

**Republic of Cuba
National Water Resources Institute (INRH)**

**TECHNICAL COOPERATION
PROJECT
ON
CAPACITY DEVELOPMENT ON
GROUNDWATER DEVELOPMENT
AND MANAGEMENT FOR CLIMATE
CHANGE ADAPTATION
IN THE REPUBLIC OF CUBA**

ABSTRACT

January 2012

**Japan International Cooperation Agency (JICA)
KOKUSAI KOGYO CO., LTD.**



Project Photos (1/2)



Technical transfer of Geophysical Prospecting

The GEIPI's engineers were able to acquire the electric prospecting technology (in particular, 2-D imaging) and the electro-magnetic prospecting technology.



Hydrogeological study

A test borehole was drilled at the JICA_01 site in Sola district, where geophysical logging and pumping test were conducted.



Technical transfer of Groundwater Model

The GEIPI's engineers were able to acquire experience in a series of analytical work spanning the hydro-geological investigation to the Groundwater Model's construction and the predictive simulations.



Technical transfer of GIS

The GEIPI's engineers constructed GIS/DB of the Eastern Area (Provinces of Camagüey, Holguín, and Las Tunas).



Seminar on Groundwater Development & Management

During 2011, the GEIPI's engineers played the role of lecturers in the following four Seminars: Camagüey Seminar, Granma Seminar, Santiago de Cuba Seminar and Havana Seminar.



Dissemination seminar of Geophysical Prospecting

Geophysical Prospecting seminar was held in Pinar del Rio on 12 to 14 September 2011 (lecturer: GEIPI's core engineer, participant: 27 engineers and students of Pinar del Rio University).

Project Photos (2/2)



Dissemination seminar of Groundwater Model

Groundwater Model seminar was held in Havana on 26 September 2011 (lecturer: GEIPI's core engineer, participant: 11 engineers).



Dissemination seminar of GIS

GIS seminar was held in Granma on 14 to 15 September 2011 (lecturer: GEIPI's core engineer, participant: 14 engineers).



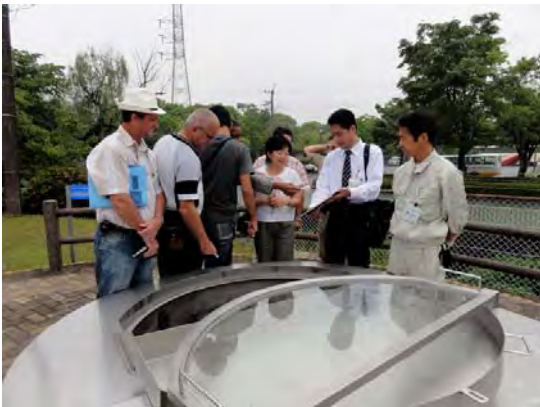
Workshop of the project results

Workshop of the project results was held in Havana on 14 to 15 December 2011 (participant: 72 technical personnel of GEIPI, GEARH, INRH and other institutions).



Public seminar

A Joint Public Seminar with Camagüey University was held on 22 September 2011, where the output of this project was presented by the engineers of EIPH Camagüey and CITA.



Training course (Study tour) in Japan

JICA accepted 5 Cuban trainees and conducted training on groundwater development and management through a study tour in Japan.



Management of the project

For project management, meetings of JCC (Joint Coordination Committee) were held 4 times, while meetings of PEC (Project Execution Committee) were held 8 times.

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ABBREVIATIONS

PEC	Project Execution Committee
(CEP)	(Comité Ejecutivo del Proyecto)
CITA	Water Technology Integrated Center (Centro Integrado de Tecnologías del Agua)
EIPH	Enterprise for Research, Hydraulic Projects (Empresa de Investigaciones, Proyectos Hidráulicos)
EIPI	Enterprise for Research, Projects and Engineering (Empresa de Investigaciones, Proyectos e Ingeniería)
GEAAL	Public Company of Aqueducts and Sewer Systems (Grupo Empresarial de Acueductos y Alcantarillados)
GEARH	Managerial Group of Hydraulic Use (Grupo Empresarial de Aprovechamiento de Recursos Hidráulicos)
GEILH	Enterprise Group for Hydraulic Engineering and Logistics (Grupo Empresarial de Ingeniería y Logística Hidráulica)
GEIPI	Hydraulics Projects and Researches Enterprises Group (Grupo Empresarial de Investigaciones, Proyectos e Ingeniería)
GIS (SIG)	Geographic Information System (Sistema de Información Geográfica)
INRH	National Institute of Hydraulic Resources (Instituto Nacional de Recursos Hidráulicos)
JCC (CCC)	Joint Coordination Committee (Comité de Coordinación Conjunta)
JICA	Japan International Cooperation Agency (Agencia de Cooperación Internacional del Japón)
MINCEX	Ministry of External Trade and Foreign Investment (Ministerio de Comercio Exterior e Inversión Extranjera)
PDM	Project Design Matrix
PO	Plan of Operations

1 Outline of the Project

1.1 Background

Climate change has gained the forefront of the international news in the past decade. An effect of the climate change, namely, rainfall pattern that differs from past trends, has affected Cuba, where annual precipitation decreased to less than the average. The evidence is given by the dry spell, which continued during a period of several years, peaking in 2004 when the rainfall registered the smallest value since 1931. Within Cuba, rainfall shortage hit the hardest the Eastern 5 Provinces, where the water volume in the dams declined to 36% of the capacity. Needless to say, this rainfall shortage caused a significant deterioration in the water supply service, forcing the concerned authorities to introduce water rationing, and water supply relying on the use of water-tank trucks.

