

Sustainable use of Groundwater Resources

An evaluation of SUWaR, Nicaragua

Ingvar Åhman

**Department for Natural
Resources and the
Environment**

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Sida Evaluation 00/29

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Author: Ingvar Åhman.

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SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

Address: S-105 25 Stockholm, Sweden. Office: Sveavägen 20, Stockholm

Telephone: +46 (0)8-698 50 00. Telefax: +46 (0)8-20 88 64

Telegram: sida stockholm. Postgiro: 1 56 34-9

E-mail: info@sida.se. Homepage: <http://www.sida.se>

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Executive Summary

Some years back, not too long ago, the water of lake Masaya was drinkable, so was also the water in lake Tiscapa in the centre of the city, not so any more. Today the groundwater in the Managua aquifer is drinkable. The question is for how long? The economic value rests with protecting valuable resources. Alternative solutions will turn out much too costly at the best and in some instances there are no alternatives.

70% of the Nicaraguan Pacific economy is dependent on groundwater, where there is very little surface water. If sustainability of groundwater in quantity and quality is not kept, economic hardship at the best and catastrophe at the worst will result. With a contamination of the aquifers will also follow human suffering through unhealthy environments leading to illness.

It is difficult to make a long-term development scenario important and to provide awareness and action for protection of resources in fast moving economic expansion. However, what seems to be a gain today may result as a loss tomorrow if a too short development perspective is applied.

The Pacific region of Nicaragua in particular is dependent of sustainable quality groundwater supplies. With contamination of aquifers, populations, cattle industry and farming will be the first to suffer. This will have serious consequences since farming is the most important economic activity in the country. The results of SUWaR when implemented on a larger scale will play an important role in safeguarding the resource.

SUWaR is a project dealing with the protection of groundwater resources for the aquifer serving Managua the capital of Nicaragua. The project, which started in the beginning of the 90's, will end with its second phase year 2000. Technical support to the project has been provided by KTH, the Royal Institute of Technology, Stockholm, Sweden and the University of Linköping, Sweden. The co-operating counterpart organisations in Nicaragua are MARENA, ENACAL and UNI. The project has been financially supported by the Swedish International Development Co-operation Agency (Sida).

The project has focused on development of methods for groundwater protection. So far some activities to implement the methods have taken place. Work is now entering into a phase of large-scale implementation and possible replication in other areas of Nicaragua. The project area consists of the three sub-basins of the Managua aquifer south of the city with emphasis on the eastern sub-basin.

The Results

The successful development of SUWaR has left the following substantial contributions:

A) A *technical framework* for groundwater protection containing a number of tools and methods developed during the Project's second phase.

- tool for estimating vulnerability of groundwater;
- tool for estimating contamination sources and contamination load in aquifers;
- tool and procedures for estimating relative protection value of groundwater supply;

Each one of these methods has a value of its own and can be applied individually. In addition there is the value of combining the different methods. By overlaying the results further analysis can produce additional methods. One such method has been the development of risk identification. This has

resulted in a simple to understand pragmatic division of risk zones into three categories high, medium and low. The project identified a total of over 450 risks in the Managua area.

- B) The Project has provided *education of staff and on the job training*. A critical mass of technical personnel in different co-operating organisations is now available. Implementation of the results can now take place as well as extending the work to other areas in Nicaragua.
- C) The SUWaR project has dealt with dissemination of results and awareness raising. Studies of barriers to implementing results were also carried out. This work is leading to what the evaluation team has defined as a *communication framework* for groundwater protection. The main areas include:
- Awareness raising;
 - Identification of stakeholders;
 - Identification of barriers to groundwater protection;
 - Education and knowledge raising;
 - Communication materials and dissemination methods;

The two frameworks (technical and communication) act in parallel to produce future impact on the protection of groundwater resources.

The project, so far, did not achieve the implementation of a protection plan as envisaged at the start of Phase II in 1996. This is mainly due to the lack of a coherent legal framework (Water Law) and institutional changes. The Water Action Plan (Plan de Accion de Recursos Hidricos) supported by Danida has not been implemented so far which is a mayor draw back. However, protection measures have been implemented in an informal way as a part of the advisory work.

Tasks still pending under the Project, which are now being emphasised

- A) A groundwater protection plan to be called Directives for Groundwater Protection (Directrices para Proteccion de Agua Subterranea) will be the next step towards implementation. Different ministries and organisations using the Directives could start implementing groundwater protection measures in their regular programmes based on the Directives.

The Directives will be based on the findings of SUWaR from the projects II phase and will respond to a number of laws, which already regulates environmental quality. However, there are still a number of areas not covered by legal regulation. Due to these circumstances the Directives requires some form of formal approval process. Recommended steps to be taken from mid 2000 include:

1. Consultation with concerned institutions (which would ultimately apply norms);
2. Presentation of draft Directives to National Water Commission;
3. Approval of Directives;
4. Decision that MARENA as parent organisation will guide implementation;
5. Decision of institutionalisation of Directives within MARENA (providing budget and staffing)
6. Information and consultation with all involved parties in the Project's final seminar 4 October 2000;
7. Adaptation of the Directives by institutions and organisations (specifying the norms to be used to regulate the work in each individual institution or organisation);
8. Specifying and adjusting programmes in institutions and organisations to implement the norms interpreted from the directives.

It should be noted that the results produced by SUWaR fall well within the mandate of the National Water Commission. The results need to be presented to the Commission urgently in view of the final seminar in October

B) Urgent work to be carried out by ENACAL:

- A plan for use and management of water resources in the eastern sub-aquifer, including rules for well field protection zones.
- A monitoring system for water quality and quantity in the sub-aquifer;
- An extraction plan for the three Managua sub-aquifers including rules for land use

See Recommendation in 3.5.3

The SUWaR methodology should now come to use. There is no more need for development on the methods per se but an urgent need to apply the results in a fast and pragmatic way.

Recommendations

A number of recommendations are provided under “5. Recommendations”. The following four recommendations have immediate priority:

- *To create an entity called “Protección Ambiental de Agua” within MARENA, with a budget and personnel, in charge of institutionalising and co-ordinating the results of SUWaR. The objective of the entity would be to mount a national plan for the protection of groundwater in Nicaragua.*
- *To present the results of SUWaR to the National Water Commission with the purpose of obtaining an authorization to disseminate results from the project and to institutionalise the results within the institutions that are relevant to the work.*
- *To meet with business leaders (Chamber of Commerce) and other influential interest organisations representing sectors such as agriculture and construction. This would be an important next step in the consultation process that should now also involve MARENA and ENACAL.*
- *To develop a monitoring system co-ordinated between MARENA, ENACAL, INAA, INETER and MINSA based in MARENA and forming a platform for follow up of the SUWaR project. The whole aquifer to be monitored in terms of quantity and quality of groundwater. Special emphasis to be put on occurrence of nitrates and pesticides.*

1. Programme Context

SUWaR is a project dealing with the protection of groundwater resources for the aquifer serving Managua the capital of Nicaragua.

