CS-02.0000

ARRANGEMENT
BETWEEN THE
UNITED STATES GEOLOGICAL SURVEY
OF THE UNITED STATES OF AMERICA
AND
MINISTERIO DE AMBIENTE Y ENERGÍA
OF THE REPUBLIC OF COSTA RICA

SUBJECT: Groundwater exploration and assessment in the Republic of Costa Rica

LEGAL BASIS: General Agreement for Economic, Technical and Related Assistance between the Government of the United States of America and the Government of Costa Rica, signed in San José, December, 1961; entered into force September 7, 1962 and confirmed with Law N° 3011 July 18, 1962: where it is agreed the following:

Article I: In order to assist the Government of Costa Rica in its national development and in its efforts to achieve economic and social progress through effective use of its own resources and other measures of self-help, the Government of the United States of America will provide economic, technical and other related assistance required by agencies of the Government of Cost Rica and approved by representatives of the agency or agencies designated by the Government of the United States of America for the administration of their commitments under this Convention.

Article II: To promote social and economic progress of the country, the Government of Costa Rica will contribute to the maximally permitted by its resources and general economic conditions to the development program and to the programs and activities related to it, including those made in accordance with this Agreement, and provide as much information to the people of Costa Rica with respect to programs and activities contemplated.

OBJECTIVES: This Arrangement between the Ministerio de Ambiente y Energía (MINAE) and the United States Geological Survey (USGS) provides the framework to implement, in close collaboration with Costa Rican counterparts, an integrated country-wide groundwater resources project. This Arrangement provides the vehicle through which the USGS can conduct this project with funding provided by MINAE. Both MINAE and USGS intend to make the results available to advance the mission needs of both MINAE and USGS, and to benefit the broader science community and public.

BACKGROUND: Costa Rica is experiencing drought in populated and high potential tourism areas of the country, in particular the northwestern part of the country. The U.S. Geological Survey (USGS) has proposed a study described in the document attached on Annex I. The Embassy of the Republic of Costa Rica was interested and agreed to consider funding this study at a meeting at the Embassy, on June 24, 2015. On December 14, 2015

two USGS staff traveled to Costa Rica and presented the proposal to the Minister of the Ministerio de Ambiente y Energía. On Feb 10, 2016 the Ministry agreed to fund the project and develop an Arrangement with USGS.

AUTHORITY TO PUBLISH:

It is understood that the results of this work will be available to the USGS for publication in close collaboration with Costa Rican counterparts.

STATEMENT OF WORK:

The proposed study consists of four components: (1) Component A – Remote Sensing Tool (WATEX), (2) Component B – Hydrogeologic Assessment, (3) Component C – Economic Assessment of Groundwater Development and Use, (4) Component D – Capacity Building and Technology Transfer.

Component A: Remote Sensing Tool, Water Exploration (WATEX)
WATEX is an algorithm that combines remotely sensed data collected by various satellites and ancillary data such as climatological, geologic, geomorphologic, hydrologic and hydrogeologic, and seismic and geophysical data, where available, to reveal areas of potential groundwater wells.

WATEX is a cost effective methodology that will provide a rapid evaluation of groundwater resources to enhance resiliency to climate change and contribute to long-term planning and development.

Component B: Hydrogeologic Assessment
While WATEX has proven effective in locating subsurface features that provide groundwater, it cannot address such issues as long-term productivity and sustainability, water-quality, or detecting deeper aquifers buried under thick sedimentary layers with the absence of seismic data. Such characterization requires the use of both traditional and state of the art ground-based groundwater assessment.

Component B is a 14-month, ground-based assessment of two groundwater basins in Costa Rica. Component B will be done concurrently with Component A and will build upon the data from the remote-sensing (WATEX) analysis, described above. While WATEX will assess the groundwater development potential of the entire country, the objective of this component is a detailed assessment of two high-priority "type sites" basins identified by the WATEX analysis.

Component C: Economic Assessment of Groundwater Development and Use
Component C will be done concurrently with Components A and B and will build on the WATEX analysis and findings, and the hydrogeology assessment, described above. The objective of this component is to conduct a detailed economic analysis of the sustainable economic use patterns of two high-priority "type sites" basins identified by the WATEX and the hydrogeologic analysis.

