Global Water Partnership Central America

Case Study

Adaptation and vulnerability reduction to climate change in the water sector

THE UPPER BASIN OF THE REVENTAZON RIVER IN COSTA RICA

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I. Summary

This initiative began in 2000, as a response to the inadequate management of the upper basin of the Reventazón River.A workgroup was established with representatives from different organizations interested in the basin's management so that they could work together on its conservation.

One of the primary problems for the basin was water contamination, which is why adopting measures for its control and protection was a priority .The contamination of water bodies favors the proliferation of waterborne diseases, reduces the number of available water sources, increases the cost of supplying water for human consumption and threatens species of flora and fauna.

Water quality improvement will reduce the high levels of contamination and protect the basin's inhabitants' health. It will also support the improvement of the quality of life for those living in the Cartago province whose water supply comes from the Reventazón River.

As a result, in 2000, alaw for a better management of the Reventazón River's Upper Basin was proposed and passed (Law Nº 8023, published in*La Gaceta* Nº 203 onOctober 24, 2000).This law proposed the creation of the ***Commission for the Planning and Management of the Upper Basin of the Reventazón River (Comisiónpara el Ordenamiento y Manejo de la Cuenca Alta del Río Reventazón),*** or COMCURE by its acronym in Spanish. This is adecentralized office of the Ministry of Environment and Energy (Ministerio de Ambiente y Energía – which is now the MINAET) and holds instrumental legal status.

COMCURE must address some of the consequences of the poor management of the upper basin of the ReventazónRiver, which, include the disruption of the natural hydrological cycles. The disruption of the hydrological cycles has result in an alteration ofthe seriousness and frequency of floods and droughts, as well as in anincrease of contamination. Thishas resulted in significant losses for the human populations living in the watershed. Therefore, its management and conservation is essential so that itsecosystems can increase their resilience to the effects of extreme weather events related to variability and climate change and continue supplying important goods and services to local communities.

In the last 10 years, some soil conservation actions have been implemented and reduction of approximately 20% of the sedimentation that reaches the dams has been achieved. This represents a reduction of 400 tons out of 2,000 tons of sediment that reach the dams on an annual basis. This has contributed to reduce flood riskin the basin area.

Costa Rica's economy has also been affected. Sedimentation reduces usable water volume in the reservoirs, which then affects the availability of water resources for the generation of electricity. As a result, Costa Rica needs to rely more on thermal energy generated from fossil fuels, which causes an increase onthe cost of electricity generationthat is ultimately passed on directly to water users.

Annual draining of the reservoirs is necessary in order to extractthe sediment that generates environmental problems. These problems are reduced through efforts to decreasesedimentvolumes that accumulate each year; at the same time, this reducesthe vulnerability to variability and climate change. Furthermore, reducing the amounts of sediment extends the lifetime of the dam.

The Reventazón River basin is part of the UNESCO´s "HELP" watersheds (Hydrology for the Environment, Life and Policy). In 2009, the Sustainability Index (ISC) was defined for theReventazónRiver basinfor the period between 2000 and 2005, representing a global ISC value

for the basin of 0.74. To determine this index, the following characteristics of the basin were evaluated: hydrology, environment, life and policy. Among the hydrological aspects considered werethe quality and quantity of water in the basin as well as the availability and rational use of water resources.

With the support of GWP Costa Rica, two internship students from the SUPAGRO University in Montpellier, France updated the index for the five year period between 2005-2010.The ISC value for the basin is now0.69.They considered that the index previously established was overvalued despite the actions taken in the last several years in relation to the efficient use of the water resource.

In the period from 2000 to 2009, the basin's vegetationcover increased 11%. This translates into approximately 16,000 planted hectares; contributing to improved water infiltration, reduction of floods and diminishment of the occurrence of landslides. As a result, the basin's vulnerability during the occurrence of extreme weather events is reduced.

Currently, management actions are being implemented in 80% of the basin.This has left valuable lessons learned that can be replicated inother basinsofthe country, thus contributing to an improved situation for water resources and its sustainable use.

II. The area's characteristics and current situation

The Reventazón River basin is located in the central area of the Atlantic Slope of Costa Rica and includes territories from both the provinces of Cartago and Limón.It covers an area of 2,950 km^2(this is equivalent to 5.20% of the national territory)and has an extension of 125 km. .Its approximate population is of 550,000 inhabitants and it is mainly concentrated in the basin'supperand middleareas. It is the third largest basin in the country and has an important role in Costa Rica's economy.It is the source of 38% of the country's hydroelectric energy, of 25% of the drinkingwater forSan José (the capital city), of 85% of horticulture production (potatoand onion), of 33% of livestock and 50% of the country´s cement production, without taking into account the contributions of the lower basin area.

This basin is currently under full development and there is an equally strong demand for its resources by the industrial sector as well as by the agricultural/livestock sector. In addition to the increase in population and waste generation that has contributed to a degradation process of the basin's resources. This process is evidentin the degradation of productive land, the increase in erosion and the movement of sediment, the contamination of water and the environment, the increase in waterborne illnesses and in the risk of landslides and flooding in critical areas.These problems causing this situation have to do with the excessive use of pesticides and chemical fertilizers, improper wastedisposal on farms, the lack of urban residual waste water treatment systems,inadequate disposal of urban waste, deforestation and the over use of land by poor farming practices (especially poor tillage practicesfor horticulture).

