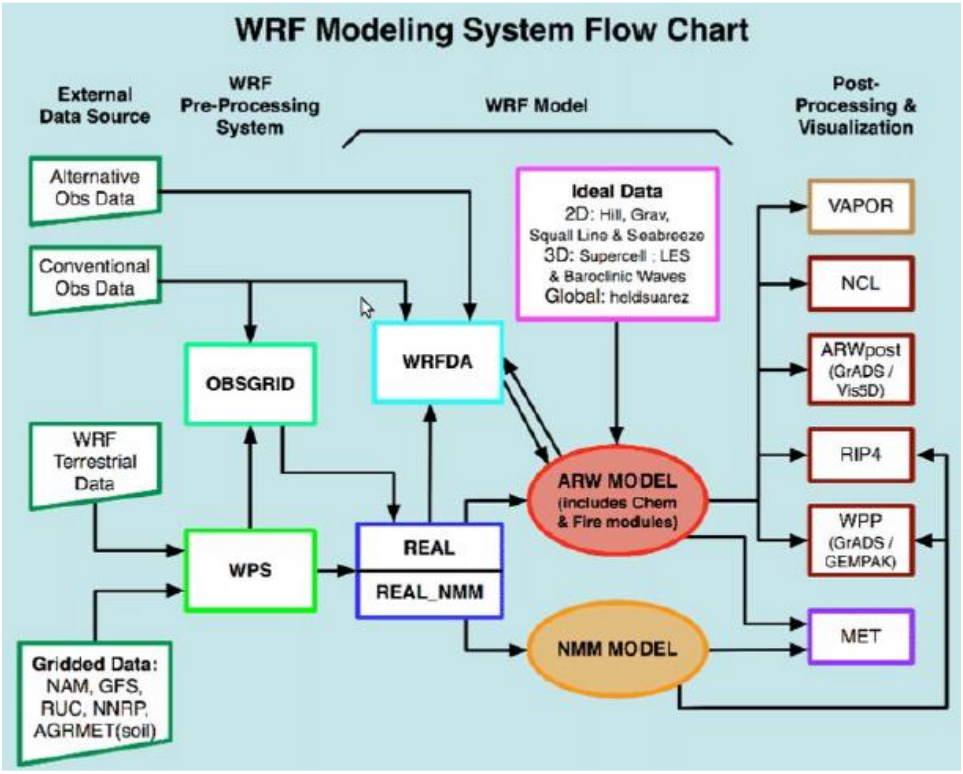


Detailed examples of each application are given in the PPTs uploaded to the workshop website.

P-10: Comprehensive concept of PM2.5 forecast: a case study in Thailand

Expert: Dr. Sakda Tridech, Pollution Control Department (PCD), Bangkok, Thailand

The contents of Dr. Tridech's presentation included the basics of air quality models, PM2.5 Problem in Thailand, Chemical Transport Model, requirement for WRF-chem, model configuration and input data, product example, and preliminary evaluation. Three kinds of models are used in air quality management, namely, dispersion models (to simulate concentration of a pollutant at specified ground level), photochemical models (to simulate chemical reactive pollutant over large spatial scale), and receptor models (to quantify source contributions to receptor concentrations). Following is the flowchart of the WRF modeling system:



Forecasting of air pollution needed high-performance computing system. Detailed scheme and setup used for forecasting of air pollution, including an example of forecasting in Thailand, is given in the PPTs uploaded to the workshop website.

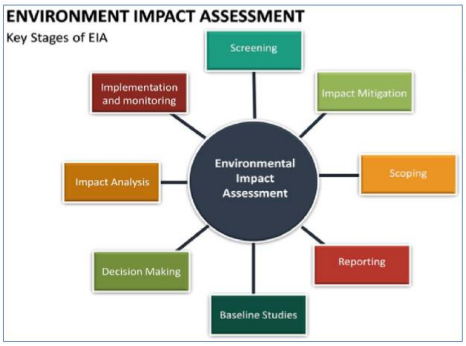
MODULE 4: IMPACT ASSESSMENT (DAY 4)

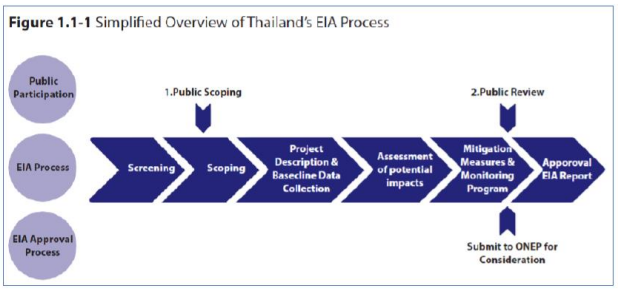
The Impact Assessment Module covered the concepts of impact assessment of air pollution on human health and the environment including models/tools used for impact assessment of air pollution on health and the environment. The focus was made on how the impact assessment tools/models can be used in air quality management including formulations of effective emission reduction policies and co-benefits of air pollution reduction. There were 3 presentations to cover the scope of the Impact Assessment Module. The presentations and a video of the session had been uploaded to the Resource Materials section of the website (http://www.rrcap.ait.ac.th/apn/Pages/Resource-Materials.aspx). The summaries of each presentation of the Impact Assessment Module are given below:

P-11: Overview of air pollution impact assessment

Expert: Dr. Patcharawadee Suwannathada, Pollution Control Department, Bangkok, Thailand

Dr. Suwannathada presented an overview of the air pollution impact assessment; the environmental impact assessment (EIA) in ASEAN countries, with an example of the EIA in Thailand; and the general concept of air quality impact assessment which included air quality monitoring, source estimation, and air quality modeling. EIA is a process of examining the anticipated direct and indirect environmental impacts of a proposed project or activity in order to determine appropriate mitigation measures and monitoring programs. It considers environmental, social, and health impacts before the project. Air pollution impact assessment is a part of EIA which can be used for strategic environmental assessment and planning. The following figures present the stages and the flow chart of the EIA process:





Details of air quality impact assessments and examples of air quality impact assessments from Thailand are given in the PPTs uploaded to the workshop website.

P-12: Impact assessment of air pollution on health

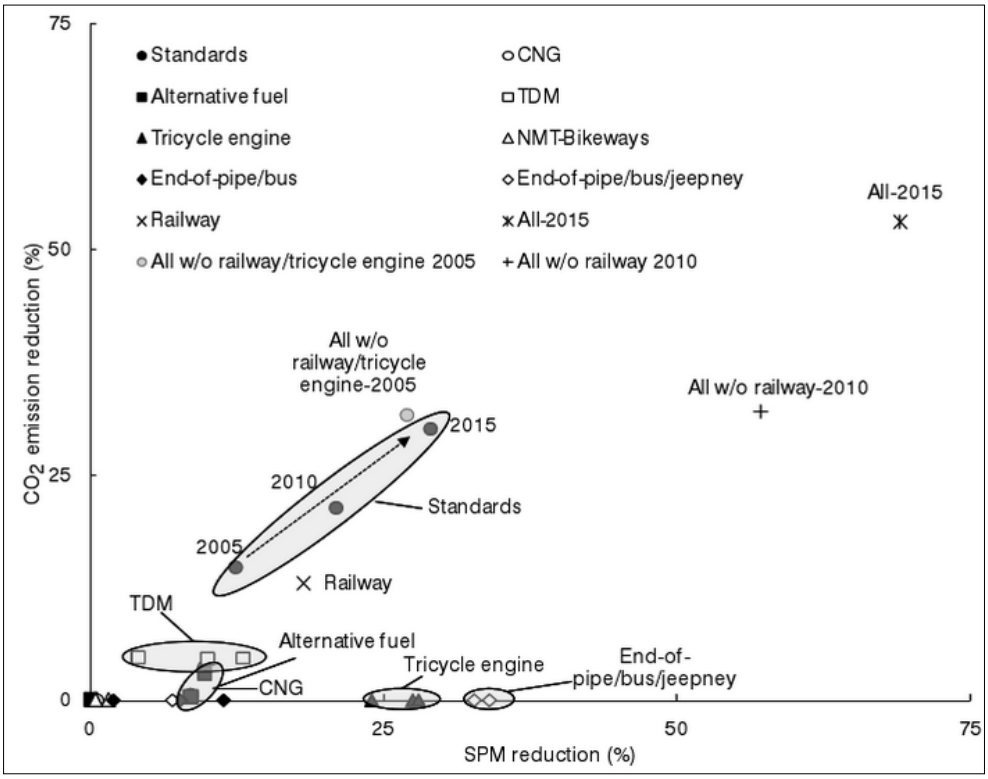
Expert: Prof. Tze Wai Wong, The Chinese University of Hong Kong

Prof. Wong's presentation included the background of impact assessment of air pollution on health, the definition of health impact assessment (HIA), HIA and public policies, models used for HIA, HIA process, the health risk of air pollution, the burden of diseases due to outdoor air pollution, the impact of outdoor air pollution on health, health risks estimates and unit health risks associated with air pollution, health outcomes associated with short-term exposure, mortality associated with short-term exposure to air pollution, morbidities associated with short-term exposure to air pollution, unit health risks, economic impact assessment of air pollution, productivity loss from premature mortality, cost of illness estimate, and total economic impact. Details of each topic of the presentation of Prof. Wong are given in the PPTs uploaded to the workshop website.

P-13: The Co-benefits from Integrated Air Pollution and Climate Change Planning: Concepts, Solutions, and Governance

Expert: Dr. Eric Zusman, Institute for Global Environmental Strategies (IGES), Japan

Dr. Zusman presented the concepts, solutions, and governance for co-benefits from integrating air pollution and climate change planning. Climate change and air pollution are closely related. Impacts of climate change are severe in coastal countries, such as Bangladesh. The number of Disability-Adjusted Life Year (DALYs) from air pollution is high in Asian countries, namely, India, China, Mongolia, Indonesia, and many other countries. The following figure illustrates the areas to focus for co-benefits in reducing CO2 and suspended particulate matters (SPM):



For the near-term response to mitigation of climate change, emission reduction of short-lived climate pollutants (SLCP) must be focussed. Current policies will avoid further large-scale deterioration but not achieve air quality standards. Full implementation, coupled with 80% expected economic growth forecast could result in no further increase in air pollution while lifting tens of millions out of poverty. But 4 billion will remain exposed to health-damaging levels of air pollution. So, there is a need for more ambition to reduce health impacts in the next decades. Details of co-benefits approaches and related data are given in the PPTs uploaded to the workshop website.

MODULE 5: POLICY MEASURES FOR AIR POLLUTION MITIGATION (DAY 5)

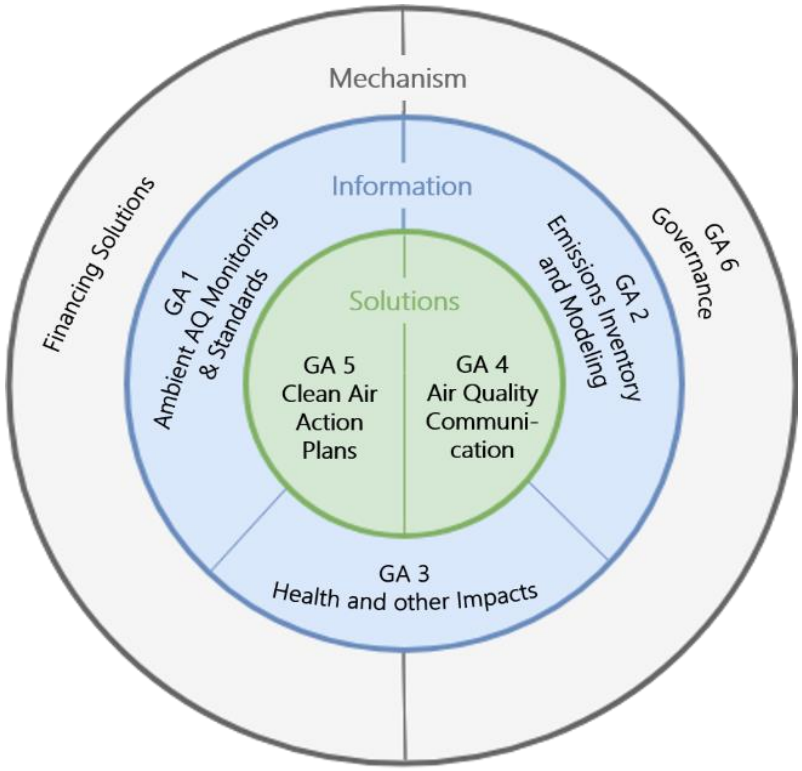
The Policy Measures for Air Pollution Mitigation Module covered air pollution emission reduction policies, action plans incorporating mitigation scenarios, strengthening emissions standards, etc. This module provided perspectives on air pollution mitigation

strategies and actions in Asia, air pollution and climate change linkages, models/tools for emission mitigation scenarios, and science-based solutions for emission reduction. An example of a national mitigation program was also presented. There were 5 presentations to cover the scope of Policy Measures for Air Pollution Mitigation Module. The presentations and video of the session had been uploaded to the Resource Materials section of the website (http://www.rrcap.ait.ac.th/apn/Pages/Resource-Materials.aspx). Summaries of each presentation of Policy Measures for Air Pollution Mitigation Module are given below:

P-14: Perspectives on air pollution mitigation strategies and actions in Asia

Expert: Ms. Glynda Bathan Baterina, Clean Air Asia, Manila, Philippines

Ms. Baterina in her presentation on perspectives on air pollution mitigation strategies and actions in Asia introduced the work that Clean Air Asia is doing which included Guidance Framework for Better Air Quality in Asian Cities, IBAQ Learning Portal, and City Solutions Toolkit, and Clean Air Action Planning for Sustainable Air Quality Improvements in India, China, Indonesia, Mongolia, Philippines, and Viet Nam. Given below is a guidance framework for air quality management:

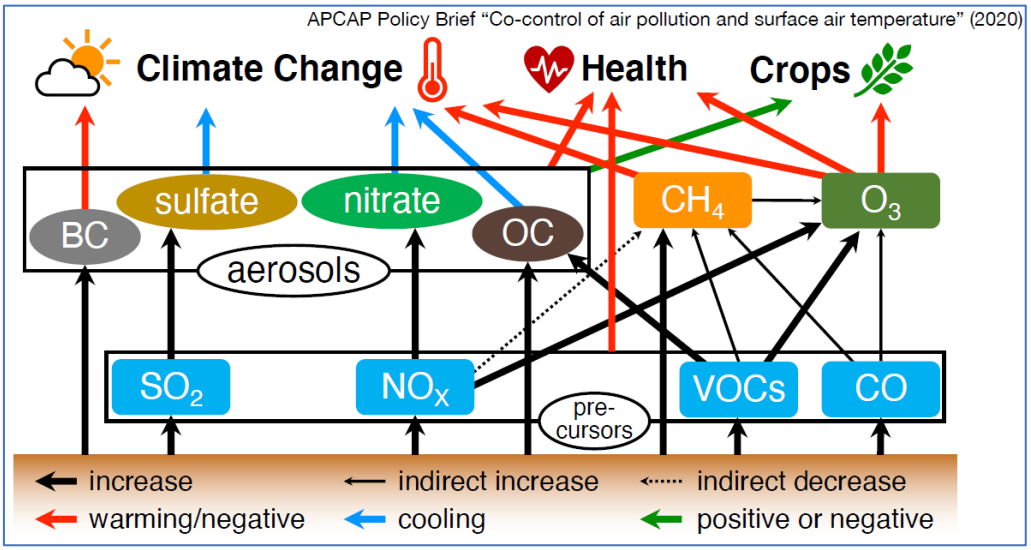


This framework is guided from developing the knowledge base (pollution level, pollution sources, impacts, etc.) to the solution (policies and frameworks, clean air action plans and measures) and institutionalized clean air action plans and actions. Good practices in clean air action planning include drawing inputs from assessment of air pollution sources and emissions, ambient air pollution levels, air quality goals, information on source apportionment and exposure assessment; evaluating source mitigation and control options for their efficacy, technical feasibility, and ease of implementation; sets targets and timelines for action; discussion with major stakeholders, and delineates roles and responsibilities; addresses implementation issues such as institutional arrangements and partnerships, infrastructure, and financial resources; considers future activity growth and projected air pollution scenarios; define monitoring and evaluation mechanism, and provides opportunities for mid-term corrections. Details of policies, actions, measures undertaken by different countries are given in the PPTs uploaded to the workshop website.