1.1 Development Context of the Project

Some 97 percent of all freshwater found on the planet (excluding the continental ice caps) is stored underground in sand and gravel and in fractures of rocks. A large part of the world's population is dependent on groundwater for their drinking water and for economic activities such as agriculture and cattle farming.

Groundwater supplies, which are contained in aquifers, are recharged by rainwater that infiltrates through the soil. Groundwater moves underground at rates varying from a few millimetres to a few meters a day. Groundwater can find natural outlets in springs or can be extracted by wells perforated by drilling etc. to different depths.

Groundwater supplies, have a more or less constant capacity but are tolled by increasing extraction due to increasing demand from a growing human population and increasing economic activities in need of water supply.

Also, groundwater is becoming increasingly polluted from foul water and sewerage from urbanisation in developing countries with inadequate sanitation systems. Agricultural activities including spraying with pesticides, and the use of fertilisers constitute pollution risks. Industrial activities allowing liquid wastes to be released into the ground as well as spilling of chemicals, fuels and solvents are some other pollution threats. Groundwater containing too high concentration of nitrates, micro-organisms and chemicals can not be used.

The restoration of groundwater quality requires extended time periods, is very costly and many times impossible, which in principle mostly leaves only one option, that of closing the wells. The cost of finding and exploring alternatives (if at all possible) is normally much more costly than investing in protection of the existing resources.

A global consensus has been reached on the need to protect and manage the use of water resources. The Dublin Conference on Water and Environment early 1992, as well as the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro the same year dealt with the issue. The conclusions emphasise an integrated approach to water resources management, known as Integrated Water Resources Management (IWRM). It stresses the development of means for equitable decisions based on a participatory approach to ensure the sustainable use of water resources.

Sida's objective is to promote a sustainable management and equitable use of water resources to benefit people while safeguarding the environment. Especially resource poor women, men and children should benefit.

The water supply of Managua the capital of Nicaragua is derived from groundwater from the aquifers south of the city. The catchment area is located on the southern shores of Lake Managua (lake Xolotla), on land sloping from the mountain ridge to the south (Sierras de Managua). The lake is situated at an altitude of 40 m whilst the mountain ridge reaches elevations of 900 m above sea level. The water of the lake is severely polluted and can not be used. The dependence of groundwater supplies, without

any immediate realistic alternative, can be a threat to continued economic activities, should the groundwater resources be polluted. Also, the health of people will be negatively affected.

1.2 Project History

The project “Sustainable Use of groundWater Resources, (SUWaR)” henceforward referred to as the “Project”, was initiated 1992 with a first phase covering the years 1992–1996. Financial support for the Project was provided by the Swedish International Development Co-operation Agency (Sida). Implementation of the Project was headed by KTH, the Royal Institute of Technology, Stockholm Sweden through its Div. of Land and Water Resources. KTH was contracted by Sida as an implementing consultant, responsible for the entire project administration. Successively KTH sub-contracted the University of Linköping (LiU), Sweden, through its Dept. of Water and Environmental Studies (Institute of Tema Vatten).

The main Nicaraguan counterpart organisation during phase one was the Ministry of Natural Resources and the Environment (MARENA) through its Dept. of Water Management. The Project was based on a contract between KTH and MARENA. An inter-institutional committee of advisory character exchanged information and carried out some activities. (The committee was composed of INAA, INETER, UCA, UNA, UNI, MARENA and ALMA)

During the first phase a general groundwater protection strategy was developed based on work in the Eastern sub-basin of the Managua aquifer. A proposal for a plan to delimit areas needing implementation of protection measures in order to safeguard future water quality was to be developed. Emphasis were also put on training and capacity building of technical staff at MARENA, and to other Nicaraguan organisations.

At the end of the first phase an appraisal mission visited the project to evaluate the activities performed during the first three-year period. Furthermore the preconditions for a three-year prolongation of the project were appraised. In September/October 1996 a Logical Framework (LFA) Workshop was held together with counterparts in Nicaragua to formulate the details of a prolongation.

The second phase of the Project (1997–99) were to give more emphasis to implementation of groundwater protection plans for the Managua aquifer, as well as finalising development of methods and training of staff. In 1999 the Project was finally extended for one year till end 2000 in order to finalise some pending activities.

During the second phase KTH continued its role as implementing consultant under a contract with Sida. KTH and LiU, were responsible for developing the technical inputs and to give backstopping to the Nicaraguan counterparts. The main Nicaraguan organisations at the start of the second phase were: MARENA, the Nicaraguan Institute of Aqueducts and Sewerage Systems (INAA), and the National Engineering University (UNI). A joint agreement was signed between KTH, UNI, MARENA and INAA. The Nicaraguan counterparts, as institutions, were to take responsibility for the field implementation. Activities under this phase were also open to other organisations in Nicaragua.

In August 1998 INAA was split into two parts, ENACAL the national water distribution and service company and INAA with regulating powers in the drinking water supply and sanitation sector. The projects further contacts were with ENACAL, which assumed the role as counterpart organisation. The reason for this was that staff, including the project director at INAA was transferred to ENACAL.

By end 1999 the project was assumed to deliver the final outcome and a closure including an end of project seminar to report on findings. Due to delays of certain activities the closure was postponed. The project was prolonged to end 2000, and the final seminar is now scheduled for 4 October 2000.

In order to provide a magnitude of the investments made during the second phase it is estimated that SEK 8.700 000 provided by Sida funding was finally partitioned as follows: 3 M SEK to support Nicaraguan counterparts operations; 4.5 M SEK to cover KTH and LiU costs for capacity building and training of Nicaraguan counterpart staff, and the remaining for miscellaneous activities carried out by other Nicaraguan organisations.

1.3 Project Description

The site of the project is the Managua groundwater system (1040 km²) located south of Lake Managua. The basin is divided into three sub-areas, the Western, the Central where most of the urbanisation of Managua is situated and the Eastern. The latter includes the main well fields (Managua I) along the road to Masaya close to the town of Ticuantepe. The project has been focussed on the Eastern sub-area (450 square km).

The objectives of the Project were first established September/October 1996 in a workshop using the Logical Framework (LEA). The content of the framework has since undergone slight modifications but only on the more detailed level as the project developed. The present evaluation which only concerns Phase II of the Project, is based on the content of the higher levels of the goal hierarchy produced 1996.

1.3.1 The Development Objective of the Project

- To contribute to sustainable use of groundwater resources in Nicaragua in general, and specifically for the Managua aquifer.

Main indicators and means of verification (MOV) for developments on national level are:

- The groundwater protection framework (or substantial parts of it), is used in the management and protection of the most important aquifers in the country (e.g. the aquifers of Leon, Esteli' and Sebaco). MOV – the existence of a protection plan and manuals/reports from the implementation in the mentioned areas;
- The water quality is maintained or improved, for drinking water supply or other usage in the aquifers where the protection framework has been duly implemented. MOV – comparisons between historical records and present situation of water quality and land-use.