The degradation process is associated with high rainfall, steepslopes, and soil fragility. The basin's soils are primarily of volcanic origin and produce high levels ofrun-off, landslides, sediment transport and a long history of floodingin the basin'scritical areas. In the last several years, this has worsened as a consequence of variability and climate change.

When the management actions for the basin began, water contamination levels were at 11% with respect to the national contamination levels--making it the second most contaminated basin. The basin also has important protected areas that cover 75,608 hectares and correspond to 26% of the country's total area.

As a result of this situation and due to the basin's economic and environmental relevance, the Law Nº 8023 was approved in 2000, thus creating the ***Commission for the Planning and Management of the Upper Basin of the Reventazón River (Comisiónpara el Ordenamiento y Manejo de la Cuenca Alta del Río Reventazón-*** known as COMCURE by its Spanish acronym). This was a pilot project in the fieldof watershedmanagement that had the rest of the country's basinsin mind. With the application of the Management Plan, an effective process for the sustainable development of the basin was put into place.
In order to implementthe management planfor the Upper Basin of the Reventazón River, the following bodies were established:

a) Land use and management commission
b) Consultative committee
c) Executing unit
d) Regional committees

Annex No. 1 includes the objectives, functions, and composition of COMCURE and the Consultative Committee, whose main function is to advise and support COMCURE in the direction and evaluation of the different components of the Basin Management Plan.

III. Operational strategy

ACTIVITIES IMPLEMENTED

Since its establishment, COMCURE set upthe guiding, consultative and executing bodies. It also introduced and presentedthe Basin Management Plan to the communities in preliminary meetings and sectorial assemblies that have continued on a permanent basis in order to have a participatory and dynamic process.

Project Management and Institutional Coordination

A. Between 2000 and 2008, projects have been formulated and executed with their respective evaluation and monitoring plans in the three priority sub basins (Reventado, Pacayas, and Guayabo/Birris)under 3 technical components including:

- ***Agrosilvopastoral Sustainable Systems***: Activities within this component include: A) Soil preparation and conservation: more than 2,293 farms are using systems for protection and conservation of soils. This includes more than 8,342 hectares that have been prepared with chisels and mechanical shovels. B) Waste management: more than 197 worm composting bins have been established along with 249 farm biodigestors; these are used to heat pigs, cook food, etc. There also are at least 21 Efficient Microorganism (EM) projects. C) High altitude fruit trees: 120 hectares (326 farms) of high altitude fruit trees (avocado, fig, etc.) have been planted. D) Semi-confined cattle: there are 186 farms with 125 hectares of pasture land and foraging bushes that have semi-confined cattle. E) Capacity building: this has all been accomplished with 102 visits (including some workshops) to the area.

- ***Management of Vegetation Cover:*** 7 communal nurseries managed by women have been established. These nurseries rely on a mix of 27 different timber species for the protection and reforestation of farms that are near water sources and springs, river banks and riparian forests. More than 2,500,000 trees have been planted in 3,427 reforestation areasin the basin and 16 farms are implementing Payment for Environmental Services (PES).
- ***Environmental Education***. 4 water management modules were produced for 4th graders and pre-schoolers.Approximately 15,586 children from 572 primary and secondary schools have used them. More than 155 events including field trips, educational tours, and plays, among others, have been carried out with the participation of 13,221 students.

B. Implementation of the Priority Actions Project of the Reventazón-Parismina RiverIntegrated Management Plan, towards the Carribbean Slope in the Provinces of Cartago and Limón, Lot 1.

In the framework of the Environmental Degradation and Vulnerability Reduction Program (Programa de Reducción de la Vulnerabilidad y DegradaciónAmbiental, or PREVDA by its Spanish acronym), COMCURE signed the European Union External Support subsidy contract onDecember 16, 2008 – Europeaid/127131/M/ACT/CR-Lote 1, PREVDA/06-08 for the execution of lot 1 "Biophysical and Organizational Improvement of the Upper and Middle areas of theReventazón River Basin".

This Project lasted 24 months and was developed from 2009 to 2010. After this, an extension of 6 months was obtained and the project concluded in June 2011. The cost of the project was € 873,050 Euros of which PREVDA financed € 698,440 Euros (80%) while COMCURE and their partners provided € 174,619 Euros (20%). The primary project activities in the area of water resource vulnerability were:

1. **To define the basin's water resource vulnerability, taking into account the areas susceptible to contamination, the reduction of the basin's hydric potential, and the effects of climate change.**

There are five microbasins with their respective calibrated hydric balance (Navarro Aguacaliente, Pejibaye, Grande de Orosi, TurrialbaandGuayabo rivers). After conducting a statistical analysis of rainfall levels, these calibrated balances allow for the modeling of river bank behavior in different precipitation scenarios such as dry years, years with average precipitation and rainy years. This analysis allows for the adaptation and reduction of vulnerability to climate change in the water sector.

2. **To introduce an early warning system in the sub-basins of the Taras, Reventado and Turrialba rivers.**

An early warning system model is in place for the Turrialba, Taras and Reventado rivers. Currently, it is being calibrated in conjunction with hydraulic modeling in elements such as basin response time, maximum levels for bank overflow, as well asclimactic, telemetric, precipitation, relative humidity, radiation, velocity and wind direction conditions. This system will be connected to the automaticprecipitation measuring stations and pluviographs that emit climate information in real

time for the respective generation of alerts. The system allow for the adaptation and reduction to climate change vulnerability in the water sector.