P-15: Air pollution and climate change linkages

Expert: Prof. Toshihiko Takemura, Kyushu University, Fukuoka, Japan

Prof. Takemura explained that the change in energy budget in the atmosphere is the main cause of climate change. GHGs absorb infrared radiation from the ground, sea surface, and atmosphere, and re-emit infrared radiation isotropically. Increasing levels of GHGs in the atmosphere result in an increase in the temperature of the earth's surface. Aerosols present in the atmosphere also change the energy budget of the earth's surface through scattering and absorption of radiation. Global aerosol climate model MIROC-SPRINTARS used to study climate effects of aerosols including aerosol-radiation interaction (scattering and absorption of radiation) and aerosol-cloud interaction (cloud particle size and lifetime through acting CCN). Short-lived climate forcers (SLCFs), such as aerosols and trace gases established linkages between air pollution and climate change. The following figure shows a comprehensive relationship among SLCFs and their precursors:

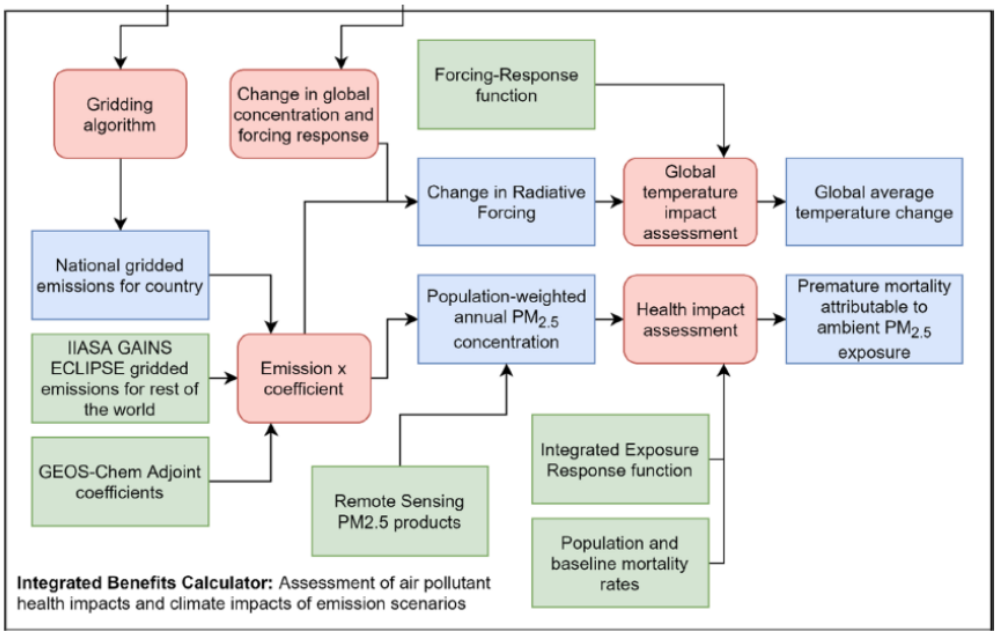


Further details on air pollution and climate change linkages including the role of SLCFs or SLCPs is given in the PPTs uploaded to the workshop website.

P-16: The Long-range Energy Alternatives Planning -Integrated Benefits Calculator (LEAP-IBC)

Expert: Dr. Johan C.I. Kuylenstierna, Stockholm Environment Institute (SEI), UK

Dr. Kuylenstierna in his presentation mentioned that there is a strong linkage between air quality, SLCP, and climate planning. The same emission source emits GHGs which have long-term warming and climate change, SLCPs have near-term warming and climate change, while aerosols and trace gases have adverse impacts on health and agriculture productivity. So reducing emissions of GHGs or SLCPs from the same source would help in reducing climate change and air pollution-related impacts. It is estimated that by reducing CO2 emissions to achieve the Paris Agreement target, over one million premature deaths may be avoided by 2050. There is a need for enhancing capacity to undertake integrated national planning by supporting national planning, strengthening institutions, and providing training and planning tools. SEI is working with countries in SNAP using LEAP-IBC for integrated air quality and climate planning through developing emissions scenarios for helping in the planning process. LEAP, created by SEI, is a software system for quantitative modeling of energy systems, pollutant & GHG emissions from energy and non-energy sources and empower the developing countries to perform their own analyses well-suited to long and medium-term national planning. Following is a data flowchart for the LEAP-IBC:



It provides quantitative assessments from emissions, regional transport, exposure, and impacts on climate, health and agriculture. Details of LEAP-IBC is given in the PPTs uploaded to the workshop website and the LEAP website: https://leap.sei.org/

P-17: Clean air measures for the Asia-Pacific region

Expert: Ms. Maria Katherina Patdu, UNEP Asia Pacific Regional Office, Bangkok, Thailand

Ms. Patdu in her presentation mentioned that there is a serious health crisis in the Asia Pacific region due to air pollution. About 4 billion people are exposed to poor air quality and over 4 million premature deaths occurred in the Asia-Pacific region. Air Pollution in Asia and the Pacific: Science-based Solutions report identifies 25 cost-effective policy and technological measures for air pollution mitigation. These 25 measures are classified into 3 clusters, namely, application of conventional measures (vehicles, power plants, and industries), air quality measures that are not yet major components of clean air policies (burning of agricultural and municipal solid waste and proper management of livestock manure), and measures which contribute to development priorities with air quality benefits (promoting use of electric vehicles, using renewable energy for electricity generation). However, there are many gaps to be filled and a lot more to do. For example, one in three countries lack any legally mandated standards for outdoor air quality, at least 31 percent of countries with powers to introduce standards have not used them, many countries and cities continue to struggle to establish and maintain a sustainable air quality monitoring network, and 60% of countries, accounting for 1.3 billion people or 18% of the global population have no routine, annual ground-based monitoring of PM2.5 at all. Further details on clean air measures for the Asia-Pacific

region including examples of policies implementations in the countries are given in the PPTs uploaded to the workshop website.

P-18: National Clean Air Programme (NCAP) of India

Expert: Mr. Sundeep, Ministry of Environment, Forest and Climate Change, Government of India, New Delhi, India

Mr. Sundeep presented the NCAP of India. The NCAP was launched in January 2019 with an aim to improve the air quality of 124 Non–Attainment Cities by reducing 20-30% PM levels by 2024 through inter-departmental coordination for convergence of actions and addressing limitation of knowledge at the implementation level. Stages of NCAP implementation includes: stage 1 - identification and recognition of the problem (monitoring & assessment, existing data, documents, coalition, consultation with stakeholders; stage 2 – reduction of emission levels at source (sector level interventions and emission inventories); stage 3 - reduction of air pollution levels (regional level interventions and source apportionment); and stage 4 – reduction of the impact (cost-effectiveness and benefit analysis). Details of implementation strategies for the NCAP are given in the PPTs uploaded to the workshop website.

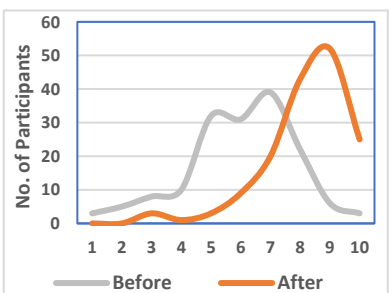
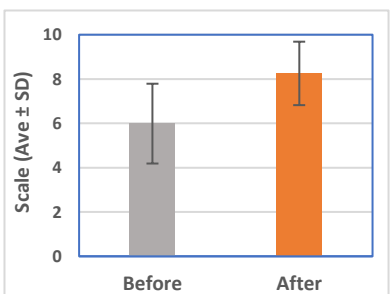
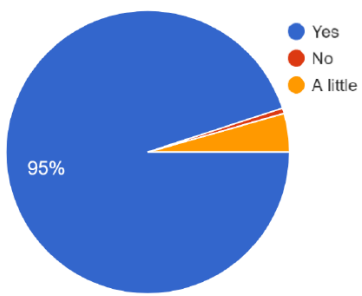
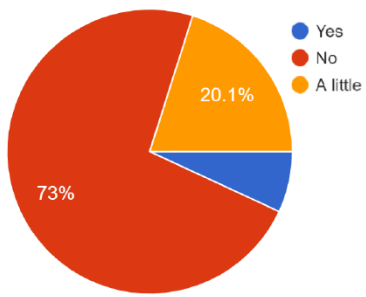
6. WORKSHOP EVALUATION AND CERTIFICATE OF PARTICIPATION

The evaluation of participants was made by providing a set of questions for each topic of presentation and for the whole workshop in order to measure the enhancement of knowledge and understanding on participants on the Modules and the topics of presentations. The evaluation questionnaire is given in Annex 4. A total of 159 participants had provided their feedback. Among the respondents, 32% of participants were holding bachelor's degree, 42% were masters, and 26% were Ph.D. A Certificate of Participation had been issued to those participants who provided the evaluation feedback. The participants were asked to rate the enhancement of their understanding and knowledge on each topic of presentation and on the whole workshop on a scale of 1 to 10. The table below illustrates the evaluation results.

Evaluation results of the participants on their increased understanding and knowledge before and after each lecture and after the whole workshop.

Table 1: Evaluation of each presentation

P-01: Overview of air quality management and air quality monitoring programmes

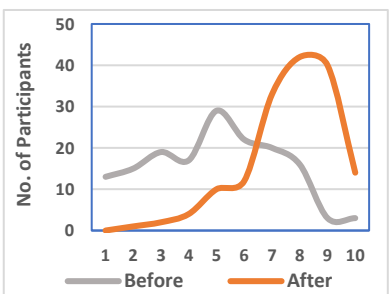
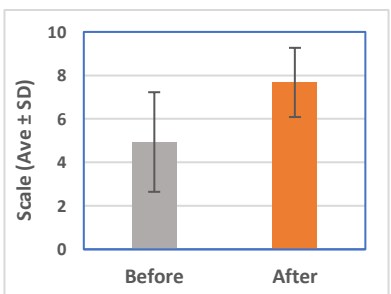
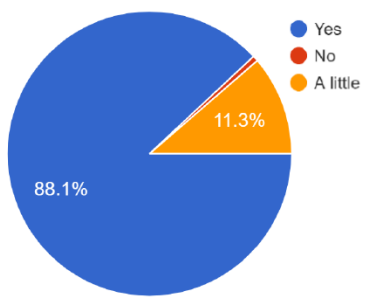
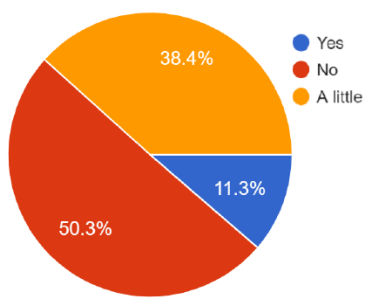
How much of your knowledge and understanding has increased on the ambient air quality monitoring before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

- The majority of participants rated 7 about their knowledge and understanding on the ambient air quality monitoring before the lecture. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding of participants on the ambient air quality monitoring before the lecture was 5.9±1.8 which increased to 8.3±1.4 after the lecture, with a net increase of 2.4.

- About 95% of participants found that the contents of the lecture on the ambient air quality monitoring were as per their expectations and they have learned new information which will be useful in their work or study. However, few participants found that the contents of the lecture were insufficient as per their expectations.

- About 73% of participants thought that the lecture was not too technical, and they understood it easily. However, 20% of participants found that the lecture was a little difficult for them, while about 7% found that the lecture was too difficult for them and they could not understand it fully.

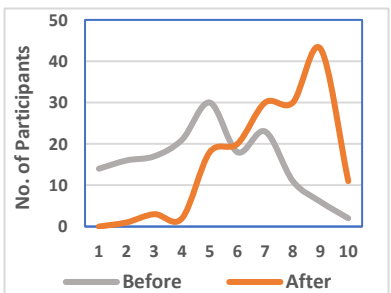
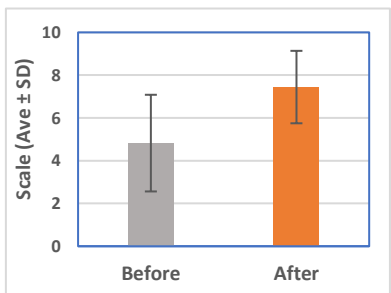
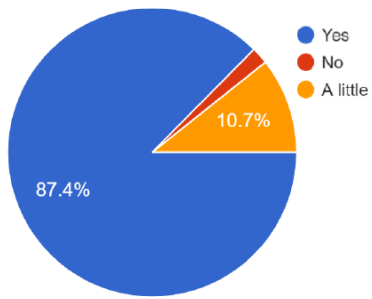
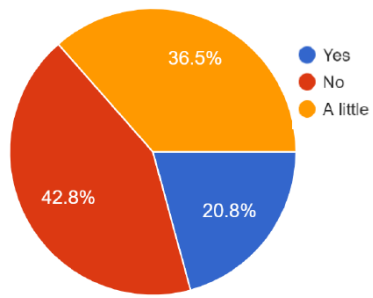
P-02: Low-cost sensor-based air quality monitoring networks

How much of your knowledge and understanding has increased on the low-cost sensor-based air quality monitoring before and after the lecture? Please rate on a scale of 1 to 10?		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

- The majority of participants have rated 5 about their knowledge and understanding about the low-cost sensor-based air quality monitoring before the lecture. Their knowledge and understanding were increased to 8-9 after the lecture.

