

Country Name	The Project for Capacity Development on Groundwater Development and Management for Climate Change Adaptation (El Proyecto de Mejoramiento de la Capacidad de Desarrollo y Manejo del Agua Subterránea para la Adaptación al Cambio Climático)
Republic of Cuba	

I. Project Outline

Background	<p>In Cuba, annual rainfall was 1,375mm., the total annual available water volume, including surface water and groundwater, was 24.0km³ (data in 2001 by the National Institute of Water Resources (INRH: Instituto Nacional de Recursos Hidráulicos) and the annual available amount of water per person was 2,239m³ (the Water Supply and Swage Corporation (GEARH: Grupo Empresarial de Acueductos y Alcantarillados)). According to the INRH's data, the actual water consumption per person in 2000 was 1,295m³ and 64% of the water consumption came from surface-water. However, the annual rainfall has been less than the average over the years and the lowest annual rainfall was recorded in 2004 for the first time since the rainfall observation started in 1931. In particular, in 5 provinces in the eastern region, the water supply capacity became seriously deteriorated: water supply by water tank trucks and water supply restrictions became normalized due to the limited annual rainfalls lower than the average for the several consecutive year and the lowered total water storage in dams to 36% of the capacity. For the 5 provinces, there was another reason: the proportion depending on surface water was high as 90% because aquifers in shallow layers were limited. In response to the situation, INRH was considering expansion of groundwater utilization from deep layers. However, since INRH did not have sufficient knowhow about geophysical exploration techniques and potential groundwater assessments to properly develop, manage and preserve groundwater in deep layers (under 200m), the government of Cuba requested the government of Japan a technical cooperation project on enhancement of capacities of maximizing geophysical exploration techniques and the exploration's results as well as groundwater management using numerical models.</p>						
Objectives of the Project	<p>Through delivery of trainings on geophysical exploration, groundwater models and the Geographic Information System (GIS) as well as conducting various surveys including geophysical exploration in the model sites, the project aimed at enhancing INRH's capacity for groundwater development and management, thereby contributing to proper utilization of groundwater in the eastern region.</p> <ol style="list-style-type: none"> Overall Goal: Groundwater is properly used for water resources utilization in the eastern region. Project Purpose: INRH (including GEIPI and GEARH)'s capacity of groundwater development and management are improved. <p>*GEIPI (Grupo Empresarial de Investigaciones, Proyectos e Ingeniería): the Investigation, Planning and Engineering Corporation, GEARH (Grupo Empresarial de Aprovechamiento de Recursos Hidráulicos): the Water Supply and Swage Corporation</p>						
Activities of the project	<ol style="list-style-type: none"> Project site: (Model Site) Sola area in Camaguey province, (Site for establishment of GIS) Provinces of Holguin, Las Tunas and Camaguey Main activities: 1) Development of a training plan for core instructors and preparation of training materials on each training (geophysical exploration, groundwater models and GIS), 2) Implementation of geophysical exploration, hydro-meteorological investigation, ground-surface/hydrogeological investigation and others in model sites, 3) Delivery of On-the-Job trainings (OJT) for GIS design on water resources, delivery of trainings for staffs of GEARH and the Directorates Watershed Management and the Directorate of Water Supply Works of INRH on geophysical exploitation and groundwater assessments and management based on groundwater models, 4) Delivery of trainings on geophysical exploration, groundwater models and GIS by the core instructors trained by the project. Inputs (to carry out above activities) <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>Japanese Side</p> <ol style="list-style-type: none"> Experts: 11 persons Acceptance of trainees in Japan: 5 persons Equipment: Electromagnetic prospecting instruments, Well logging machines, Water quality checker, equipment for geophysical exploration and pumped water trials, GIS software, PC, vehicles, and so on. Others: Cost for local consultants (test excavation) </td> <td style="width: 50%; vertical-align: top;"> <p>Cuban side</p> <ol style="list-style-type: none"> Staff allocated: 28 persons Land and Facilities: Office space for the Japanese experts Local Cost: Cost for drilling of observation wells, fuel cost and costs for trainings </td> </tr> </table> 					<p>Japanese Side</p> <ol style="list-style-type: none"> Experts: 11 persons Acceptance of trainees in Japan: 5 persons Equipment: Electromagnetic prospecting instruments, Well logging machines, Water quality checker, equipment for geophysical exploration and pumped water trials, GIS software, PC, vehicles, and so on. Others: Cost for local consultants (test excavation) 	<p>Cuban side</p> <ol style="list-style-type: none"> Staff allocated: 28 persons Land and Facilities: Office space for the Japanese experts Local Cost: Cost for drilling of observation wells, fuel cost and costs for trainings
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Ex-Ante Evaluation	2008	Project Period	September 2008 – February 2012	Project Cost	(Ex-ante) 240 million yen (Actual) 245 million yen		