Main indicators and means of verification (MOV) for developments concerning the Managua aquifer are:

- The eastern sub-basin provides Managua with drinking water to the same extent as the present (under safe-yield conditions). Also the groundwater quality is maintained in the areas protected for drinking water supply. MOV – comparison of recommendations with field observations;
- Guidelines and recommendations are followed for high and medium risk areas in the protection plan, when allocating new potential polluting activities. MOV – comparisons of recommendations with field observations;
- Protection measures and actions have been taken to the extent, that work with the protection plan can be geared from immediate actions to long-term land-use planning and monitoring of the resource. (indirect indicator of success of implementation of the protection plan). MOV – monitoring the kind of protection work carried out, and compare with recommendations in plan.

Assumptions made concerning development objectives

External factors, which could influence the achievement of the stated development objectives:

- Economic development does not have a negative impact on the groundwater quality;
- The Governmental institutions, municipalities as well as other organisations in Nicaragua, continue to give priority to the protection of groundwater resources.
- A good working relationship between the Nicaraguan governmental organisations and private organisations that have impact on the actual implementation of protection measures, for example farmer's organisations and industries.

1.3.2 Immediate Objectives

The immediate objectives of the Project are:

- **Improved protection of groundwater resources**

This will be achieved through:

- A. Development of methods for the generation of groundwater protection plans;
- B. Implementation of the developed protection plan has been initiated in the Managua aquifer;
- C. New attitudes towards groundwater contamination and training of staff within the co-operating Nicaraguan institutions.

- **Replicability**

The aim is that the strategy developed and tested in the Managua pilot area will be general in the sense that it can be implemented elsewhere in the country. With the fact that this is a *methods development* project also follows that Sida has a more general interest in the outcome of the project. Results and experiences could be used in other programmes in the region or elsewhere within the Swedish development Co-operation.

Main indicators and means of verification (MOV) for the Immediate Objectives are:

- The protection plan for the Managua aquifer with complementing manuals are written, published and approved by the involved institutions. MOV – the publishing of the documents;
- The most urgent protection actions and measures proposed by the plan are initiated. MOV – activities in the field have started;
- The protection plan is presented to groundwater managers and decision-makers at a seminar for increased awareness. MOV – the seminar is held;
- The staff at co-operating institutions that have received training is able to manage the working process of groundwater protection plans by their own. MOV – short term through evaluation mission documents – after the project has ended through the quality of the continuous work with the protection plan for the Managua aquifer, and the quality of implementation in other areas.

Assumptions made concerning Immediate Objectives

External factors, which could influence the achievement of the stated Immediate Objectives:

- The Nicaraguan institutions involved in the project, continues to give priority to the protection work, and assign staff to work with the implementation phase;

- Most of the staff trained during the first project phase remain working with the project, especially the staff at MARENA, and INAA;
- The universities continue to give priority to the project, through co-operating in courses on ground-water resources management and protection.

1.3.3 Expected Results

At the end of the project it is expected that the Nicaraguan institutions working in the project will have a comprehensive tool for groundwater protection planning. A proposal for protection planning should also be under implementation in the Managua aquifer. Further, that project staff at the co-operating institutions has acquired the skill to carry out protection plans by their own.

The Expected Outputs at the end of the project are:

- Methods developed for the implementation of groundwater protection plan;
- The implementation of the groundwater protection plan is initiated in the Managua aquifer;
- Staff within co-operating institutions is trained in the implementation of the groundwater protection plan.

1.3.4 Target Groups

The target groups include:

- Organisations participating in the development of the methods;
- Individuals in governmental organisations and universities benefiting from the advisory functions, field testing and training;
- The population of the Managua watershed in general, which will be indirectly affected by the activities, carried out under the Project. This group include consumers of water, the same who threatens the quality of the water in the aquifer through their activities. They are conceived of as having an active part of implementing the plan. The project therefore has the ambition to reach at least a part of this group by the activities directly connected to the different sub-topics through information meetings and workshops.

1.3.5 Counterpart Organisations

According to the Project plan MARENA, the government body with a general responsibility for environmental protection in Nicaragua was to carry out the main co-ordinating responsibility of the implementation of the development strategy. The project staff situated in the Directorate for Environment and Water Resources (DGA) was to receive the training needed to develop and implement groundwater protection plans.

INAA was initially to be responsible for carrying out protection zoning and abstraction licensing. The staff was to receive training to carry out this part of the protection plan. INAA was initially a member of the implementing committee. From 1998 ENACAL assumed the position as counterpart organisation.

UNI was to develop a course in hydrogeology and groundwater protection for professionals. UNI was also to take active part in the development of methodologies for institutional issues. UNI is a member of the implementing committee.

1.3.6 Other Organisations and projects co-operating with or related to the Project

According to the Project plan the National Agrarian University (UNA), the Central American University (UCA) and the National Autonomous University of Nicaragua (through the Centre for Water Resources Research, CIRA) were to benefit from courses and seminars;

The Nicaraguan Institute of Territorial Studies (INETER) would mainly benefit from the information processed by the Project. INETER would have an important role in the groundwater quality-monitoring programme.

The protection plan was predicted to be an important instrument for the Municipalities (ALMA, Nindirí, Masaya, San Marcos and others) in support of the urban planning process.

Water Action Plan (Plan de Accion de Recursos Hidricos) was carried out with Danida support. The aim of the Plan is to provide a realistic framework for co-ordinated development and management of water resources at national level. The plan includes a proposal for a new water law.

The Environmental Action Plan (PAA-NIC) developed with support from Sida and Danida. Consists of a plan for priorities for water use within mayor watersheds in the country. This plan had already been completed at the onset of the second phase of SUWaR.

Study on Water Supply Project in Managua (INAA/JICA 1991–93). The Japanese International Co-operation Agency (JICA) financed the study carried out by INAA: The study deals with further development of groundwater resources of the Managua aquifer. Since the compilation of the study JICA has continued through several projects including the construction of well field Managua I and lately Managua II, close to Sabana Grande in the Eastern sub-basin. JICA projects are traditional well drilling programmes that do not consider protection of wells, thus leaving an important task to SUWaR.

Institutional Support to MARENA/DGA financed by DANIDA with the aim of establishing an efficient organisation in the field of pollution prevention, environmental impact assessments and water resources management.

MASICA, regional programme for water quality monitoring supported by Sida and PAHO

1.3.7 Activities under Phase II

In the second phase of SUWaR activities shifted from identifying the protection strategy and developing a proposal for a groundwater protection plan, to finding methods for implementation of a protection plan and developing sustainable institutional solutions for the long-term protection of the groundwater from contamination.

