Internal Ex-Post Evaluation for Technical Cooperation Project (SATREPS[1])

Conducted by Mexico Office: February 2023

Country Name	**Joint Research Project on Formation Mechanism of Ozone, VOCs, and PM2.5 and Proposal of Countermeasure Scenario**
United Mexican States	

I. Project Outline

Background	In Mexico, although the critical situation on air pollution was improved in 1990's, (particularly in the Mexico City Metropolitan Area), air pollution control had been continuously an important policy issue since the air pollution was expanding to the rural areas. Photochemistry air pollution is mainly caused by Ozone which is produced by photochemistry reaction of NOx (nitrogen oxides) and VOCs (volatile organic compounds) by ultraviolet radiation. The strong oxidation by Ozone adversely affects human body and ecological system. VOCs include toxic elements such as benzene and toluene. VOCs produce PM (particle matter) 2.5 which induces health problems, in particular, on respiratory tract, as a result of reaction against Ozone. Therefore, it was necessary to research on formation mechanisms of such pollutants and countermeasures.		
Project Objectives	Through evaluation of the dynamics of VOCs and PM2.5 in the atmospheric environment as well as personal exposure level to VOCs, and elaboration of countermeasure scenarios to mitigate air pollution, the project aimed at enhancement of capacity to study formation mechanism of Ozone, VOCs and PM2.5 and to develop proposal of co-benefits countermeasures scenario based on key scientific findings. 1. Expected Overall Goal: None 2. Project Purpose: Capacity to study formation mechanism of Ozone, VOCs and PM2.5 and to develop proposal of co-benefits countermeasure scenario based on key scientific findings are enhanced.		
Project Activities	1. Project Site: Mexico City, Monterrey, Guadalajara 2. Main Activities: 1) Development of the ozone measurement system and measuring of distribution of Ozone and meteorological factors in atmospheric environment, 2) Evaluation of dynamics of VOCs in atmospheric environment, 3) Establishment of instrumental analytical systems for specification of PM2.5 and evaluation of dynamics of PM2.5 in the atmospheric environment, 4) Evaluation of personal exposure level to VOCs including Aldehydes, PM2.5 and CO, 5) Establishment of database by utilizing monitoring data produced by the three target cities and estimation of rates of contribution of emission sources to air pollution, 6) Elaboration of countermeasure scenario to mitigate air pollution, and so on. 3. Inputs (to carry out above activities): Japanese Side 1) Experts: 18 persons 2) Trainees received: 24 persons 3) Equipment: Ozonesonde observation system, slit-jet air samplers, ion chromatography, automatic air samplers, servers for modeling, and so on. Mexican Side 1) Staff allocated: 40 persons 2) Facilities and land: Laboratory and project office in INECC 3) Equipment: Analytical equipment, including X-ray fluorescence analyzer 4) Local operation costs: Utility costs, travel expenses for staff		
Project Period	Ex-ante: January 2011 – December 2015 Actual: January 2011 – December 2015	Project Cost	Ex-ante: 287 million yen, Actual: 255 million yen
Implementing Agencies	National Institute of Ecology and Climate Change (INECC)		
Cooperation Agency in Japan	Ehime University		

II. Result of the Evaluation

< Special Perspectives Considered in the Ex-Post Evaluation >

[Evaluation on the achievement level of the Project Purpose by the time of project completion]

Since no verifiable indicator was set in the project design, the achievement level was verified based on the judgement by the terminal evaluation which was agreed by both parties of the counterpart and JICA.

[Verification of the achievement level of the expected Overall Goal]

Since there is no Overall Goal set in the project design, efforts for the utilization of the research outcomes such as the utilization of the scientific findings and monitoring data produced by the SATREPS project for policy/programs to be formulated by the targeted state governments and the federal government was verified as "the expected Overall Goal".

1 Relevance

<Consistency with the Development Policy of Mexico at the Time of Ex-Ante Evaluation >

The Project was consistent with Mexico's policies. In addition to the "National Development Plan" (2007) prioritizing "Environmental Sustainability", one of the five priorities, the "Sectoral Program of Environment and Natural Resources" highlighting the necessity of regular monitoring and management of air quality and pollutants and the "National Strategy for Climate Change" (2007) promoting mitigation measures including reduction of greenhouse gas were implemented.