Implementing Agency	the National Institute of Water Resources (INRH), the Investigation, Planning and Engineering Corporation (GEIPI), the Water Supply and Sewage Corporation (GEARH)
Cooperation Agency or Contract Agency in Japan	KOKUSAI KOGYO Co., Ltd.

II. Result of the Evaluation

<Special perspectives considered in the ex-post evaluation>

[Verifiable Indicators and Important Assumptions for the Overall Goal]

- In the Project Design Matrix (PDM) “Appropriate utilization of groundwater in the eastern region” was defined as “the Overall Goal” and “Regular and sustainable implementation of investigation on available groundwater in the eastern region” and “Reduction of proportion of the population with water supply by water tank trucks at the time of droughts” are set as verifiable indicators. Also, “Development and implementation of water supply plan based on groundwater management” was defined as one of the important assumptions to achieve the Overall Goal. However, in case where “development and implementation of water supply plan based on groundwater management” would not have been realized, the project cannot directly contribute to “Reduction of proportion of the population with water supply tank trucks at the time of droughts”. In addition, “proper utilization of groundwater” and “development and implementation of water supply plan based on groundwater management” are closely linked each other. Therefore, in this ex-post evaluation “development and implementation of water supply plan based on groundwater management using the project outputs” was regarded as the important assumption and it was verified as supplemental information to assess achievement level of the Overall Goal.

[Continuation status of project effects (project purpose/output) after projection completion and the important assumption]

- Although “proper maintenance of equipment for groundwater exploration, the established groundwater models and the GIS database” was set as an important assumption for the Overall Goal, it was verified as continuation status of project effects at the time of ex-post evaluation.

1 Relevance

<Consistency with the Development Policy of Cuba at the time of ex-ante evaluation and project completion>

The project was consistent with Cuba’s development policies of at the time of ex-ante evaluation, “the INRH Strategic Plan (2007-2009)”, and “the National Development Plan (2010)” and “the National Economic and Social Development Plan (2011-2030)” at the time of project completion, prioritizing “water resources development”.

<Consistency with the Development Needs of Cuba at the time of ex-ante evaluation and project completion >

The project was consistent with Cuba’s development needs for acquirement of methods for proper groundwater management since INRH did not have so many practical experiences of groundwater development because available groundwater in 3 provinces in the eastern region was not so much compared to other provinces but demand for groundwater development was high as water supply resource at the time of droughts. The needs which were confirmed at the time of ex-ante evaluation did not change at the time of the project completion.

<Consistency with Japan’s ODA Policy at the time of ex-ante evaluation>

The project was consistent with the Japan’s ODA policy for Cuba, which was confirmed by the policy dialogue between Cuba and Japan in October, 2000, prioritizing support for agriculture and environment, including a technical cooperation project for groundwater exploration in the eastern provinces facing severe droughts as an assistance in the area of basic life.

<Evaluation Result>

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

2 Effectiveness/Impact

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

The Project Purpose was partially achieved by the project completion. In terms of publishing potentials and challenges of groundwater development in model sites (Indicator 1), presentations were made at a seminar on groundwater management in June 2011 and a seminar on groundwater development and management presenting the project outputs in December 2011. Regarding reflection of results of groundwater analysis and management GEARH by the groundwater models and the GIS database in annual reports (Indicator 2), according to the GEARH’s responses at the time of the ex-post evaluation, GEARH did not included the project outputs in their annual report because the main actor of the project activities was GEIPI and the project outputs were produced by the core instructors of GEIPI trained by the project. However, GEARH distributed the project outputs to the provincial Hydraulic Investigation and Project Corporations (EIPHs) under GEARH as notice in order to share them. With regard to reflection of results of groundwater analysis and management by INRH using groundwater models and GIS database in annual reports (Indicator 3), according to the INRH’s responses at the time of the ex-post evaluation, the results were reflected in INRH’s annual reports before the project completion.