The project activities for the second phase were divided into five major groups of activities or so called topics:

- Topic A Groundwater protection strategy;
- Topic B Institutional issues;
- Topic C Technical protection methods;
- Topic D Changing of attitudes, training and education;
- Topic E Dissemination of results.

Each topic was further divided in sub-topics, 16 in all:

1. Improvements of protection strategy using GIS
2. Compilation of protection plan
3. Barriers to improved groundwater protection
4. Institutional responsibilities
5. Planning procedure
6. Stakeholder involvement in groundwater protection
7. Water as an economic good
8. Management at the lowest appropriate levels
9. Administrative regulation
10. Land-use control
11. Engineering design standards
12. Contaminant concentration limits
13. Control mechanisms for abstraction
14. Groundwater quality monitoring
15. Changing attitudes
16. Training and education

(Sub-topics 7, 8, 9 and 13 were excluded from implementation in 1999 due to lack of funding and changes in priorities)

2. Methodology of the Evaluation

The final evaluation of the SUWaR project was carried out in May 2000 in Managua and surroundings. The evaluation team was composed of representatives of the counterpart organisations and an external evaluator.

2.1 Scope and Focus of the Evaluation

The evaluation was undertaken with the objective to increase understanding of the development co-operation processes and to contribute to learning. The feed back from experiences will generate knowledge, that can be used to increase relevance, effectiveness and efficiency of similar projects. In particular evaluation results could serve to generate necessary adjustments of methods used for groundwater protection as well as awareness raising activities.

The methodological and pilot character of the project makes it particularly valuable due to the potential for replicating methods in other aquifers in Nicaragua and elsewhere. (See Appendix I)

2.2 Approaches and Methods used

The evaluation was undertaken in the spirit of partnership. An evaluation team was formed by participation of MARENA, ENACAL and UNI. The co-ordinator of the group was an outside consultant contracted by Sida. The team member from MARENA represented eight years of experience with the project from a central technical position, from ENACAL three years and UNI five years of involvement. The team members participated full time in the evaluation sessions and the discussions leading to the conclusions.

The evaluation was carried out from 4 to 16 May 2000 in Managua and surroundings. The status of the Project and results to date were presented at the onset by the Project co-ordinators of the three counterpart organisations (MARENA, ENACAL and UNI). During the first days of the evaluation mission a representative of KTH was also present to facilitate the introduction to the Project and to assist with the evaluation programme. Evaluation team members had already been selected and the team came to an early start with their work.

There followed a number of visits to key organisations in Managua, with direct or indirect contact with the execution of the Project over the years. Meetings were held with key personnel in MARENA, ENACAL and UNI. Discussions took place with technical staff who had been involved in the methodological pilot work including interviews with stakeholders and other target groups.

Field visits were carried out to places of importance in the Managua watershed with focus on the Eastern sub-basin where most of the pilot work had been carried out. Technical visits were carried out to the Ticuantepe well field (Managua I), oxidation ponds of Laguna Masaya, Laguna Asososca and Tiscapa. The municipalities of Nindiri, Ticuantepe and Managua were visited for discussions with municipality leaders and their advisory teams. Two schools were visited, one primary school in Ticuantepe and one secondary school in Nindiri. Meetings were held with the agricultural association in Ticuantepe (Union de Productores de Ticuantepe) and with a local NGO. In all 15 meetings were held, and 12 individual interviews and 6 field visits were performed. (See Appendix 2)

Meetings and individual interviews concentrated on the experienced relationship to SUWaR – what impression had the project left? – what was remembered as beneficial? where had difficulties been found? – how had the person interviewed continued, proliferated or diffused the ideas and knowledge provided by SUWaR? During the meetings and the interviews the compounded experience available in the team from many years of Project work was very valuable to lead the discussion onto essential topics in interview situations, that were many times difficult to structure.

2.3 Limitations of the Study

First of all it should be remembered that SUWaR as a project has dealt with development and application of methods. Different technical methods for estimating aquifer vulnerability, contamination load etc were developed. Socio-economic methods were also applied such as stakeholder barrier studies in order to improve likelihood of a successful implementation of a protection plan. Hence, the emphasis has not been on implementation at this stage, although some implementation work has been carried out. The dividing point here is in the definition of implementation, and a more or less fruitful discussion can easily be extended on this topic. The Project could therefore also be referred to as pilot undertaking. This implies that the measurement of impact of work carried out will be limited to whatever these pilot activities have produced.

Most important are observations concerning a probable outcome in the case of a large-scale replication in terms of the impact on target groups and the population at large. Other observations concern the value of the technical and the socio-economic methods applied. These were not dealt with at the level of scrutinising the different methods from the technical point of view. That work had already been carried out by the advisory services provided by KTH and LiU based on good scientific judgement. Rather the value of the evaluation rests with the observations concerning the extent the whole framework and its parts can be replicated. In particular parts have been identified that merits further attention as well as obstacles for applying the whole methodological framework. This naturally goes beyond detailed observations into the overall situation of institutionalising the SUWaR framework.

3. Findings

The evaluation team reviewed the Development Goal of the Project in relation to the overriding goals and policies of Swedish development co-operation

- Poverty reduction;
- Peace, democracy and human rights;
- Environmentally sustainable development;
- Gender equity.

3.1 Poverty reduction

The principal losers if the ground water in the Managua aquifer is not adequately protected, are the people living in the region. At the same time, the inhabitants contribute to the contamination of ground water. The main aim is to change people's attitudes and behaviour towards groundwater protection.

Potential future use of the aquifers in Nicaragua is a predominant and decisive factor for development. 70% of the Nicaraguan Pacific economy is dependent on groundwater, where there is no or very little surface water. If sustainability of groundwater in quantity and quality is not kept, economic hardship at the best and catastrophe at the worst will result. With a contamination of the aquifers will also follow human suffering through unhealthy environments leading to illness.

Alternative solutions will turn out much too costly at best and in some instances there are no alternatives. In the eventuality of contaminated aquifers, cleaning actions could be very costly or impossible leading to closing of well fields and extraction with severe negative economic consequences. This will increase poverty and the health status will deteriorate in the poor part of the population, which will have to depend on contaminated water.

The value of applying the SUWaR framework rests indirectly in granting a basis for continued economic growth. Provided economic factors do produce growth and income distribution is present, poverty reduction will occur. Poverty reduction in the population is seen as long term and there are no immediate effects.

Conclusions

Applied large scale and on a continuous basis the effects could in the long run lead to increased sharing of resources, and could lead to more equal opportunities in the use of resources. Participation of a municipal population with understanding of groundwater protection problems will increase likelihood of protected water quality which will generate the basis for sustained economic growth provided other factors apply.

3.2 Peace, Democracy and Human Rights

Long-term sustainability is ensured through a continued dialogue regarding the need for groundwater protection activities at different levels in the society. With a dialogue the chances of self-determination increase and the levels of conflict decrease.