Component D: Capacity Building and Technology Transfer

Any long-term effort to independently assess, develop, and manage the water resources of the Republic of Costa Rica will require a community of well-trained Costa Rican hydrologic scientists, engineers, and technicians. The participants intend to develop this community through technology transfer to active professionals, training technicians in field techniques, and the education of water professionals by universities. To this end, capacity building and technology transfer are essential parts of the current proposal.

Detailed information on each component is shown in Annex I.

PROJECT COORDINATORS AND ADMINISTRATIVE CONTACT:

USGS Personnel:

- Project Manager:
  - Verne Schneider, Chief, International Water Resources Branch, vrschnei@usgs.gov

- Key Personnel:
  - Saud Amer, remote sensing and water specialist, OIP, samer@usgs.gov
  - Vic Heilweil, Research Hydrologist, USGS Utah Water Science Center, heilweil@usgs.gov

- Administrative:
  - Nancy Zeigler, Chief, Branch of Administration and Special Projects, nzeigler@usgs.gov

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Ministerio de Ambiente y Energía Personnel:

- Project Manager:
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- Key Personnel:
  - Leonardo Cascante Chavarría, Ingeniero Agrícola, lcascante@da.go.cr
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- Administrative:
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PERIOD OF ARRANGEMENT:

The total period of the study is 14 months and all components will start concurrently. The final reports, drilling handbook and hydrogeologic and economic assessment will be delivered no later than sixty days after the completion of the study. This Arrangement will become effective upon signature by both participants.

FINANCIAL ARRANGEMENTS:

The total project cost is USD $1,458,243; this amount should be transferred from MINAE to USGS.

The transfers should be made in two tracts:

- ***First transfer:***
  It should be made in the last quarter of 2016, in the amount of: $1,250,000 (USD).

- ***Second transfer:***
  It should be made in the second quarter of 2017, in the amount of: $208,243 (USD).

The execution of the project will begin once the first transfer has been made.

USGS intends to submit quarterly invoices and progress reports to the program manager and administrative staff of the Ministerio de Ambiente y Energía.

AMENDMENTS:

The particpants may make changes to this Arrangement. Changes to the arrangement should bei n writing, and signed by both the the USGS and Ministerio de Ambiente y Energía.

AUTHORITY:

This Arrangement was developed under the authority of (22 United States Code 2357 (Public Law No. 87-195) and the General Agreement for Economic, Technical and Related Assistance between the Government of the United States of America and Government of Costa Rica.

SIGNATURES:

For the USGS:

Vic Labson
Director
Office of International Programs, USGS

11/15/16
Date

For the Ministerio de Ambiente y Energía:2

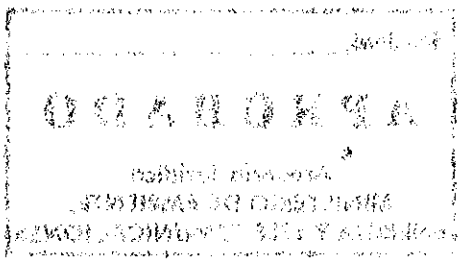
Edgar E. Gutiérrez Espeleta
Minister
Ministerio de Ambiente y Energía

09/11/16
Date

San José, 24/03/2017
APROBADO
Asesoría Jurídica
MINISTERIO DE AMBIENTE, ENERGIA Y TELECOMUNICACIONES

MINISTERIO DE AMBIENTE Y ENERGIA
DIRECCIÓN DE ASESORÍA JURÍDICA
COSTA RICA

DIRECCION DE ASESORIA JURIDICA
COSTA RICA



ANNEX I

Project Proposal:
Groundwater Exploration and Assessment in the Republic of Costa Rica

Background and summary

The U.S. Geological Survey (USGS) has proposed a study described in this document.

The Embassy of the Republic of Costa Rica was interested and agreed to consider funding this study at a meeting at the Embassy, on June 24, 2015.

The proposed study area (outlined in the red polygon, Figure 1) covers 51,260 km^2, the entire land area of the republic of Costa Rica. The proposed study consists of four components: (1) Component A – Remote Sensing Tool (WATEX), (2) Component B – Hydrogeologic Assessment, (3) Component C – Economic Assessment of Groundwater Development and Use, (4) Component D – Capacity Building and Technology Transfer. Component A is expected to be completed in 6 months; Components B, C, and D are expected to be completed in 14 months.

The total period of the study is 14 months and all components will start concurrently. The final reports, drilling handbook and hydrogeologic and economic assessment will be delivered no later than sixty days after the completion of the study. The study will commence upon receiving the funds.