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

The project effects have been mostly continued since the project completion.

[The Groundwater Models]

The groundwater models developed by the project have utilized by INRH and GEIPI. INRH has disseminated advanced techniques and utilized techniques on the groundwater models as one of advanced techniques. Also, in Sola area, the models have been applied to investigations at new sites. The software for groundwater management has been utilized not only in the target provinces but also for works related to groundwater management, groundwater resources exploration and water quality investigations. The results of groundwater resource exploration and groundwater analyses by GEIPI were reflected in annual reports of INRH and GEIPI, respectively. Although GEARH has not included those results in their annual reports because GEARH is responsible for management of water supply plans prepared by each EIPH at the national level, they have promoted to share those results with EIPHs through distribution of notices or reports in order to enable EIPHs to utilize them for preparation of their water supply plans.

[GIS Database in 3 provinces in the eastern region]

INRH has used the GIS database as a tool for supporting to ensure quality of planned projects in the 3 target provinces and implement

them. GEIPI has also utilized the GIS database. GEARH has utilized the GIS database through trainings from the GEIPI's core instructors to other officers.

[Exploration and investigation using the equipment for groundwater exploration]

The equipment for groundwater exploration installed by the project are managed by GEIPI and the exploration and investigation activities have been continued by using those equipment. By using electromagnetic exploration instruments, hydrogeological investigation have been conducted for securement of water in Manzanillo city (Granma province) and for exploration for new water sources in provinces including Granma and Santiago de Cuba provinces and other activities in addition to the 3 target provinces.

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

The Overall Goal has been partially achieved at the time of the ex-post evaluation. After the project completion, groundwater availability investigation is undertaken every year in each site of the eastern region including the target provinces, especially in a branch office of INRH located in a special zone of Isle of Youth (Indicator 1). GEIPI mentioned that the investigation period varied from 3 months to 2 years. In terms of changes in proportion of population with water supply by water tank trucks in case of droughts in the eastern region (Indicator 2), the proportions have not decreased in any of the provinces at the time of the ex-post evaluation compared to the baseline data in 2007. On the other hand, water supply plans based on the project outputs have been developed and implemented in the 3 target provinces. In all the three provinces including Holguin and Las Tunas, the Camaguey EIPH, which is responsible for the provinces of Holguin and Las Tunas, implements the water supply plans based on data provided by EIPH and DPRH in January, April, July, August, September and October every year. Based on the water consumption balance by users in each province, EIPH is responsible for measures such as control of well drilling, water supply restrictions, and suspension of cultivation of crops requiring large volume of water consumption. The Camaguey EIPH has appropriately conducted those operations and GEARH has been conducting overall supervisions. However, according to GEIPI, droughts had become severer since 2007 even during the project implementation. In particular, the deteriorating trend of droughts has become more serious since 2014, and then, the severity of the droughts became further tense in 2016 due to El Niño phenomenon so that many watersheds have been dried up. Under this situation, it is difficult to clearly judge whether the unchanged proportion of the population with water supply by water tank trucks has been attributed to any problems of water supply planning or the higher severity of the droughts than the prediction.

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

Some positive impacts have been observed at the time of the ex-post evaluation. According to the Camaguey Basic Corporation Unit (UEB: Unidad Empresarial de Base), better actions for proper underground water management and utilization of water resources have been taken through utilization of the geophysical exploration equipment introduced by this project in other provinces besides the target provinces. The hydro-geophysical maps prepared by the project have been used by GEIPI and the other related agencies for other purpose of underground water exploitation and management., They have been also utilized in Sola area for planning proper water of water to users in terms of water use of economic water flows including other areas. Furthermore, the maps have been used for countermeasures against salinization problems such as prevention of sea water intrusion by artificial lagoon of La Siguanea.