The Project during its second phase carried out a large number of interviews with stakeholders in order to analyse barriers to introducing protection measures. There were also a number of activities concerning

awareness raising, education in groundwater pollution and activities in general to increase the knowledge in the population for environmental protection

The purpose of the activities was to involve the local population, stakeholders and target groups, raising awareness and knowledge of groundwater pollution as well as providing some education.

Target groups and stakeholders in the catchment area

The evaluation team carried out a number of meetings, interviews and discussion in the area with the following target groups:

- Pineapple growers and agricultural union
- Representatives of NGOs
- Schoolchildren primary and secondary school
- Teachers, primary and secondary schools
- Technicians in municipalities, including planners for municipal housing developments
- Politically appointed municipality leaders (Alcaldes)

The effects produced which was noted during the evaluation team's visit to these target groups in Ticuantepe and Nindiri⁴ were:

- Increased understanding;
- Increased access to information;
- Access to alternative solutions through increased knowledge of the problems in technical as well as economic areas;
- Increased influence and power to make decisions concerning the own group and with effect on people in the community;
- Increased knowledge in general of environmental protection among the people in the municipality, particularly parents of schoolchildren.

Farmers are well aware of the need to protect the resource as a result of the contacts with SUWaR. The Project has generated a positive impact through discussion meetings and interviews. The messages were transmitted on to all farmers through meetings with the farmers' association. However, a difficult economic situation prevails with a general lack of resources, that impedes action, i.e. there used to be funds for tree planting and other protection measures which are badly needed, but no more. The project has opened a dialogue and made everyone to contribute, but there is a feeling that there should be some sort of compensation. The farmers association would rather like to see the whole matter regulated through a co-ordinated basin approach.

Municipalities are very thankful for the support generated through the Project. Meetings and seminars arranged by the Project have resulted in the incorporation of protection measures in municipal planning. Municipalities are eager to continue the process of consultation. There is an almost desperate need of information concerning norms and regulations. This is needed for land-use and housing development planning, that is now in an advanced stage. (See also 3.6)

Students and teachers were able to utilise the support provided by SUWaR. Groundwater protection is well understood and has resulted in a number of projects and initiatives within the schools and outside. School children have told their experiences and news to their parents, who often are poor agricultural workers and amongst whom the understanding is slowly spreading.

There was much expressed need from teachers, students, technicians and stakeholders in municipalities to be provided continued support with information, material etc., and in general to continue to be a part of a dialogue. In effect a process has been started and not a once upon a time event. To be effective the process needs to be followed through on a continuous basis. This will require special attention by the authorities. A general conclusion is the present lack of support to environmental education to schools.

Stakeholders in Government, Municipalities, Agriculture, Industry, Urban developers, NGOs and Petrol stations

Interviews were also carried out with technicians in ministries and organisations participating in SUWaR, the municipality of Managua (ALMA) as well as a private market consultant. Additional interviews were carried out with Project staff that had participated in interviewing stakeholders in: industry, agriculture, municipalities, urban development, media and other activities such as petrol stations.

The evaluation team noted: The SUWaR strategy has resulted in reducing the level of conflict among stakeholders and among government institutions. Stakeholders were initially very suspicious, reluctant and in some cases hostile to the proposition of opening a dialogue about groundwater pollution (or any other environmental theme for that matter). This reflects a state of distrust in government and among actors. With the actions taken with the SUWaR strategy a development of interest, co-operation and support developed as well as understanding of concerns for other parties. When persons interviewed were revisited in phase two of the project a positive development was recorded. Information gathering also became substantially more fruitful and meaningful. If the SUWaR strategy were to be implemented in a larger context than a pilot exercise these effects would be more noticeable.

In particular concerning people and stakeholders in municipalities including technicians and politically elected persons the team noted: Implying the SUWaR strategy has led to a situation where suddenly the value of the persons and the groups are taken into account. The mere fact that someone takes interest and bothers about informing has led to changes in attitudes. This in turn leads to increased self-estimation. Some episodes could be recorded where villagers were revolting to the fact that “their water” was extracted for the more well-off Managua, leaving the village people with a conceived threat of a depletion of their own scarce water sources.

The work of SUWaR leads to changes in attitudes and has reduced the potential for conflict, that could have had serious consequences. There is now an understanding of the value of shared resources and the benefit to all and the measures, which have to be taken by the villagers. This development is possible provided the key condition is met: that the persons, which in a sense are controlling the extraction zone, are consulted and identify themselves as a part of the decision taken over the common good. People in general do agree to co-operate after the introduction work done by SUWaR, and are willing to put in their effort. The most important condition is the need for consultation and follow-up.

In contrary the same understanding is not in the minds of the receivers downstream in Managua. There is a future need to inform and educate on the need to respect the rules for shared resources including compensating the villagers, at least symbolically. With a full-scale implementation of the SUWaR strategy, through a development programme for the whole catchment area including Managua, these attitudes may change.

Conclusions from the visits also confirm the recommendation to revert in Nicaragua to a catchment management approach to facilitate the understanding and the economics of sharing resources and opportunities.

Conclusions

Democratisation processes include reduction of conflicts, opening a dialogue, increasing participation of people in the decision making process and increasing knowledge. To have not only a political vote but also the opportunity and insight to participate in a decision-making process is of great democratic value. The right to be counted for is a human right. Application of the SUWaR framework in a larger scale will positively contribute towards this Sida action point.

The critical area for success is embedded in the slowness of taking decisions at central level. Problems are eminent and critical in the municipalities, but a rapid response is not coming from the authorities. (See also 3.6)

3.3 Environmentally Sustainable Development

The main emphasis of the project has been to achieve an environmentally sustainable development of the society through groundwater protection.

The Project has provided a *technical framework* for groundwater protection containing a number of tools and methods developed during the Projects second phase.

- tool for estimating vulnerability of groundwater;
- tool for estimating contamination sources and contamination load in aquifers;
- tool and procedures for estimating relative protection value of groundwater supply.

Methods developed to identify risks have resulted in a simple to understand pragmatic division of risk zones into three categories high, medium and low. The project has identified the following number of activities with a groundwater contamination risk potential in the three Managua watershed areas:

Activity	High Risk	Moderate Risk	Low Risk
Agriculture	66	51	31
Industry	60	69	35
Municipality	23	25	11
Other activities	74	5	13
Total	223	150	90

The Project is also producing:

- A plan for use and management of water resources in the eastern sub-aquifer including rules for well field protection zones.
- A monitoring system for water quality and quantity in the sub-aquifer;
- A protection plan for the three Managua sub-aquifers including rules for land use

The Project has dealt with dissemination of results and awareness raising. Studies of barriers to implementing results were also carried out. This work is leading to what the evaluation team has defined as a *communication framework* for groundwater protection. The main areas include:

- Awareness raising;
- Identification of stakeholders;
- Identification of barriers to groundwater protection;
- Education and knowledge raising;
- Communication materials and dissemination methods;

These two frameworks (technical and communication) act in parallel to produce future impact to protect the groundwater resources. A groundwater protection plan to be called Directives for Groundwater Protection will be the next step towards implementation. Different ministries and organisations using the Directives and the recommendations from the institutional and communication framework will convert the process into implementation through incorporation in their regular programmes.