Component A: Remote Sensing Tool, Water Exploration (WATEX)

WATEX is an algorithm that combines remotely sensed data collected by various satellites and ancillary data such as climatological, geologic, geomorphologic, hydrologic and hydrogeologic, and seismic and geophysical data, where available, to reveal areas of potential groundwater wells.

WATEX is a cost effective methodology that will provide a rapid evaluation of groundwater resources to enhance resiliency to climate change and contribute to long-term planning and development. Analysis of the survey results will:(1) reveal productive aquifers suitable for multiple uses; (2) contribute to long term planning for agricultural and economic growth and development; and (3) identify locations suitable for groundwater recharge that might be appropriate for the construction of micro-dams and irrigation projects. By utilizing the results of the survey and analysis, this project will provide new water sources and equip local men and women with the knowledge and tools necessary to find water to improve livelihood, promote economic growth, and enhance resiliency to climate change.

Approach:

1. Identify, acquire, process and interpret remotely sensed data from several satellites, including Landsat, orbital radar, and Shuttle Radar Terrain Mission (SRTM) to delineate areas of interest, and classify each site and sub-site for potential water resources.

2. Acquire ancillary data, including rainfall, topographical maps, and geologic, seismic, geomorphologic and hydrogeologic data to help interpret the remotely sensed data.
3. Calibrate and validate the interpretation of the remotely sensed data by collecting field data.

Data to be Supplied by Costa Rican Agencies:

To ensure the success of Component A, the following data need to be supplied by the Costa Rican counterparts for development of a country-wide assessment of potential groundwater: (1) geologic maps/cross sections; (2) groundwater-level measurements and well logs; (3) soil maps and land use/land cover maps; (4) aquifer tests for evaluating yield; and (5) seismic/geophysical measurements.

Products:

1. Digitization of data and creation of GIS data layers.
2. A series of maps and high-resolution images will be provided. The maps will be based on an integration of radar, terrain, and Landsat satellite images. Maps will be geo-referenced (GIS format) and include: (a) water potential sites to increase success rate of drilling boreholes, (b) aquifer recharge maps, indicating potential aquifer recharge areas, and (c) potential locations for micro dams.
3. Two Groundwater Exploration Navigation System (GENS) will be provided. GENS is a hand-held GPS connected to a tablet where all the necessary maps and coordinates that lead to high potential water sites are downloaded, resulting in higher accuracy locating potential water sites. GENS is a very compact and rugged system that can be carried by hand and withstand harsh field conditions.
4. Aquifer recharge zones will be identified.
5. Metadata used in the project will be provided in standard format.
6. Quarterly progress reports will be submitted that summarize findings of potential water sites and potential recharge sites within the study area, if any.
7. A drilling handbook that describes the study area with recommended drilling sites will be prepared.

Schedule:

The WATEX process is expected to be completed in **6 months** from the time the funds are received. WATEX process will be applied for the entire country of Costa Rica, 51,260 km^2, Figure 1.

Budget:

The total budget for this component is $789,634.

Personnel and responsibilities:

Saud Amer is the coordinator for the project and he will have primary responsibility for ensuring the proposed study achieves its goals, timely delivery of products and providing interim progress reports and presentations. Dr. Amer will also serve on the team as one of the remote sensing experts that are required to accomplish the study.

The project will primarily require: two remote sensing experts, a geologist, a GIS expert, metadata expert, a senior hydrologist, and hydro-geochemist.

Other personnel requirements:

We will collaborate with government, academia, private sector, and NGOs working in the area to increase efficiency, especially during field visits.

In addition, we would like to see participation from professionals from the federal and regional governments and universities in the WATEX process training course and any planned field activities.

Project risks and mitigation:

We plan the component will be completed in 6 months, which leaves little time for significant delays. Due to logistical measures, the team is planning for minimum field visits and field activities. This will be accomplished by the close collaboration of the team with government professionals and personnel, universities and NGOs. Previous experiences and lessons learned will be applied to minimize any risk. Training will be conducted on the new data and analysis to build the capacity and skills within stakeholders.

Justification for the project – technical and socioeconomic:

- Improve access to potable water and for other uses.
- Save time and money by improving the drilling success rate rather than depending on outdated data or simply drilling by trial and error.
- Provide a strategy to manage groundwater resources to minimize future impacts of droughts and enhance economic growth and improve livelihood.