<Consistency with the Development Needs of Mexico at the Time of Ex-Ante Evaluation>

[1] SATREPS: Science and Technology Research Partnership for Sustainable Development

The Project was consistent with Mexico's development needs for mitigating air pollutions based on scientific findings through study of formation mechanism of Ozone, VOCs and PM2.5.

<Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation>

The Project was consistent with Japan's ODA Policy for Mexico prioritizing support for environmental issues, as one of the three priority areas[2].

<Evaluation Result>

In light of the above, the relevance of the project is high.

2 Effectiveness/Impact

<Status of Achievement of the Project Purpose at the time of Project Completion>

The Project Purpose was achieved at the time of project completion. Through the research activities to produce the planned research outputs, the capacity to study formation mechanism of targeted air pollutants, Ozone, VOCs and PM2.5 was strengthened and the capacity to develop countermeasure scenarios was enhanced.

<Continuation Status of Project Effects at the time of Ex-post Evaluation>

The project effects have continued since project completion. INECC has still maintained the capacity obtained in the SATREPS project in terms of assessing the dynamics of transformation of pollutants in the Atmosphere (analytical capacities for particle assessment, VOCs analysis, personal exposure and modeling). In addition, INECC expanded the result of the SATREPS project through various projects with new organizations. So far, three new organizations have participated in the projects. INECC has been also working with the Megalopolitan Environmental Commission (México's Comisión Ambiental de la Megalópolis: CAME） which includes 7 States (Mexico City, State of Mexico, Hidalgo, Morelos, Tlaxcala, Puebla and Queretaro). There is an agreement within INECC and CAME for Air Quality Assessment of all components of the SATREPS project to be conducted in Mexico City, State of Mexico, Hidalgo, Morelos, Tlaxcala, Puebla and Queretaro (2019-2024). The activities included are: i) Monitoring of PM2.5 and VOCs in the Megalopolis, ii) Modeling of transport and photochemical transformations in the atmosphere by using photochemistry model of an automatic vertical profile system, iii) Personal exposure studies, and iv) Evaluation and assessment of monitoring networks.

In addition, new research projects related to the SATREPS project have been implemented in the States of Guanajato, Hidalgo and Monterrey under the collaboration with INECC and the states governments, SENMARNAT and the National Autonomous University of Mexico.

In terms of operation and maintenance of the research equipment provided by the SATREPS project, they have been almost good. For example, INECC has used Slit-jet air samplers and Ion chromatography in Mexico City Area for contingence assessment under cooperation among INECC, the Ministry of Environment and Natural Resources (SEMARNAT), and Mexico City Secretary of Environment and CAME. The main goal is to assess contingencies in ozone of the dry season. Also, INECC has been using the Modeling Servers to evaluate the air quality through photochemistry models of WRF-CHEM, and currently INECC is transferring to cloud systems. In addition, the X-Ray Particle Analyzer is to be used in Tula, Hidalgo; and other sites on Megalopolitan Area. However, some equipment, such as Ozonesonde observation system, has not been used at the time of the ex-post evaluation since official attribution for ozone observation is in the National Meteorological Service (NMS) and structure changes have been taking place at the NMS and a national ozone observation program has not been implemented in a regular basis.

<Status of Achievement for Expected Overall Goal at the time of Ex-post Evaluation>

Since the Expected Overall Goal was not set forth for this SATREPS project, this ex-post evaluation verified "efforts for utilization of the research outcomes by the project"[3]. The research outputs and results of the SATREPS project are included in the Air Quality Program of Nuevo Leon (Pro Aire Nuevo León Period 2016-2025), and all components of the SATREPS project including the Ozoneonde observation system are reflected in the Air Quality assessment in the capitol city and the six state governments (2019-2024) under the agreement between INECC and CAME as mentioned above. In addition, the results from the SATREPS project are also to be considered in the actualization of the Air Quality Program of Mexico City （Mexico City PROAIRE）(2021-2030) after finishing of the "Mexico City PROAIRE" (2011-2020) as well as the National Strategy of Air Quality 2018 (Until publication of the new Pro Aire, the previous one is still valid). Furthermore, the activities related to the research outputs of the SATREPS project have been aligned with the Sectorial Program for Environment and Natural Resources (Programa Sectorial de Medio Ambient y Recursos Naturales: PROMARNAT) (2020-2024). PROMARNAT includes all the activities for administration of the Federal Government for the period from 2020 to 2024. Besides that, the research outputs of the SATREPS project were included in the Air Quality Program of Nuevo Leon (PROAIRE Nuevo León Period 2016-2025).