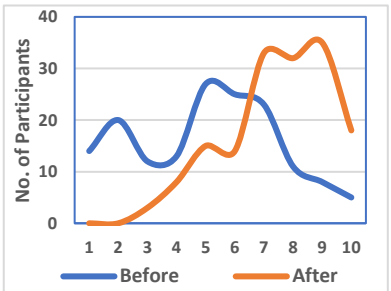
- On an average, the knowledge and understanding of participants on the low-cost sensor-based air quality monitoring before the lecture were 4.9±2.3 which increased to 7.7±1.6 after the lecture, with a net increase of 2.8.
- About 88% of participants found that the contents of the lecture on the low-cost sensor-based air quality monitoring were as per their expectations and they have gained new information which would be useful in their work or study. About 11% of participants found that the contents of the lecture were not what they were expecting.
- About 50% of participants thought that the lecture was not too technical for them, and they understood it easily, while about 38% of participants found that the lecture was a little difficult for them to understand, and about 11% of participants found that the lecture was too difficult for them and they could not understand it fully.

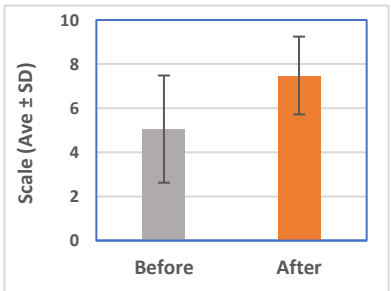
P-03: Air quality monitoring using satellite remote sensing

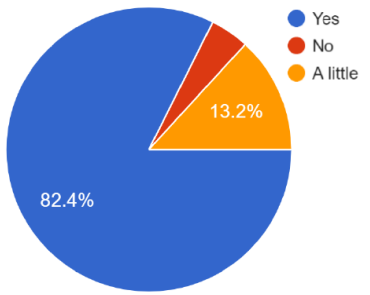
How much of your knowledge and understanding has increased on the air quality monitoring using satellite remote sensing before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

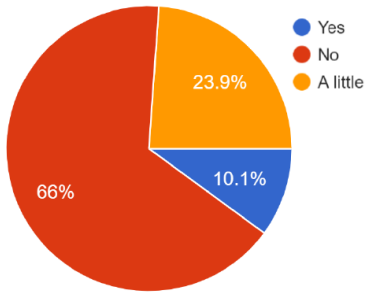
- A large number of participants have rated 5 about their knowledge and understanding on the air quality monitoring using satellite remote sensing before the lecture. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding of participants on the air quality monitoring using satellite remote sensing before the lecture was 4.9±2.3 which increased to 7.7±1.6 after the lecture, with a net increase of 2.8.
- About 87% of participants found that the contents of the lecture on the air quality monitoring using satellite remote sensing were as per their expectations and they have gained new information which will be useful in their work or study. About 11% found that the contents of the lecture were a little as per their expectations.
- About 43% of participants thought that the lecture on the air quality monitoring using satellite remote sensing was not too technical for them, and they understood it easily. About 37% of participants found that the lecture was a little difficult for them to understand, and about 11% of participants found that the lecture was too difficult for them and they could not understand it fully.

P-04: Continuous Emission Monitoring System (CEMS)		
How much of your knowledge and understanding has increased on the CEMS before and after the lecture? Please rate on a scale of 1 to 10?	Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?



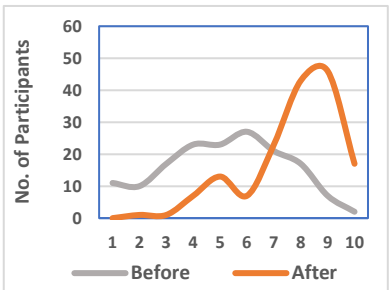
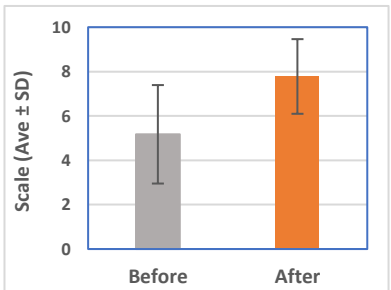
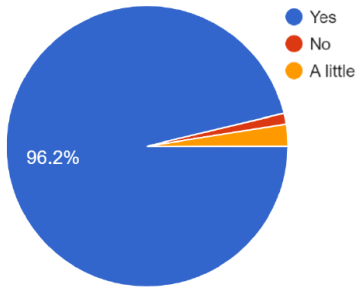
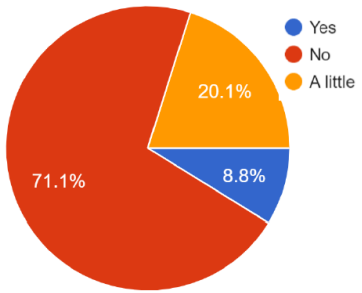




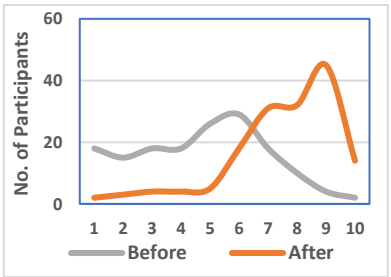
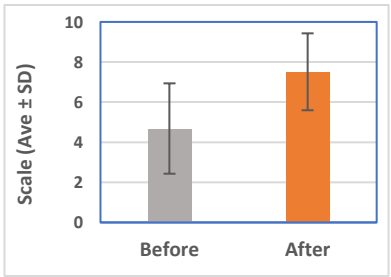
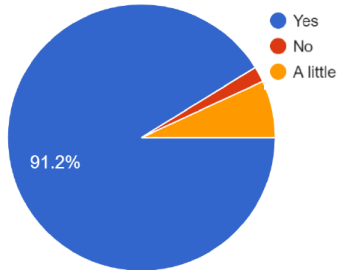
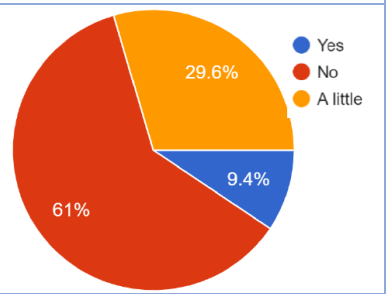


- The majority of participants have rated 5 on their knowledge and understanding on the CEMS before the lecture. Their knowledge and understanding were increased to 7-9 after the lecture.
- On an average, the knowledge and understanding of participants on the CEMS before the lecture were 5.1±2.4 which increased to 7.5±1.8 after the lecture, with a net increase of 2.4.
- About 82% of participants found that the contents of the lecture on the CEMS were as per their expectations and has new information which will be useful in their work or study. About 13% found that the contents of the lecture on the CEMS were a little as per their expectations. Few participants thought that the contents of the lecture on the CEMS were not as per their expectations.
- About 66% of participants thought that the lecture on the CEMS was not too technical for them, and they understood it easily. About 24% of participants found that the lecture on the CEMS was a little difficult for them to understand, and about 10% of participants found that the lecture was too difficult for them and they could not understand it fully.

P-05: Overview of emission inventory development process and emission factors		
How much of your knowledge and understanding has increased on the emission inventory development process and emission factors before and after the lecture? Please rate on a scale of 1 to 10?	Do you think the contents of the lecture were as per your expectations and have new	Do you think the lecture was too technical and you could not understand it fully?

		information which will be useful in your work or study?	
			

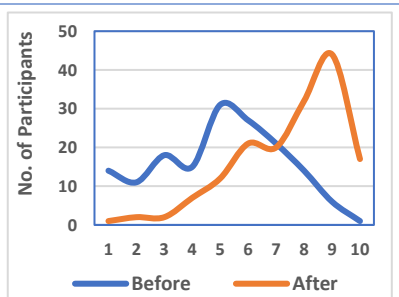
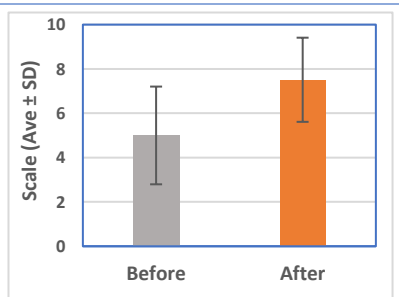
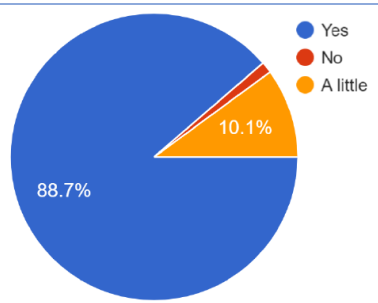
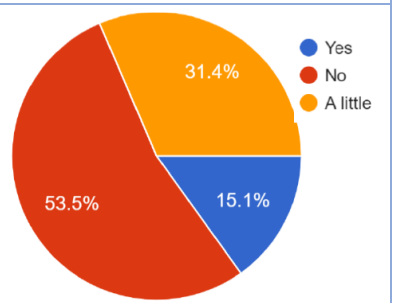
- A large number of participants have rated 6 about their knowledge and understanding on the emission inventory development process and emission factors before the lecture. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding of participants on the emission inventory development process and emission factors before the lecture was 5.2±2.2 which increased to 7.8±1.7 after the lecture, with a net increase of 2.6.
- About 96% of participants found that the contents of the lecture on the emission inventory development process and emission factors were as per their expectations and have new information which will be useful in their work or study. A few participants found that the contents of the lecture were a little or not as per their expectations.
- About 71% of participants thought that the lecture on the emission inventory development process and emission factors were not too technical for them, and they understood it easily. About 20% of participants found that the lecture was a little difficult for them to understand, and about 8.8% of participants found that the lecture was too difficult for them and they could not understand it fully.

P6: Emission Inventory Tools			
How much of your knowledge and understanding has increased on the Emission Inventory Tools before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

- The majority of participants have rated 6 about their knowledge and understanding on the Emission Inventory Tools before the lecture. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding of participants on the Emission Inventory Tools before the lecture were 4.7±2.3 which increased to 7.5±1.9 after the lecture, with a net increase of 2.8.
- About 91% of participants found that the contents of the lecture on the Emission Inventory Tools were as per their expectations and has new information which will be useful in their work or study. About 7% of participants found that the contents of the lecture on the Emission Inventory Tools were a little as per their expectations. Also, a few participants thought that the contents of the lecture were not as per their expectations.

- About 61% of participants thought that the lecture on the Emission Inventory Tools was not too technical for them, and they understood it easily. About 30% of participants found that the lecture was a little difficult for them to understand, and about 9% of participants found that the lecture was too difficult for them, and they could not understand it fully.

P7: Source apportionment of emissions of air pollutants

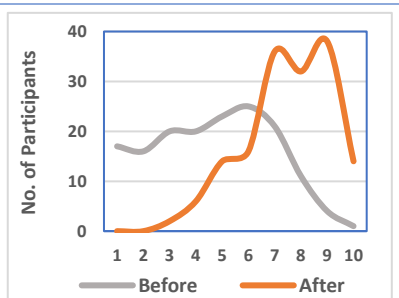
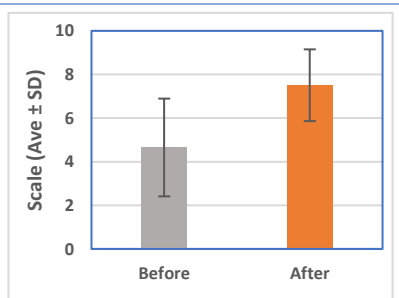
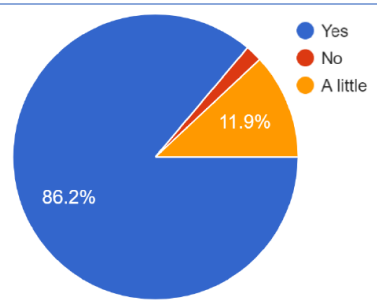
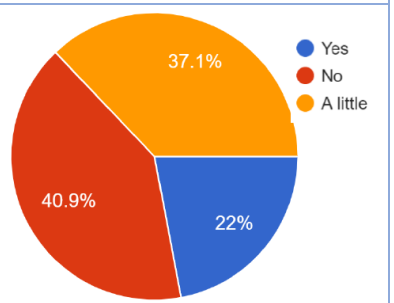
How much of your knowledge and understanding has increased on source apportionment of emissions of air pollutants before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

- A large number of participants have rated 7 about their knowledge and understanding on the source apportionment of emissions of air pollutants before the lecture. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding of participants on the source apportionment of emissions of air pollutants before the lecture were 5.0±2.2 which increased to 7.5±1.9 after the lecture, with a net increase of 2.5.
- About 89% of participants found that the contents of the lecture on the source apportionment of emissions of air pollutants was as per their expectations and has new information which will be useful in their work or study. About 10% of participants found that

the contents of the lecture on the source apportionment of emissions of air pollutants were a little as per their expectations. Few participants thought that the contents of the lecture were not as per their expectations.

- About 54% of participants thought that the lecture on the source apportionment of emissions of air pollutants was not too technical for them, and they understood it easily, while about 31% of participants found that the lecture was a little difficult for them to understand, and about 15% participants found that the lecture was too difficult for them and could not understand fully.

P8: Overview of air quality modeling

How much of your knowledge and understanding has increased on air quality modeling before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

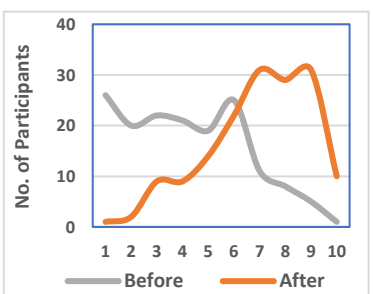
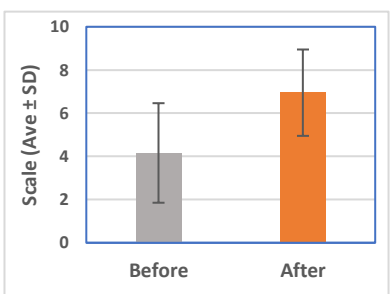
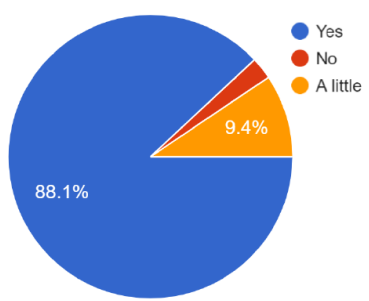
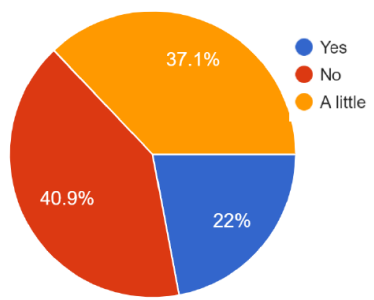
- A large number of participants have rated 6 about their knowledge and understanding on the air quality modeling before the lecture. Their knowledge and understanding were increased to 9 after the lecture.

- On an average, the knowledge and understanding of participants on the air quality modeling before the lecture were 4.7±2.2 which increased to 7.5±1.6 after the lecture, with a net increase of 2.8.