One of the causes of water supply shortage was the limited areal extent of shallow aquifers. As a result, 90% of water supply services in the Eastern Provinces depended on surface water. In order to mitigate the situation, the National Water Resources Institute (INRH) of Cuba established a policy of augmentation of water resources through the exploitation of deep aquifers. And for the implementation of this policy, the INRH requested the Government of Japan to provide technical cooperation for groundwater investigation, consisting of the dispatch of Japanese experts, the training of Cuban engineers, and the supply of the necessary equipment and materials.

In response to this request, the Japan International Cooperation Agency (JICA) dispatched a Preparatory Study Team to Cuba from January to February 2008. Later, a Record of Discussion (R/D), which defined the contents of the Project, was concluded on 25 June 2008 between the Ministry of Foreign Investment and Economic Cooperation (MINVEC)*, INRH, Hydraulics Projects and Researches Enterprises Group (GEIPI) and JICA.

* At present, Ministry of External Trade and Foreign Investment (MINCEX)

1.2 Objectives

This Project aims at supporting the capacity development on groundwater development and management of INRH and its affiliate GEIPI, in order to increase the use of deep groundwater. The Project is implemented in the Eastern Area, which is vulnerable to draught and flood damages resulting from climate change. The Project plans to achieve the following.

- Improving the capacity of the GEIPI core engineers through OJT (On the Job Training).
- Maintaining the necessary information for actual groundwater development and management
- Training of INRH professional staff by the trained GEIPI core engineers

Table 1-1 shows the PDM₄ (final version) with overall goal, project purpose and outputs.

1.3 Project Area

- Objective area: Eastern part of Cuba: The Provinces of Camaguey, Las Tunas and Holguin.
Model site: Sola district, Province of Camaguey
GIS construction sites: Provinces of Camaguey, Las Tunas and Holguin.
- Base: Water Technology Integrated Centre (CITA), Province of Camaguey.

Table 1-1: PROJECT DESIGN MATRIX (PDM₄)

Version: 4.0: June 27, 2011

Title of the Project: Capacity Development on Groundwater Development and Management for Climate Change Adaptation in the Republic of Cuba

Period of the Project: November 2008～February 2012

Target Area

- Target Area of the Project: Training Site -“Sola” District in the Province of Camagüey (No. of inhabitants: 35,700)
- Target areas for the elaboration of GIS databases: Province of Camagüey (790,000), Holguín (1,030,000) and Las Tunas (530,000)
- Target area for training course within INRH and GEIPI: Countrywide

Target Group

- Target Group Instructors able to teach training courses: GEIPI Technical Personnel (No. of Instructors: 15)
- Target Group Technical Personnel able to receive training courses: GEIPI (No. of Personnel: 30) and GEARH(No. of Personnel: 40) Personnel
- Indirect Beneficiaries: Inhabitants of the 3 Eastern Provinces of the country (Holguín, Camagüey, Las Tunas, No. of inhabitants: 2,350,000)

Summary of the Project	Indicators	Source of Information	External Conditions
<p>< Overall Goal ></p> <ul style="list-style-type: none"> Groundwater in water resources of Eastern Region is adequately utilized. 	<ul style="list-style-type: none"> To execute periodic and ongoing studies on the availability of groundwater in the eastern provinces of the country. (Applied within the 3 provinces as a minimum) An alternative source of water is assured when faced with drought in the eastern provinces of the country. (Applied within the 3 provinces as a minimum, and the ratio is reduced between the number of inhabitants and the coverage of piped potable water, for which 2007 will be taken as the base number) 	<ul style="list-style-type: none"> GEIPI Records GEAAL Records 	
<p>< Project Purpose ></p> <ul style="list-style-type: none"> Improve the ability of INRH (including GEIPI and GEARH) to exploit and manage groundwater. 	<ul style="list-style-type: none"> Groundwater potential and issues (hydrogeology, groundwater yield, future prediction by groundwater model, etc.) in Model Site (Sola district) are compiled and published. The results of groundwater analysis and management are published in the GEARH Annual Report. The results of analysis and management of groundwater realized through Groundwater Models and GIS database are reflected in the INRH Annual Report. 	<ul style="list-style-type: none"> Progress Report of the Project GEARH Annual Report INRH Annual Report 	<ul style="list-style-type: none"> Equipment is correctly maintained for groundwater studies, groundwater mathematical model construction, as well as GIS database within the Project. Elaborate and execute a water supply plan.
<p>< Outputs ></p> <p>1 Improve the skills of GEIPI instructors with respect to geophysical prospecting.</p> <p>2 Improve the technical ability of GEIPI instructors to construct groundwater models.</p> <p>3 Improve the technical ability of GEIPI instructors with respect to GIS.</p> <p>4 Improve the ability of GEARH and the Departments of Watershed and Hydraulic Works, INRH, to manage and evaluate groundwater resources utilizing the results of geophysical prospecting, mathematical model and GIS, prepared and provided by GEIPI.</p> <p>5 Technology is transferred to GEIPI technical personnel at the national level (Geophysical prospecting, groundwater model and GIS)</p>	<p>1-1 Elaborate and modify training text.</p> <p>1-2 Train technical personnel to conduct electrical (tomography) and electromagnetic prospecting (5 people)(Paper and prospecting tests are conducted at the training).</p> <p>1-3 Present the results of geophysical prospecting.</p> <p>2-1 Elaborate a plan of training text.</p> <p>2-2 Train technical personnel to conduct mathematical modeling (5 people)(A test is conducted at the time of final training)</p> <p>2-3 Groundwater models are constructed based on 2-2.</p> <p>2-4 Existing hydro-geological map is revised and refined.</p> <p>3-1 Elaborate a plan of training text.</p> <p>3-2 Train technical personnel to construct GIS system for water resources (5 people) (Confirmed by the maps)</p> <p>3-3 GIS maps are prepared.</p> <p>4-1 Two or more training courses are held intended for technical personnel of GEARH and Dept. of Watershed of INRH in the training program of INRH.</p> <p>4-2 Of the total participants (approx. 45), 90% pass the knowledge exam at the end of the course.</p> <p>5-1 Two or more training courses are held intended for technical personnel of GEIPI in the training program of INRH.</p> <p>5-2 Of the total participants (approx. 30), 90% pass the knowledge exam at the end of the course.</p>	<p>1 Progress Report of the Project</p> <p>2 Progress Report of the Project</p> <p>3-1 Progress Report of the Project</p> <p>3-2 Outputs of the maps etc</p> <p>4-1 INRH training records</p> <p>4-2 Progress Report of the Project</p> <p>5-1 INRH training records</p> <p>5-2 Progress Report of the Project</p>	<ul style="list-style-type: none"> Close collaboration is maintained between INRH and companies.

