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

conducted by India Office: March 2021

| Country Name | Information Network for Natural Disaster Mitigation and Recovery |
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| India | |

**I. Project Outline**

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| Background | Many parts of India are susceptible to natural disasters due to their geographical location. However, government measures had tended to be limited to emergency measures such as rescue and assistance for victims. In the fields such as disaster forecasting, disaster mitigation, and reconstruction, the accumulation of knowledge, technology, and capacities to respond was not sufficient. Given this situation, there was a need for assistance in the latest disaster prediction and response technology, especially by countries with similar disaster environments and countermeasures such as Japan. |
| Objectives of the Project | The project aimed 1) to establish infrastructure for the continuous data collection on earthquake and weather with a global information network and to develop technical bases for rescue and support for restoration and for disaster recovery support, and 2) to develop a rapidly deployable, robust communications system for during/after a natural disaster, through (i) conducting Seismic Hazard Assessment, (ii) developing the Weather Sensors and Analysis Platform, (iii) developing the Emergency and Post-disaster Communications System with data processing, and (iv) developing the Information Sharing Platform and Resources and the Advanced Disaster Management System, thereby contributing to the strengthening of research collaboration between India and Japan in the field of natural disaster prevention and information communication technology (ICT) and to the advancement of scientific knowledge and technology to resolve global issues.<br>1. Expected Overall Goal: To strengthen research collaboration between India and Japan in the field of natural disaster prevention and information communication technology and to advance scientific knowledge and technology for resolving global issues such as natural disasters.<br>2. Project Purpose: 1) To establish infrastructure for continuous data collection on earthquake and weather with global information network by applying it to India and Japan as example cases and to develop technical bases for rescue and support for restoration and for disaster recovery support.<br>2) To develop rapidly deployable robust communications system that can be deployed during/after a natural disaster to provide voice, data, and video connectivity for emergency communications and relief work. |
| Activities of the Project | 1. Project Site: Medak District, State of Telangana (State of Andhra Pradesh at the time of ex-ante evaluation)<br>2. Main activities: Designing each system, deploying the equipment, collecting and analyzing data using the installed equipment, etc.<br>3. Inputs (to carry out above activities)<br>Japanese Side<br>1) Experts: 21 persons (1 long-term and 20 short-term)<br>2) Trainees received: 65 persons<br>3) Equipment: Strong motion seismometers, global positioning system (GPS) receivers, automatic weather stations (AWSs), satellite communications equipment, servers, personal computers, etc.<br>4) Operation cost<br>Indian Side<br>1) Staff allocated: 51 persons<br>2) Offices, meeting rooms, and others<br>3) Operation cost |
| Project Period | July 2010 – June 2015 / Project Cost: (ex-ante) 488 million yen, (actual) 486 million yen |
| Implementing Agency | Indian Institute of Technology, Hyderabad (IITH); Indian Institute of Technology, Madras (IITM); Indian Institute of Technology, Kanpur (IITK); Indian Institute of Technology, Bombay (IITB); International Institute of Information Technology, Hyderabad (IIITH); Indian Meteorological Department (IMD); National Geophysical Research Institute, Hyderabad (NGRI) |
| Cooperation Agency in Japan | KEIO University; The University of Tokyo; Hiroshima University; Osaka University |

**II. Result of the Evaluation**

< Special Perspectives Considered in the Ex-Post Evaluation >

This project did not have indicators for the Project Purposes and the Overall Goal. To verify the achievement of the Project Purposes, we used the terminal evaluation's qualitative assessment of the elements that make up the Project Purpose, namely, (1-a) Infrastructure for continuous data collection on earthquake and weather with global information network by applying it to India and Japan as example cases, (1-b) Technical bases for rescue and support for restoration and for disaster recovery support, and (2) A rapidly deployable, robust communications systems that can be deployed during/after a natural disaster to provide voice, data, and video connectivity for emergency communications and relief work. To verify the achievement of the Overall Goal, similarly, we examined qualitatively whether the elements that make up the Overall Goal, namely, (a) Research collaboration between India and Japan in the field of natural disaster prevention and information communication technology and (b) Advancement of scientific knowledge and technology for resolving global issues such as natural disasters, have manifested.

1 Relevance

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

This project was consistent with India's development policies such as the Eleventh Five Year Plan (2007-2012) that stated, "the development process needs to be sensitive towards disaster prevention, preparedness and mitigation," the National Disaster Management Guidelines–Management of Earthquakes (2007), and the National Disaster Management Guidelines–Management of Cyclones (2008).

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

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

As mentioned in "Background" above, this project was consistent with the need for the latest disaster prediction and response technology.