Once the calibration tests for the model are finalized, the data will be transferred to the National Emergency Commission (CNE, by its acronym in Spanish). Then, the communities will be introduced to the organization and they will receive training on the system. Once this is done, the operationalization of the system will begin.

3. To install 7 rainfall measuring stations and 1pluviographic station

These stations provide real-time information about precipitation, daylight hours, relative humidity, and wind velocity, etc. with a radio frequency that allows for data transfers to the National Emergency Commission (CNE), the National Meteorologic Institute(IMN),and the Costa Rican Electricity Institute(InstitutoCostarricense de Electricidad-ICE). These stations also supply information to the basin's early warning systems. Meteorological stations are already installed in: Organic Agriculture School (Escuelade AgriculturaOrgánica -INA), Chinchilla,Durán Nursing Home, Tierra Blanca,Tobosí El Guarco, Pacayas, Llano Grande in Cartago, Concavas ICE in Paraíso and San Antonio in Turrialba. The information collected by these stations is a contribution to the reduction of climate change vulnerability in the water sector.

Although, this is currently in the test phase, once these stations are operational, it is expected that the data generated for the provision ofinsight on the climactic conditions, riverbanks, etc. will allow for the implementation of the early warning system. Furthermore, a website is expected to be developed, so that communities arepermanently informedabout the climactic conditions.

IV. Results

1. 20% of the sediment in the dams has been reduced due to conservation and land management actions. In other words, this means that 400 tons out of the 2000 tons of sediment that annually arrive to the dam have been reduced.
2. The reduction of sediment allows for an improved use of the reservoir's usable volume. This means an increasing of the volume of water availablefor electricitygeneration. As a result, there is a contribution to reducethermalpower generationthroughfossil fuels whose combustion produces significant quantities of contaminants and greenhouse gases.
3. The reduction in the sediment load insidethe dam leads to less frequent draining and thus to a dimishment of the environmental problems caused by the process. Additionally, the reduction in the quantity of sediments increases the dam's useful life.
4. After conducting a statistical analysis of rainfall levels, the five microbasins with a calibrated hydric balance (Navarro Aguacaliente, Pejibaye, Grande de Orosi, Turrialba and Guayabo rivers), have ariverbank behavior model fordifferent precipitation scenarios such as dry years, years with average precipitation and rainyyears. This helps to define the basin's vulnerability to the effects of climate change considering the variation in the availability of water and its possible consequences on the population.
5. The early warning system model is available for the Turrialba, Taras andReventado rivers' sub-basins. It is currently being calibrated in conjunction with the hydraulic model withelements

such as basin response time, maximum levels for bank overflow, etc. This system will be connected to the automatic precipitation measuring stations and pluviographs for the emission of climate information in real time. It will also generate the respective alerts that will allow for the establishment of preventive measures for the reduction in the population's vulnerability.

6. Seven automatic precipitation measuring stations and one pluviographic station were installed toprovide real-time information about precipitation, daylight hours, relative humidity, wind velocity, etc. with a radio frequency that allows for data transfers to the National Emergency Commission (CNE), the National Meteorologic Institute (IMN) and the Costa Rican Electricity Institute (InstitutoCostarricense de Electricidad -ICE). These stations supply information to the basin's early warning systems. Meteorological stations are already installed in: Organic Agriculture School (EscuelaAgriculturaOrgánica -INA), Chinchilla,Durán Nursing Home, Tierra Blanca, Tobosí El Guarco, Pacayas, Llano Grande in Cartago, Concavas ICE in Paraíso and San Antonio in Turrialba.
7. The work developed by COMCURE has supported the definition of the Reventazón River's Sustainability Index (Índice deSostenibilidad de la Cuenca-ISC) for the 2000-2005 period. This index provides information for the evaluation of the basin's management efficiency as well as a foundation for decision-making regarding water use reduction to guarantee the system's sustainability.
8. The basin's vegetationcover has increased by 11% from 2000-2009 and represents approximately 16,000 planted hectares. This contributes to a reduction in floods and in the occurrence of landslides; and therefore, to a reductionof the vulnerability to climate change for the water sector in this basin.
9. COMCURE's intervention, including reforestation campaigns and other actions, has achieved a drastic reduction in the density of fecal coliform bacteria at the points where samples were taken. The deposit of excretions has been avoided as these are used since itis the raw material for the 400 biodigestors that are being used.
10. The fecal contamination analysis carried out by the National Water Laboratory (LaboratorioNacional de Aguas) of the Costa Rican Institute for Aqueducts and Sewage (InstitutoCostarricense de Acueductos yAlcantarillados-AyA) shows an important reduction in the Reventazón River basin's fecal contamination.This permits the waters from the various flows of the river banks in Orosí, Turrialba, Siquirres and Jiménez, to be used for different purposes such as recreation, irrigation, agriculture, drinking and irrigation of fruit tree and lawns. This is an indication of an improvement in comparison to the results obtained in the period from 1994-1996.The improvement is due primarily to the reforestation activities that allow, furthermore, for greater sequestration of CO_2.
11. The workthat COMCURE has carried out has caught the interest from national and international stakeholders.In fact, it has resulted in a flow of exchange students from schools and universities; technical employees from municipalities and watershed organizations; and interns from international universities. National universities such as the University of Costa Rica (Universidad de Costa Rica -UCR), the Distance Learning State University(Universidad Estatal a Distancia–UNED), the National University (Universidad Nacional–UNA), the Tropical Agronomic Center for Research and Teaching (Centro Agronómico Tropical de Investigación y Enseñanza–CATIE) have watershed management courses within their curriculums and include on-site training for the students. There are also students working on their undergraduate and graduate theses (*licenciatura*, for its corresponding name and grade in Costa Rica) while some

other students dedicate 300 hours to community service (TCU–TrabajoComunalUniversitario), as part of their programs.

