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REVIEW OF PROGRAMME PLANNING AND IMPLEMENTATION

(Item 5(a) of the provisional agenda)

Transboundary Air Pollution in North-East Asia

Note by the Secretariat

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I. OVERVIEW OF PROGRESS

1. In 2012, NEASPEC completed the implementation of a project on the "Review of existing and required capacities for addressing adverse environmental impact of transboundary air pollution in North-East Asia". The project conducted a comprehensive review of existing regional and multilateral mechanisms and scientific studies on air quality monitoring and management, which include the Acid Deposition Monitoring Network in East Asia (EANET), the Joint Research Project on Long-range Transboundary Air Pollutants in North-East Asia (LTP Project), the Model Inter-Comparison Study in Asia (MICS-Asia) and the Convention on Long-range Transboundary Air Pollution (LRTAP). This review showed strong potential for further improvement of national and subregional capacity on air pollution issues both on technical and policy levels, and identified existing gaps and possible steps forward.

2. The review also highlighted some common recommendations from existing mechanisms including the development of a subregional framework that promotes a holistic approach covering all components of transboundary air pollution management, strengthen connections between science and policy, and provide channels for open and effective exchange of knowledge and information, etc.

3. As a follow-up to the review, the Russian Government presented a new project proposal entitled "the Development of Technical and Policy Framework for Transboundary Air Pollution Assessment and Abatement" to the 17th Senior Officials Meeting (SOM-17) held in 2012. The proposed Project aims to enhance cooperation on assessment and mitigation of transboundary air pollution in the subregion through promotion of common methodologies and establishment of a framework that would function on a continual basis. Activities under the proposed project include data and technology assessment, modeling study, formulation of a conceptual approach to the development of the framework, and extensive expert discussions. Subsequent to the SOM-17, member States have been further consulted on the proposal to clarify and resolve different views and questions on proposed approaches and activities.[1]

4. The SOM-18 in November 2013 endorsed the proposal while noting respective suggestions of member States on the key components and approach of the project, which includes a comprehensive subregional framework (ROK), capacity training and information exchange (China), the efficient use of resources and close collaboration with existing programmes (Japan), and the link with existing bilateral programmes (Mongolia).

5. Further to the endorsement, the Secretariat held an Expert Group Meeting (EGM) on 1 May 2014 in Incheon, ROK, to discuss technical approaches and activities, develop an

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[1] The consultation process and views of member States were summarized in the SOM-18 document on transboundary air pollution, which is available on the NEASPEC website. (http://www.neaspec.org/sites/default/files/1.%20SOM18_TAP.pdf)

overall implementation plan for data assessment, modeling and framework concept development, and discuss the role of national implementing bodies and experts. The EGM was attended by national focal points/experts nominated by member Governments, and the representative of the CLRTAP.

6. The EGM came to the conclusion that subregional cooperation framework on transboundary air pollution needs to be strengthened in order to involve all subregional members and scientific assessment with high policy relevance. Recommendations of the EGM on the proposed framework are as follow.

- **Target pollutants:** $PM_{2.5}$, PM_{10} and Ozone and their linkages with other pollutants including SO_x, NO_x, Black Carbon, NH_3 and VOCs.
- **Priorities of the framework:** (a) health impact of air pollution, (b) policy scenarios, (c) emission inventory, (d) abatement technology assessment, (e) modeling of source-receptor relationship of transboundary air pollution, policy scenarios, impact assessment, etc.
- **Focuses of the activities under the current project:** modeling of source-receptor relationship of transboundary air pollution in collaboration with the planned modeling work of LTP and relevant research, and by utilizing national emission inventories and EANET monitoring data.
- **Implementing body of the modeling:** the Scientific Research Institute for Atmospheric Air Protection (SRI), the Russian Federation, and respective national institutions including the Chinese Research Academy of Environmental Sciences and Busan National University, Republic of Korea, and national experts involved in LTP modeling.

II. REVIEW OF SUBREGIONAL WORK PERTAINING TO THE PRIORITIES OF THE FRAMEWORK

A. Modeling of source-receptor relationship (SRR)

7. SRR modeling using chemical transport models (CTM) is the key to quantify the impacts of long-range transport of air pollutants on each other, and thus provide a scientific basis for cooperation. The EGM therefore decided to carry out a SRR analysis and connect it with the planned work of LTP. The SRR modeling has been a key programme of LTP, which divides the three countries into five separate regions: Northern, Central, and Southern China, Republic of Korea and Japan, and focuses on sulfur dioxide (SO_2) and nitrogen oxides (NO_x). Through the work of LTP during last ten years, participating scientists have substantially narrowed the gaps in understanding transboundary movement of air pollutants through coordinating modeling methodologies such as air quality models and meteorological models,

and improving quality of input data. As a result, the value disparity in SRR modeling among participating countries has been significantly narrowed.