<p>< Activities ></p> <p>1-1 Elaborate a training plan for instructors 1-2 Prepare and revise the text on electrical and electro-magnetic prospecting 1-3 Conduct training for instructors on Geophysical Prospecting 1-4 Conduct field training for instructors on Geophysical Prospecting in the Model Site 2-1 Elaborate a training plan for instructors 2-2 Prepare the text on the Groundwater Models 2-3 Conduct training for instructors the Groundwater Models 2-4 Conduct meteorological and hydrological surveys and field reconnaissance on surface geology and hydrogeology 2-5 Drill observation wells in the model site and conduct pumping test, groundwater leveling, geophysical logging and so on. 2-6 Guide the instructors to construct precise Groundwater Models 3-1 Elaborate a training plan for instructors 3-2 Prepare the text on GIS 3-3 Conduct OJT on GIS design for water resources 4-1 Give advice on the training program for professionals in GEARH and Depts. of Watershed and Water Works, INRH, prepared by the instructors on the basis of findings and data collected concerning geophysical prospecting, groundwater model, and GIS. 4-2 Give advice on the text prepared and revised by the GEIPI instructors 4-3 Attend and give supplementary explanation, if needed, at the training courses conducted by GEIPI instructors 4-4 Feed back the results of a given training session for the benefit of the subsequent training session, through discussion with GEIPI instructors 5-1 Support training program for GEIPI professionals, internally conducted by GEIPI instructors 5-2 Attend and give supplementary explanation, if needed, at the training courses conducted by GEIPI instructors who were trained by Japanese Experts. 5-3 Feed back the results of a given training session for the benefit of the subsequent training session, through discussion with GEIPI instructors</p>	<p>< Inputs ></p> <p><u>Inputs by Japanese Party:</u></p> <ol style="list-style-type: none"> 1. Experts : Chief Advisor/Groundwater Modeling 1, Groundwater Modeling 2, Hydrogeology 1, Hydrogeology 2, Geophysical prospecting and GIS 2. Equipment and materials 3. Training in Japan 4. Partial contribution to expenses <p><u>Inputs by Cuban Party</u></p> <ol style="list-style-type: none"> 1. Counterpart Personnel 2. Administrative Staff 3. Installations necessary for the implementation of the Project (Offices for Experts, office furniture and others) 4. Local operation expenses <ul style="list-style-type: none"> • Test well drilling expenses • Training expenses • Salaries and other expenses for Cuban counterpart personnel • Electrical and gas expenses • Customs, domestic transport and other expenses • Equipment maintenance expenses <p>Other expenses necessary for the implementation of the Project</p>	<ul style="list-style-type: none"> • Necessary equipment and materials are acquired without delay of the execution of training. • Necessary information for the Project activities is obtained without delay. • Logistics are prepared means of transport, accommodation facilities) to facilitate participation in the training course. • Training course participants have a basic and general knowledge of groundwater investigations. <p>< Preconditions ></p> <ul style="list-style-type: none"> • It is possible to import the adequate and necessary equipment and computer software into Cuba. • Cuban counterparts are appropriately assigned.
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1.4 Project Staff

1.4.1 Japanese Side

The JICA Expert Team consisted of the following experts and coordinators

Expertise Area	Name	Affiliation
Leader/Groundwater Modeling 1 (1 st to 3 rd year)	Kamata Akira	Kokusai Kogyo Co., Ltd.
Leader/Groundwater Modeling 1 (4 th year)	Kihara Shigeki	Kokusai Kogyo Co., Ltd.
Groundwater Modeling 2	Shibasaki Naoaki	Fukushima University
Hydrogeology 1	Oshika Yusuke	Earth Science System Co., Ltd.
Hydrogeology 2 (1 st to 3 rd year)	Kihara Shigeki	Kokusai Kogyo Co., Ltd.
Hydrogeology 2 (4 th year)	Tanaka Masatoshi	Kokusai Kogyo Co., Ltd.
Geophysical Prospecting	Yabuta Takuya	Earth Science System Co., Ltd.
GIS	Lei Peifeng	Kokusai Kogyo Co., Ltd.
Coordinator 1	Obara Masaru	Kokusai Kogyo Co., Ltd.
Coordinator 2	Kina Masaharu	Kokusai Kogyo Co., Ltd.