Among the achievements of the actions implemented to contribute to the improvement of the situation there are:

By reducing erosion, the sediment levels that reach the dam are reduced and consequently the useful life of the aquifer is increased.

- There is a reduction of sediment extraction costs, shutdown costs for hydroelectric plants over time, and drainage times.
- With the increase of the useful lives of the hydroelectric plants, the water flows, and their electricity generation capacity; there is a reduction in the use of petroleum derivatives for the generation of electricity.
- By reducing erosion, soils are more fertile and the application of fertilizers is reduced, which requires less financing for their purchase.
- The management of excrement that has been ongoing with the 350 biodigestors that process 1.8 tons of per year has avoided the dumping of 630 tons of excrement into rivers, and, therefore, water quality has improved due to a reduction ofthe volume of fecal coliforms.
- River contamination by fecal coliforms diminished according to the AyA National Water Laboratorystudies,andallows for more water to be used for recreation.
- Despite the fact that the original problem has not been completely resolved (more time is required), there has definitely been an improvement in the basin's health. Now, there is more vegetation cover and there has been a reduction in the use of agrochemicals which have been sustituted by the use of organic fertilizers and biopesticides.
- The basin's inhabitants can attest to having developed increased awareness about the protection of water resources. Likewise, the training provided to pre-schoolers and fourth graders has contributed to increased awareness.

Regarding success factors identified, there is the existenceof an integrated commission that includes the participation of the public and private sectors, development associations, community water committees (ASADAS), environmental associations, agricultural associations, and municipalities. This allows for the coordination of actions for the implmentation of climate change adaptation activities.

Finding financial sustainability is necessity that can be achieved through the research of funding sources by the State, water users, and other bodies that are concerned with watershed management.

V. The experience's sustainability

COMCURE was created 11 years ago as a pilot project with the aim of replicating it in other basins. It is the first basin authority created by law, while others were created by executive order.

There is a monitoring system with meteorological and climatological stations owned by the project as well as by the Costa Rican Electricity Institute (InstitutoCostarricense de Electricidad-ICE).

The financial, technical and human resources are never enough, and that is why identifying resources is an ongoing activity in order to achieve the proposed objectives.

In2011, $152,000 USD (76 million colones) was designated in the Ministry of Environment, Energy and Telcomunications (MINAET) budget to pay for the salary of the only person hired for the project (the COMCURE's administrator) and one vehicle. These funds are also used to cover operations costs such as electricity, water, and gasoline. The ICE also assigns a sociologist, pays the internet and telephone, and the MAG assigns an engineer who is the technical coordinator and cleaning staff. The Administrative Board of the Cartago Electricity Service (la Junta AdministradoradelServicioEléctrico de Cartago -JASEC), provides the accountants and cleaning staff. A request has been made to AyA to provide support with additional technical staff.

In the ICE Management Unit there is a project called "Basin Management Plan" and some direct investments are being made in the Reventazón River.

Other financial resources come from the MINAET water tax which provided $80,000 USD (40 million colones) in 2008 and $100,000 USD (50 million colones) in 2009. Funds were not provided in 2010 and 2011.

It is evident that in order to continue generating positive results, morefinancial, technical and human resources are required to provide support to the municipalities with regards to the Solid Waste Law. Support to other stakeholders regarding water resource management and risk prevention with the National Emergency Commission (CNE) is also needed.

The European Union's PREVDA project has concluded and requires additional fundingto continue with thegrants program. This consists of providing some funding to communities, companies or persons who have developed activities related to a) Environmental and risk management b) Water and soil protection, as well as forest management c) Strengthening of local capacity for the protection of resources. The possibility of funding from private industry and the International Cooperation is being evaluated.

In order to ensure the efficiency of these activities continuous improvement is necessary. Some improvements required have been identified in order to extend the reach of the learning experience: a) Solid waste managementand b) Sewage. It is necessary to promote the implementation of work with regards towaste water with the Municipalities (which are the responsible by law of the management of solid waste). The PREVDA project began with the training of municipality managers, but the development of a Management Program for Solid Waste, including waste recycling and reuse, is needed.

There is also a needto implement programs for the use of organic waste coming from the cultivation of crops such as banana and pineapple,as well as biomass in general.The idea is that municipalities willbe strengthened and will promote the creation of companies for electricity production through the use of these waste products.

In terms of following up the reduction of vulnerability and adaptation to climate change, work is being implemented in the microbasins through the commissions that are involved as well as through the municipalities, local stakeholders and community aqueducts.

VI. Lessons learned

The coordinated work between the different stakeholders should be emphasized as the key element in the facilitation and development of this experience, and the achievement of the results. The stakeholders involved include: public sector institutions, the private sector, and users such as the development associations, the community water committees (ASADAS), environmental associations, and agricultural associations, among others. This coordination includes their common objectives and a basin management plan.

The legal support COMCURE has had in being created by law has been fundamental and is very important in order for it to enjoy the credibility that it has had to the present date.

In terms of the management budget, there must be a sustainable source of revenue in order to support the costs of the annual management plan. In the case of COMCURE, this comes from the National State Budget, money from the water tax, and contributions from the member institutions.