8. ***Air quality models.*** The NEASPEC Project can benefit from the accumulated experiences of SRR modeling under LTP as well as the use of the same chemical transport model, Community Multiscale Air Quality Model (CMAQ). National experts of China and the Republic of Korea involved in both LTP and this Project are currently using CMAQ, which has multi-pollutant capabilities to address diverse air quality issues including photochemical ozone, airborne particulate matter and air toxics, and, as a multi-scale system, covers all hemispheric, continental, regional and urban modeling domains. The Scientific Research Institute for Atmospheric Air Protection (SRI) also plans to use this model. While Japanese experts use their own model, Regional Air Quality Model (RAQM), developed by the Asia Center for Air Pollution Research (ACAP) which also acts as the network center of EANET, the application of different models should not hinder the modeling work considering a decade-long experience of joint modeling exercises under LTP.

9. Furthermore, as the proposed framework targets secondary pollutants (PM and Ozone),[2] the SRR modeling under this Project as well as the framework requires taking account of more complex variables associated with seasonal variations, microclimatic conditions, nonlinear chemical reactions and photochemical reactions for higher accuracy of the results. This requires the application of advanced methodologies that provide more detailed and quantitative information about the contribution of selected sources, source categories, and concentrations of target pollutants, and calculate the spatial and temporal sensitivity of pollutant concentration with respect to the change of emissions.[3] As CMAQ supports the application of such advanced methodologies, the Project will involve consultations among national experts on this matter.

10. In terms of the domain of SRR modeling, SRI has suggested to focus on the territories of all NEASPEC member States within 30°N-60°N (latitude) and 100°E-145°E (longitude) for mother domain with the resolution 150 km x 150 km. The proposed scope of the mother domain is slightly different from the scope of LTP[4] while it will have more in-depth study with regard to Mongolia and the Russian Far East. Nevertheless, finalizing the scope and resolution will be the subject of further discussions among experts.

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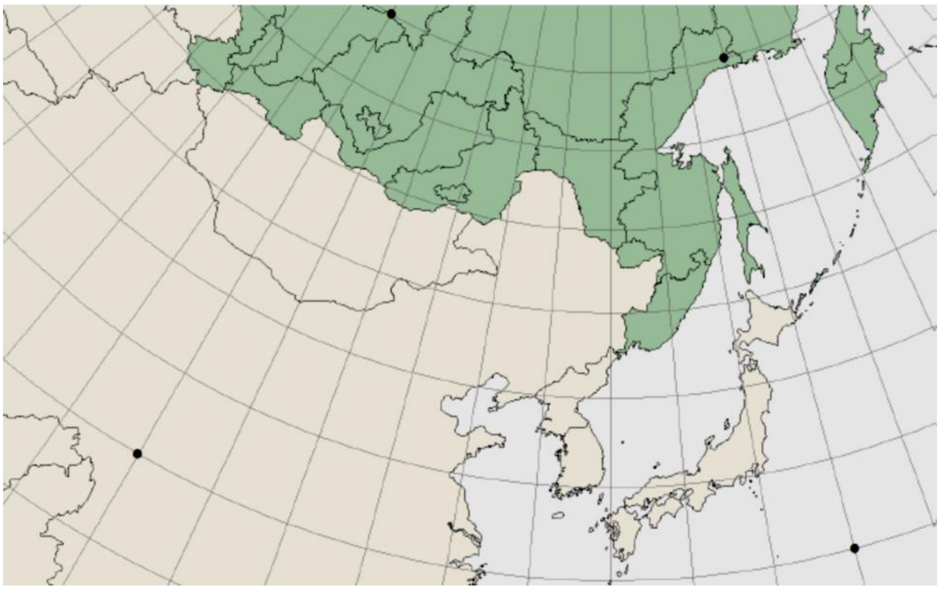
[2] Secondary pollutants are those formed in the atmosphere through chemical reactions from the primary pollutants such as Sulfur Oxide, Nitrogen Oxides and Volatile Organic Compounds.
[3] Such methodologies are PPTM (Particle & Precursor Tagging Methodology) and HDDM (High-order Decoupled Direct Method).
[4] LTP covers 20°N-50°N (latitude) and 100°E-150°E (longitude).