In addition, according to core-instructors of the groundwater models trained by the project and the Holguin UEB, results from the groundwater models and the geophysical exploration conducted in Cuentas Claras and Cayo Redondo of Manzanillo area contributed to development of younger researchers through utilization of them in dissertations written by a student of the University of Havana and a Cuban student studying at the University of Magdeburg (Germany). Furthermore, the core instructors have contributed to human resource development through continuation of trainings for junior core instructors, who are mainly university graduates, and technicians. No negative impact was confirmed.

<Evaluation Result>

In light of the above, the project partially achieved the Project Purpose and the Overall Goal and contributed to improvement of groundwater management by implementation of groundwater analysis and geophysical exploration for groundwater management and water resources development in other sites besides the target provinces through utilization of the groundwater models, GIS database and equipment for groundwater exploration introduced by the project. Therefore, the effectiveness/impact of the project is fair.

Achievement of project purpose and overall goal

Aim	Indicators	Results
<p>(Project Purpose) INRH (including GEIPI and GEARH)'s capacity for groundwater development and management are improved.</p>	<p>(Indicator 1) Potentials and challenges of groundwater development in model sites (such as hydrogeology, groundwater availability, water quality and future forecasts by groundwater models) are compiled and released.</p>	<p><u>Status of the achievement: Achieved</u> (Project Completion)</p> <ul style="list-style-type: none"> ● Seminar for groundwater management in June 2011(in Camaguey province): potentials and challenges of groundwater development in a model site (Sola area) were presented by the core instructors of GEIPI trained by the project ● Seminar on groundwater development and management as well as the project results in December 2011 (in Havana city): analytical results with higher-precision including potentials and challenges of groundwater development (issues to be considered for development of groundwater) were presented by the core instructors of GEIPI trained by the project. <p>(Ex-post evaluation) Continued</p> <ul style="list-style-type: none"> ● The first-year technical seminar in June 2013 (in Havana city): Presentation on extended cases of groundwater development after the project completion (groundwater models presented by the engineer of Havana EIPH, achievements presented by the core engineer of Camaguey /Holguin EIPH and groundwater management presented by the engineer of Grandma/Holguin EAH and Japanese expert)

		<ul style="list-style-type: none"> The second-year technical seminar in June 2014 (in Havana city): Presentation on cases of spreading groundwater development after the project completion (geophysical exploration presented by the engineers of EIPHH, progress in technical transfers presented by the core engineer of Camaguey/Holguin EIPH, hydrogeological investigation presented by the engineers of GEIPI and EIPHH)
	(Indicator 2) Results of groundwater analysis and management based on groundwater models and GIS database are reflected on GEARH's annual reports.	<p><u>Status of the achievement: Not achieved</u> (Project completion)</p> <ul style="list-style-type: none"> The project mainly targeted GEIPI technicians so that results of groundwater analysis and management based on groundwater models and GIS database were produced by the core instructors of GEIPI trained by the project. Therefore, those results were not reported in the annual reports. However, those results were distributed to each EIPH as a notice for utilization of the project outputs. <p>(Ex-post Evaluation) Partially continued.</p> <ul style="list-style-type: none"> Since underground water analyses are conducted by the core instructors of GEIPI, the results have not reported in the annual reports of GEARH. However, same as the project implementation those results have been sent to each EIPH as notice or report and the analysis and results have been shared and utilized.
	(Indicator 3) Results of groundwater analysis and management based on groundwater models and GIS database are reflected on INRH's annual reports.	<p><u>Status of the achievement: Achieved</u> (Project completion)</p> <ul style="list-style-type: none"> The results of groundwater analysis and management based on groundwater models and GIS database were reported in the annual reports. <p>(Ex-post Evaluation) Continued</p> <ul style="list-style-type: none"> The results have been reflected in monthly reports every two months as an article of the projects implemented by EIPHS and the INRH has compiled them in their annual reports.
(Overall goal) Groundwater is appropriately used in utilization of water resources in the eastern region.	(Indicator 1) Groundwater availability investigations are regularly and sustainably implemented in the eastern region (at least 3 provinces).	<p><u>Status of achievement: Achieved</u> (Ex-post Evaluation)</p> <ul style="list-style-type: none"> The investigations have been conducted in the eastern region, especially a branch office of INRH located in a special zone of Isle of Youth. For 2013, Camaguey HIPH conducted hydro-geological survey, groundwater model survey and GIS survey, and Holguin EIPH conducted hydro-geological survey, and GIS survey. For 2014, Camaguey HIPH conducted geophysical exploration and Holguin EIPH conducted hydro-geological survey and GIS survey. No EIPH exist in Las Tunas.
	(Indicator 2) Alternative water resources are ensured for droughts in the eastern region (in at least 3 provinces, the proportion of population with water supply by water tank trucks in 2007 decreases).	<p><u>Status of achievement: Not achieved</u> (Ex-post Evaluation)</p> <ul style="list-style-type: none"> Droughts had become severer since 2007 and its seriousness has been larger since 2014, in particular. The severity of the droughts became deeper because of El Niño phenomenon in 2016 so that the watersheds have been dried up. Under the situation, although the exploration to utilize groundwater continues, because of the dried up watersheds by the extremely severe droughts. As a result, frequency of water supply by water tank trucks has not reduce and the population with water supply by water tank trucks have not decreased.