- About 86% of participants found that the contents of the lecture on the air quality modeling were as per their expectations and have new information which will be useful in their work or study. About 12% of participants found that the contents of the lecture were a little useful as per their expectations. Few participants thought that the contents of the lecture were not as per their expectations.

- About 41% of participants thought that the lecture on the air quality modeling was not too technical for them, and they understood it easily. About 37% of participants found that the lecture was a little difficult for them to understand, and about 22% of participants found that the lecture was too difficult for them and they could not understand it fully.

P9: Applications of Chemical Transport and Photo Chemical Models in air quality management

How much of your knowledge and understanding has increased on the application of air quality models in air quality management before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

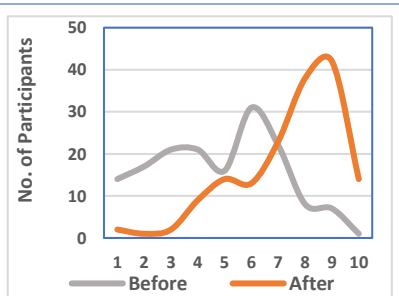
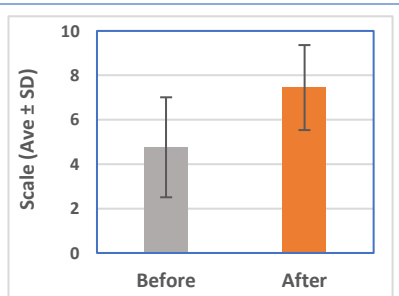
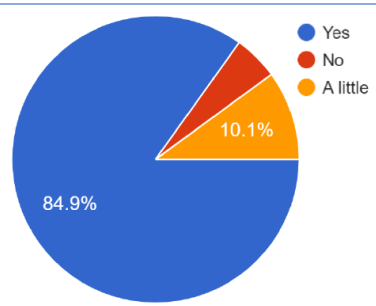
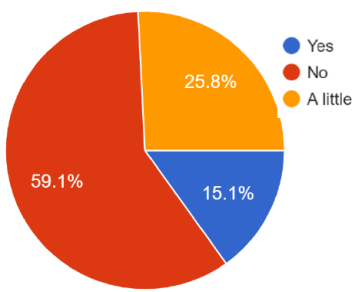
- The majority of participants have rated 1 about their knowledge and understanding on the application of air quality models in air quality management before the lecture. The application of air quality models in air quality management appeared to be a new topic for the participants. Their knowledge and understanding were increased to 7-9 after the lecture.

- On an average, the knowledge and understanding of participants on the application of air quality models in air quality management before the lecture were 4.2±2.3 which increased to 6.9±2.0 after the lecture, with a net increase of 2.7.

- About 88% of participants found that the contents of the lecture on the application of air quality models in air quality management were as per their expectations and have new information which will be useful in their work or study. About 9.4% of participants found that the contents of the lecture were a little useful as per their expectations. Few participants thought that the contents of the lecture were not as per their expectations.

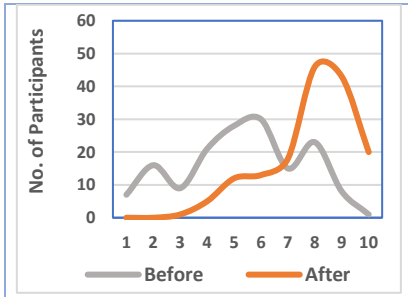
- About 41% of participants thought that the lecture on the application of air quality models in air quality management was not too technical for them, and they understood it easily, while about 37% of participants found that the lecture was a little difficult for them to understand. About 22% of participants found that the lecture was too difficult for them and they could not understand it fully.

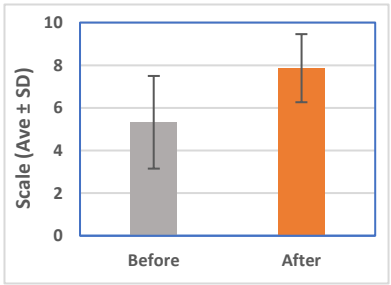
P10: Air pollution forecasting with a focus on PM2.5

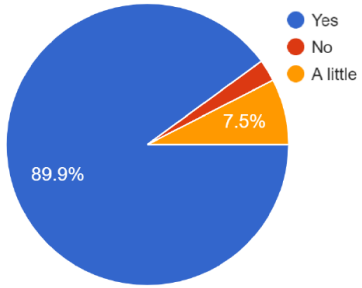
How much of your knowledge and understanding has increased on air pollution forecasting before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

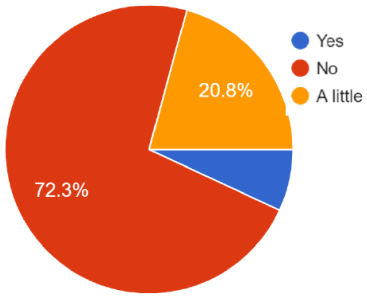
- The majority of participants rated have 6 about their knowledge and understanding on the air pollution forecasting before the lecture. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding of participants on the air pollution forecasting before the lecture were 4.6±2.3 which increased to 7.4±2.0 after the lecture, with a net increase of 2.8.
- About 85% of participants found that the contents of the lecture on air pollution forecasting were as per their expectations and have new information which will be useful in their work or study. About 10% of participants found that the contents of the lecture were a little useful as per their expectations. About 5% of participants thought that the contents of the lecture were not as per their expectations.
- About 59% of participants thought that the lecture on the air pollution forecasting was not too technical for them, and they understood it easily. About 26% of participants found that the lecture was a little difficult for them to understand, and about 15% of participants found that the lecture was too difficult for them and they could not understand it fully.

P11: Overview of air pollution impact assessment		
How much of your knowledge and understanding has increased on air pollution impact assessment before and after the lecture? Please rate on a scale of 1 to 10?	Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?



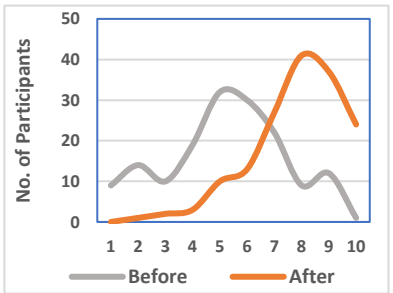
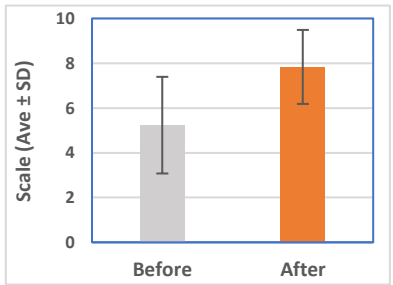
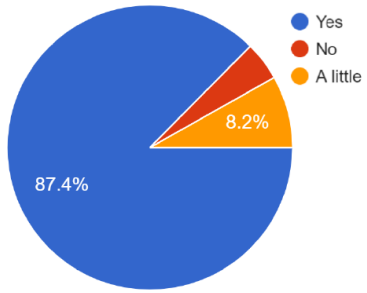
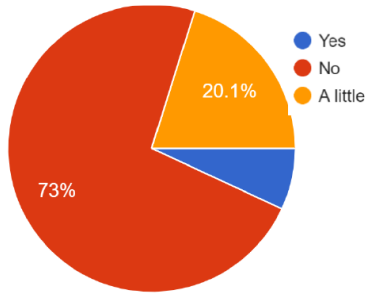






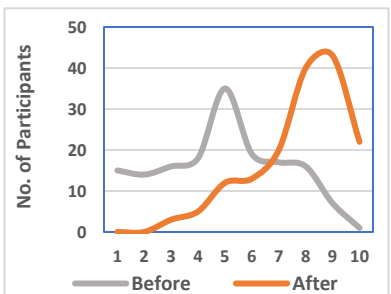
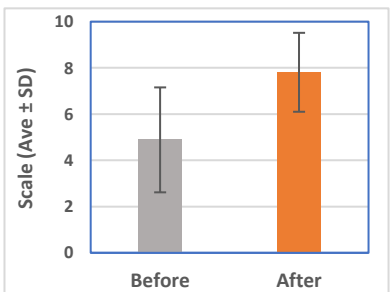
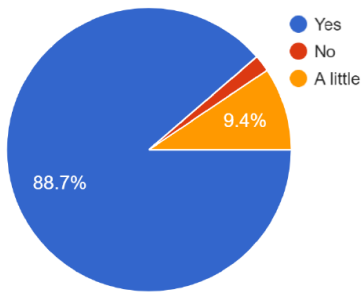
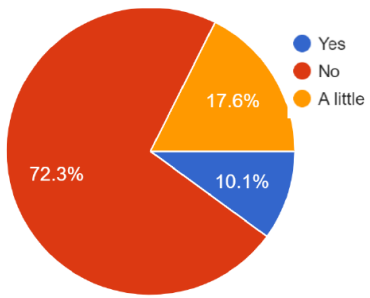
- The majority of participants have rated 6 about their knowledge and understanding on the air pollution impact assessment before the lecture. Their knowledge and understanding were increased to 8 after the lecture.
- On an average, the knowledge and understanding of participants on the air pollution impact assessment before the lecture were 5.3±2.2 which increased to 7.9±1.6 after the lecture, with a net increase of 2.6.
- About 90% of participants found that the contents of the lecture on the air pollution impact assessment were as per their expectations and have new information which will be useful in their work or study. However, about 7.5% of participants found that the contents of the lecture were a little useful as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.
- About 72% of participants thought that the lecture on the air pollution impact assessment was not too technical for them, and they understood it easily, while about 21% of participants found that the lecture was a little difficult for them to understand, and about 7% participants found that the lecture was too difficult for them and they could not understand it fully.

P12: Impact assessment of air pollution on health		
How much of your knowledge and understanding has increased on the impact assessment of air pollution on health before and after the lecture? Please rate on a scale of 1 to 10.	Do you think the contents of the lecture were as per your expectations and have new	Do you think the lecture was too technical and you could not understand it fully?

		information which will be useful in your work or study?	
			

- A large number of participants have rated 5 about their knowledge and understanding on the impact assessment of air pollution on health before the lecture. Their knowledge and understanding were increased to 8 after the lecture.
- On an average, the knowledge and understanding of the impact assessment of air pollution on health before the lecture were 5.2±2.2 which increased to 7.8±1.7 after the lecture, with a net increase of 2.6.
- About 87% of participants found that the contents of the lecture on the impact assessment of air pollution on health was as per their expectations and have new information which will be useful in their work or study. About 8% of participants found that the contents of the lecture were a little useful as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.
- About 73% of participants thought that the lecture on the impact assessment of air pollution on health was not too technical for them, and they understood it easily, while about 20% of participants found that the lecture was a little difficult for them to understand. About 7% of participants found that the lecture was too difficult for them and could not understand it fully.

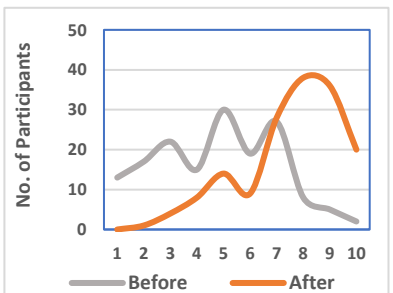
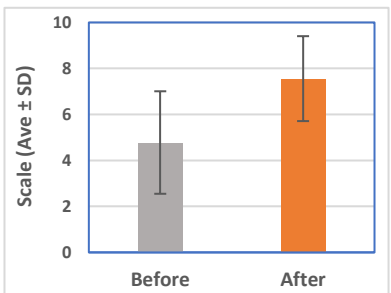
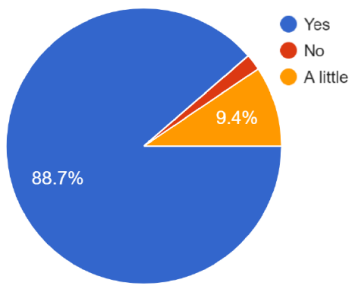
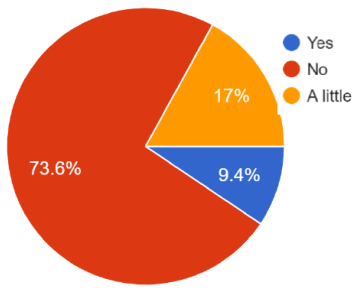
P13: Co-benefits of air pollution emission reduction

How much of your knowledge and understanding has increased on the co-benefits of air pollution emission reduction before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

- The majority of participants rated have 5 about their knowledge and understanding on the co-benefits of air pollution emission reduction before the lecture. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding on the co-benefits of air pollution emission reduction before the lecture was 4.9±2.3 which increased to 7.8±1.7 after the lecture, with a net increase of 2.9.
- About 88% of participants found that the contents of the lecture on the co-benefits of air pollution emission reduction were as per their expectations and have new information which will be useful in their work or study. About 9% of participants found that the contents of the lecture were a little useful for them as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.

- About 72% of participants thought that the lecture on the co-benefits of air pollution emission reduction was not too technical for them, and they understood it easily, while about 18% of participants found that the lecture was a little difficult for them to understand. About 10% of participants found that the lecture was too difficult for them and could not understand it fully.

P14: Perspectives on air pollution mitigation strategies and actions in Asia

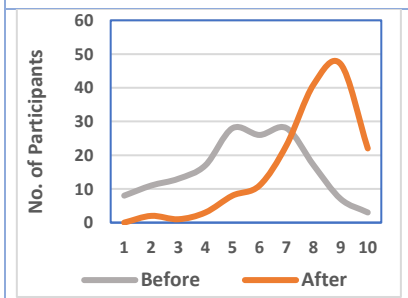
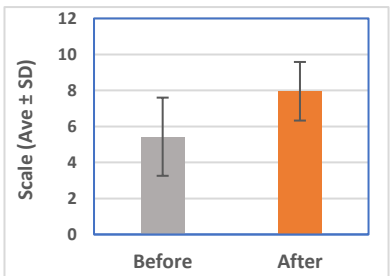
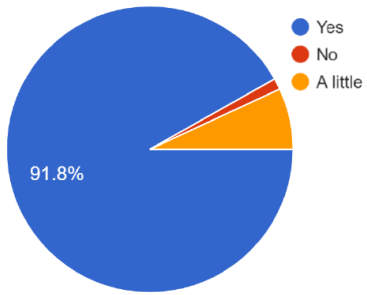
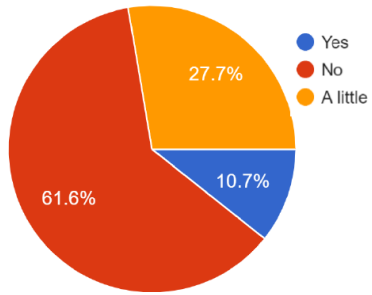
How much of your knowledge and understanding has increased on air pollution mitigation strategies and actions in Asia before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

- The majority of participants rated 5 about their knowledge and understanding on the air pollution mitigation strategies and actions in Asia before the lecture. Their knowledge and understanding were increased to 8 after the lecture.
- On an average, the knowledge and understanding on the air pollution mitigation strategies and actions in Asia before the lecture were 4.8±2.2 which increased to 7.6±1.8 after the lecture, with a net increase of 2.8.
- About 89% of participants found that the contents of the lecture on the air pollution mitigation strategies and actions in Asia were as per their expectations and have new information which will be useful in their work or study. About 9% of participants found

that the contents of the lecture were a little useful as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.