1.4.2 Cuban Side

Position in the Project	Name	Institution (Position)	Period
Director General	Wilfredo Leyva Armesto	INRH (Vice President)	December, 2008 – May, 2009
	Aimee Aguirre Hernández		June, 2009 – February, 2012
Director	José Antonio Hernández Álvarez	GEIPI (Director General)	December, 2008 – May, 2009
	Wilfredo Leyva Armesto		June, 2009 – February, 2012
Administrator	Evaristo Baños Guerra	GEIPI (Technical Director)	December, 2008 – October, 2009
	Julio César Martínez Horta		October, 2009 – October, 2010
	Yarin Benitez Haza		October, 2010 – January, 2010
	José Luis Blanco García		January, 2011 – February, 2012
Advisor	Arturo Gonzalez Baez	GEIPI (Advisor)	December, 2008 – February, 2012
Geophysical prospecting	Arturo Lorenzo Ferrás	EIPI Matanzas	December, 2008 – February, 2012
	Rodolfo Bordón	EIPH Holguín	January, 2009 – February, 2012
	Rebeca Fernández	EIPH Camagüey	January, 2009 – February, 2012
	Leonardo Cantillo Riveri	EIPH Camagüey	January, 2009 – February, 2012
	Ernesto Rodríguez	EIPH Villa Clara	January, 2009 – February, 2012
	Ernesto Morales	EIPH Pinar del Río	August, 2010 – February, 2012
Groundwater model	Arturo Lorenzo Ferrás	EIPI Matanzas	February, 2009 – February, 2012
	Manuel A. Burgos Diaz	EIPH Villa Clara	February, 2009 – February, 2012
	Jorge Luis Blanco Blázquez	EIPH Holguín	February, 2009 – February, 2012
	Juan José Almirall Beltrán	UEB Granma, EIPH Holguín	February, 2009 – February, 2012

	Adán Echemendía Martínez	EIPH Camagüey	February, 2009 – February, 2012
	Luis Fidel Miranda	EIPH Ciego de Avila	February, 2009 – February, 2012
GIS	Arturo Lorenzo Ferrñas	EIPI Matanzas	July, 2009 – February, 2012
	Jorge Luis Blanco Blázquez	EIPH Holguín	July, 2009 – February, 2012
	Juan José Almirall Beltrán	UEB Granma, EIPH Holguín	July, 2009 – February, 2012
	Adán Echemendía Martínez	EIPH Camagüey	July, 2009 – February, 2012
	Carlos Luke Zayas Bazan	EIPH Camagüey	July, 2009 – February, 2012
	Marcell Martínez Contreras	UEB Las Tunas, EIPH Holguin	July, 2009 – February, 2012
	Javier Acosta Infante	EIPH Villa Clara	July, 2009 – February, 2012

2 Achievement of Outputs and Project Purpose

2.1 Output 1: Improve the skills of GEIPI instructors with respect to geophysical prospecting.

To achieve Output 1, the following activities were executed.

- Elaborate a training plan for instructors
- Prepare and revise the text on electrical and electro-magnetic prospecting
- Conduct training for instructors on Geophysical Prospecting
- Conduct field training for instructors on Geophysical Prospecting in the Model Site

The GEIPI's engineers were able to acquire the electric prospecting technology (in particular, 2-D imaging) and the electro-magnetic prospecting technology (in particular, TDEM method) through the above activities.

Though some GEIPI's engineers received training in electric prospecting from a Japanese expert in 2006, the knowledge and the technology were deepened further in this training.

Meanwhile, the groundwater survey by the electro-magnetic prospecting was the first experience for the GEIPI's engineers. The understanding of the hydro-geological structure of the deeper section is facilitated by this technology.

The result of the survey executed in the Model Site of Sola district is presented in this Seminar.

2.2 Output 2: Improve the technical ability of GEIPI instructors to construct groundwater models.

To achieve Output 2, the following activities were executed.

- Elaborate a training plan for instructors
- Prepare the text on the Groundwater Models
- Conduct training for instructors of the Groundwater Models
- Conduct meteorological and hydrological surveys and field reconnaissance on surface geology and hydrogeology
- Drill observation wells in the Model Site, and conduct pumping test, groundwater leveling, geophysical logging, and so on
- Guide the instructors to construct precise Groundwater Models

Through the above activities, the GEIPI's engineers were able to acquire experience in a series of analytical work spanning the hydro-geological investigation to the Groundwater Model's construction and the predictive simulations.

The hydrogeological data (classification of aquifer, aquifer's distribution, aquifer's thickness, aquifer's parameter, etc.) of the Sola district were systematized to input into the Groundwater Model. In addition, the groundwater recharge and discharge were estimated by the tank model, and GEARH's data were systematically arranged for use in the Groundwater Model.

In Sola district, the drilling of a test well reached the depth 200m, and the well was developed as an observation well. The drilling result was compared with the analytical result of geophysical prospecting. Up to the drilling of the test well in this project, such a deep observation well was unknown in the Sola district. Automatic water level recorder was installed in this observation well, in order to continue the measurement of groundwater level.

An analytical result obtained by the Groundwater Model in the Sola district was presented in the Final Seminar in December 2011. Moreover, GEIPI's engineers have been able to replicate the analysis by using the Groundwater Model in Manzanillo.

2.3 Output 3: Improve the technical ability of GEIPI instructors with respect to GIS.

To achieve Output 3, the following activities were executed.

- Elaborate a training plan for instructors
- Prepare the text on GIS
- Conduct OJT on GIS design for water resources

The GEIPI's engineers who participated in this activity already had basic knowledge on GIS. Therefore, the lecture time was reduced compared with the two above-mentioned technologies, and priority was given to the construction of GIS/DB of the Eastern Area (Provinces of Camagüey, Holguín, and Las Tunas).

The JICA Expert visited several times the Eastern Area in order to conduct the prepared training activities, which led to the completion of the GIS/DBs of the three Provinces. However, it will be necessary to continue updating the GIS data in the future. Moreover, it is necessary to improve the environment in which the GEIPI professionals can use the completed GIS/DBs.