Also, INECC has been disseminating the research outputs of the SATREPS project through the INECC homepage, including the Joint Research Project on the Mechanisms of Ozone Formation, Volatile Organic Compounds and PM2.5 and proposal of scenarios of measures for their control in the Metropolitan Areas of Mexico City, Guadalajara and Monterrey. INECC has the Operational Program (2020-2024) including a research project for air quality issues in order to protect people's health.

Additionally, through the learning obtained by the SATREPS Project among INECC-University of Ehime, it was possible to work for the first time in Mexico on cutting-edge research projects on air quality and its effect on climate change at the peer level, and several articles were published in Peer-reviewed journals. This experience was used by INECC in negotiations with the National Science and Technology Council (CONACYT) for the development of the "National Strategic Program on Climate Change and Air Quality (PRONACE)" with emphasis on cities and that will run from 2021-2024. PRONACE will coordinate national research on these issues and will allocate financially resources from CONACYT. With regard to actions at the international level, Mexico has provided learning from the SATREPS Project within the framework of the Forum of Ministers of the Environment of Latin America and the Caribbean and through south-south cooperation with El Salvador, and so on.

<Other Impacts at the time of Ex-Post Evaluation>

Some positive impacts by the SATREPS project were observed at the time of ex-post evaluation. The Authorities in the State and Local Governments learned the importance on scientific information to prevent air contamination and how the air quality modeling could help to

[2] Ministry of Foreign Affairs, "ODA Country Data book" 2010

[3] In case of SATREPS projects without Overall Goal, those expected impacts mentioned at terminal evaluation should not be considered for evaluation assessment at sub-rating for effectiveness/impact nor does at its overall rating).

the air quality forecast. Also, INECC developed the air quality modeling research, with one deputy director of modeling. Personnel of the State Governments of of Nuevo Leon, Jalisco and Mexico City; personnel of SEMARNAT; and the CAME improved their scientific literacy on air quality monitoring and control. INECC has training programs to air quality authorities of the local governments. The last training activity is planned for 2021

The Laboratory of INECC moved to a new location in 2018-2020 and secured the quality of the analysis done with the infrastructure obtained with the SATREPS project.

No negative impact by the SATREPS project was confirmed at the time of ex-post evaluation.

<Evaluation Result>

Therefore, both the effectiveness and impact of the project is high.

Achievement of Project Purpose

Aim	Indicators	Results	Source
(Project Purpose) Capacity to study formation mechanism of Ozone, VOCs and PM2.5 and to develop proposal of co-benefits countermeasure scenario based on key scientific findings are enhanced.	N.A.	Achievement Status: Achieved (Continued) (Project Completion) ● The capacity to study formation mechanism of targeted air pollutants, Ozone, VOCs and PM2.5 was strengthened through the production of the Outputs of the SATREPS project. ● The capacity to develop countermeasure scenario was enhanced through the production of the Outputs of the SATREPS project. (Ex-Post Evaluation) INECC started the following new research projects with other institutes: ● Low Emission Zone in Guadalajara (2019-2021): Collaborating with the Ecology Institute of the State Government of Guadalajara. The main output is to get information to prepare policy strategies for the City of Leon, the capital city of Guadalajara ● Air Quality Assessment in Tula, Hidalgo (2020-2021): Collaborating with CAME, the State Government of Hidalgo, the National Autonomous University of Mexico, and SEMARNAT. The main output is to assess information on the air pollution and environmental transformations in order to take measures to prevent it and to reduce the exposure of the population of Tula. ● Characterization of the environment of the monitoring stations currently in operation in the Metropolitan Area of Monterrey City (2020): Collaborating with the Centro Mario Molina, the State Government of Nuevo Leon. The main output of this project is to identify policy actions to reduce air pollution in the Metropolitan Area of Monterrey City.	- Terminal Evaluation Report, - JST Terminal Report, - Questionnaire survey to INECC

3 Efficiency

Both the project cost and the project period were within the plan (ratio against the plan:89%, 100%, respectively). The project outputs were produced as planned.