In order for this experience to continue being successful, the strengthening of COMCURE in its different areas of work is required. This includes counting on specialists such as geologists, biologists, civil engineers, business administrators, operations support professionals and other professionals that provide operations support in community management. Currently, the project only has two agronomists. Additional support staff is also needed including a driver, a secretary and other miscellaneous staff.

COMCURE was never envisioned as an action for climate change; however, many of the actions that have been implemented to this date are for the adaptation and reduction of climate change vulnerability for water resources.

VII. Recommendations

1. The promotion of the use of the early warning system for the sub-basins of other rivers will generate information for the improvement of response times to the population that lives in the basin. By being connected to the precipitation and pluviographic measuring stations system that emit information in real-time, the respective alerts of the EWS will be generated to facilitate the establishment of preventive measures for the reduction of the population's vulnerability.
2. The execution and follow up of the actions for the reduction of vulnerability and adaptation to climate change is facilitated by working at the basin and microbasin level through the creation of coordination spaces where the different stakeholders can interact-including those from the public sector, the private sector and water users.
3. It is recommended that the project rely on a sustainable source of funding to support the expense incurred for the implementation of the Management Plan while also trying to maintain a continuous search for financial, technical and human resources.
4. The increase in the basins' vegetation cover contributes to reduced flooding and a reduction in the occurrence of landslides which furthermore results in reduced vulnerability to climate change for the water sector in the basins.
5. The reduction in the deposit of excretions that flow to the rivers is achieved through reforestation campaigns in the basins.. This diminishes the high density of fecal coliforms and requires less frequent draining, which at the same time diminishes the environmental problems associated with this process.

6. The systematization of the processes that have been functioningsince the creation of COMCURE will help in case of a shortage of trained staff, so that those entering the project cancontinue the work seamlessly. The systematization can provide a basis for the experience to be replicated in other basins.
7. It is fundamental that all basin organizations be legally registered by the law since their establishment to provide the necessary support to generate an environment of greater trust and credibility among the different stakeholders involved in basin management.

VIII. People contacted and interviewed

1. Ing. Salvador López Alfaro, COMCUREPresident and Director of the Centro Nacional de Control de Energía, ICE, slopez@ice.go.cr, Telephone: (506) 2220-6428
2. Ing. Guillermo Flores Marchena, COMCURE Technical Coordinator, gflores@racsa.co.cr, Telephone: (506) 2592-2821/2552-5797
3. Ing. Gustavo Calvo, Gcalvo@ice.go.cr, Telephone: (506) 2520-8904

IX. References

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2. Regulation to the Planning and Management Law of the Upper Basin of the Reventazón River, March, 2002.
3. Grant Project: "***Implementation of the Priority Actions Project of the Reventazón-Parismina River Integrated Management Plan, towards the Carribbean Slope in the Provinces of Cartago and Limón***", Technical Handbook of Incentives. January, 2009.
4. Newsletter 3, COMCURE, Novembre 2009.
5. Environmental Degradation and Vulnerability Reduction Program, PREVDA, National Management Unit-Costa Rica, Towards a sustained proposal of development 2010-2021, San José, Costa Rica, 2008.

ANNEX Nº 1

The objectives of COMCURE are:

a) To develop, execute and control the management plan for the Reventazón River's high basin with an emphasis on conservation and water protection.
b) To define and execute a training project for the community in terms of basin planning and management.
c) To train the managers of institutions and community leaders involved in the project in areas of specific support to the plan.
d) To incorporate women in the execution of the plan's activities.
e) To develop specific projects in geological, sanitation, production, environmental and cultural areas.

The functions of COMCURE are:

a) To promote the necessary participation and coordination of the institutions linked to the plan's execution.
b) To organize, program, direct, revise and evaluate the execution of the activities that the executingunit should meet.
c) To analyze and approve management initiatives in order to receive the support of international cooperation bodies and to finance the activities, projects or any other action in the plan.
d) To recommend projects and research studies to the executing body as necessary.
e) To approve the implementation and results monitoring plan.
f) To dictate its organizational rules and any others as necessary in order to achieve its competencies.
g) To know and approve the COMCURE annual budget and work plans.
h) To administer the trust created by law.
i) To name the director of the executing unit according to article 21 of the present law.
j) To consult with the consultativecommittee regarding the programs and activities that the executing unit will carry out and convene the committee as necessary.
k) To oversee the achievement of this Law's requirements.
l) Any other function that is assigned to it by law and that is compatible with the nature of its functions.

COMCURE's composition is the following:

a) TheMinistry of Energy and Environment or its supervising representative.
b) The Ministry of Agriculture and Livestockor its supervising representative.
c) The Executive President of the Costa Rican Electricity Institute or its supervising representative.
d) The Executive President of the Costa Rican Institute of Aqueducts and Sewage or its supervising representative.
e) The Director of the National Emergency Commission (ComisiónNacional de Emergencias) or its supervising representative.
f) TheDeanof the Institute of Technology of Costa Rica (InstitutoTecnológico de Costa Rica) or its supervising representative.

g) A representative from the Municipality Federation of Cartago.
h) Two representatives from the water user associations, and the environmetal, agricultural and industrial associations that form part of the consultative committee and are designated by it.