Some of the maps completed by the GIS/DBs were presented in the Final Seminar in December 2011.

2.4 Output 4: Improve the ability of GEARH and the Departments of Watershed and Hydraulic Works, INRH, to manage and evaluate groundwater resources utilizing the results of geophysical prospecting, mathematical model and GIS, prepared and provided by GEIPI.

To achieve Output 4, the following activities were executed.

- Give advice on the training program for professionals in GEARH and Depts. of Watershed and Water Works, INRH, prepared by the instructors on the basis of findings and data collected concerning geophysical prospecting, groundwater model, and GIS.
- Give advice on the text prepared and revised by the GEIPI instructors
- Attend and give supplementary explanation, if needed, at the training courses conducted by GEIPI instructors
- Feed back the results of a given training session for the benefit of the subsequent training session, through discussion with GEIPI instructors

Before the start of the training by the GEIPI's engineers, a JICA Expert visited six Provinces (Provinces of the engineers who participated in the trainings to attain Outputs 1-3) during October-November 2010, in order to provide lecture style Seminars concerning the groundwater resource management.

During 2011, the GEIPI's engineers played the role of lecturer in the following four Seminars.

- Camagüey Seminar (21 July 2011)
- Granma Seminar (16 September 2011)
- Santiago de Cuba Seminar (19 September 2011)
- Havana Seminar (14-15 December 2011)

Not only the engineers of related organizations within INRH, but also engineers of the Ministry of the Environment, and those in the Provincial Governments, participated in these Seminars. Added benefits of these Seminars were the improvement of the texts, and the completion of the Outputs 1-3.

2.5 Output 5: Technology is transferred to GEIPI technical personnel at the national level (Geophysical Prospecting, Groundwater Model and GIS).

To achieve Output 5, the following activities were executed.

- Support training program for GEIPI professionals, internally conducted by GEIPI instructors
- Attend and give supplementary explanation, if needed, at the training courses conducted by GEIPI instructors who were trained by JICA Experts
- Feed back the results of a given training session for the benefit of the subsequent training session, through discussion with GEIPI instructors

According to the training plan of GEIPI, some training on Geophysical Prospecting, Groundwater Modeling, and GIS were held in 2011, and the JICA Experts participated in the following Seminars.

- Geophysics Seminar in Pinar del Río (12-14 September 2011)
- Groundwater Modeling Seminar in Havana (26 September 2011)
- GIS Seminar in Granma (14-15 September 2011)

The training plan presented by GEIPI was intended for general engineers. Not only engineers of GEIPI but also many engineers of related organizations, such as GEARH, participated in these “diffusion Seminars” intended to gradually expand the results of technology transfer to as many professionals as possible.

2.6 Project purpose: Improve the ability of INRH (including GEIPI and GEARH) to exploit and manage groundwater.

The above-mentioned project purpose is to be attained by achieving Outputs 1-5. The Indicators to measure such achievements are the following.

- Groundwater potential and issues (hydrogeology, groundwater yield, future prediction by groundwater model, etc.) in Model Site (Sola district) are compiled and published.
- The results of groundwater analysis and management are published in the GEARH Annual Report.
- The results of analysis and management of groundwater realized through Groundwater Models and GIS database are reflected in the INRH Annual Report.

The drafts of these publications were prepared before the end of this project.

2.7 Overall Goal: Groundwater in water resources of Eastern Region is adequately utilized.

This project aims at achieving the overall goal of adequate groundwater utilization in the Eastern Region of Cuba after the end of project (Prospect after several years).

To achieve this overall goal, INRH and GEIPI plan the following activities.

(1) Examination of Method of Continuous Use of Results

The 2012 Training Plan was prepared on the basis of results obtained in the trainings undertaken in 2011, and taking into account the advice from JICA Experts. The training courses in 2012 will take place in the training centers of Santa Clara (for trainees from the Central and Western Provinces) and Bayamo (for trainees from the Eastern Provinces). The two training centers belong to INRH, thereby INRH is planned to absorb the cost of utilization of these facilities, while each institution is planned to finance the participation cost of the professional belonging to the institution.

The budgets are prepared for each single year, thereby the budgets for 2013, or thereafter, will be based on the results to be obtained in the previous year, and will be prepared by all concerned institutions. In any event, all concerned institutions are expected to set aside the budget for the training of their professionals.

As will be explained later on in (3), the equipment for OJT of local professionals will be administered by the Technical Director of GEIPI, while one license of the specialized computer software will also be administered by the main GEIPI office, which will permit the use of the license key by Provincial engineers when such needs arise.

(2) Clarification of Dissemination Method of Technology

The training plan for 2011 was prepared at the time of the Terminal Evaluation of the Project. The 2012 training plan clarifies the importance of the technology transfer of this project to GEIPI within the overall training plan of GEIPI, in addition to securing the necessary budget, as already explained in (1). The 2013 training plan was also prepared by GEIPI in reference to the technology transfer by this project, but the relative standing of these trainings within the overall GEIPI training plan will be detailed only at the end of 2012, by taking into account the training results of 2012, and in coordinated efforts with the other related institutions within INRH.

(3) Clarification of the Equipment Maintenance System

Each equipment of the project was already assigned to a specific office within GEIPI, and the person in charge of the assigned equipment in that office was also already decided. This information was attached to the document of the official transfer of equipment from the Japanese Side to the Cuban Side.