Therefore, the efficiency of the project is high.

4 Sustainability

<Policy Aspects>

The policies and programs related to research on air quality have been elaborated in the level of region and institution. The results of the SATREPS project were included in PROAIRE of the State of Nuevo Leon. Some of the actions and coordination with INECC were considered in the preparation of PROAIRE of the State of Jalisco and the review of the PROAIRE developed in 2018. For the Megalopolitan Area in Central Mexico, where Mexico City is included, CAME included the results and activities from SATREPS project in their activities as shown in their Working Plans. At the federal level, the results of the SATREPS project and cooperation with INECC was included in the National Strategy of Air Quality.

<Institutional/Organizational Aspects>

As mentioned above, INECC has the agreement within CAME for air quality assessment based on all components of the SATREPS project to be conducted in Mexico City, States of Mexico, Hidalgo, Morelos, Tlaxcala, Puebla and Queretaro (2019-2024). In addition, there have been joint activities with the State Government of of Nuevo Leon, Mexico City, Guanajuato, and CAME. The air quality modeling group, personal exposure, VOCs and particle matter groups of INECC participate in several project with CAME and with Monterrey City local government.

INECC has 10 scientists in the General Coordination of Contamination and Environmental Health who have been capacitated by the SATREPS project. Also, the relevant authorities have sustained the technicians trained by the SATREPS project: The National Center of Metrology with least 5 technicians, the Government of Mexico City with at least 2 technicians, the State Government of Nuevo Leon with at least 2 technicians and the Jalisco Government with at least 2 technicians.

Furthermore, INECC has cooperation with the Atmosphere Sciences Center (CCA) of UNAM, the Autonomous University of Ciudad Juarez, the Public Health National Institute, the National Center of Metrology , the National Council of Science and Technology under the National Strategic Program of Air Quality and Climate Change.

The Ministry of Environment and Natural Resources (SEMARNAT) confirmed on December 21,2021 that the person and authority of INECC will be part of Semarnat.

<Technical Aspects>

INECC has a legal mandate to make scientific research. The research line is implemented for air quality issues and projects are done every year. INECC has maintained the laboratory capacity and acquired independence by moving the laboratory to a new facility that belongs to the Ministry of Environment. INECC has also maintained the methodology of cooperation used in the SATREPS project and is now planning a similar project for Tula-Hidalgo region where work will be done with CCA-UNAM. INECC has a training program every year where training is provided to all technical personnel. On the other hand, the Laboratory of INECC has a Quality Management System and as part of that, training is secured to all technical staff in order to warranty the quality of results from the laboratory.

The above-mentioned governments have been improving their scientific literacy to formulate necessary government program for air quality control based on the research outputs by the SATREPS project.

<Financial Aspects>

In despite of budget cuts, INECC has secured budget for maintaining all equipment and capacities established by SATREPS project on annual basis. The Sectorial Program for Environment and Natural Resources (Programa Sectorial de Medio Ambiente y Recursos Naturales, PROMARNAT) 2020-2024 includes all the activities for the Federal Government for the Administration 2020-2024.Also, the Federation Expenses Program (Presupuesto de Egresos de la Federación: PEF) secures the budget for all institutions in a yearly basis. PEF 2021 has been published and budget for INECC has been secured for 2021.

When there is cooperation with State Governments, they give additional budget for specific activities. INECC has programed the following activities for 2021: i) Campaigns for the identification of high-emitting vehicles, via remote sensor, at the entrances to the Megalopolis (2020-2024), ii) Development and maintenance service for the analysis, processing and dissemination of air quality information system of the Megalopolis), iii) Elements for the characterization and diagnosis of air quality in the Tula air basin), iv) Training of staff of the SMCAs in the Megalopolis in the facilities of the INECC Laboratories), v) Advice to define the maximum values of concentration of atmospheric pollutants for the Metropolitan Area of the Valley of Mexico, and vi) Weather and air quality forecast for the Metropolitan Areas of Monterrey, Guadalajara and Mexico Valley . In despite of the reduction in government budget, cooperation was secured considering different institutions. The most relevant cooperation was the Memorandum of Understanding among INECC and CAME for the monitoring support of air quality using the methods established in SATREPS project; INECC has also included the topics related to support of air quality to local governments and maintaining the Laboratory Capacities in its Institutional Program 2020-2024.