Conclusions

The relevance of this work is most appropriate for creating environmentally sustainable development. This is particularly the case when the implementation of SUWaR's technical framework is complemented by the communication framework, and when the important components of awareness raising and training are added. Full scale replication in other watershed areas in Nicaragua and elsewhere when using the full strategy will have long-term environmental relevance.

Legal and institutional barriers and barriers of knowledge are the most important barriers to a successful implementation to achieve the development goal concerning this Sida action point. There is an almost complete lack of knowledge and awareness of all aspects of groundwater and groundwater protection in the country. This is true with the exception of technical level staff in government and organisations and persons having been exposed to SUWaR.

3.4 Gender Equity

No direct and observable effect on gender distribution was noticed at the occasion of the team's interviews. However, in the long term the following observations concerning gender distribution and availability of uncontaminated water in Nicaragua were made:

Women count for most of the work, which is dependent of clean uncontaminated water, and water in sufficiency, such as for washing, cooking etc. A disruption in the availability of clean uncontaminated water will affect women more than men.

In very poor circumstances women still carry water. The development is directed towards increased use of piped water. Contamination of water and closing of piped systems even temporarily, will revert women to carry water. In addition the open well which may be the alternative, is most likely to be contaminated, coming from the same groundwater resources;

Especially lone mothers will be negatively affected by negative changes in the water situation.

The Project's contacts have included an equal distribution of men and women. This is particularly true among municipality administrations and their technical staff and the schools. This was also found among government staff at the technical level and at the university. The activities, messages and opportunities of SUWaR have consequently been equally distributed in these cases. The evaluation team itself counted with a majority of women participation.

3.5 Fulfilment of Objectives

The objective of the project (the Immediate Objective) "improved protection of groundwater resources:" was to be achieved through (Expected Results and outputs of project):

- A. Development of methods for the generation of groundwater protection plans;
- B. Implementation of the developed protection plan has been initiated in the Managua aquifer;
- C. New attitudes towards groundwater contamination and training of staff within the co-operating Nicaraguan institutions.

Since this is a *methods development* project, there is a value in the possibility of replicating the project or the individual methods developed. Hence, observations in this respect will be provided in connection with each item above.

The Expected Results and the expected outputs at the end of the Project coincides with “A”, “B” and “C” above and are dealt with accordingly.

3.5.1 Development of methods for the generation of Groundwater protection plans (A)

Within the framework for protection of groundwater resources the following components were delivered:

1) assessment of groundwater vulnerability, 2) estimation of potential contamination load and 3) estimation of a protection value. This was carried out for the study area defined as the Eastern sub-area of the Managua groundwater system. However a majority of activities covered the total study area of the aquifer covering an area of 1040 km². The data collected has been stored with the use of GIS, and maps (scale 1:50 000) have been produced for each individual component.

For each one of these components methods development took place ranging from the application and modification of known methods (e.g. the Drastic method) to the development and testing of new methods. The general conclusion is that this development has been very successful. In particular the individual methods prove to be simple, robust, systematic and sustainable. This has a great value when it comes to replicating individual methods, or the whole framework, in other areas in Nicaragua, and elsewhere.

There is first of all a great value in each method individually, which can be applied independent of the others. Secondly, there is a great value in the results that can be achieved by combining the methods in different ways. By overlaying the results, information can be extracted that can be used e.g. for managing land-use. Also, methods developed to identify risks have resulted in a simple to understand pragmatic division of risk zones into three categories high, medium and low. (See also 3.3)

Increased efficiency is reached in operating the methods using computerisation. This will make replications in other aquifers faster. It is estimated that there will be at least a 50% gain in time. As a rough estimate replications in smaller basements in Nicaragua could be done within a time limit of four months. In the case of larger basins with more complicated characteristics such as Leon – Chinandega, there will also be the need for flow-path modelling which will increase the time period needed to 12 months. The particular water resources situation in the country is to be taken into account when planning replication work. Groundwater is the predominant source on the Pacific side whilst surface water dominates the Atlantic side of the country, where only moderate groundwater resources are available. Also, there are only two more complex groundwater systems of importance, the one in Managua and the other in Leon – Chinandega. By far the most complex from the point of view of groundwater protection is the Managua aquifer. There are two other aquifers to consider: the Valle Sebaco (irrigation and water supply to Matagalpa city) and the area around Rivas with potential for irrigation.

For estimations of replicability in areas elsewhere in Central America etc. it should be noted that the composition of activities with a contamination potential decides the time and size of the operation. This is due to the fact that activities are different time and resource consuming. The by far most complex are industrial type activities whilst others can be more easily estimated.

Technical staff in different participating organisations are now available to secure the sustainability of using existing results, and the replication of the methods in other basin areas. Staff has been trained in MARENA, ENACAL, UNI and elsewhere. This is recognised as one of the essential outputs of SU-

WaR. It should be pointed out that the most important aspect of forming the human resource base has been the training through doing. The fact that technical staff participated in the development of methods and the carrying out of surveys has left a broad and deep understanding on how to carry out the work. In addition it should be noted that formal training and the advice provided by KTH and LiU has been most appropriate and also very much appreciated.

The importance of involving the technical staff in all aspects of carrying out the methods cannot be stressed enough. Critical remarks on why the project has needed two phases and been active since 1992 should be seen in the light of forming a knowledge base and a sustainable setting which very likely has few comparisons. Also, some of the methods applications and developments have been a first in developing countries and the experimentation. However, learning by experience is always time consuming. In a sense the project is conceived of as a fully owned Nicaraguan experience and should be critically compared to a number of other projects with less or little anchoring in the country.

Extract from replies to evaluation team's questions:

"Before SUWaR we used to work as some sort of data clerks. Our only job was to provide foreign experts in the projects with information, and then stand on the side and see them carry out the job. This was very demotivating and did not do anything to increase our knowledge. So when the projects were done that was the end. But the results are still in the library"

3.5.2 Observations in view of Replication

- 1) Method for estimating vulnerability of groundwater;
An adjusted drastic method was used which now lends itself to faster replication. This consists of rather straightforward work and there are no particular observations concerning replication.
- 2) Method for estimating contamination load in different contamination sources threatening the aquifer;

For the weighing of the contamination load the following variables were modified and used:

- A. Contamination class or type
- B. Relative contaminant concentration or intensity
- C. Mode of deposition
- D. Duration of contamination load
- E. Remediation

Inventory of industries

This is a long process that is very time consuming. Industry will require most time among the sectors, but is also the most critical. Reactions from the persons interviewed will at first attempt be one of suspicion. There could be difficulties even to get the interview accepted (up to three letters had to be sent, each new with stronger wordings - finally quoting the law) before reaction came. Another difficulty was that the interviewers did not have identity cards for a start. When this was arranged the process was speeded up considerably.