Similarly, the Consultative Committee is established, whose function is to advise and support COMCURE in the direction and evaluation of the different components of the plan. It is composed of the following:

a) The mayor of each one of the cantons as listed in article 1 of Law º 8023, or its representative
b) A representative from the National Irrigation and Drainage Service.
c) A representative from the Ministry of Health.
d) A representative from the Administrative Board of the Cartago Electric Service.
e) A representative from the Ministry of Public Works and Transportation.
f) A representative from the Ministry of Public Education.
g) A representative from the Costa Rican Petroleum Refinery.
h) Two representatives from the Network of Cantonal Development Associations of Cartago.
i) Three representatives from the Cartago province environmental associations.
j) Two representatives from the Cartago province business sector.
k) Two representatives from the Cartago province industrial sector.
l) Three representatives from the Cartago province agricultural organizations.
m) One representative from the local work units established in acticle 18 of this Law.

Finally, the executing unit was established under the direction COMCURE. Its primary function is to execute the technical-operational components of the project's different work phases. Law Nº 8023 is attached.

ANNEX Nº 2

Other activities carried out in COMCURE's 10 years in operation:

1. **The construction of the Greenhouse School costing approximately 30 million colones and financed by the Cartago Electric Service Administrative Board (Junta Administradora del ServicioEléctrico de Cartago –JASEC - 24 millioncolones is equivalent to $48,000) and the National Learning Institute (InstitutoNacional de AprendizajeINA- 6 millioncolones, equivalent to $12,000)**

The Greenhouse School is located on the grounds of the National Center for Organic Agriculture (Centro NacionalEspecializado en AgriculturaOrgánica) of the National Learning Institute (InstitutoNacional de Aprendizaje -INA) locatedin Chinchilla Oreamuno in Cartago. An agreement between COMCURE-JASEC-INA was signed in order to build it.

This project aims is to incorporate new alternative and environmentally-friendly production activities which reduce the use of agrochemicals (insecticides, fungicides, herbicides, chemical fertilizers) and production costs, to obtain higher quality products for a longer production period, since the system allows for the control of some environmental factors and pests.

Fig. 1 Greenhouse School COMCURE-INA-JASEC

2. **Completed the project "Electricity generation with biogas obtained from pig excrement", costing € 68,924. The project was carried out with the Costa Rican Electricity Instutite (InstitutoCostarricense de Electricidad- ICE) and the Central American Energy and Environment Alliance (Alianza en Energía y Ambiente en Centroamérica -AEA) of the SICA. It was financed at 55% by the Finnish Cooperation Agency (Agencia de Cooperación de Finlandia). Located in SEMIDE farm in Ujarrás, Paraíso, Cartago.**

This project achieved the incorporation of a new technology on the farm that allows for the integrated and sustainable treatment and use of pig excrement. The farm has 4,000 pigs that produce 10,079 kg of solid waste, and this has the potential to produce 498 m^3/day of biogas that can keep an electric plant (60 Kw) operatingfor 13 hours per day at full charge. This corresponds to an average daily production of 270 Kwh and an annual total of 88 MWh.

In addition, this technology allows for the removal of 80% to 85% of the total waste solids, capturing 1,452 tonsof CO_2 per year.Finally, the effluent obtained on a daily basis is 37 $m^3$and this covers the requirements of nitrogen of 150 KgN/hectare/yearfor a hectare of sugarcane.

Fig. 2 Biodigestor produces 498 m^3

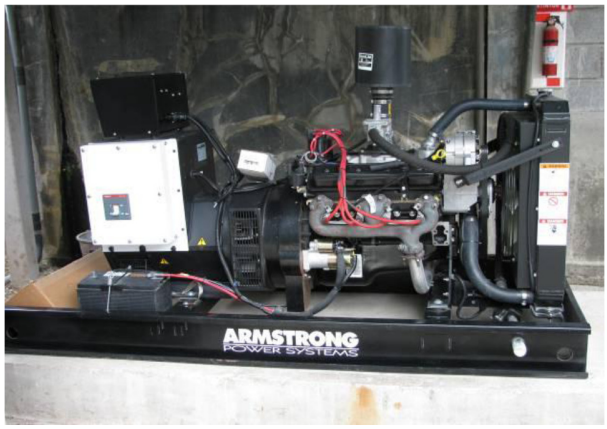

Fig. 3 Biogas-based electricity generation plant

3. Grants awarded for innovative practices for biophysical management of the basin

Grants were awarded to 22 proposals in the 3 participation categories (strengthening of the local capacity for environmental protection; soil resource conservation, water resource conservation, and forest management; environmental management and risk management) totaling 80,000 Euros.

4. Implementation of the following projects with resources from the Water Use according to Executive Decree No. 32868-MINAE:

In 2011, the Integrated Water Resource Management project was implemented in the Purires River microbasin, and in theReventazónRiver basin.In 2012, the following projects were budgeted:

PROJECT NAME	AMOUNT	ENTITY
Alvarado Municipality Recycling and the canton's organized women's group (ARLISA).	20,000,000	ALVARADO MUNICIPALITY
Integrated Water Resource Management in the PuriresRivermicrobasin, Río Reventazón basin	11,000,000	PURIRES COMMISSION
Identification of water collection areas and spring protection areas, Agua Caliente-Reventadosubbasins, Páez-Birrisito-Cachi, Birrís y Chiz-Maravilla, Cartago province, Costa Rica.	27,000,000	MINAET, SENARA, CARTAGO MUNICIPALITY
Participatory evaluation of water resource vulnerability and joint planning for the microbasins that supply the area of influence in the Río Turrialba sub-basin.	9,464,390	CATIE
Strategy for local water management in the Reventazón River basin.	9,009,348.80	UNA