- About 74% of participants thought that the lecture on the air pollution mitigation strategies and actions in Asia was not too technical for them, and they understood it easily, while about 17% of participants found that the lecture was a little difficult for them to understand, and about 9% participants found that the lecture was too difficult for them and could not understand it fully.

P15: Air pollution and climate change linkages

How much of your knowledge and understanding has increased on the air pollution and climate change linkages before and after the lecture? Please rate on a scale of 1 to 10?		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

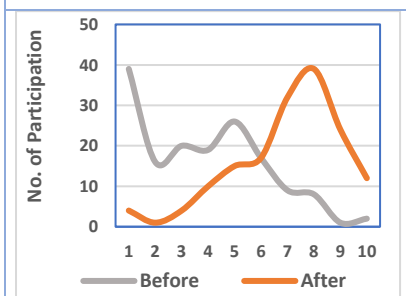
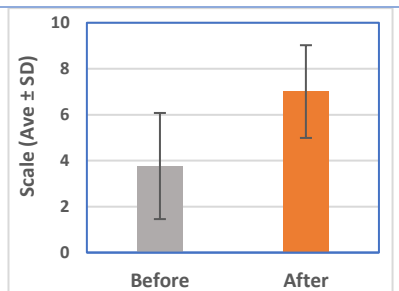
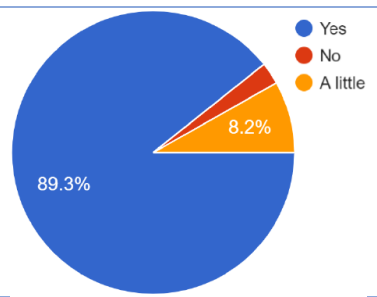
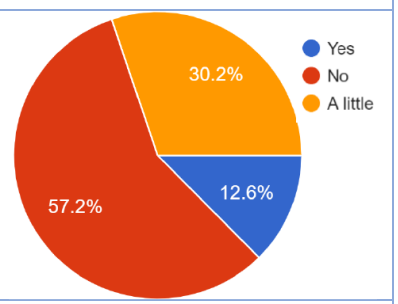
- The majority of participants rated have 5-7 about their knowledge and understanding on the air pollution and climate change linkages before the lecture, however, their knowledge and understanding were increased to 9 after the lecture.

- On an average, the knowledge and understanding on the air pollution and climate change linkages before the lecture were 5.4±2.2 which increased to 8.0±1.6 after the lecture, with a net increase of 2.6.

- About 92% of participants found that the contents of the lecture on the air pollution and climate change linkages was as per their expectations and have new information which will be useful in their work or study. About 7% of participants found that the contents of the lecture were a little useful for them as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.

- About 62% of participants thought that the lecture on air pollution and climate change linkages was not too technical for them, and they understood it easily, while about 28% of participants found that the lecture was a little difficult for them to understand, and about 11% participants found that the lecture was too difficult for them and could not understand it fully.

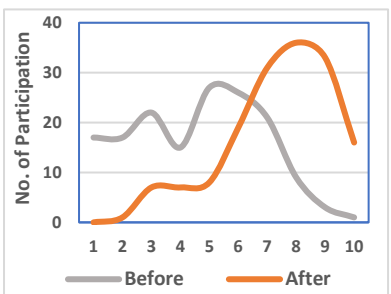
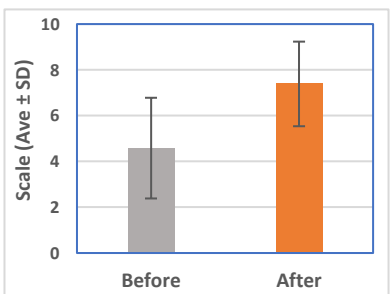
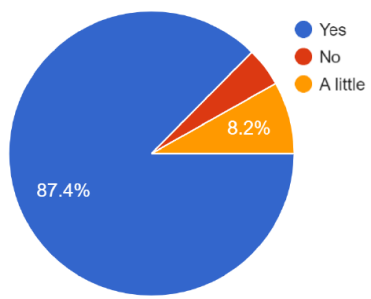
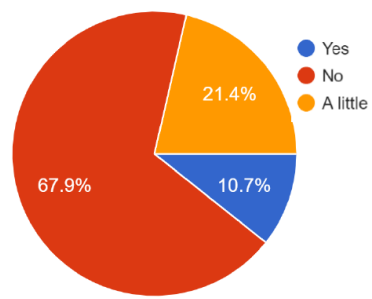
P16: The Long-range Energy Alternatives Planning -Integrated Benefits Calculator (LEAP-IBC)

How much of your knowledge and understanding has increased on the LEAP-IBC before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

- The majority of participants have rated 1 about their knowledge and understanding on the LEAP-IBC before the lecture, however. This topic seems to be a new topic for the participants. Their knowledge and understanding were increased to 8 after the lecture.

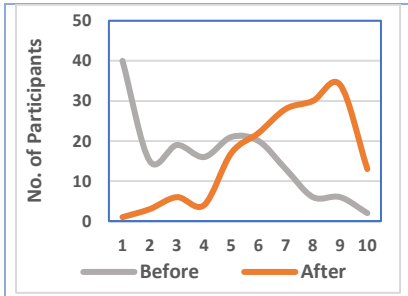
- On an average, the knowledge and understanding on the LEAP-IBC before the lecture was 3.8±2.3 which increased to 7.0±2.0 after the lecture, with a net increase of 3.2.
- About 89% of participants found that the contents of the lecture on the LEAP-IBC were as per their expectations and have new information which will be useful in their work or study. About 8% of participants found that the contents of the lecture were a little useful as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.
- About 57% of participants thought that the lecture on the LEAP-IBC was not too technical for them, and they understood it easily, while about 30% of participants found that the lecture was a little difficult for them to understand, and about 13% of participants found that the lecture was too difficult for them and could not understand it fully.

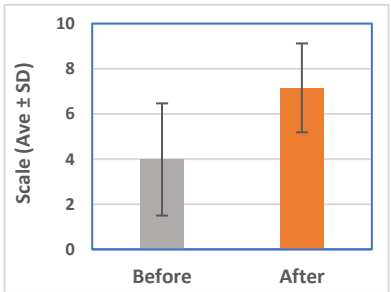
P17: Clean air measures for the Asia-Pacific region

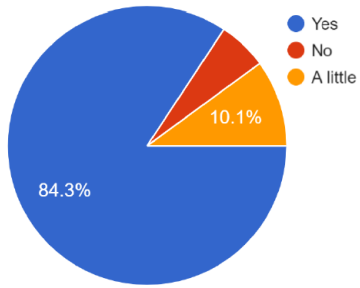
How much of your knowledge and understanding has increased on clean air measures for the Asia-Pacific region before and after the lecture? Please rate on a scale of 1 to 10.		Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?
			

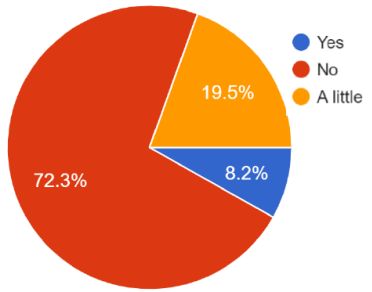
- The majority of participants rated have 5 about their knowledge and understanding on the clean air measures for the Asia-Pacific region before the lecture. Their knowledge and understanding were increased to 8 after the lecture.
- On an average, the knowledge and understanding on the clean air measures for the Asia-Pacific region before the lecture was 4.6±2.2 which increased to 7.4±1.8 after the lecture, with a net increase of 2.8.
- About 87% of participants found that the contents of the lecture on the clean air measures for the Asia-Pacific region were as per their expectations and have new information which will be useful in their work or study. About 8% of participants found that the contents of the lecture were a little useful as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.
- About 86% of participants thought that the lecture on clean air measures for the Asia-Pacific region was not too technical for them, and they understood it easily, while about 21% of participants found that the lecture was a little difficult for them to understand, and about 11% participants found that the lecture was too difficult for them and could not understand it fully.

P18: National Clean Air Programme (NCAP) of India		
How much of your knowledge and understanding has increased on NCAP of India before and after the lecture? Please rate on a scale of 1 to 10.	Do you think the contents of the lecture were as per your expectations and have new information which will be useful in your work or study?	Do you think the lecture was too technical and you could not understand it fully?



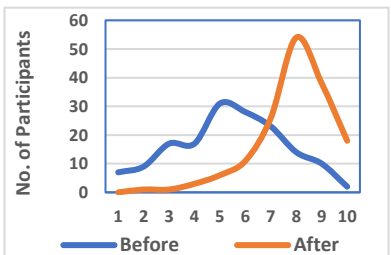


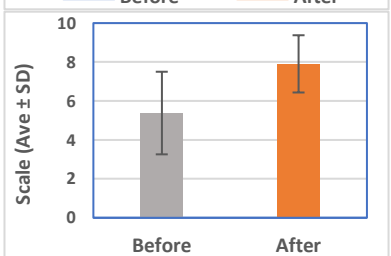




- The majority of participants have rated 1 about their knowledge and understanding on NCAP of India before the lecture. This topic seems to be a new topic for the participants. Their knowledge and understanding were increased to 9 after the lecture.
- On an average, the knowledge and understanding on the NCAP of India before the lecture was 4.0±2.5 which increased to 7.2±2.0 after the lecture, with a net increase of 3.2.
- About 84% of participants found that the contents of the lecture on NCAP of India were as per their expectations and have new information which will be useful in their work or study. About 10% of participants found that the contents of the lecture were a little useful as per their expectations. A few participants thought that the contents of the lecture were not as per their expectations.
- About 72% of participants thought that the lecture on NCAP of India was not too technical for them, and they understood it easily, while about 20% of participants found that the lecture was a little difficult for them to understand, and about 8% of participants found that the lecture was too difficult for them and could not understand it fully.

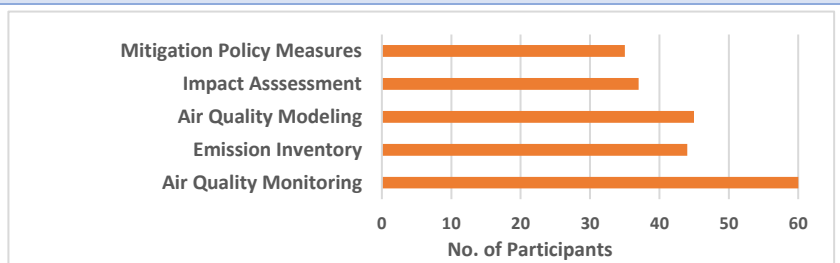
Table 2: Evaluation of the Whole Workshop
How much of your knowledge and understanding has increased about all aspects of air quality management (i.e., monitoring, emission inventory, modeling, impact assessment, and mitigation policies) before and after the workshop? Please rate your response on a scale from 1 to 10?





- The majority of participants have rated 5 about their knowledge and understanding on all aspects of air quality management (i.e., monitoring, emission inventory, modeling, impact assessment, and mitigation policies) before the workshop. Their knowledge and understanding on all aspects of air quality management were increased to 8 after the workshop.
- On an average, the knowledge and understanding of participants on all aspects of air quality management before the workshop were 5.4±2.1 which increased to 7.9±1.5 after the workshop, with a net increase of 2.5.

Which module or modules of the AQM workshop do you like the most?



Majority of participants like the Air Quality Monitoring Module, followed by the Air Quality Modeling Module and then Emission Inventory Developments and Impact Assessment. Mitigation Policy Measures Module was liked less.

Would you like to have further interaction with us for knowledge sharing and learning on air quality management or any particular module or an individual topic?
Most participants would like to interact with us for knowledge sharing and learning on air quality management, in particular, on climate change, air pollution and health, air quality modeling, LEAP-IBC software, emission inventory, source apportionment, low-cost monitoring sensors, air quality monitoring by satellite, science-policy gaps, air pollution impact assessment, CEMS, air pollution mitigation policies and measures, and many other topics related to air quality management.
Would you be interested in developing project proposals on air pollution-related issues on your country or at the regional level, if any opportunity comes in the future?
The majority of participants are interested in developing project proposals on air pollution-related issues in their country or at a regional level, in particular related to regional air quality modeling, air pollution impact assessment, emission inventory development, and other topics related to air pollution mitigation.
What is your overall experience of participating in the AQM workshop organized online?
Participants were happy and very satisfied with the organization of the workshop including the contents of the presentations. Annex 5 provides some comments from the participants.

7. LESSONS LEARNED

Opportunities

- The workshop on AQM had successfully gathered a registration of over 300 participants from 30 countries of Asia and other parts of the world. About 150-200 participants from 29 countries had fully participated during the 5-day workshop. Such large participation from many countries may not be possible if the workshop was organized physically. This opened an avenue to organize more events online in order to provide more opportunities and benefits to a large number of participants from many countries.

- The extensive use of social media (Facebook, LinkedIn, WhatsApp, etc.) for the advertisement of the workshop helped to bring a large number of participants. Thus the use of social media for spreading information across the region is a useful tool for reaching out to various stakeholders and partners.

- Organizing the workshop online provided an opportunity to various interested participants including policymakers, students, researchers, technical staff who may not have had the opportunity to attend the workshop if it was organized physically. Therefore, organizing the workshop online enabled many participants from distant places to join and gained more learnings from the workshop.

- With less investment of resources, the virtual workshop was successful in inviting well-known resource persons and experts from India, China, Japan, Hong Kong, Indonesia, Malaysia, Nepal, Philippines, Thailand, United Kingdom, and UNEP who delivered the lectures on various topics related to air quality management. This could not be possible if the workshop was organized in a physical setting.

- Gathering many feedback from the participants was only made possible because the workshop was organized online.

- The feedback from participants showed that they learned a lot from the workshop which is an important output and an indication of a successful workshop organization.

- Minimal resources including financial resources are required for organizing a workshop online.

Challenges

- In an online workshop, it is difficult to monitor and ensure the regular participation of the participants on screen. It is likely possible that not all the participants had fully attended all the lectures.

- Internet connectivity could be a big challenge for organizing workshops online. Some participants complained that they could not participate in the workshop fully due to the weak internet connectivity at their places.