The geophysics equipment is expected to be used all over the country, and although the equipment is to be kept in EIPH Camaguey, the ultimate responsibility lies with the Technical Director of GEIPI, so as to avoid any trouble in the use of the equipment in other sites of the country. Likewise, one license of the specialized computer software will also be administered by the main GEIPI office, which will permit the use of the license key by Provincial engineers when such needs arise.

3 Results of Activities

Table 3-1 shows the Plan of Operation (version 4) (PO₄ (final version)).

3.1 Results of Activities in the 1st Year

Output 1: Technical transfer of Geophysical Prospecting

- Preparation of training program on Geophysical Prospecting

Output 2: Technical transfer of Groundwater Model

- Preparation of training program on Groundwater Model
- 1st Groundwater Model seminar
- Hydrogeological study: data collection and outline of hydrogeology

Output 3: Technical transfer of GIS

- Preparation on technical transfer of GIS

3.2 Results of Activities in the 2nd Year

Output 1: Technical transfer of Geophysical Prospecting

- Preparation and revision of the textbook for Geophysical Prospecting.
- Technical training (2-D resistivity) at the model site (Sola district)

Output 2: Technical transfer of Groundwater Model

- Preparation of textbook for Groundwater Model
- 2nd Groundwater Model seminar
- 3rd Groundwater Model seminar
- 4th Groundwater Model seminar
- Hydrogeological study: compilation and digitalization of hydrogeology in Sola district

Output 3: Technical transfer of GIS

- Preparation of textbook for GIS
- 1st GIS Seminar
- 2nd GIS Seminar
- OJT on GIS design (Camagüey, Holguín, Las Tunas)

3.3 Results of Activities in the 3rd Year

Output 1: Technical transfer of Geophysical Prospecting

- Training of electromagnetic survey

Output 2: Technical transfer of Groundwater Model

- 5th Groundwater Model seminar
- 6th Groundwater Model seminar
- Hydrogeological study: arrangement of geologic columnar section in Sola district, test drilling in Sola district

Output 3: Technical transfer of GIS

- OJT on GIS design (Camagüey, Holguín, Las Tunas)
- Guidance for GIS upgrading (Camagüey, Holguín, Las Tunas)

Output 4: Improve the Groundwater Management ability of GEARH and INRH

- Seminar on Groundwater Development and Management (Camagüey, Holguín, Las Tunas, Ciego de Avila, Villa Clara, Matanzas)

Output 5: Technology is transferred to GEIPI technical personnel

- General technical seminar (Camagüey, Holguín, Las Tunas)
- Dissemination seminar of GIS (Camaguey)
- Dissemination seminar of GIS (Villa Clara)

Other

- Training course (Study tour) in Japan

3.4 Results of Activities in the 4th Year

Output 1: Technical transfer of Geophysical Prospecting

- Training of electromagnetic survey (especially, analysis method)

Output 2: Technical transfer of Groundwater Model

- 7th Groundwater Model seminar
- Hydrogeological study: Training of Operation of Geophysical Logging Equipment, Training of Operation of Automatic Water Level Recorder, Training of pumping test

Output 3: Technical transfer of GIS

- Guidance for GIS upgrading (Camagüey, Holguín, Las Tunas)

Output 4: Improve the Groundwater Management ability of GEARH and INRH

- Seminar on Groundwater Development & Management (Camagüey)
- Seminar on Groundwater Evaluation & Management (Granma)
- Seminar on Groundwater Evaluation & Management (Santiago de Cuba)
- Seminar on Groundwater Development & Management (Havana)

Output 5: Technology is transferred to GEIPI technical personnel

- Dissemination Seminar of Geophysical Prospecting (Pinar del Río)
- Dissemination Seminar of Groundwater Model (Havana)
- Dissemination Seminar of GIS (Granma)

- Workshop of the project results

Other

- Public Seminar (Camagüey University)

4 Inputs

4.1 Dispatch of experts

JICA expert's dispatch results are as shown in the table below.

Table 4-1: EXPERT'S ASSAINGMENT FOR THE PROJECT

Assignment	Name	Affiliation	2008					2009					2010					2011					2008		2009		2010		2011		Total																			
			11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	Cuba	Japan	Cuba	Japan	Cuba	Japan	Cuba	Japan	Cuba	Japan
			<p><i>(Detailed monthly assignment data for each expert and assignment, including numerical values and task names like 'Leader/Groundwater Modeling 1', 'Hydrogeology 1', etc.)</i></p>																																															
Total in Cuba																										7.40	15.70	12.60	8.60	44.30																				
Total in Japan																										0.60	0.30	0.90																						
<p>Reports Presentation of reports (Indicate the name of each report and Δ) ▲ IC/F ▲ P/R ▲ P/R2 ▲ P/R ▲ P/R ▲ P/R ▲ F/R</p>																																																		
<p>Workshop (Geophysical prospecting, groundwater model and GIS) Δ GIS Δ Geophysical prospecting, Groundwater model and GIS</p>																																																		
<p>Seminar (Evaluation and management of groundwater) Havana and Camagüey Δ Seminar (9 provinces) Δ Groundwater evaluation and management (Camagüey) Δ Groundwater evaluation and management (Havana)</p>																																																		
Total																										7.40	0.60	15.70	0.30	12.60	0.00	8.60	0.00	44.30	0.90															
Total																										8.00	16.00	12.60	8.60	45.20																				

4.2 Training Course (Study Tour) in Japan

JICA accepted 5 Cuban trainees and conducted training on groundwater development and management through a study tour in Japan. Outlines of the study were as follows:

- Duration of training (except traveling time from Cuba to/from Japan): May 11, 2010 - May 25, 2010.
- Trainees: 5 Cuban core engineers (Institution: EIPI and GEARH)
- Places visited: Kokusai Kogyo Co., Ltd., Fukushima University, Nichu Dam Management Office, Clean Water Network in Kitakata, Mine Museum in Yamaguchi, Water Works of Kumamoto City, Aqua Biwa
- Training items: Case study of GIS, Geology and land subsidence in Tokyo, Groundwater conservation in Kitakata City, Groundwater in Akiyoshi Limestone, Groundwater development and management in Kumamoto City, Integrated water resources development in Lake Biwa

4.3 Equipment and Materials

The equipment and materials brought into Cuba by the Japanese side is shown in the following table.