Project Name	COMCUREmatching funds	Water tax	TOTAL
Implementation of efficient fertigation systems with effluents from biodigestors on cattle farms with the application of BPP in the basin	10,000,000	9,108,000	19,108,000
Arborization of: water sources, river banks, water ways, infiltration areas and public parks in the urban areas of the headwaters of the high Reventazón River basin	10,200,000	40,400,000	50,600,000
Electricity generation from biogas obtained from pig excrements	48,000,000	6,000,000	54,000,000
The application of environmental education modules on the topic of water resources	12,000,000	24,350,000	36,350,000
TOTAL	**80,200,000**	**79,858,000**	**160,058,000**

5. Consolidate information regarding the environmental variables in order to support land use planning in each of the municipalities.

Studies are now available with basic technical information so that the Turrialbaand Jiménez Municipalities can hire an entity to develop a Land Use Plan. Likewise, Fundevi-ProDUS carried out an evaluation on the Cartago, Oreamuno, El Guarco, Alvarado and Paraíso management and land use plans of the basin with the purpose of adjusting it to the Management Plan for the basin.

6. Identify the current state of rainwater drainage and basin wastewater, develop the terms of reference and develop a training program for technical staff for each municipality regarding the operation and maintenance of those systems.

The sewage and rainwater treatment system diagnose was completed for the Turrialba, Oreamuno and Jiménez urban areas. The minor projects for the Blanquillo de Oreamuno and El Mora Turrialbatreatment plants were completed for a total of 31,550 Euros.

7. Exchanges promoted among universities and schools

The work that has been carried out in the Reventazón River basin has caught the attention of national and international stakeholders, and resulted in a flow of exchange students from schools and universities, municipalities, watershed organizations and interns from international universities. National universities such as the University of Costa Rica (Universidad de Costa Rica - UCR), the Distance Learning State University (Universidad Estatal a Distancia –UNED), the National University (Universidad Nacional –UNA), the Tropical Agronomic Center for Research and Teaching (Centro Agronómico Tropical de Investigación y Enseñanza –CATIE) have watershed management courses within their curriculums and take students to field trips in the area of the Reventazón River basin. There are also students working on their undergraduate and graduate theses (*licenciatura* in Costa Rica) while some students dedicate 300 hours to community service, TCU, as part of their programs.

8. Water analysis carried out by the National Water Laboratory

The fecal contamination analysis carried out by the National Water Laboratory of the Costa Rican Institute for Aqueducts and Sewage (InstitutoCostarricense de Acueductos yAlcantarillados–AyA), showed a significant reduction in the fecal contamination of the Reventazón River basin. This allowed for waters in the various trajectories of its riverbank, in Orosí, Turrialba, Siquirres and Jiménez, to be used for different purposes including: recreation, irrigation, aquaculture and purification.Thestudies compared two periods of analysis. In the first period from 1994-1996, persistent fecal contamination was found and results ranged from 4,500 to 6,200 fecal coliforms /100 ml. This contamination qualified the Reventazón River basin as the second most contaminated in the country. However, for the 2006-2008 period, the average results for fecal coliforms indicated a mild fecal contamination level in 7 of the 8 sample points studied, with values ranging from 308 to 800 fecal coliforms/100 ml. COMCURE's intervention including reforestation campaigns and other actions have achieved a drastic reduction in the fecal coliform densities in the points where samples were taken. Excretion deposits were avoided since this is raw material for the 400 biodigestors that are being used. This reduction makes these waters of sufficient quality for drinking, for recreation (landscape and navigation), aquaculture and fruit tree and grass watering. This indicates an improvement in comparison to the results seen in the 1994-1996 period due primarily to the reforestation that allows for improved CO_2 sequestration.Currently, due to the low levels of contamination, the basin is apt for agricultural use.

9. Implementation of the soil conservation practices program

In 2009, agricultural machinery was purchased in order to prepare the soil with the purpose of reducing soil erosion. The equipment purchased consisted of 6 mechanical shovels, 6 chisel ploughs, 6 pasture renovators and 6 rotary harrows. These were borrowed under an agreement to 8 Agricultural Basin Associations. (See Box 1)

Box 1.Agriculturalsoilconservationmachineryborrowed per organization

Organization	Mechanical shovel	Chiselplough	Pasture renovator	Rotary harrow	TOTAL
El Guarco Association for Small and Medium Farmers (AGRITEC)	1	-	-	-	**1**
Llano Grande Flower Producers Association (APROFLOR)	1	1	1	2	**5**
Tierra Blanca Agricultural Workers Chamber Association (ASOCAGRI)	1	1	1	1	**4**
OreamunoAgricultural Center (Oreamuno-CACOreamuno)	1	1	-	-	**2**
GuarcoAgricultural Center (CACGuarco)	-	1	-	-	**1**
Pacayas Agricultural and Cattle Ranchers Association (AGAP)	1	1	2	2	**6**
Santa Cruz de Turrialba Agricultural and Livestock Producers Association (ASOPROA)	-	-	2	-	**2**
TurrialbayJimenezR.L.Cooperativeforsugarproduction and multipleservices (COOPECAÑITA)	1	1	-	1	**3**
TOTAL	**6**	**6**	**6**	**6**	**24**

Source: Data provided by Guillermo Flores Marchena, COMCURE

During the project, more than 1,140.35 hectares of terrain were prepared for vegetable crops (potato, carrot, broccoli, cabbage, and onion), flowers and pasture. The farming equipment used weremechanical shovels, chisel plough, rotary harrow and a pasture renovator.250 *codales*[1] were given to farmers for plotting soil conservation projects for vegetable crops, flowers, orange and coffee, and 318 farmers were trained in the appropriate use of agricultural machinery. (See Box 2).