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

This project was consistent with Japan's Country Assistance Program for India (2006) that included "efforts with a view of disaster prevention" in "the improvement of poverty and environmental issues," one of the priority areas of assistance.

<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 achieved the Project Purposes at the time of its completion. Regarding Project Purpose 1, the expected infrastructure for continuous data collection was established. For earthquakes, subsurface structure models in the central part of Indo-Gangetic Plain, together with the study on the vulnerability of buildings at the target area, were constructed based on the data collected from the GPS receivers, strong motion seismometers, and building sensors installed by the project. For weather, the online weather monitoring system in city-wide using Vaisala-type AWSs (simplified AWSs with a lower cost than AWSs meeting the World Meteorological Organization's standard) were installed and enabled observation of the behavior of local heavy rain. These studies constituted the technical bases for rescue and support by enabling the assessment of hazards.

Regarding Project Purpose 2, the project developed a prototype of an emergency communications system that met the communications infrastructure in India and a portal service (information-sharing platform) for centralized management of disaster information and cloud computing for secure and flexible data management during disasters.

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

The project effects have partially continued to the time of ex-post evaluation. Concerning Project Purpose 1, the research outputs in the field of earthquakes, such as the seismic hazard assessment and building vulnerability assessment through sensor networks, have been used in research on an ongoing basis. The seismological data generated from the sensor networks developed by the SATREPS project has contributed to several publications and one Ph.D. award, and the data acquired from building vibration sensors have contributed to Masters and Ph.D. theses. In the weather field, the AWSs and the information-sharing platform are no longer being used due to some equipment's failures. Meanwhile, the High Power Excimer Laser, which was provided under this project and used for new material to detect air pollution as part of AWSs, has produced four Masters and five PhDs.[2]

Concerning Project Purpose 2, the emergency communications system prototype was utilized in local events in 2016, but the equipment has since broken down and has not been used. The information-sharing platform has also stopped functioning as the data server has gone down, and funding has been insufficient to maintain and utilize the platform.[3] However, based on this project's achievement, a research project is ongoing on the application of the concept of emergency communications system.

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

The Expected Overall Goal has been partially achieved by the time of ex-post evaluation. Although there were many research collaborations between India and Japan during the project period, and such relationships among researchers have been maintained after project completion, outstanding collaborated research or projects have not been confirmed at the time of ex-post evaluation mainly due to budget constraints. Even so, the above-mentioned ongoing research in the field of earthquakes can be said as a case of the advancement of scientific knowledge and technology in the field of natural disasters by this SATREPS project.

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

No negative impact on the natural environment has been observed. As a positive impact, the researchers' research capacity involved in the project activities has improved in the continued research mentioned above.

<Evaluation Result>

Therefore, the effectiveness/impact of the project is fair.

Achievement of Project Purpose and Overall Goal

| Aim | Indicators | Results |
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| (Project Purpose 1)<br>To establish infrastructure for continuous data collection on earthquake and weather with global information network by applying it to India and Japan as example cases and to develop technical bases for rescue and support for restoration and for disaster recovery support. | (1-a) Infrastructure for continuous data collection on earthquake and weather with global information network by applying it to India and Japan as example cases<br><br>(1-b) Technical bases for rescue and support for restoration and for disaster recovery support | Status of the Achievement: achieved (partially continued)<br>(Project Completion)<br><u>Earthquake</u><br>- The Broadband Velocity Type Strong Motion Seismometers were installed in all of the planned 26 sites in the target areas of Indo-Gangetic Plain and interconnected online. Based on seismometer records of near and distant earthquakes, three-dimensional subsurface models on the central part of the Indo-Gangetic Plain were completed.<br>- The building sensors were installed at various positions of six selected public buildings or housing complexes at Chandigarh. Based on observation results from the sensors, the fragility of the building structures was analyzed using a three-dimensional frame model.<br><u>Weather</u><br>- Vaisala-type AWSs and a data network were installed, and they demonstrated the usefulness of a weather monitoring system with the dense deployment of AWSs. |

[2] Among the major equipment this project provided for Project Purpose 1, the strong motion seismometers with the data loggers the building sensors and the High Power Excimer Laser and the Vacuum Chamber with related equipment are functioning and used for research, but equipment related to the AWSs have not been functioning since 2016 due to failures of the data loggers and the data transmission system.

[3] Among the major equipment this project provided for Project Purpose 2, the infrastructure for the emergency communications system such as the GSM Optical Distribution Unit (ODU) and servers have not been used since the connected computer's motherboard was broken and software update is required. The equipment for the information-sharing platform, such as personal computers and smartphones, are used for other research purposes since the original platform has stopped functioning.