8. CONCLUSION AND WAY FORWARD

The Capacity Development Programme on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries was successfully organized by the RRC.AP and partners from 13-17 September 2021, online. The workshop was aimed to build capacities of the Asian countries on air quality management. Participants from the member countries of the intergovernmental networks of the Asian region, namely, ASEAN Haze Agreement, EANET, Malé Declaration, APCAP), and APN were invited. The 5-day workshop gathered around 150-200 participants, including policymakers, air quality managers, technical staff, air quality professionals, academicians, young researchers, and students. The workshop was divided into 5 Modules, namely, Air Quality Monitoring, Emission Inventory Development, Air Quality Modeling, Impact Assessment, and Policy Measures for Air Pollution Mitigation. A total of 18 lectures were delivered by 17 well-known resource persons during 5-day workshop. Evaluation of participants was made by providing a set of questions to measure the enhancement of their knowledge and understanding of the workshop contents, which garnered a total of 159 responses. On a scale of 1-10, the majority of participants had initially rated 5 about their knowledge and understanding of all aspects of air quality management before the workshop, which was increased to 8 after the workshop. On average, the knowledge and understanding of participants on all aspects of air quality management before the workshop were 5.4±2.1 which increased to 7.9±1.5 after the workshop, with a net increase of 2.5. The feedback showed that participants had learned a lot from the workshop and were quite satisfied with the contents of the workshop. A large attendance from 29 participating countries indicated that organizing training workshops online could provide maximum benefits with minimum resources. Internet connectivity could however be a challenge.

Feedback from the participants provided a way forward for continuity in learning on air quality management. Most participants would like to interact for further knowledge sharing and learning on air quality management, in particular, on climate change, air pollution and health, air quality modeling, LEAP-IBC software, emission inventory, source apportionment, low-cost monitoring sensors, air quality monitoring by satellite, science-policy gaps, air pollution impact assessment, CEMS, air pollution mitigation policies and measures, and many other topics related to air quality management. The majority of participants are interested in developing project proposals on air pollution-related issues in their country or at a regional level, in particular related to regional air quality modeling, air pollution impact assessment, emission inventory development, and other topics related to air pollution mitigation.

Annex 1: Workshop Agenda

Capacity Development Program on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries

13-17 September 2021, Online Platform

Day 1 (13 September 2021)		
Time	**Agenda Item**	**Description**
13:00 – 13:30	**Opening Session**	**Moderator: Dr. R. L. Verma**, PI for Capacity Development Program on AQM
13:00 – 13:05	Welcome Remarks	**Dr. Naoya Tsukamoto** Director, Regional Resource Centre for Asia and the Pacific (RRC.AP), Thailand
13:05 – 13:10	Opening Remarks	**Dr. Monthip Sriratana Tabucanon** Senior Advisor to National Research Council of Thailand, Former Director ERTC, and Former Deputy Permanent Secretary, Ministry of Natural Resources and Environment, Thailand
13:10 – 13:15	Opening Remarks	**Mr. Yoichi Toyama,** Director, Asia-Pacific Network for Global Change Research (APN) Secretariat, Japan
13:15-13:20	Opening Remarks	**Prof. Mario Tabucanon** Senior Advisor**,** Regional Resource Centre for Asia and the Pacific (RRC.AP), Thailand
13:20 – 13:22	Photo Session	Screenshot
13:22 – 13:30	Overview of Air Quality Management and Agenda of Capacity Development Program on Air Quality Management. **Dr. R. L. Verma**, PI of Capacity Development Program	
13:30 – 17:30	**Module 1: Air Quality Monitoring** Moderator: Dr. R. L. Verma	
13:30 – 14:30	**P1: Overview and importance of ambient air quality monitoring for air quality management**	

	Expert: Prof. Nguyen Thi Kim Oanh, Asian Institute of Technology (AIT), Thailand
14:30 – 15:30	**P2: Air quality monitoring by low-cost sensors** Expert: Prof. S. N. Tripathi, Indian Institute of Technology (IIT) Kanpur, India
15:30 – 16:30	**P3: Air quality monitoring by satellites** Expert: Prof. Muhammad Bilal, Nanjing University of Information Science and Technology, (NUIST), Nanjing, China
16:30 – 17:30	**P4: Continuous Emission Monitoring System (CEMS)** Expert: Dr. Sirakan Leungsakul, Air Pollution Section, Industrial Environment Technology Promotion Division, Department of Industrial Works, Thailand
Day 2 (14 September 2021)	
13:00 – 16:00	**Module 2: Emission Inventory Development** Moderator: Dr. R. L. Verma
13:00 – 14:00	**P5: Overview of emission inventory development process and emission factors** Expert: Dr. Ekbordin Winijkul, Asian Institute of Technology (AIT), Thailand
14:00 – 15:00	**P6: Emission Inventory Tools** Expert: Dr. Didin Agustian Permadi, National Institute of Technology (ITENAS), Bandung, Indonesia
15:00 – 16:00	**P7: Source apportionment of emissions of air pollutants** Expert: Dr. Md Firoz Khan, University of Malaya, Kuala Lumpur, Malaysia
Day 3 (15 September 2021)	
13:00 -16:00	**Module 3: Air Quality Modeling** Moderator: Dr. R. L. Verma
13:00 – 14:00	**P8: Overview of air quality modeling** Expert: Dr. Bhupesh Adhikary, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal,

14:00 – 15:00	**P9: Applications of Chemical Transport and Photo Chemical Models in air quality management** Expert: Dr. Bhupesh Adhikary, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal,
15:00 – 16:00	**P10: Air pollution forecasting with a focus on $PM_{2.5}$** Expert: Dr. Sakda Tridech, Pollution Control Department (PCD), Bangkok, Thailand
Day 4 (16 September 2021)	
13:00 – 16:00	**Module 4: Air Pollution Impact Assessment** Moderator: Dr. R. L. Verma
13:00 – 14:00	**P11: Overview of air pollution impact assessment** Expert: Dr. Patcharawadee Suwannathada, Pollution Control Department, Bangkok, Thailand
14:00 – 15:00	**P12: Impact assessment of air pollution on health** Expert: Prof. Tze Wai Wong, The Chinese University of Hong Kong
15:00 – 16:00	**P13: Co-benefits of air pollution emission reduction** Expert: Dr. Eric Zusman, Institute for Global Environmental Strategies (IGES), Japan
Day 5 (17 September 2021)	
13:00 – 17:40	**Module 5: Air Pollution Mitigation Policies** Moderator: Dr. R. L. Verma
13:00 – 14:00	**P14: Perspectives on air pollution mitigation strategies and actions in Asia** Expert: Ms. Glynda Bathan Baterina, Clean Air Asia, Manila, Philippines
14:00 – 15:00	**P15: Air pollution and climate change linkages** Expert: Prof. Toshihiko Takemura, Kyushu University, Fukuoka, Japan
15:00 – 16:00	**P16: The Long-range Energy Alternatives Planning -Integrated Benefits Calculator (LEAP-IBC)** Expert: Dr. Johan C.I. Kuylenstierna, Stockholm Environment Institute (SEI), UK

16:00 – 16:45	**P17: Clean air measures for Asia-Pacific region** Expert: Ms. Maria Katherina Patdu, UNEP Asia Pacific Regional Office, Bangkok, Thailand
16:45 – 17:25	**P18: National Clean Air Programme (NCAP) of India** Expert: Mr. Sundeep Singh, Ministry of Environment, Forest and Climate Change, Govt. of India, New Delhi, India
17:25 – 17:30	**Closing Remarks** Secretariat

Annex 2: Workshop Web Poster

Capacity Development Program on Air Quality Management and Emission Reduction of $PM_{2.5}$ for Asian Countries

13-17 September 2021, Online
http://www.rrcap.ait.ac.th/apn/

Program Agenda (Thailand Standard Time (GMT+7))

13 Sept 2021: Opening Session (13:00 – 13:30)

Dr. Naoya Tsukamoto
Director, AIT RRC.AP
Welcome Remarks

Dr. Monthip Sriratana
Senior Advisor, NRC, Thailand
Opening Remarks

Mr. Yoichi Toyama
Director, APN Secretariat
Opening Remarks

Prof. Mario Tabucanon
Senior Advisor, AIT RRC.AP
Opening Remarks

Dr. R. L. Verma
Head, APC, AIT RRC.AP
Program Overview & Moderator

13 Sept 2021: Air Quality Monitoring (13:30 – 17:30)

Prof. NT Kim Oanh
AIT, Thailand
Overview of Air Quality Monitoring

Prof. S N Tripathi
IIT Kanpur, India
AQM by Low-cost Sensors

Prof. Muhammad Bilal
NUIST, China
AQM by Satellites

Dr. Sirakarn Leungsakul
DIW, Thailand
Continuous Emission Monitoring System

14 Sept 2021: Emission Inventory (13:00 – 16:00)

Dr. Ekbordin Winijkul
AIT, Thailand
Emission Inventory Development

Dr. Didin A. Permadi
ITENAS, Indonesia
Emission Inventory Tool

Dr. Md Firoz Khan,
Univ. of Malaya, Malaysia
Emission Source Apportionment

15 Sept 2021: Air Quality Modeling (13:00 – 16:00)0

Dr. Bhupesh Adhikary
ICIMOD, Nepal
Air Quality Modeling
and Applications

Dr. Sakda Tridech,
PCD, Thailandl
Air Pollution Forecasting

16 Sept 2021: Impact Assessment (13:00 – 16:00)

Dr. Patcharawadee Suwanathada,
PCD, Thailand
Impact Assessment Overview

Prof. Tze Wai Wong
Chinese Univ. of Hongkong
Health Impact Assessment

Dr. Eric Zusman
IGES, Japan
Co-benefits

17 Sept 2021: Mitigation Policies in Asia (13:00 – 17:20)

Ms. Glynda B. Baterina,
Clean Air Asia, Philippines
Mitigation Policies

Prof. Toshihiko Takemura,
Kyushu Univ., Japan
Air Pollution Climate Change Linkages

Dr. Johan C.I. Kuylenstierna,
SEI, UK
LEAP-IBC

Ms. Maria K. Patdu,
UNEP ROAP
Clean Air Measures

Mr. Sundeep
MOEFCC, India
NCAP India

APN ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH · RRC.AP Regional Resource Centre for Asia and the Pacific · UN environment programme · Asia Pacific Clean Air Partnership · ERTC · UNIVERSITI MALAYA KUALA LUMPUR · itenas

Annex 3: Details of Expert Resource Persons

1. Prof. Nguyen Thi Kim Oanh is a Professor at the Asian Institute of Technology (AIT), Thailand, and a member of the science panel of the Asia Pacific Clean Air Partnership (APCAP). She has 35 years of experience in research, education, consultancy, and capacity building and is internationally recognized for her work on air pollution and climate in Asia. She provided a better characterization of air pollution issues in Asian developing countries through field measurements, emission inventory, and modeling studies at urban, national, and regional scales. She has published 2 books, 110 scientific papers and 50 book chapters, and over 50 development reports. She has conducted, as PI or Co-PI, over 50 regional collaboration research projects and supervised 190 Master's and 16 PhD students.

2. Prof. Sachchida Nand Tripathi is a Senior Professor and Head of the Department of Civil Engineering at the Indian Institute of Technology (IIT) Kanpur, India. Prof. Tripathi also holds Arjun Dev Joneja Chair in Civil Engineering. He is the recipient of the Shanti Swarup Bhatnagar Award and the J C Bose National Fellowship. He is an elected fellow of the Indian National Science Academy, Indian National Academy of Engineering, and National Academy of Sciences. He was a Senior Fellow at NASA Goddard Space Flight Centre. Professor Tripathi is also on the editorial board of Environmental Science and Technology Letters, Journal of Aerosol Science and Environmental Science: Atmospheres. He has made an impactful contribution to addressing the challenges of Air Pollution and Climate Change. He has built an indigenously low-cost sensor-based network for nationwide urban air quality monitoring and real-time source apportionment. He also coordinates the National Knowledge Network of the National Clean Air Programme, India

3. Prof. Muhammad Bilal is a Professor at the Nanjing University of Information Science and Technology, (NUIST), Nanjing, China. Prof. Bilal devised four innovative methods, namely, simplified Aerosol Retrieval Algorithm (SARA), Simplified Merge Scheme (SMS), Simplified and Robust Surface Reflectance Estimation Method, and Aerosol classification using a novel Satellite remote sensing Approach (AEROSA). He has published more than 90 research papers in top journals including Remote Sensing of Environment, Environmental Science and Technology, Journal of Geophysical Research, IEEE TGRS, Environmental Pollution, Atmospheric Research, etc. The Jiangsu Provincial Education

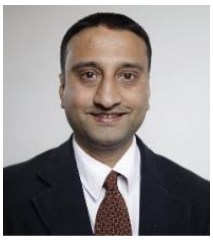
Department, China, has conferred him with a special title of "Distinguished Professor" based on his outstanding research achievements. In 2020, he was ranked among the top 2% World's Scientists in Meteorology & Atmospheric Sciences based on a single-year contribution to science.

4. Dr. Sirakan Leungsakul is a Director at the Air Pollution Section, Industrial Environment Technology Promotion Division, Department of Industrial Works, Thailand. Dr. Leungsakul is involved in many guidelines and air emission standard development, such as code of practice for petrochemical industry aiming to reduce VOCs emission from storage tank, flaring and shutdown/turnaround activities, power plant air emission standard, CEMS requirement and PRTR requirement for industrial sector.

5. Dr. Ekbordin Winijkul is an Assistant Professor at the Asian Institute of Technology (AIT), Thailand. Dr. Winijkul's research areas are emission inventory, air pollution modeling and monitoring, air quality management, and environmental system dynamic. His recent research is focusing on emission inventory development, air quality management and cost-benefit analysis of introducing cleaner fuels and vehicles. He got his Ph.D. in Environmental Engineering from the University of Illinois at Urbana-Champaign, USA. Before joining AIT, Dr. Ekbordin worked at Argonne National Laboratory (USA), International Institute for Applied System Analysis (Austria) and Atmospheric and Environmental Research, Inc. (USA).

6. Dr. Didin Agustian Permadi is an Assistant Professor at the National Institute of Technology (ITENAS), Bandung, Indonesia. Dr. Permadi's research is mainly focused on the application of 3-dimensional chemistry-transport models, emission inventory, environmental impact assessment and monitoring, and air pollution-climate change linkages. He published many research papers in highly reputed journals including 16 book chapters. He has served as a trainer in many international trainings in the fields of emission inventory and air quality monitoring and modeling. Professionally, he is engaged with the international scientific communities as a reputed scientist and a member of the International Global Atmospheric Chemistry (IGAC) and the Asian Network on Climate Science and Technology (ANCST).

7. Dr. Md Firoz Khan is a Senior Lecturer at the Faculty of Science, University of Malaya, Kuala Lumpur, Malaysia. He is also a visiting professor at the China University of Mining and Technology, China for the period of 2019-2022. His research interests cover a wide variety of topics in air pollution, source apportionment, environmental analytical chemistry, and human health risk factors of pollutants. He received his Ph.D. degree in Risk Management and Environmental Sciences from the Yokohama National University, Japan in 2010. He published more than 100 journal papers, book chapters, and a book. Dr. Khan is serving as an Associate Editor to Elementa: Science of the Anthropocene and Arabian Journal of Geosciences.