Source : the Completion Report, responses to questionnaires for GEARH, INRH and GEIPI, core instructors (5 in total) for geophysical explorations and GIS trained by this project

3 Efficiency

Although the project cost was slightly exceeded the plan (ratio against the plan: 102%), the project period was within the plan (ratio against the plan: 100%). Therefore, the efficiency of the project is fair.

4 Sustainability

<Policy Aspect>

Hydrological management has been constantly prioritized in national strategies including “the National Economic and Social Development Plan (2011-2030)”, and the importance of groundwater management and development has been sustained. While a JICA technical cooperation project, “the Project for Capacity Enhancement of Groundwater and Seawater Intrusion Management (2013-2017)”, was implemented (completed in February, 2017), a groundwater management plan prepared by this technical cooperation project has been approved by INRH. The plan aims at better implementation of groundwater management. The National Water Policy has already been approved by INRH and was likely to be enacted as a new law during 2017. In the policy, there are 4 pillars and one of them is “water management.” In this context, groundwater exploration and analysis must become key techniques.

<Institutional Aspect>

There has been no change in role and organizational structure of INRH as a policy decision agency for groundwater development and utilization. In spite of no disclosed data on personnel, the Directorate of Watershed Management and the Directorate of Hydraulic Works of INRH have continued the activities of groundwater exploration, analytical works, and groundwater management. INRH has deployed the

necessary number of personnel and does not have plan of reshuffle or retirement. In case of the reshuffle or retirement, the new personnel has been deployed and no problem has been observed. There have been improvements of the data management through cases such as data sharing between EIPH and EAH and presentation on cases with establishments of data system after the project completion and they have policy to promote data sharing further.

Also in GEIPI, there has been no change in organization for geophysical exploration for groundwater, utilization and sustaining the groundwater models, maintenance of the GIS database and maintenance of equipment for groundwater exploration installed by the project in spite of no disclosed data on personnel. Although some staffs were reshuffled, new staffs have been assigned and no problem has been observed in conducting geophysical exploration, investigations on groundwater management and so on. On the other hand, most of the equipment provided by the project have been mostly maintained in proper manner though some of them have been less functioning due to the lack of spare parts.

For the provincial level, the Camaguey EIPH has deployed 5 staffs for geophysical exploration, 3 for the groundwater models and 4 for the GIS database. The Holguin EIPH has deployed 2 staffs for geophysical exploration, 6 for the groundwater models and 6 for the GIS database. There is no EIPH in Las Tunas province but there is the Las Tunas UEB within the Holguin EIPH. Since the instructors in Camaguey support geophysical exploration in Holguin and Las Tunas provinces, the number of staffs for geophysical exploration in Holguin and Las Tunas provinces is 1, respectively. Also, with regard to the groundwater models, the 2 engineers of the Holguin EIPH cover 3 provinces of Holguin, Las Tunas and Granma. GEARH submit INRH two kinds for data sets composed of the water demand to be required for productive activities in each province for next year based on compiled volume of water utilization requested by clients of water users and the available water supply for each province in the next year based on calculation by each EAH. GEARH has aimed at operation of a more effective “water balance” system by utilization of calculation techniques for available water supply with higher precision and more rigorous identification of actual volume of water use acquired through the project supported by Japan’s ODA.