Table 4-2: Procurement equipment and materials

No.	Equipment & Materials	Quantity
1	Electro-Magnetic Prospecting Equipment	1 set
2	Vehicle	1 unit
3	Geophysical logging equipment	1 unit
4	Transceiver	5 units
5	Water quality checker	1 unit
6	Groundwater sampler	1 unit
7	Sampling rope for groundwater sampler	1 unit
8	Automatic water level recorder	1 unit
9	Groundwater leveling meter	5 units
10	Desktop computer	10 units
11	Laptop computer	7 units
12	Projector	1 unit
13	Laser printer	1 unit
14	Ink jet printer	1 unit
15	GIS software	6 licenses
16	Current meter	1 unit
17	Submersible pump	1 unit
18	Generator	1 unit
19	Equipment for pumping test	1 set

No.	Equipment & Materials	Quantity
20	Groundwater management software (MIKE-SHE (Studio))	1 license
21	Groundwater management software (FEFLOW)	6 licenses
22	Supplementary parts for geophysical survey (2-D Resistivity) equipment	1 set
23	Photocopier	1 unit

4.4 Results of activities in Cuba

4.4.1 Cost for local activities

The table below shows the cost that the JICA expert team spent on the local activities.

Table 4-3: Local cost of the project (Japanese side)

Item		1st year	2nd year	3rd year	4th year	Total
1	General expenses	1,031,084	2,104,780	2,510,355	4,069,477	9,715,696
	1.1 Labor cost	0	16,006	420,530	340,924	777,460
	1.2 Equipment maintenance cost	0	0	6,965	67,004	73,969
	1.3 Consumable cost	52,292	392,886	588,722	339,490	1,373,390
	1.4 Transportation & travel cost	17,032	0	40,213	0	57,245
	1.5 Communications cost	72,879	160,080	81,231	15,531	329,721
	1.6 Document preparation cost	184,274	625,407	451,570	1,613,756	2,875,007
	1.7 Rental cost	704,607	797,107	814,690	1,670,569	3,986,973
	1.8 Cost of electricity and water	0	0	0	0	0
	1.9 Cost of human resources training	0	0	0	0	0
	1.10 Local training cost	0	17,957	106,434	14,252	138,643
	1.11 Miscellaneous expenditures	0	95,337	0	7,951	103,288
2a	Acquisition cost for provision of equipment (excludes vehicle and equipment for geophysical exploration and includes transportation cost)	11,559,440	5,083,186	53,500	185,651	16,821,132
2b	Transportation cost for provision of equipment (includes vehicle, geophysical prospecting equipment and transport cost)	2,154,000	2,591,000	15,937,000	0	20,682,000
3	Acquisition cost of equipment accompanied by expert dispatch	757,950	5,312,846	1,921,740	0	7,992,536
4	Acquisition cost of other equipment	0	0	0	0	0
5	Transportation cost of other equipment	0	0	23,868	48,479	72,347
6	Report preparation cost (Printing & binding)	0	0	0	775,000	775,000

7	Report preparation cost (Other than printing & binding)	175.000	6.000	24.000	24.000	229.000
8	Contract with local consultants	0	0	2.848.093	0	2.848.093
9	Contract with local NGO	0	0	0	0	0
10	Training course (Study tour) in Japan (Cost for the consultant)	0	0	650.314	0	650.314
Total		15.677.474	15.097.812	23.968.870	5,102,607	59,846,763

Unit: Japanese yen

4.4.2 Contract with Local Consultants

In this project, a local consultant executed the test drilling.

- Contractor: Empresa Nacional de Perforación y Construcciones (ENPC)
- Contract price (original: for 2 test wells): 48,805.44 CUC (The amount of 62296.76 MN for the home currency specified in the contract is the expense of the Cuban Side.)
- Contract price (after change to one test well): 31,685.50 CUC
- Work contents: 1 drilling (depth of 200 meters) and well completion, pumping test (step, continuous, recovery)

5 Operation and Management of the Project

In this project, the Joint Coordination Committee (JCC) and the Project Execution Committee (PEC) were held as shown in the table below