Examples of previous work:

- In 2005, USAID funded a study in Darfur for groundwater exploration for the 2.5 million IDPs. The study resulted in increasing drilling success from 33% to 95% and reduced overall drilling costs by more than 70% in a sample of 1,000 wells drilled using the results of such study.

- USAID also funded a study in Afghanistan to prevent a humanitarian crisis. The project was to determine whether there was enough water to support 50,000 Afghan refugees in a selected site in Afghanistan. The WATEX process revealed within a couple of weeks that there was not enough water. Further analysis and hydrogeological studies confirmed the accuracy of the WATEX process.
- In 2013, USAID funded a study in the Somali region of Ethiopia. The study resulted in increasing drilling success from a range between 25 and 45% to 80%. Also the study contributed to an improved and more accurate geologic map for the area.
- In 2014, UNESCO funded project in northwestern Kenya. The study revealed the presence of five aquifers; several boreholes have been drilled and all productive.
- In 2014 UNESCO funded project to map groundwater resources in Iraq, countrywide. The study is in progress but several potential water exploration sites are being identified.

Component B: Hydrogeologic Assessment

While WATEX has proven effective in locating subsurface features that provide groundwater, it cannot address such issues as long-term productivity and sustainability, water-quality, or detecting deeper aquifers buried under thick sedimentary layers with the absence of seismic data. Such characterization requires the use of both traditional and state of the art ground-based groundwater assessment.

Component B is a 14-**month**, ground-based assessment of two groundwater basins in Costa Rica. Component B will be done concurrently with Component A and will build upon the data from the remote-sensing (WATEX) analysis, described above. While WATEX will assess the groundwater development potential of the entire country, the objective of this component is a detailed assessment of two high-priority "type sites" basins identified by the WATEX analysis. This ground-based assessment is essential for identifying dependable, long-term groundwater supplies to minimize and mitigate the effects of climate change in the region and promote economic growth. The USGS team will work closely with the Costa Rican professionals to identify criteria for selecting two high-priority "type sites".

Hydrogeologic conceptual models will be developed to evaluate the groundwater resources of these two areas for sustainability, and suitability for intended uses. If one or more Costa Rican agencies have already developed hydrogeologic conceptual models in these two areas, USGS efforts will focus on refining these models. These models will help identify water supplies more resistant to drought. Through cooperation with local, national, regional, and international entities, these two pilot studies will further develop the capacity of scientists and engineers to assess and sustainably develop groundwater resources in other areas having the potential for groundwater development, as identified by WATEX.

Approach:

Because many of the features identified by WATEX as containing groundwater are buried stream channels and fissures, long-term sustainability may depend on whether these features act as sumps for regional aquifers, as conduits for higher elevation recharge, as collectors of local precipitation, or some combination of the these factors.

Once two high-priority "types sites" have been identified, hydrogeologic conceptual model development will include: (1) 2-D cross sections or 3-D solids models showing hydrogeologic unit thickness, along with estimates of permeability and storage; (2) potentiometric maps showing groundwater flow directions; (3) estimated groundwater budgets based on easily measurable groundwater discharge, as feasible.

The USGS team will work closely with the Costa Rican professionals to develop hydrogeologic conceptual models for two high-priority "type sites". The conceptual models will describe the current understanding of the groundwater system, including sustainability of the newly found groundwater resources, water quality, and the resource's suitability for its intended use.

To the extent possible, all work will be conducted in collaboration with the various governments and entities involved in studying and assessing the area's water resources. Although capacity building and technology transfer are included as a separate item, **these will occur throughout the project as USGS and Costa Rican personnel interact.**

The proposed study will require intensive field work, but given such difficulties as logistical issues and the expense for USGS scientists to work in parts of the study area, Costa Rican scientists and engineers will perform the majority of these tasks under guidance of the USGS. This technology transfer will not only aid this study but will build essential local skills for the continued assessment of Costa Rica's groundwater resources.

Data to be Supplied by Costa Rican Agencies:

To ensure the success of Component B, the following hydrologic data for two "type sites" need to be supplied to the USGS by our Costa Rican counterparts for development of hydrogeologic conceptual models: (1) geologic maps/cross sections and previously-conducted aquifer tests for evaluating aquifer permeability and storage; (2) groundwater-level measurements from monitoring well networks for developing potentiometric maps and evaluating groundwater flow directions; (3) historical pumping records of large production wells, along with base-flow discharge measurements of streams and springs for estimating groundwater budgets; (4) identification of suitable well and (or) spring sites for environmental tracer sampling to evaluate groundwater ages and recharge sources.