<Evaluation Result>

In the light above, there has been no problem from any aspects. Therefore, the sustainability of the effects through the Project is high.

5 Summary of the Evaluation

The project has achieved the Project Purpose to enhance capacity to study formation mechanism of Ozone, VOCs and PM2.5 and to develop proposal of co-benefits countermeasure scenario based on key scientific findings, and the research outputs of the SATREPS project have been utilized for the policies and programs related to air quality in Mexico. Considering all of the above points, this project is evaluated to be highly satisfactory.

III. Recommendations & Lessons Learnt

Recommendations

[For INECC]

- To keep working in an interinstitutional way in order to secure continuous improvement on air quality issues and use capacities created with the SATREPS Project.
- To strengthen cooperation with State and Municipal Governments in order to reduce the gaps of knowledge on their staff and internalize the learning from SATREPS Project.
- To work together with the National Meteorological Service to include ozone observation in their rutinary activities.

Lessons Learnt for JICA:

- The SATREPS project resulted the excellent research outputs. In particular, the research on formation mechanism of Ozone, PM2.5 and VOCs have been implemented not only in the three pilot cities of the SATREPS project but also other states and have contributed to improving quality of life of the people. Thus, it can be considered as a good practice of the efforts for the utilization of the research outcome. In, addition, INECC has continuously been promoting utilization of their survey results in the SATRPES project for updating the PROAIREs under the cooperation with other state governments and metropolitan governments. Also, INECC has continued necessary activities and trainings. In this background, although the budget of INECC has been reduced and the new headquarters of the INECC Air Quality Research Center moved, the Mexican leaders of the SATREPS project have continued to their activities and disseminated the technologies which they have learned through the SATREPS project. Thus, in order to materialize the utilization of research outcomes of SATREPS projects, it is effective to select research institutes with human resources and organizational capacity for coordination and cooperation with government organizations in addition to high research capacity to steadily produce results through international joint research. For this SATREPS project, the coordination and collaboration with the following institutions involved in air environment management has contributed to continuous dissemination and utilization of the research outputs; the Megalopolis Environmental Commission (Comisión Ambiental de la Megalópolis: CAMe) (federal organization), the National Autonomous University of Mexico (Universidad Nacional Autónoma de México: UNAM) (academic institution), the state environmental authorities (the state governments), and Mario Molina Center for Strategic Studies of Energy and Environment (NPO think-tank) established by Mr. Mario Molina, a co-recipient of the Nobel Prize in Chemistry, who discovered the Antarctic ozone hole and the threats to ozone layer from chlorofluorocarbon gases.
- As mentioned above, since there are various governmental organizations, research and academic institutions concerning air environment management in Mexico, the researchers involved in the SATREPS project have been able to belong to any of those institutions and be engaged in activities related to air environment management in despite of personnel reshuffling caused by the change of the government. In addition, good relationships among the researchers of INECC and other institutions which has been inspiring each other has made INECC functional as a responsible federal organization for air environment management. Under such situation, cooperation or collaboration among those institutions through some projects enabled to elaborate alternative methodologies or system for viable air monitoring by even limited resources through mutually covering by budget shortage and renting necessary equipment. Therefore, from

the viewpoints of continuity of research work and continuous efforts for utilization of research outcomes after project completion, it is preferrable to a strategy for post project period based on proper stakeholder analysis for reviewing research networks and collaborative work with government institutions of possible counterpart research institutes at the time of project formulation.

Air Quality Monitoring Station using research outputs of SATREPS projects, Integrated System of Environmental Monitoring (Sistema Integral de Monitoreo Ambiental: SIMA) at Nuevo Leon, the Government of Monterrey

Trainings for local technicians for operation of equipment sampling PM2.5 (small volume) at the monitoring station in Monterrey, Nuevo Leon, during the implementation of measuring activity.

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