[Map 1] Proposed Mother Domain



The black dots indicate the proposed domain.

11. ***Emission Inventories.*** The SRR modeling requires reliable data from emission inventories. An emission inventory includes estimates of emissions from various pollution sources within a specific geographical area. The quality of modeling depends on the accuracy, comparability (among participating countries), completeness (all sources and pollutants) and consistency (across reported years) of input data.[5] NEASPEC member States have developed (sub)regional emission inventories, notably, Regional Emission Inventory in Asia (REAS) by Japan and Comprehensive Regional Emissions inventory for Atmospheric Transport Experiments (CREATE) by the Republic of Korea.

12. REAS, developed by Frontier Research Center for Global Change and National Institute for Environmental Studies of Japan, covers all major air pollutants for East Asia, South Asia and the Russian Far East except China and the ROK.[6] CREATE, developed by Kunkuk University and National Institute of Environment Research of the ROK, has similar geographical scope of REAS with a particular focus on China, Japan and the ROK with their updated national data.

13. At international level, notable regional inventories include those under the Greenhouse Gas-Air Pollution Interactions and Synergies (GAINS) Asia, which is developed by International Institute for Applied Systems Analysis (IIASA). GAINS Asia aims to explore cost-effective emission control strategies that simultaneously tackle local air quality

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[5] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013: Technical guidance to prepare national emission inventories

[6] For China and the ROK, REAS covers only CH_4 and N_2O (Woo, Zhang, Ohara, *et.al*. 2014, Summary of emission data provided to topic 1.).

and greenhouse gases, so as to maximize benefits at all scales. Model Inter-Comparison Study (MICS) Asia, is currently implemented as a research activity of EANET and the current phase III of MICS Asia has an activity component of developing the MIX Asia Emission Inventory. Scientists lead it from China, Japan and the ROK to improve the reliability of the existing emission inventories and understand uncertainty of bottom-up emission inventories in Asia. In this connection, the MIX inventory will be built utilizing national inventories including China Multi-resolution Emission Inventory (MEIC), Japan Auto-Oil Program Emission Inventory-Data Base (JEI-DB) and ROK Clean Air Policy Support System (CAPSS) and REAS for emissions from other countries in Asia.

14. Such regional inventories are linked with global inventories such as EDGAR (Emission Database for Global Atmospheric Research) – HTAP (Hemispheric Transport of Air Pollution) Emission Inventory, which was developed to harmonize and improve emission inventories at global scale. It incorporates annual data of all major air pollutants for the period 2000-2005 using existing regional emission inventories including REAS (East Asia), GAINS (Asia and Europe), European Monitoring and Evaluation Programme (EMEP for Europe and North America) and global inventories, UNFCCC and the earlier version of EDGAR.

15. This brief overview of national, regional and global inventories show high levels of interaction and integration of emission inventories of China, Japan and the ROK with regional and global inventories, which provides opportunities for harmonization of methodologies. However, the participation of the other three NEASPEC member States in these processes have been very limited while the Russian Federation has the opportunity of interaction and integration with EMEP processes through this Project. The overview also shows the availability of data for the SRR modeling under the NEASPEC Project while the project and the new subregional framework could work on the improvement of availability, completeness and comparability of updated national annual data of all member States.

B. Health impact of air pollution

16. As the frequency and level of air pollution increase, concerns on its health impact have grown significantly. Exposure to air pollutants, especially particulate matters, could cause or worsen various health conditions, including lung cancer, bronchial asthma, cardio cerebral vascular diseases, pulmonary mortality, atherosclerosis, coronary heart disease, birth defects and premature death.[7] Researchers have been studying the correlations between air pollutants and adverse health impact, but there are different methodologies,

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[7] Dongmug Kang and Jong-Eun Kim, "Fine, Ultrafine, and Yellow Dust: Emerging Health Problems in Korea", *J Korean Med Sci* 29: 621-622 (2014)

subjects, pollutants studied under different circumstances and there are knowledge gaps especially when applied to specific local circumstances.