Products:

The primary deliverable of Component B is a technical report describing the results of the hydrogeologic assessment

Budget:

The total budget for this component is $501,613.

Personnel and responsibilities:

Saud Amer is the Project Coordinator and will have primary responsibility for ensuring that the proposed study achieves its goals, delivers products on time, and provides interim progress reports and presentations.

In addition to the Project Coordinator, The work described here will require a Senior Hydrogeologist and a Senior Groundwater Analyst. Additional personnel include: a Senior Hydrogeochemist, and two Mid-level Groundwater Specialists; additional groundwater personnel may be tasked for a limited number of hours if analyses require additional specialized knowledge. USGS and where possible, local lab facilities will be used to analyze groundwater samples.

Project risks and mitigation:

The component is scheduled for 14-month duration. Delays in identifying appropriate sites, securing funding, and organizing field work can adversely extend timelines. Logistical issues affecting travel by USGS personnel could delay field work.

Justification for the project – technical and socioeconomic:

Priority will be given to assessment of the WATEX-identified resource to facilitate further application of WATEX.

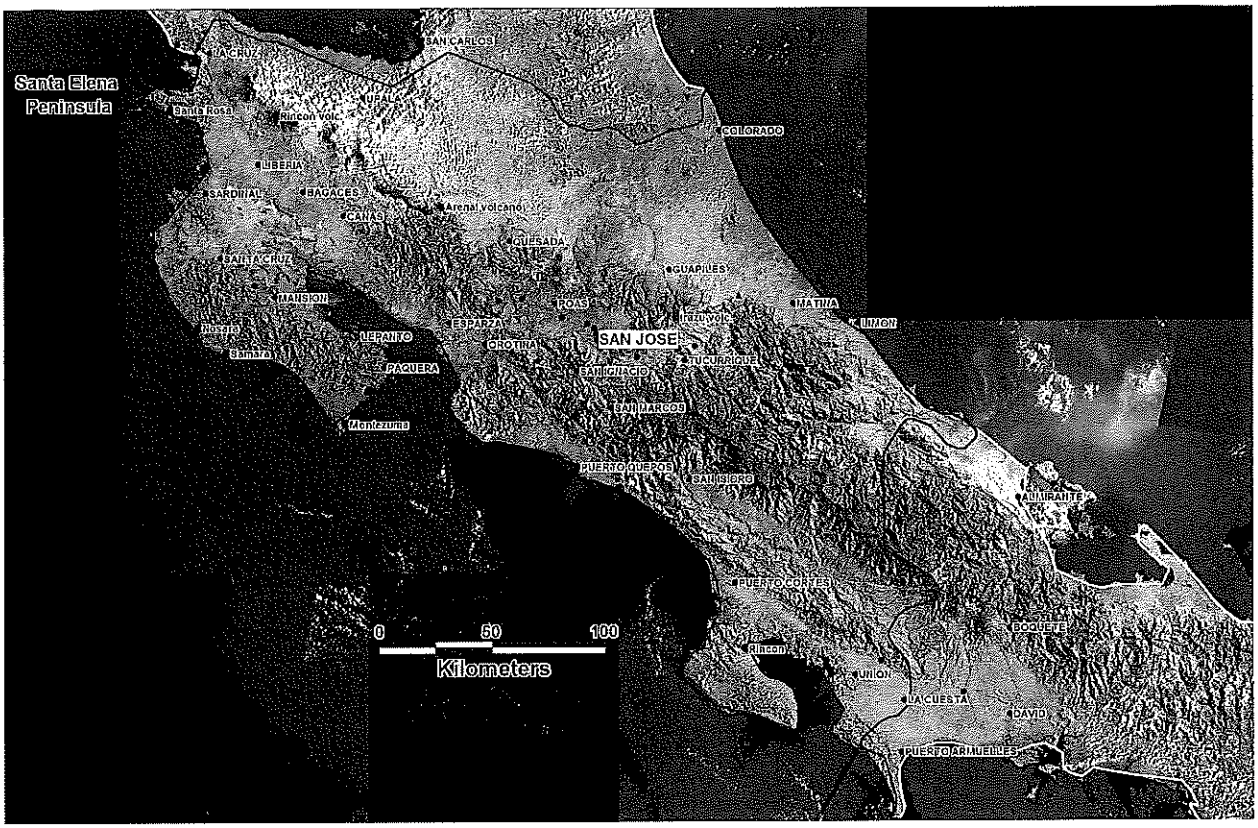


Figure 1. Landsat image of Costa Rica, study area (red polygon). It covers an area of 51,260 km^2.