The first round contained some 30 interviews. In total 4 months were spent on this during the first phase. The data was all hand coded and analysed as a part of the methods development work. The second round, carried out during the Project's second phase, was larger including 130 interviews out of 191 total with a duration of more than a year. The interviews were directed towards obtaining data in order to estimate contamination load using variable A to E above. A pre-prepared questionnaire was guiding the interviewer who still had to use a lot of discretion to get to the answers. Interviewers must

be trained in the substantive areas concerned. The data was computerised which considerably speeded up reporting.

One difficulty in the first phase was that industry types were not fully known as well as the valid questions to ask. Training in the methodology was subsequently carried out. When doing the work during the second phase the results were very much improved. In particular important information was added and completed. The original lists, which were used to pick industries were taken from Instituto Nicaraguense de Estadística. Industries are normally listed after size in terms of number of people employed (1–3, 4–10, more than 10, names and tel. number given etc.) Larger industries were all chosen for interviews, smaller were sampled by type such as chemical industry, pharmaceutical industry etc.

A replication would now be much faster since the methodology is known. Also, there is knowledge of the relative importance of each sector and type of industry and the amount of time and effort needed in each case. By far the most complex activity area is industry (particularly chemical and pharmaceutical industry). Some areas in contrary have very little importance and require minimum effort, such as food processing. It should also be noted that nearly all industries are situated in Managua. A replication would be easier in other regions since this category would hardly be present.

As reported earlier there is substantial training value in data collection and application of the methods. It also provides the best guarantee of replicability and sustainability. The contaminant sources characteristics rightly used will save time compared to more traditional approaches. However, at this stage continued detailed field studies of individual sites can be a waste of effort.

Agricultural activities

Work was carried out in the first and second phase of the Project. Out of 148 agricultural areas 91 were selected using photos (aerial); The largest threat here is diffused contamination from an old cotton growing area to the east. When it comes to agro-chemicals it should be noted that constant name changes takes place and old chemicals are sometimes used under new names. This caused difficulties. Storage of agro-chemicals at farms is a problem.

Municipalities and urbanisation

Out of 350 settlements 250 were selected. Data was collected in municipality offices (Alcaldías) in the seven districts. In the case of small settlements a sample was taken. The task took a year. Urban settlements were mostly located in Managua. This area was also the most complex with a lot of difficulties in finding the settlements i.e. name changes with each new government. Also a number of registration errors exist, i.e. settlements which are registered and do not exist and settlements existing which are not registered. Sometimes the registration is in the wrong “alcaldía”, meaning that there is a lack of co-ordination among the municipalities. In municipalities oxidation ponds were the main sources of pollution.

Managua settlements mostly count with drinking water supply services. However, owners of property can sink they own private wells without authorisation. This has particularly been the case for industrial activities. It also follows that the extraction, which at times is substantial in comparison to other activity areas, is not taxed with a water tariff. Nicaragua used to have a system to regulate well development including issuing permits for drilling and the volume to extract.

When it came to question of drainage and disposal systems the municipalities did not normally have much information. The researchers (interviewers) had physically to find the places of disposal and make their own observations. With farmers (agricultural stakeholders) this was different since they normally have a good command and knowledge of the statistics of their property and production such as area, pesticides used in quantity and type and number of farm hands employed etc.

Other activities

Out of a total of 75 petrol stations 40 were selected. The information was retrieved from local headquarters of the petrol companies operating in Nicaragua (ESSO, TEXACO, SHELL and PETRON-IC). They provided name and location on maps. There were especially problems with the older petrol stations, some being around for more than 20 years. Insufficient protection and earthquakes make these very vulnerable. Newer stations have the prescribed double bottom protection system. Fortunately, so far only few Nicaraguan petrol stations count with car washing installations.

General Recommendations for Replication

Make maximum use of available registers, directories, listings, maps and aerial photos. It facilitates if industry types are grouped (industries sharing same type of pollution). For agricultural areas grouping can be done on pollution typical for the area. There is in principle no need to visit all sources of pollution if typical situations can be found.

3.5.3 Participation of ENACAL

The technical framework for groundwater protection as recorded above is based on the following components: (1) assessment of groundwater vulnerability, (2) estimation of potential contamination load and (3) assessment of protection value. To the framework a fourth component is added (4) the delineation of wellhead protection zones (Scharp, C. et al., 1999).

The capture zone for water supply is a sensitive area where land use should be managed more strictly. Wellhead protecting zoning is a valuable supplement to resource protection. Although INAA and ENACAL were involved in (1), (2) and (3) above the main emphasis of ENACAL's work is centred on (4).

Due to delays wellhead protection zoning has yet not been established. The following work to be carried out by ENACAL as a result of the SUWaR project is still pending:

- Plan for use and management of water resources in the Eastern sub-aquifer including rules for well field protection zones and individual wellheads and identification of zoning. These will consist of A) measures for protection of the immediate operational courtyards close to the extraction points, B) Zone I, the innermost defined to 500 m and C) Zone II, defined to 2500m. The proposed zoning is based on experiences from English, Danish and Swedish zoning systems. Groundwater modelling is used for the delineation of the capture zone (use of the computer model FLOWPATH)
- Monitoring system for water quality and quantity in the sub-aquifer;
- Extraction plan for the three Managua sub aquifers including rules for land use.

Work is presently ongoing to identify caption zones and protection zoning. This will be followed by work on regulation of land use.

Conclusion and Recommendation

The finalisation of this work is urgently needed and should be possible to conclude within short since data and information is available. The water works company, ENACAL (the service provider) should submit the proposed regulations for wellhead protection to INAA (the controlling and regulating authority). This would imply regulating activities in the zones such as industrial, commercial, petrol stations, liquid and solid waste disposal, transports, agriculture etc. This will also depend on the extraction volume and the projections of water demands for the capital. The initiative should be consulted with different affected sectors in order to obtain a consensus. A study of the law creating INAA would probably be needed in order to clarify the roles between INAA and ENAC.

Recommendation

SUWaR has not fully considered protection aspects related to the groundwater balance, which will be disturbed by different extraction patterns. It is recommended to make a study on the possible risks in connection with unbalanced extraction and also the risks in connection with natural phenomena in connection with the Masaya volcano, which is situated in the catchment area. The results could be used also to inform and reassure the populations living in the areas where the resources are extracted. The study on risks could be supported by Ing. Oscar Cruz (former MARENA) thesis on the water balance in the whole aquifer.

3.5.4 Implementation of the developed Protection Plan has been initiated in the Managua Aquifer (B)

This output has not been realised to the extent it was planned. The initial plan calls for: “the protection plan written, published and approved by the involved institutions”. Furthermore that: “the most urgent protection actions and measures proposed by the plan are initiated”. Furthermore: “the protection plan were to be presented to groundwater managers and decision makers at a seminar” (the final seminar).