17. Several studies on air pollutants occurring in ENEA have been conducted as the level of particulate matters (PM) in ambient air and yellow sands of the subregion become higher. Topics of such studies include the prevalence of diseases, mortality rates or the frequency of hospital visits, and the relevance with different sizes and components of PM to health impacts. In general, it has been concluded that PM has adverse influence on human health. One of the studies traced airborne particulates movement from the desert areas in Mongolia to Beijing and Seoul where it influenced particulate concentration, and the study concluded that health impact can differ depending on the locations of the cities along the path.

18. ***The composition of PM.*** PM tends to be formed in the atmosphere from chemical reactions and contain metals or chemicals which are hazardous to human health and the ecosystem. Several studies focused on the impact of PM-components found that (1) the inhalation of certain components of PM at almost same level of current ambient $PM_{2.5}$ mass concentration is associated with adverse health effects; and (2) combustion-derived components such as heavy metals or organic compounds are likely to be primarily responsible for adverse health effects. One study showed that exposure to manganese and lead in the particles could reduce the peak expiratory flow rate of school children aged 9-12.[8] Due to the varying components of PM, it has not been possible to conclude the specific health impact of each component. However, no components show clear evidence of zero health impact.[9]

19. ***Health Impacts.*** Researchers also examined the effects of particulate pollutants to human health. According to the study conducted in Shanghai and Beijing, China, the increase of $PM_{2.5}$ has led to the increase of total, cardiovascular and respiratory mortalities as well as hospital ER visits for cardiovascular disease and hypertension.[10] $PM_{2.5}$, as a major cause of choking smog, has also taken over smoking tobacco as the top risk factor for lung cancer without invention. When compared to PM_{10}, $PM_{2.5}$ can more easily penetrate further into lungs and blood circulation system, causing cardiovascular, cerebrovascular and respiratory diseases as well as lung cancer.[11] During the past decade, lung cancer rate in Beijing has increased by 60 percent despite no apparent increase in overall smoking rate.

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[8] Yun-Chul Hong, *et al.*, "Metals in Particulate Pollutants Affect Peak Expiratory Flow of School children", Environ Health Perspect 115: 430-434 (2007)

[9] A.C. Rohr and R.E. Wyzga, "Attributing health effects to individual particulate matter constituents", *Atmospheric Environment* 62: 130-152 (2012); for further information on literature review, please see tables 1 and 3.

[10] Fan Meng, "Review of the main activities on transboundary air pollution in Northeast Asia: with focus on China", NEASPEC Secretariat (2012)

[11] "Dangerous Breathing – $PM_{2.5}$: Measuring the human health and economic impacts on China's largest cities", Greenpeace China (2012)

Selected outdoor air pollutants and their effects on health are summarized in the Table[12] below.

Pollutant group (source)	Known health effects	Contributing or potentiating factors/agents	Populations especially vulnerable
Particulate matter (biomass and fossil fuel combustion in home heating, industry and motor vehicle engines; cigarette smoke)	upper respiratory tract irritation and infection; exacerbation of and increased mortality from cardiorespiratory diseases	sulfur dioxide, sulfuric acid; cold, heat, humidity	elderly people with respiratory and cardiovascular diseases; childern with asthma
Sulfur dioxide and acid aerosols (fossil fuel combustion; metal smelting and petrochemical industries; home heating/cooking with coal)	throat irritation; exacerbation of cardiorespiratory diseases, including asthma	exercise, particulates, asthma	people with respiratory diseases (eg. children with asthma); elderly people with respiratory and cardiovascular diseases
Oxides of nitrogen (fuel combustion at high temperature [eg. from vehicle engines, gas cooking and heating])	eye irritation; upper respiratory tract infection (especially in children); exacerbation of asthma; irritation of bronchi	exercise, respiratory tract infection, asthma	people with respiratory diseases (eg. children with asthma)
Ozone (reacion product of sunlight and vehicle pollutants; hydrocarbons and oxides of nitrogen)	eye and throat irritation; reduced exercise capacity; exacerbation of respiratory disease	exercise, respiratory tract infection, asthma	people with respiratory diseases (eg. children with asthma)
Carbon monoxide (biomass and fossil fuel combustion; cigarette smoke and vehicle exhaust)	Headache, nausea, dizziness, breathlessness, fatigue, visual disturbance, confusion; angina, coma, death; low birthweight (after maternal exposure during pregnancy)	coronary artery disease	people with ischaemic heart disease
Lead (smelting; leaded petrol [now banned in Australia])	childern: neuropsychological and cognitive effects adults: hypertension,	other sources of lead; iron deficiency	children, pregnant women