Component C: Economic Assessment of Groundwater Development and Use

Component C will be done concurrently with Components A and B and will build on the WATEX analysis and findings, and the hydrogeology assessment, described above. The objective of this component is to conduct a detailed economic analysis of the sustainable economic use patterns of two high-priority "type sites" basins identified by the WATEX and the hydrogeologic analysis. Due to anticipated results from the WATEX and hydrogeologic analysis of the study area, this analysis proposes examining the economic performance associated with various measures to put the newly-discovered water to economic good use. The economic assessment of groundwater development and use will be conducted over a **14 month** period.

Approach:

A detailed economic analysis will be performed on two high-priority "type sites". It will be based on an empirical farm income optimization model to inform ongoing policy debates dealing with the effectiveness of various patterns of crop irrigation and other water uses in the newly discovered aquifer region of Costa Rica. The analysis anticipates conducting a "with versus without new water" comparison that reflects farmers benefits from converting from the current exclusively rainfed agriculture to an agriculture supplemented by the much more reliably supplied and lower cost aquifer water use in the region.

Under the proposed program, growers would substitute increased irrigation infrastructure (at a cost) for reduced water applications per unit land irrigated. The importance of access to affordable substitutions of water conserving irrigation infrastructure for reduced surface water supplies takes on more importance in the face of growing shortages in surface water supplies.

The economic principle behind our investigation is to substitute increased irrigation infrastructure (at a cost) and a more reliable water supply for the existing arable land, taking into account high value crops, drought resistant crops, multiple crops per year, livestock grazing, and other uses of water resources.

In cooperation with Costa Rica agricultural and planning, and water and irrigation officials, data will be needed on the existing crop and livestock land use patterns, in addition to crop prices, yields, and timed water use requirements for both existing agricultural enterprises and also for potential irrigated crop production patterns.

Data to be Supplied by Costa Rican Agencies:

To ensure the success of Component C, the following data for two "type sites" need to be supplied by the Costa Rican counterparts for development of a GAMS (General Algebraic Modeling System) optimization model showing the gain in economic value produced by more reliable water supplies. These data includes: (1) water requirement per month for agriculture and other uses; (2) pumping cost per cubic meter; (3) yield per ha; (4) price per metric ton of major crops; (5) population data.

Products:

1. Assessments of costs of delivery and sustainable quantities of groundwater that can be supplied at several WATEX-identified sites in the study area where successful wells have recently been drilled.
2. With cooperation from Costa Rican officials, data will be assembled on irrigable land, crop prices, production constraints, costs of production, and water use per unit land by crop for the major crops in the study area.
3. A preliminary conceptual model describing an economically sustainable land use pattern for irrigated crops in the region based on costs of delivery and quantities of water available. The model will be a conceptual framework to identify the suite of crops that make the most economically sustainable use of groundwater resources identified in the study area.
4. Capacity building and technology transfer of farm income optimization techniques to Costa Rican scientists, engineers, and technicians.
5. A report will be prepared illustrating the suite of crops that can be produced with newly discovered groundwater in the study area.

Budget:

The total budget for this component is $115,749

Personnel and responsibilities:

Saud Amer is the Project Coordinator and will have primary responsibility for ensuring that the proposed study achieves its goals, delivers products on time, and provides interim progress reports and presentations.

In addition to the Project Coordinator, The work described here will require a senior water economist and two economic analysts.

Project risks and mitigation:

The component is scheduled for a14-month duration. Delays in identifying appropriate sites, securing funding, and organizing field work can adversely extend timelines. Logistical issues affecting travel by the project personnel could delay field work and/or capacity building exercises.

Justification for the project – technical and socioeconomic:

Priority will be given to assessment of the WATEX-identified resource to facilitate further application of WATEX and assessments of the economic performance of WATEX-identified groundwater reserves.