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| | | - The Sensor Material Development Laboratory was established at IITH, and sensor materials such as for PM2.5 observation sensor, CO2 sensor, vibration sensor, and humidity sensor were developed.<br><br>(Ex-post Evaluation)<br><u>Earthquake</u><br>- NGRI and IIITH has continued seismic hazard assessment through sensor networks and building vulnerability assessment based on the data acquired from installed sensors.<br><u>Weather</u><br>- IMD has not operated the weather monitoring with the AWSs since 2016 as data from the AWSs cannot be retrieved due to failures of the equipment provided by this project (see Footnote 2).<br>- Department of Materials Science and Metallurgical Engineering of IITH, where the Sensor Material Development Laboratory was absorbed into, has used the High Power Excimer Laser and produced four Masters, five PhDs, and five students currently pursuing Ph.D. including one in Japan under the JICA-Friendship program. |
| (Project Purpose 2)<br>To develop rapidly deployable robust communications system that can be deployed during/after a natural disaster to provide voice, data, and video connectivity for emergency communications and relief work. | (2) A rapidly deployable, robust communications system that can be deployed during/after a natural disaster to provide voice, data, and video connectivity for emergency communications and relief work. | Status of the Achievement: achieved (partially continued)<br>(Project Completion)<br>- By referring to the disaster communications systems used at the time of the Great East Japan Earthquake, and taking into account the status of India's communications infrastructure, a prototype of an emergency communications system that combined satellite communications with Wi-Fi/GSM/LTE was developed. FM-RDS was adopted for transmitting text data at lower bit rates for mobile phones that were generally attached to FM broadcast receiver units.[4]<br>- A portal site for integrating information processed by each research group and managing the emergency communications system was launched. The cloud computing system was developed as well so that these data and system can be safely and smoothly managed during emergencies. The portal site included a registration system for the safety information of people.<br><br>(Ex-post Evaluation)<br>- IITM is conducting research on the application of the concept of the emergency communications system developed under this project to accident relief and train and crowd control by the Tamil Nadu Police.<br>- According to IITH, the information-sharing platform no longer exists due to server breakdown/being no longer functional and lack of maintenance budget. |
| (Expected Overall Goal)<br>To strengthen research collaboration between India and Japan in the field of natural disaster prevention and information communication technology and to advance scientific knowledge and technology for resolving global issues such as natural disasters. | (a) Research collaboration between India and Japan in the field of natural disaster prevention and information communication technology<br><br>(b) Advancement of scientific knowledge and technology for resolving global issues such as natural disasters | (Ex-post Evaluation) partially achieved<br>- Outstanding collaborated research or projects were not confirmed at the time of ex-post evaluation mainly due to budget constraints.<br>- The ongoing research on seismic hazard assessment through sensor networks can be said as a case of the advancement of scientific knowledge and technology in the field of natural disasters by this SATREPS project. |

Source: Terminal Evaluation Report; JST Final Report; questionnaire and interview with the implementing agencies

3 Efficiency

Both the project cost and the project period were as planned (ratio against the plan: 100% for both items). The Outputs of the project were produced as planned. Therefore, the efficiency of the project is high.

4 Sustainability

<Policy Aspect>

The National Disaster Management Guidelines–Management of Earthquakes (2007), the National Disaster Management Guidelines–Management of Cyclones (2008), and the National Disaster Management Guidelines–National Disaster Management Information and Communication System (2012) are effective at the time of ex-post evaluation. Also, the National Disaster Management Plan (2019) has the Prime Minister's Ten-Point Agenda for Disaster Risk Reduction, in which two items mention the importance of technology for disaster risk reduction.

<Institutional/Organizational Aspect>

Although detailed information on organizational arrangements was not available, the research institutes responsible for research based on this SATREPS project's results are identified. They are IITH (Department of Computer Science and Engineering for the ICT platform

[4] Wi-Fi: Wireless computer network; GSM: Global System for Mobile Communications or 2G digital cellular networks; LTE: Long-Term Evolution (a standard for wireless broadband communications); FM-RDS: FM Radio Data System.

and Department of Materials Science and Metallurgical Engineering for the laser equipment for AWSs), IITK (Department of Civil Engineering), IITM (Department of Electrical Engineering), IIITH (Earthquake Engineering Research Centre), NGRI (Seismological Observatory), and IMD (IMD Hyderabad; as a governmental department that is responsible for weather monitoring and issuance of warnings as well as researches). Each of these agencies is also responsible for the maintenance of the project equipment provided to them. However, there is no clear recognition of responsibility for the maintenance of the AWS equipment installed in other institutions' premises than IMD. Organizational arrangements for implementing policy or programs based on/using this project's research outputs were not confirmed as such policies or programs have not been able to be identified.