8. Dr. Bhupesh Adhikary is a Senior Air Quality Specialist at the International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal as Senior Air Quality Specialist. He has earned double Bachelors, in Economics and Engineering, and MS, Ph.D. in Chemical Engineering, all from the universities in the US. Bhupesh is working on understanding the science and mitigation aspects of air pollution in the HKH region using chemical transport models, in-situ, and satellite-based observations. Prior to ICIMOD, he worked for the EvK2CNR Committee as their resident scientific coordinator. Bhupesh also worked in Kathmandu University as an assistant professor for several years teaching graduate and undergraduate students.

9. Dr. Sakda Tridech is an Environmentalist Senior Professional Level and Director of Air Quality Model and Geographic Information Centre in Pollution Control Department, Ministry of Natural Resources and Environment. He received his PhD degree from Brunel University in 2012.

10. Dr. Patcharawadee Suwanathada is a Director at the Air Quality and Noise Management Division, Pollution Control Department (PCD), Thailand. She graduated from Clemson University, USA, in Environmental Engineering and Science. Her background and experience are mainly in air quality management, including ambient air quality monitoring, setting and recommendation of national ambient air quality standards and emission standards; and formulating of action plan and implementation plan in AQM. At present, she is a member of the Expert Review Committee, which is responsible for the final technical

review of the environmental impact assessment report in Thailand.

11. Prof. T W Wong is a Professor at the Chinese University of Hong Kong. Prof. Wong has over 40 years of work experience in public health and occupational and environmental health, including public health practice with Hong Kong Government; research and teaching experience in Community Medicine, National University of Singapore, and School of Public Health and Primary Care of The Chinese University of Hong Kong; consultancy experience in air pollution and health studies for Environmental Protection Department in Hong Kong, persistent organic pollutants for the Department of Health and health impact assessment studies for major developmental projects. His fields of research are air pollution and health, health risk assessment, environmental epidemiology, occupational medicine, and infectious diseases epidemiology.

12. Dr. Eric Zusman is a Senior Policy Researcher and Research Group Leader at the Institute for Global Environmental Studies (IGES) in Hayama, Japan. Dr. Zusman holds a Ph.D. in political science from the University of California, Los Angeles. For the past two decades, he has conducted research on environmental issues in Asia. This has included working with China's Yellow River Conservancy Commission, the Chinese Research Academy on Environmental Science, Woodrow Wilson Center's China Environment Forum as well as Taiwan's Academia Sinica. He has published books and articles on water scarcity, air pollution regulation, environmental law, multilevel governance, sustainability transitions, low carbon development, and the Sustainable Development Goals. He is currently serving as a lead author for the sixth assessment report of the Intergovernmental Panel on Climate Change (Chapter 17). His area of expertise includes co-benefits, the political economy of low carbon development, air pollution regulation, climate policy, and SDGs.

13. Ms. Glynda Bathan-Baterina is a Deputy Executive Director of the Clean Air Asia. She is a lawyer with 20 years of experience in policy development for clean air, sustainable transport, and climate change mitigation. She helped draft the 1999 Philippine Clean Air Act Implementing Rules and Regulations and led the Asia Clean Fuels and Vehicles program which resulted in cleaner fuels and vehicle policies and roadmaps for Vietnam and the Philippines. Glynda holds a Master's in Environmental Management degree from the Ateneo de Manila University and the University of San Francisco;

and a Bachelor of Laws from the University of the Philippines.

14. Prof. Toshihiko Takemura is a Distinguished Professor at Research Institute for Applied Mechanics, Kyushu University, Japan. He obtained his Doctor of Science degree in 2001 from the University of Tokyo. His research field includes numerical simulations of climate change and air pollution caused by atmospheric aerosols. He is a highly cited researcher for seven consecutive years (2014-2020). He received Japan Academy Medal in 2019. He is the lead author of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). He is a member of the Science Panel of the Asia Pacific Clean Air Partnership (APCAP).

15. Dr. Johan C.I. Kuylenstierna is a Research Leader at Stockholm Environment Institute (SEI), a member of SEI's Global Research Committee, and Reader at the University of York, UK. He is a member of the Scientific Advisory Panel (SAP) of the Climate and Clean Air Coalition (CCAC). Key areas of interest related to the integration of strategies to address climate change and air quality, in particular, associated with strategies to reduce Short-Lived Climate Pollutants (SLCPs). He is part of a team developing an SLCP strategy support tool – LEAP-IBC – being used by many governments to develop national integrated air pollution and climate change mitigation strategies. He also contributed to assessing the impacts of air pollution on human health such as on pre-term births and asthma. He coordinated a UNEP/WMO integrated assessment on Black Carbon and Tropospheric Ozone and is an author of the CCAC/UNEP Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions.

16. Ms. Maria Katherina Patdu is an Associate Programme Officer at the United Nations Environment Program's Asia and the Pacific Office. She coordinates the Asia Pacific Clean Air Partnership (APCAP), a regional partnership working to achieve measurable reductions in air pollution emissions in Asia Pacific. She has over 10 years of experience working on air quality issues in the region. Prior to joining UNEP, Kaye worked with Clean Air Asia helping develop air quality action plans and assessing status of air pollution in the region.

17. Mr. Sundeep is a Director at the Ministry of Environment, Forest, and Climate Change (MoEFCC), Govt. of India, New Delhi, India. He is also a Project Director for Society of Integrated Coastal Management (SICOM). He possesses more than 25 years of experience in environmental management, prevention, and control of industrial and urban pollution, enforcement and monitoring, framing environmental regulatory policies, programs and emission standards, appraisal of projects for environmental clearances, river basin rejuvenation programs, and wastewater treatment technologies. He is a graduate in Civil Engineering and Master's in Environmental Engineering. His technical contributions are acknowledged in many of the CPCB research-based publications including framing guidelines and protocols on pollution prevention, abatement, and control measures. Presently, he is coordinating the National Clean Air Program.

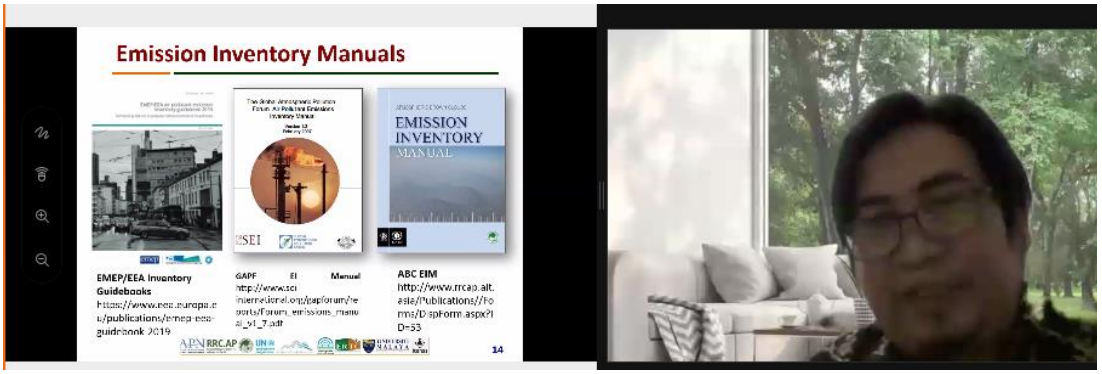
Annex 4: Snapshots during the workshop

Opening remarks of Dr. Naoya Tsukamoto, Director RRC.AP

Opening remarks of Mr. Yoichi Toyama, Director APN

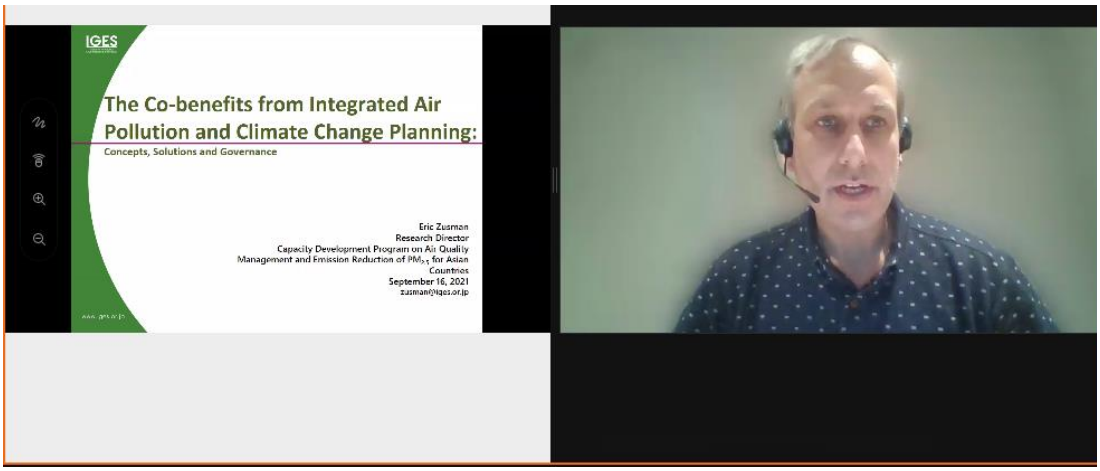
Opening remarks of Dr. Monthip Sriratana Tabucanon, Govt. of Thailand

Dr. R. L. Verma, Coordinator, AQM workshop at RRC.AP

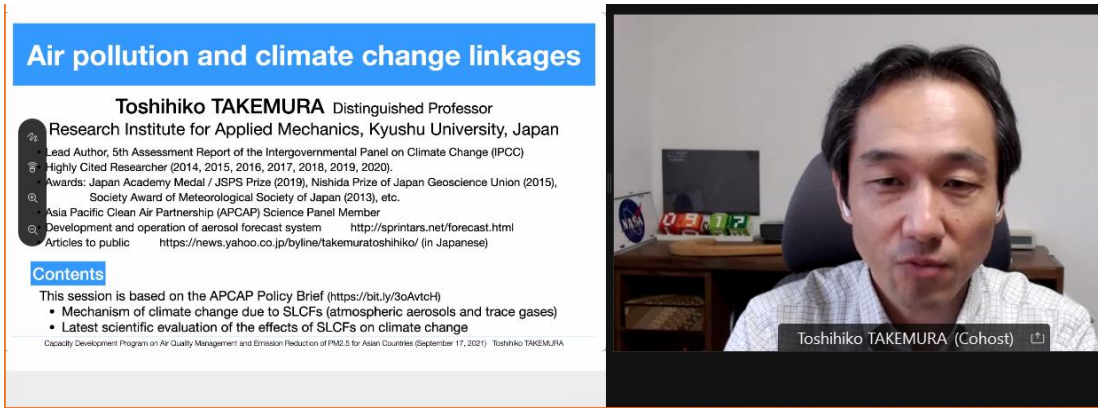


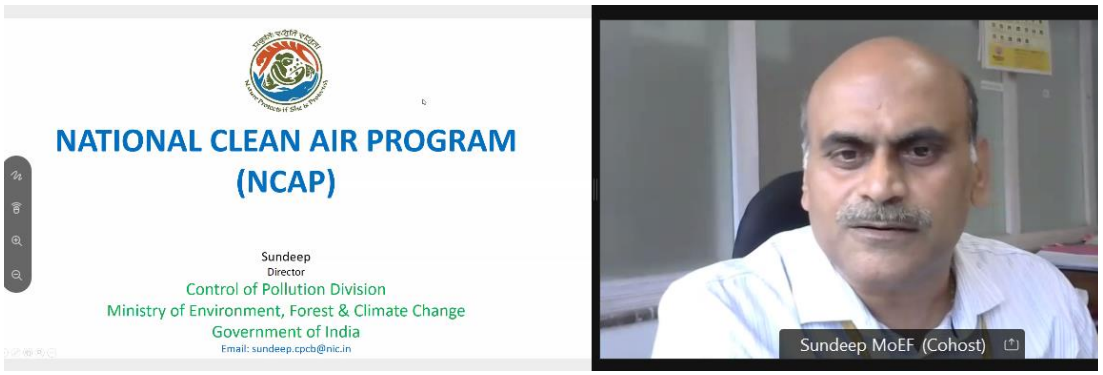
Dr. Didin Agustian Permadi, ITENAS, Indonesia


Impact assessment of air pollution on health
Capacity Development Program on Air Quality Management and
Emission Reduction of PM2.5 for Asian Countries
(13-17 September 2021)
Prof. Tze Wai WONG
Adjunct Professor, School of Public Health and Primary Care
The Chinese University of Hong Kong


IGES
The Co-benefits from Integrated Air Pollution and Climate Change Planning:
Concepts, Solutions and Governance
Eric Zusman
Research Director
Capacity Development Program on Air Quality Management and Emission Reduction of PM2.5 for Asian Countries
September 16, 2021
zusman@iges.or.jp


spectives on air pollution
mitigation strategies and actions
Asia
CLEAN AIR ASIA
Glynda Bathan_Clean Air Asia (Cohost)


Air pollution and climate change linkages
Toshihiko TAKEMURA Distinguished Professor
Research Institute for Applied Mechanics, Kyushu University, Japan
Lead Author, 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)
Highly Cited Researcher (2014, 2015, 2016, 2017, 2018, 2019, 2020).
Awards: Japan Academy Medal / JSPS Prize (2019), Nishida Prize of Japan Geoscience Union (2015), Society Award of Meteorological Society of Japan (2013), etc.
Asia Pacific Clean Air Partnership (APCAP) Science Panel Member
Development and operation of aerosol forecast system http://sprintars.net/forecast.html
Articles to public https://news.yahoo.co.jp/byline/takemuratoshihiko/ (in Japanese)
Contents
This session is based on the APCAP Policy Brief (https://bit.ly/3oAvtcH)
• Mechanism of climate change due to SLCFs (atmospheric aerosols and trace gases)
• Latest scientific evaluation of the effects of SLCFs on climate change
Capacity Development Program on Air Quality Management and Emission Reduction of PM2.5 for Asian Countries (September 17, 2021) Toshihiko TAKEMURA
Toshihiko TAKEMURA (Cohost)


NATIONAL CLEAN AIR PROGRAM (NCAP)
Sundeep
Director
Control of Pollution Division
Ministry of Environment, Forest & Climate Change
Government of India
Email: sundeep.cpcb@nic.in
Sundeep MoEF (Cohost)


Comprehensive Concept of PM2.5 Forecast: A Case Study in Thailand
Air Quality and Noise Management Bureau
Pollution Control Department, Thailand
Sakda Tridech (Cohost)


PLANNING FOR ACTION:
The Low Emissions Analysis Platform and Integrated Benefits Calculator
Johan Kuylenstierna
SEI Research Leader
CCAC SAP
Chris Malley
SEI Research Fellow
SEI Stockholm Environment Institute
LEAP

Annex 5: Evaluation questionnaire

Questions for each topic of presentation

Q1: How much did you know about the topic presented before the lecture? (Please rate your response from 1 to 10.)