Table 5-1: Selected Meetings held during the Project

Committee Meeting	Date	Place	Theme of importance
IC/R consultative meeting	19/11/2008	Havana / Conference room of GEIPI	<ul style="list-style-type: none"> • Inception Report
1st PEC	03/12/2008	Havana / Conference room of GEIPI	<ul style="list-style-type: none"> • Inception Report • Plan of activities in the 1st year
2nd PEC	09/03/2009	Havana / Conference room of GEIPI	<ul style="list-style-type: none"> • Progress Report 1 • Activities in the 1st year • Plan of activities in the 2nd year
1st JCC	12/03/2009	Havana / Conference room of GEIPI	<ul style="list-style-type: none"> • Progress Report 1 • Activities in the 1st year • Plan of activities in the 2nd year
3rd PEC	24/06/2009	Havana / Conference room of INRH	<ul style="list-style-type: none"> • Activities from May to June 2009 • Plan of activities from July to September, 2009
4th PEC	27/10/2009	Havana / Conference room of INRH	<ul style="list-style-type: none"> • Progress Report 2 • Activities from July to September 2009 • Plan of activities from October 2009 to March 2010
2nd JCC	17/03/2010	Havana / Conference room of INRH	<ul style="list-style-type: none"> • Progress Report 3 • Joint Mid-term Review Report • Activities in the 2nd year • Plan of activities in the 3rd year
5th PEC	06/07/2010	Havana / Conference room of INRH	<ul style="list-style-type: none"> • Activities from June to July 2009 • Future activities in 3rd and 4th years
6th PEC	21/10/2010	Havana / Conference room of INRH	<ul style="list-style-type: none"> • Progress Report 4 • Future activities in the second half of 3rd year
7th PEC	15/03/2011	Havana / Conference room of INRH	<ul style="list-style-type: none"> • Progress Report 5 • Activities from December 2010 to March 2011 • Plan of Operation in the 4th year
3rd JCC	27/06/2011	Havana / Conference room of GEARH	<ul style="list-style-type: none"> • Joint Terminal Evaluation Report • Activities of June 2011 • Plan of activities for September 2011
8th PEC	27/09/2011	Havana / Conference room of INRH	<ul style="list-style-type: none"> • Activities of September 2011 • Plan of activities for December 2011
4th JCC	16/12/2011	Havana / Conference room of Chateau Miramar Hotel	<ul style="list-style-type: none"> • Report of project achievement • Compliance with and/or expectations to comply with the recommendations made in the terminal evaluation • Publication in the yearbooks • Confirmation of outputs (distribution of training texts, donation of equipments) • Activity plan after completion of the project by the Cuban Side

6 Seminar and Workshop

6.1 Dissemination Technical Seminar and Workshop

In this project, the dissemination technical seminar was held as shown in the table below

Table 6-1: Dissemination Technical Seminar and Workshop

Date	Place	Seminar items	Lectures	Participant
22/06/2010	Holguín Province	Outline of the project and result of GIS/DB construction in Holguín Province	JICA experts and Core engineers (EIPH Holguín)	9 engineers of EIPH Holguín
24/06/2010	Las Tunas Province	Outline of the project and result of GIS/DB construction in Las Tunas Province	JICA experts and Core engineers (EIPH UEBPI Las Tunas)	12 engineers of EIPH UEBPI Las Tunas
28/06/2010	Camagüey Province	Outline of the project and result of the Geophysical Prospecting in Sola district	JICA experts and Core engineers (EIPH Camagüey)	4 engineers of EIPH Camagüey
30/06 - 02/07/2010	Camagüey Province	Outline of GIS	JICA experts and GEIPI Core engineers	12 engineers of GEIPI
08/03 - 10/03/2011	Villa Clara Province	Concept and function of GIS	GEIPI Core engineers and JICA experts	24 engineers of GEIPI and GEARH
12/09 - 14/09/2011	Pinar del Río Province	Geophysical prospecting	GEIPI Core engineers	27 engineers of GEIPI, EIPH, etc.
14/09 - 15/09/2011	Granma Province	GIS	GEIPI Core engineers	14 engineers of GEARH and DPRH
26/09/2011	Havana City	Groundwater model	GEIPI Core engineers	11 engineers of GEIPI and ENPC
14/12 - 15/12/2011	Havana City	Workshop of the project results	GEIPI Core engineers, GEARH's engineers and JICA experts	72 engineers of GEIPI, GEARH, etc.

6.2 Groundwater Development and Management Seminar

In this project, the Groundwater Development and Management seminar and workshop were held as shown in the table below.

Table 6-2: Groundwater Development and Management Seminar

Date	Place	Seminar items	Lecturers	Participant
25/10/2010	Camagüey Province	Introduction and outline of groundwater management	JICA Experts	15 engineers of GEIPI, GEARH, etc.
27/10/2010	Holguín Province	Introduction and outline of groundwater management	JICA Experts	7 engineers of GEIPI, GEARH, etc.
28/10/2010	Las Tunas Province	Introduction and outline of groundwater management	JICA Experts	10 engineers of GEIPI, GEARH, etc.
02/11/2010	Ciego de Ávila Province	Introduction and outline of groundwater management	JICA Experts	22 engineers of GEIPI, GEARH, etc.
03/11/2010	Villa Clara Province	Introduction and outline of groundwater management	JICA Experts	10 engineers of GEIPI, GEARH, etc.
04/11/2010	Matanzas Province	Introduction and outline of groundwater management	JICA Experts	30 engineers of GEIPI, GEARH, etc.
21/06/2011	Camagüey Province	Groundwater development and management seminar	GEIPI core engineers and JICA Experts	34 engineers of GEIPI, GEARH, etc.
16/09/2011	Granma Province	Principle of groundwater evaluation and management	GEIPI core engineers	11 engineers of GEIPI, GEARH, etc.
19/09/2011	Santiago de Cuba Province	Principle of groundwater evaluation and management	GEIPI core engineers	17 engineers of GEIPI, GEARH, etc.
14/12 - 15/12/2011	Havana City	Groundwater development and management seminar	GEIPI core engineers, GEARH's engineers and JICA Experts	72 engineers of GEIPI, GEARH, etc.

6.3 Public Seminar

A joint Public Seminar with Camagüey University was held on September 22, 2011. The outputs of this project were presented by the engineers of EIPH Camagüey and CITA.

- Venue: Camagüey University
- Presenter: Mr. Adán Echemendía (EIPH, Camagüey), Miss Rebeca Fernández (EIPH Camagüey), Mr. Carlos Luke Zayas Bazán (EIPH Camagüey) and Mr. Alien Pérez Santos (CITA)
- Participants: 40 faculty members and students at Camagüey University