[12] Tord E Kjellstrom, *et al.*, "Air pollution and its health impacts: the changing panorama", the Medical Journal of Aurstralia 177 (11): 604-608 (2002)

	classic lead poisoning		
Other pollutants; "air toxics" (hydrocarbons, aldehydes, other organic compounds, asbestos)	eye irritation; lung cancer; asthma	smoking, occupational exposures	smokers, asbestos workers, people with asthma, children
* Adapted from WHO air quality guidelines			

20. Many countries including NEASPEC member States are now establishing new regulations on air pollutants reduction, some epidemiological evidence shows that air pollution, even at levels below the commonly used air quality guidelines, increases mortality rates.[13] In order to assess health impact from air pollutants more accurately, the subregion needs to (1) collect sufficient data of PM, ozone and other pollutants, (2) improve certainties with regard to emission inventories and modeling systems, (3) share relevant data and methodologies, and (4) develop a holistic and unified methodology. The NEASPEC Project will contribute to subregional cooperation that improves the understanding and mitigation of health impacts from air pollution.

III. ISSUES FOR CONSIDERATION

21. The Meeting may wish to request member States to endorse the conclusion of the EGM and provide further guidance on the approach and implementation plan of the project.

22. The Meeting may wish to invite member States to express any intended technical support to the project and inform any national processes that are directly relevant to the activity components of this project.

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13 *Ibid.*

[Annex]

Expert Group Meeting on NEASPEC Project
"Development of the Technical and Policy Frameworks for Transboundary Air Pollution Assessment and Abatement in North-East Asia"

1 May 2014, Incheon, ROK

Conclusions of the Meeting

- The Expert Group Meeting (EGM) on NEASPEC Project "Development of the Technical and Policy Frameworks for Transboundary Air Pollution Assessment and Abatement in North-East Asia" was held on 1 May in Incheon, ROK, to discuss the approaches and plan of the Project.

- The EGM came to a conclusion on the need for strengthening North-East Asia focused voluntary cooperation framework on transboundary air pollution considering the need for subregional cooperation covering all subregional members and involving scientific assessment with high policy relevance.

- The EGM discussed potential target pollutants of the proposed framework and came to a general conclusion to focus on PM2.5, PM10 and Ozone considering the level of national concerns in member countries, and their linkages with other pollutants including SOx, NOx, Black Carbon, NH3 and VOC.

- Experts had a common view on the need of impact assessment of air pollution at the subregional level while noting various existing and planned research activities at national, regional and global levels. Experts agreed that assessing health impact of air pollution should be prioritized. In this regard, the EGM noted the importance of harnessing results of such research for subregional assessment in order to maximize mutual benefits and avoid potential duplications.

- Considering insufficient science-policy linkage in current cooperation in North-East Asia, the EGM recognized the work on policy and economic development scenarios, for instance, as an important means to strengthen the linkage, and the importance of such work to be conducted under the umbrella of an intergovernmental mechanism in order to have policy impact.

- The EGM noted that the work of the proposed framework on policy scenarios, emission inventory and abatement technology assessment could be priority areas providing added-value to existing efforts and strengthening subregional cooperation in terms of both science and policy. The EGM also recognized the significant potential of such work in contributing to relevant regional /global processes.

- The EGM noted that the proposed framework would need to cover modeling on source-receptor relationship of transboundary air pollution, policy scenarios, impact assessment, etc., to strengthen subregional cooperation.

- To develop the concept of the framework, the EGM agreed to focus on the modeling on source-receptor relationship, to seek collaboration with the planned modeling work of LTP, to utilize national emission inventories where available and expert estimates as well as EANET monitoring data, and to take stock of results from recent relevant research.

- The EGM agreed that modeling will be carried out by Scientific Research Institute for Atmospheric Air Protection, the Russian Federation, and respective national institutions including Chinese Research Academy of Environmental Sciences and Busan National University, Republic of Korea and national experts involved in LTP modeling.

- The EGM agreed to seek the collaboration and contribution from other international research institutions including International Institute for Applied Systems Analysis.

- The EGM noted there will be further communication regarding planned work and administrative arrangements by end of June 2014 between the NEASPEC Secretariat and participating institutions and experts requiring funding from the Project.