Q2: How much of your knowledge and understanding had increased after the lecture? (Please rate your response from 1-10.)

Q3: What are the five key points you learned from this lecture?

Q4: Do you think the lecture had met your expectations and has there been new information you learned which will be useful to your work or study?

Q5: Do you think the lecture was too technical and you could not understand fully?

Questions for the whole workshop (summary evaluation and way forward)

Q1: How much did you know about all aspects of air quality management (i.e., monitoring, emission inventory, modeling, impact assessment, and mitigation policies) before the workshop? (please rate your response from 1 to 10)

Q2: How much of your knowledge and understanding on all aspects of air quality management had increased (i. e., monitoring, emission inventory, modeling, impact assessment, and mitigation policies) after the workshop? (please rate your response from 1 to 10)

Q3: Which module of the AQM workshop (1-5) do you like the most?

Q4: Which module of the AQM workshop (1-5) needs improvement in terms of contents?

Q5: Which lecture (P1-P18) do you like the most?

Q6: Which lecture (P1-P18) needs improvements in terms of contents?

Q7: Would you like to have further interaction with us for knowledge sharing and learning on air quality management or any particular module or an individual topic? Please let us know.

Q8: Would you be interested in developing project proposals on air pollution in your country or at the regional level, if any opportunity comes in the future?

Q9: Would you be interested to contribute in drafting a report on the status of air quality management in your country or at the regional level?

Q10: What is your overall experience of participating in the AQM workshop organized online?

Q11: What is your recommendation or suggestion to improve the quality in organizing the workshop online?

Annex 6: Compilation of Participants' Overall Comments

- This is knowledgeable.
- Well-organized and a lot of effort in the background. Excellent presenters.
- I improved my knowledge and science about air quality management and those applications
- The workshop provides deep knowledge and skills for participants. Presenters are enthusiastic people. Kindly express my thanks to the organizers.
- I am impressed with everything, especially the content, knowledge gained, and famous speakers.
- Excellent presentation to learn the shared knowledge and experiences from all speakers and participants
- It was excellent. Thank you AIT Team for providing the opportunity.
- Good arrangement and time scale for this workshop.
- This has been one of the best opportunities to get involved in learning about ambient air quality.
- It's a great workshop and well-organized. Thank you for sharing such great useful information. I am looking forward to attending the next workshop.
- To be honest, It was a great learning experience. In 5 days, I learned about all the holistic approaches in my area of interest.
- New knowledge and very useful.
- Expert speakers from many countries make the meeting interesting. And it is convenient when attending workshops online.
- Very brainstorming.
- It was really an important experience for me.
- Very Impressive.
- My skill and knowledge in this field of work have improved.
- In general, the majority of the talks are really informative and at the same time pose challenging questions, but also provided clear guidelines on the many possible steps to take and concepts and methods to consider. To be honest, I may not be able to attend this workshop if this was held in a face-to-face setting (funding issues, etc). That is why I feel fortunate to be able to attend.
- Excellent workshop!
- GREAT, and very enjoyable!

- To me, the workshop was successful and I plan to work with International Organizations and reveal the impacts of RRC.AP workshops in the world.
- Awesome!
- First AQM workshop online.
- Gain experience and knowledge about all aspects of AQM, including other tools and methods which are useful to develop our research project.
- Great experience Especially the provision of materials for a later review is a great feature. Appreciable work by Dr. Verma.
- I think the workshop is informative and covered different topics relating to air quality management. It's a pleasure listening and learning from experts in the field.
- I have improved my knowledge a lot on Air Quality Management from fundamental to advanced through the workshop. Moreover, the materials of the workshop were available on the website and the workshop was recorded and uploaded on YouTube which help me be able to easily review all of the lectures.
- The online workshop is a great opportunity to improve and share knowledge about AQM in general, especially in the covid-19 situation.
- This workshop provided me valuable knowledge about atmospheric chemistry and pollution in general, and specifically in my interested area, which is modeling. The sharing of knowledge was intense, essential, and the lecturers were experts in their respective fields.
- My overall experience is good and I learned a lot of things about air quality. The speakers were very knowledgeable on their topics and I am very happy to be a part of this workshop. In fact, it would be helpful in my graduate studies since I am studying MS Applied Physics specializing in Environmental Physics.
- It was good and waiting for this kind of webinar in the coming future.
- Good experience, the workshop was very well-organized.
- This was a good opportunity for us. We are at home now because of the covid situation. We gained knowledge & refresh our learnings about air quality.
- Overall it is good, but actually, participants can’t concentrate well in an online workshop, so I request if possible to have some workshop in AIT.
- At first, I did not understand much since the area covered was relatively more advanced than what I am used to. However, towards the end of the workshop, I did gain valuable knowledge that will help me with my final year project relating to dicarboxylic acids and the formation of secondary organic aerosols. I have also grown accustomed to the advanced field of air pollution which is my main reason for joining this workshop.

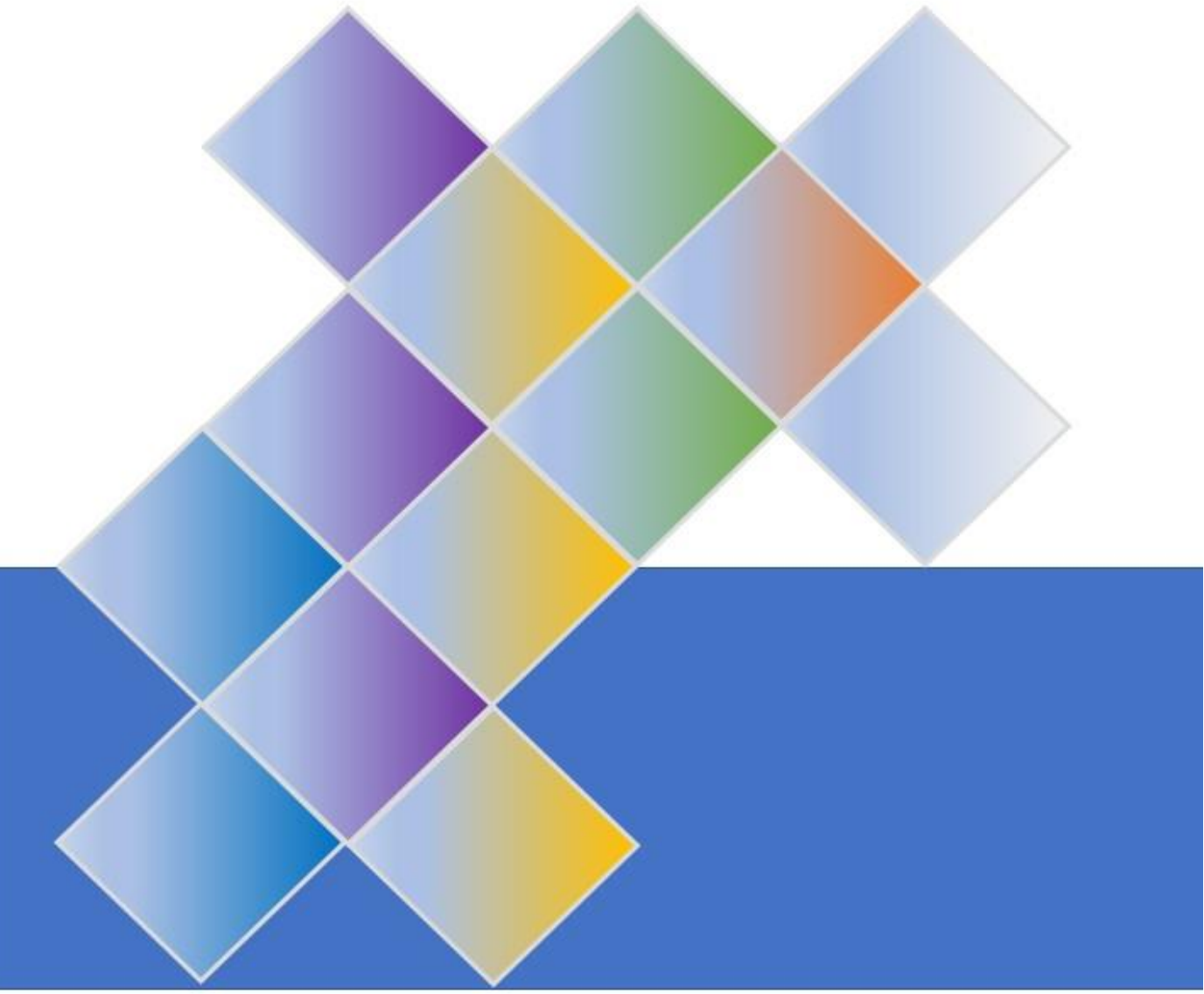
- The workshop overall is excellent. Providing the whole video sessions, reading materials, and powerpoints of every module made it even more possible for attendees to review the parts they missed or had difficulty in understanding.
- It was well organized and there was absolutely no problem with it content-wise and also presentation-wise.
- It was informative and very valuable.
- This workshop can enhance my knowledge about air pollution issues to support my work.
- Interesting and I am able to identify expertise from various countries.
- I'm beyond happy to join as a participant in the AQM workshop. That's a really great workshop and very insightful for me. My knowledge of the air quality has been well-improved since I join this workshop. I'm so excited for what's the next event to come!
- It was so much helpful for me to broaden my knowledge about atmospheric chemistry.
- Overall, I have learned many new things that I can use for my final year project thesis. Even though some of the topics and words are very new to me, I am able to understand the basic knowledge of it.
- Well-organized.
- It was the most comprehensive training related to AQM I've ever attended.
- Learned many new things. Met other researchers.
- Get more knowledge about air pollution management.
- I got a lot of new knowledge like how to improve the air.
- Improved knowledge on future air pollution management.
- I learned more about how to manage the environment in Asian countries.
- I gathered so much knowledge about air quality from the preliminary stage. It is a great advantage for me as a master's student in the Environmental Engineering field.
- It was great to gain new knowledge.
- Just sharing my honest feedback. The overall experience exceeds my expectation indeed! I was being largely fascinated by a wide range of reading materials, PowerPoint slides, and recorded videos. These rich materials played an important role to broaden my knowledge and spur me to dive into learning air quality policy issues in the long term. I sincerely appreciate AIT Team! You guys rock!
- It's a good lecture. And it's a very good experience to attend such lectures.
- The workshop highly contributed to enhancing my subject knowledge and looking forward to applying the knowledge gained to improve the air quality in my country.

Further, the workshop provided the opportunity to interact with experts in the subjects and insight to air quality practices in several other countries.

- This workshop is very important and useful for me. I can compare policies and programs that have been implemented by other countries in controlling air pollution. Knowing the development of air quality monitoring methods, tools that can be used in determining policies related to air pollution. Also, currently, as I am in a study assignment position, so I can dig up material for my upcoming thesis.
- It was an overwhelming experience for me to participate on this AQM workshop organized online.
- I upgraded my knowledge from the workshop. I learned so many new things learned.
- It was a really valuable training to develop our capacity in developing Air Quality Management reports in Sri Lanka. Further, it gave a sound knowledge in developing the emission inventory & formulating air & health quality impact assessment.
- Well-organized and the time management is superb.
- One of the best workshops.
- It is a nice experience to participate in this AQM workshop. It is a great workshop, and I received a lot of useful information and knowledge. Thank you so much.
- I can improve my knowledge on air pollution and climate change, particularly on air quality forecasts and planning.
- It is nice to get knowledge from the experts and their valuable experience. Hope this kind of workshop will continue to be organized to gain more knowledge and get updated of the projects that are still ongoing for better air quality in the future.
- Very Excellent.
- Great opportunity of learning new things from this workshop.
- Really important. Helpful. Thank you very much!
- It was very good that the workshop provided resources and media for me to open even after the lecture to review and to remember important information.
- Very useful to all of the participants.
- Excited and enjoyed
- The contents are great and world-class. However, being able to talk to other participants and knowing their experience in air quality management related to the topics being discussed would be most helpful as a means of sharing ideas and networking.
- This is very good. I likes to have more of this. Hopefully, there will also be an opportunity to cover the technical part.

- Very satisfied with the presentations and the organization of the workshop.
- I broadened my horizon related to air quality management, typically continuous emission inventory issues, and chemical transport modeling for aerosol and gas phases. Furthermore, I discovered in terms of the clean air action plan in India and the ASEAN countries and the benefits of air quality changes for human health, crop yield, and others.
- It is a vey good and valuable experience by participating in the workshop.
- I learned new things and saw how society functions in this Asian region.
- Physically attending is more preferred than virtual one. However, it is greatly appreciated conducting the AQM workshop via online with the prevailing pandemic situation.
- It was amazing.
- I am really grateful to be a participant of this very well-organized seminar.
- It was informative and excellent.
- I enjoyed and learned a lot.
- It was very insightful and helped me to understand better.
- Gain much more knowledge.
- It was good to learn about the perspective of AQM for the future and how it is depicted. It should be more accessible to people in simple language for public awareness.
- Indeed, it was a wholesome experience in a wide spectrum of the field. Gained knowledge from the very basic to advance. Will be hoping to attend such a program in near future.
- It is considered a very good experience to update knowledge from the online AQM workshop.
- This was the best learning experience as far as AQ is concerned.
- Very satisfied.
- It was a nice workshop and I learnt many new knowledge and activities.
- Excellent.
- Enjoyed and really gained new knowledge.
- Very well-organized
- This training helped me achieve new knowledge about air quality technology and air quality management. I have learned about many case studies that enhance my understanding. The course was a valuable experience for me and I believe I could apply it in my works certainly.

- It was a great learning, especially from the Q & A sessions with the experts of the subject matter or the given topics.
- It's interesting and helpful. If it will be organized offline in the future, then we can learn more things from that.
- Excellent workshop.
- It was good and informative. Many new dimensions have been explored.
- The content of this course made me familiar with more issues to see what activities the other departments did and what achievements they had so that I could use them in my work.
- Learning about all the aspects involved in the mitigation and monitoring of Air Pollution has been a huge step in the right direction for me. Hearing from experts in their respective fields and seeing the work they have done or are doing was a great experience.
- AIT did a really good job in organizing such a technical workshop virtually, despite the challenges involved. Special credit goes to Dr. Ram Lal Verma, who coordinated individually with each and every participant, and remained active & facilitative even during each workshop presentation.
- In my 3 years of working as a government regulator in the field of air quality monitoring/control, this AIT training was my first. And the credit for this also goes to AIT for keeping the participation open to all those interested - and that its free of cost too! (Limited funds being a persistent constraint in developing countries).
- I am hopeful that the things I learned during the workshop will help me perform a better job as environmental pollution control regulator.



Regional Resource Centre for Asia and the Pacific
Asian Institute of Technology
58 Moo 9, Km 42, Paholyothin Highway
P.O. Box 4, Klong Neung, Klong Luang, Pathum Thani - 12120, Thailand
Email: info@rrcap.ait.ac.th
Website: http://www.rrcap.ait.asia/