Component D: Capacity Building and Technology Transfer

Any long-term effort to independently assess, develop, and manage the water resources of the Republic of Costa Rica will require a community of well-trained Costa Rican hydrologic scientists, engineers, and technicians. This community will be developed through technology transfer to active professionals, training technicians in field techniques, and the education of water professionals by universities. To this end, capacity building and technology transfer are essential parts of the current proposal.

Component D, as described herein, will focus on providing formal training in groundwater field techniques and remote sensing applications for water resources. The nature and subject of this training will be determined in close consultation with the relevant Costa Rican agencies. The capacity building and technology transfer will be conducted over period of the study.

The USGS has the experience working in Costa Rica through various projects.

Approach:

The capacity building and technology transfer component is broken into several tasks. The tasks and subtasks are:

1. Capacity building and technology transfer: throughout the study period
    a. Preparation and preliminary assessment:

i. Identify key participating Costa Rican agencies and personnel; assess training needs as identified by the agencies.
ii. Prepare appropriate training material for identified classes.

b. Conduct hands-on training classes in Costa Rica. Training conducted during the study period of the project will emphasize the skills needed to conduct field work and document data. USGS employees involved in earlier training efforts believe that the most urgent training need is in basic groundwater field techniques. Possible courses include:
   i. Groundwater field methods, 1 week: The course will emphasize the collection of high-quality groundwater information in the field. Topics will include well inventory, reconnaissance, and documentation; use of GPS and maps; water-level measurement; estimation of discharge; and other topics as appropriate.
   ii. Groundwater-quality field techniques, 1 week: The course will emphasize the collection of field water-quality data such as temperature, pH, and specific conductance, as well as the collection of water samples for laboratory analysis.
   iii. Estimation of aquifer properties using single- and multiple-well aquifer tests, 1 week: The course will provide an introduction to aquifer tests including theory, field techniques, and interpretation of results.
   iv. Other possible, more advanced topics include numerical groundwater modeling, introduction to geophysical techniques, interpretation of groundwater-quality data, groundwater-resource protection and management, or case studies in current groundwater-assessment techniques. These topics may be taught as short courses, seminars, or lectures.
   v. Remote sensing, 1 week: The course will provide an introduction to the physics of remote sensing, remotely sensed data search and download, and remote sensing applications exercises.
   vi. One week of training will be conducted for professionals from non-governmental organizations (NGOs), drilling companies, the federal and regional governments, universities and others on the use of the delivered products, including the use of the hand-held GPS to locate potential water wells.
   vii. One week of training on farm income optimization techniques to Costa Rican scientists, engineers, and technicians.

c. A summary of the training will be compiled to:
   i. Document training material.
   ii. Course evaluation.
   iii. List course participants.

d. Contact between USGS and Costa Rican scientists and engineers will continue throughout the project in the form of information exchange, technical guidance, and presentations.

Products:

The primary deliverable for the capacity building and technology-transfer component will be the courses conducted in Costa Rica and knowledge passed by working with Costa Rican scientists and engineers.

Schedule:

Component D - capacity building and technology-transfer is planned to be completed 14 months from the time the funds are received.

Budget:

The total budget for this component is $51,247

Personnel and responsibilities:

Saud Amer is the Project Coordinator and will have primary responsibility for ensuring that the proposed study achieves its goals, delivers products on time, and provides interim progress reports and presentations.

In addition to the Project Coordinator, Component D will require a Senior Hydrogeologist and a Senior Hydrogeologist. These two will act as instructors and lecturers for all courses, seminars, lectures, and any other interactions. Additional groundwater personnel may be tasked for the preparation of training material.

Project risks and mitigation:

The capacity building and technology-transfer component is planned for a duration of 14 months which leaves little time for significant delays. Once the project is funded, an initial visit needs to occur as quickly as possible in order to meet professionals from Costa Rica to assess training needs, and make arrangements for facilities and other logistics. Current and former USGS personnel with experience in Costa Rica will be consulted extensively to facilitate planning and implementation.

Justification for the project – technical and socioeconomic:

Capacity building and technology-transfer activities described here will:

- Provide training and information to Costa Rican groundwater scientists, engineers, and technicians.
- Contribute to the development of Costa Rica hydrology community that will be able to independently assess, develop, and manage the water-resources of the country.
- To the extent possible, provide insight or suggest alternative approaches on any current studies by Costa Rican groundwater personnel.

The overall budget for all four Components, A, B, C, and D, is $1,458,243.