Box 2. Summary of activities carried out in soil conservation

Activity	2009	2010	2011	TOTAL
Area prepared for production with machinery		668,75	471,50	1140,35
*Codales*delivered		226,00	24	250
Training on the appropriate use of agricultural machinery	131	187,00		318

Source: Data provided by Guillermo Flores Marchena, COMCURE

10. Establish agrosilvoconservationist practicesat the farm level through the installation of worm composting bins, biodigestors, efficient microorganisms, fruit tree plantings, semi-confined cattle systems and nurseries.

Follow up visits to farms were carried out on behalf of the engineers with the goal of providing technical assistance to the **500** farmers (Box 3) which were able to be benefitted by receiving **23,500** avocado, fig, plum and orange trees. **1,642** sacks of organic fertilizer were provided, covering an area of approximately **135** hectares. They also benefitted by receiving **95** pasture choppersfor the semi-confined cattle projects, **910** kg of California red worms, **100** liters of efficient microorganisms,the construction of **88** biodigestors and the delivery of**80**gas stoves, **636 Kg** of grass seed, **20** strimmers, **20** macro tunnels for vegetable production, and **20** grass-drying structures. Finally, in the last 2.5 years, **1,401 farmers** were trainedin the various agrosilvoconservationist practices (See Box 3).

Box 3. Summary of theagrosilvoconservationistpractices

Agrosilvoconservationistpractices	2009	2010	2011	TOTAL
Diagnostics	-	472	81	553
Farmplans	-	416	81	497
Biodigestors	-	68	20	88
Gas stoves	-	49	31	80
High altitudefruittrees	8000	15500		23500
Avocado Fig	4000 500	7000 1500		11000 2000

[1] A piece of wood, generally of 3" wide by 1" thick and 8.22 to 10.96 feet long, used as a guide to obtain straighted lines or leveled lines.

Citrus Peach Plum	1500 1000 1000	3500 2500 1000		5000 3500 2000
Pasture chopper	40	55		95
EM (EfficientMicroorganisms) liters	50	50		100
Grassseed (Kg)		636		636
Organic fertilizer sacks (40 Kg sacks)	442	1200		1642
California Red Worm (Kg)	210	700		910
Strimmers			20	20
Macrotunnels			20	20
Grass-drying structures			20	20
Training	278	988	135	1401

Source: Data provided by Guillermo Flores Marchena, COMCURE

11. Tree planting in the northern sector of Cartago and in the medium area of the basin.

Follow-up was conducted regarding the trees provided to the ASADAS and included verification for the 10 water source protection fences that were installed along the water sources identified.Materials provided (71 rolls of wire totaling 325 meters, and 150kg of staples) were used for the demarcation of the water sources. In terms of tree planting for reforestation in agriculture farms, water sources, river areas and aquifers in the upper and middle areas of the basin, it is estimated that **468,662** trees were planted (235,524 in 2009 and 233,138 in 2010) and **33,138 trees** were planted for the protection of water sources.

12. Execute a program for solid waste management and experience exchanges on this topic, on the part of farmers and the municipalities.

This activity was implemented by the Agriculture School of the Tropical Humid Region (Escuela de Agricultura de la Región Tropical Húmeda–EARTH).Training was provided regarding different waste management practices and methods to **458** people including those from associations, community leaders, municipalities, schoolboys and girls, and school youth.

There are **2** pilot projects for waste management with theOreamuno y Alvarado Municipality.

600 Solid Waste ManagementManuals were provided as well as **350** eco-literacy brochures.

13. Equip and train technical staff from ASADAS and 7 municipalities in the basin on water quality control and designed an information system to monitor water quality variability in each of the canton's municipalities.

Loan agreements were signed and **10** Water Quality teams (residual chlorinemeter and multiparametermeter) were provided to the boards of the ASADAS of Orosi, San Isidro del Guarco, Santa Rosa de Turrialba, Santiago de Paraíso, Quebradilla El Guarco, ConcejosMunicipales de Turrialba, Jimenez, Alvarado andOreamuno.

450 water quality brochures and **500** "Potable water quality measuring and control program for aqueducts in the Reventazón River basin" brochures were provided, and **209** people were trained.

14. Work plan implementation in order to identify the aquifer recharge areas and the subterranean water flows.

Little information was previously available regarding the characteristics of the basin's subterranean water, and now studies that identify the recharge and water flow areas of the subterranean waters for the subbasins of the Río Grande Orosi, Río Pejibaye, and Río Guayabohave been completed. This study will provide information about subterranean water flow patterns, aquifer recharge areas as well as about the sustainable **water volumes available and their quality.**

15. Identify small projects for surface run-off management

Projects were completed including the Small Projects for the Reconstruction of the Waste Water Treatment Plant Drying Bedsfor BlanquilloOreamuno and Projects for the Reduction of Solid Waste in the Blanquillo Sewage Systems. The Waste Water Treatment Plant Mud Drying Beds project was also completed for El Mora in Turrialba.