<Technical Aspect>

The GEIPI engineers acquired sufficient skills and knowledge on geophysical exploration, utilization of the groundwater models and the GIS database and have sustained those skills and knowledge after the project completion. In addition, during the period between 2012 and 2015, the core instructors GEIPI trained by the project have delivered technical trainings and guidance for university graduates on geophysical exploration (10 participants), groundwater models (9) and database (9) and have contributed to development of junior engineers and to ensuring human resource for future. On the other hand, the engineers of the Directorate of Watershed Management and the Directorate of Water Supply and Construction of INRH as well as GEARH have sufficient skills and knowledge to conduct groundwater assessment and management using analytical results from geophysical exploration, the groundwater models and the GIS database implemented by GEIPI. Levels of knowledge and skills acquired by the participants have been confirmed by comprehensive test at the time of training completion. INRH used to deliver trainings for engineers of INRH and GEARH twice a year for the period from 2012 to 2014. Trainings for the engineers of GEIPI and GEARH on geophysical exploration, pumping test, hydrological information system, groundwater numerical model and groundwater management plan as compilation of the two projects. are planned to be delivered by the core instructors trained by this project and the successive project of “The Project for Capacity Enhancement of Groundwater and Seawater Intrusion Management (2013-2017)” .

<Financial Aspect>

The budgets of the related authorities of Cuba have not been disclosed even to the public and were not available for the ex-post evaluation. However, since INRH, GEIPI and GEARH have continuously undertaken the activities related to groundwater exploration through technical transfer by the project, maintained the underground water models, the GIS database and the equipment of groundwater exploration, and deployed necessary personnel. It can be judged that they have secured sufficient budgets so far. For GEIPI, although the maintenance budget for the groundwater models has been suspended 2 years after the project completion, budgetary actions are planned to be taken in 2017. According to them, it is expected that they will be able to ensure the necessary budgets in future. The budget sources of GEIPI are the Directorate of Investment of INRH and the provincial governments. One of the budget sources of GEARH is charges for agricultural and industrial water. While the necessary budget has been ensured, they define work contents and coverages in accordance with the budget sizes.

<Evaluation Result>

In light of the above, no problem has been observed in terms of the policy, institutional, technical and financial aspects. Therefore, the sustainability of the project effects through the project is high.

5 Summary of the Evaluation

The project partially achieved the Project Purpose and the Overall Goal for appropriate groundwater utilization through improvement of groundwater management based on groundwater exploration and analytical results by INRH, GEIPI and GEARH. Also, groundwater exploration has been undertaken in non-targeted areas by using groundwater models, GIS database and equipment for groundwater investigation introduced by this project. As for sustainability, no problem has been observed in terms of the policy, institutional, technical and financial aspects. As for efficiency, the project cost exceeded the plan.

In the light of above, the project is evaluated to be satisfactory.

III. Recommendations & Lessons Learned

Recommendations for Implementing Agency:

- It is recommended for the implementing agencies to ensure sufficient budget allocation for scheduled procurement of spare parts which are necessary for maintenance, or replacement of equipment and purchase of new equipment when necessary in order to continuously utilize the equipment for groundwater exploration provided by the project further.
- GEIPI, as an actual implementer of the project activities, needs to attain results based on application of the techniques transferred by the project, and is desired to continuously deliver trainings in order to aim at human resource development and capacity development of the engineers through further utilization of the techniques acquired. On the other hand, it is required to sustain well information sharing and collaboration in the Cuban side for future since support of INRH and GEARH as relevant agencies are also essential.

Lessons learned for JICA:

- Among the equipment of underground water exploration provided by the project, major ones have been continuously utilized after the project completion and the activities for groundwater exploration have been continued. i On the other hand, functions of some equipment are less functioning due to the lack of spare parts. In cases where important equipment for works and activities and maintenance of those equipment is essential from the aspect of sustainability of project effect, support for preparation of maintenance plan for the equipment, including procurement system including procurement of spare parts for the equipment is important.



Observation point installed by the project



Opinion exchange between the EIPH officers and the workers of plantation in front of a pivot irrigation