<Technical Aspect>

According to IITH, IITM, IIITH, and NGRI, their researchers/professors have sustained their research capacity through continued research in the related fields. According to these institutes and IMD, they have sufficient skills and knowledge to operate and maintain the equipment provided by the project even though some equipment is no longer functioning due to lack of budget.

<Financial Aspect>

IITH and IIITH have secured some funds for research and maintenance of the equipment related to this project from such sources as the respective institutions and the Department of Science and Technology (DST), India.[5] Although financial information was not available from other implementing agencies, it appears from what has been described so far that a certain amount of funding for research activities related to this project has been obtained. The budget for the repair and replacement of some equipment has not been ensured, partly because of the nature of the field where equipment is quickly outdated in a few years, which reduces the motivation to maintain and/or update old less-functioning equipment. For the AWSs, IMD could not secure a budget to maintain the system that does not match their specified standard. Other institutions where the AWSs were installed have not allocated the maintenance budget as the responsibility for maintenance was not clearly recognized.

<Evaluation Result>

In light of the above, some problems have been observed in terms of the institutional/organizational and financial aspects of the implementing agency. Therefore, the sustainability of the effects through the project is fair.

5 Summary of the Evaluation

The project achieved the Project Purposes of establishing infrastructure for the continuous data collection on earthquake and weather with a global information network and developing a rapidly deployable, robust communications system for during/after a natural disaster. The project's effects have partially continued: the research related to earthquakes has been continuously conducted based on this project's outputs, but those related to weather have not continued. The Overall Goal has been partially achieved: outstanding collaborative activities between India and Japan have not been confirmed after project completion; however, there has been some advancement of scientific knowledge and technology brought by the above-mentioned continued research activities. Regarding sustainability, no major problem has been found in the policy and technical aspects, but enough information was not available in the institutional/organizational and financial aspects. Considering all of the above points, this project is evaluated to be satisfactory.

**III. Recommendations & Lessons Learned**

Recommendations for Implementing Agency:

- IITH and other involved institutions and department are recommended to promote periodical meetings among concerned institutions and department to share research outputs and progress and to discuss the possibility of collaboration and application of an integrated platform in emergency incidents.

Lessons Learned for JICA:

- The equipment for the AWSs have not been properly maintained and thus not utilized after project completion. The purpose of installing simplified and more economical AWSs (Vaisala-type) was to establish a prototype network with dense granularity for micro-scale weather observation and to utilize the data for disaster forecast. In addition, the institute or department who is responsible for equipment maintenance, especially those installed in other institution's premises than IMD, was not clearly recognized, and it resulted in lack of necessary budget for maintenance and proper repairs. To avoid such situation, the following actions could have been taken:
  - To ensure that the project clearly identify who is responsible for equipment ownership and maintenance and confirm the strategy/plan to secure the necessary maintenance budget for at least a few years at the time of project completion.
  - To promote installation of equipment to be done under the most relevant organization/institute to ensure ownership of the equipment as much as possible.
- Regarding the ICT equipment, the installed equipment became outdated in a few years after project completion, and they are not utilized anymore. To avoid such situation, the following action could have been taken:
  - To recommend the project to carefully select specifications and technologies from the point of view of sustainability and easiness of upgrading when necessary.

[5] For example, IITH received 6,700,000 Indian Rupee (INR) from DST for a research on strain induced structure and microstructural studies on lead free piezoelectrics (2019-2021) and INR1,000,000 from IITH-Interdisciplinary Research Projects Fund (IDP) for a research on flexible hybrid ferroelectrics (2020-2021). IITH allocated the following budget for the major equipment provided by this project: (i) for the High Power Excimer Laser and auxiliary devices, INR150,000 (from IITH maintenance support) in 2017 and INR1,300,000 (INR800,000 from DST and INR500,000 from IITH-IDP) in 2019; (ii) for the Vaccum Chamber and auxiliary devices, INR1,300,000 (INR800,000 from DST and INR500,000 from IITH-IDP) in 2019.

IIITH received INR300,000 each from IIITH for ambient vibration studies (2016-2019) and path study (2018-2020). For the maintenance of the building sensors and all related and auxiliary devices provided by this project, IIITH spends INR100,000 every year.

Strong motion sensor (ITK sensor)
installed in the IIITH building to conduct constant monitoring

Portable microtremors observation system being used for research at IIITH