The situation as of May 2000 is the following. A protection plan is under preparation. It will be issued under the title “Directives for Groundwater Protection” (Directrices para Proteccion de Agua Subterranea) which will be presented at the final seminar of SUWaR scheduled for 4 October 2000.

The Directives will be based on the findings of SUWaR from the Project’s II phase and respond to a number of laws, which already regulates environmental quality. However, there are still a number of areas not covered by legal regulation. Due to these circumstances the Directives requires a formal approval process at national level. Recommended steps to be taken from mid 2000 include:

1. Consultation with concerned institutions (which would ultimately apply norms);
2. Presentation of draft Directives to National Water Commission;
3. Approval of Directives;
4. Decision that MARENA as parent organisation will guide implementation;
5. Decision of institutionalisation of Directives within MARENA (providing budget and staffing)
6. Information and consultation with all involved parties in the Project’s final seminar 4 October 2000;
7. Adaptation of the Directives by institutions (specifying the norms to be used to regulate the work in each individual institution or organisation);
8. Specifying and adjusting programmes in institutions and organisations to implement the norms interpreted from the directives.

It should be noted that the results of the Project fall well within the mandate of the National Water Commission. The results need to be presented to the Commission urgently in view of the final seminar in October. It should also be noted that much of the reason for these cumbersome procedures is the lack of a Water Law to regulate and co-ordinate activities.

The Directives would provide the following categories of regulating high and moderated risk zones (see example appendix 3).

Activity area to Regulate	High Risk Zones	Moderate Risk Zones
Agriculture etc....	Activities subject to prohibition	Activities subject to prohibition
	Activities subject to certification	Activities subject to certification
	Activities subject to notification	Activities subject to notification
	Activities subject to monitoring	Activities subject to monitoring

Conclusions

The objectives in the LFA were not formulated with the needed precision. In a plan which otherwise is very detailed and precise the particular point of implementation seems to have jumped or missed one or two steps. It is obvious that going from a stage of a completed technical framework of methods, including the produced maps into an implementation phase involves a large number of steps and unknown factors. Implementation starts first when the organisations concerned have included ground-water protection measures, with budget and staff into their regular programmes.

Would the end results have been different if it had been an institution-building project (using the technical framework) than a technical methods building project trying to fit into institutions? Often when the product of a project is a technical innovation or a new method there is by natural reason an emphasis on producing the product. It is taken as more or less granted that the product would be implemented since it is *obvious* that it is useful. In reality and looking upon things from the implementing programmes point of view, this novelty may be unknown, or it is not opportune by one reason or another whether political, economical or else, or it is not backed by some common agreement shared by all.

This is easy to say and in reality the situation could have been different at the time of the planning workshop 1996? It is obvious that there are changes in institutions and also politics over a period of four years, which could explain why the initial intent was not followed.

Initially the Project had another orientation in terms of implementation. It was thought that the work would be based on a legal acceptance of the strategy and the protection plan. Through the second phase this approach has been changed in the sense that the Project's implementation will be based on existing laws and that the protection plan will contribute to the implementation of these laws.

Although the main character of the project has been one of a pilot project, it should be pointed out that some implementation of groundwater protection measures has been carried out in an informal way concerning the Managua aquifer, as a result of the investigating and advisory work.

Some of the facts still stand:

There is still no Water Law available to regulate all aspects of common use of water in Nicaragua. A bill is still under consideration in the Parliament since some time.

With this follows that there are difficulties in co-ordinating actions. The National Water Commission (Comision Nacional de Recursos Hidricos) is filling the gap under the leadership of MIFIC (Ministry of Industry and Development). However, the Commission lacking a full-fledged administrative body staffed with water experts has to rely on a minimum set of advisers.

Recommendation:

It is recommended that MARENA, being in charge of protecting the resource and ENACAL and INAA in charge of extracting from the resource, to enter into inter-institutional co-ordination to implement the existing legal framework concerning the protection of the resource. In this connection the draft Water Law should be analysed from the viewpoint of reinforcing aspects of groundwater protection. The work would have to count on the support of the National Water Commission and its advisory group.

The Project, and rightly so, included a heavy component to study barriers to implementing a groundwater protection plan. This was done through identification of stakeholders and target groups and providing their profiles etc. This is laudable work, and is essential, to implementation. However, it was all done within a setting of a pilot study just as the rest of the project was a methods development project.

There are probably two equal parts here one consisting of a “Technical Framework” and one of a “Communications Framework”, and not a “Technical Framework with some institutional studies” etc. added on to it. The concept “Communication Framework” does not appear in the original plan. The concept has been added by the evaluation. Interesting enough the priority order given to the outputs in the LFA listed the point “new attitudes towards groundwater contamination and training of staff within the co-operating Nicaraguan institutions” *after* the implementation of a plan.

Recommendation

In order to achieve a successful implementation in the Managua catchment area and when replicating SUWaR elsewhere it is imperative that the implementation of the norms (the Directives) in parallel or beforehand is supported by activities defined in the Communication Framework. There is thus the requirement to define this framework in more structured and detailed manner and to define activities and the cost for implementation. Where this support framework will be housed or funded is at present not clear, but it will most certainly include sectors and organisations yet not fully involved in the work such as the Ministry of Education, the media, and the different interest organisations in the country.

Even so other factors have to be weighted in. In a situation of scarce economic resources the situation becomes more precarious. In order to achieve some attention it will be needed to show the economic benefit of protecting groundwater. Groundwater has an economic value and should be recognised for its value to economic development. The services provided which are taxed through water tariffs should produce a return, which is also to be shared for protection measures. Since groundwater is a common good the sharing must be regulated on economic grounds e.g. Nicaragua used to have regulations for authorising well sinking and extraction volumes. Not so now where some potential contributors to the common good do not participate.

Recommendation:

It is recommended to carry out a study on the value of water as an economic good. The results will contribute to the analysis of the present water tariffs. The results will also contribute to re-establish water consumers confidence in the billing and metering system. It could also provide the starting point for a system, which reflects all costs and benefits in connection with water as a resource. The end goal would be a system to tax the real cost of the resource. In initiative No 4 in the Cumbre de las Americas 1996 water is described as an under evaluated resource. The study could be coupled with a review of water demand for different economic sectors. The results could be used for forming a strategy, including differentiation on seasonal variations, to achieve a better balance between demand, price and extraction rate.

Recommendation:

Another possible development to look into is the initiative of MIFIN (No 006-98) to introduce tax exemptions for sectors, which invest in environmental improvements.

The protection work of the aquifer has so far not sufficiently considered the groundwater balance and the dangers of over-extraction.

Extract from replies to evaluation team's questions:

"We are dealing with the management of a catchment area, where the hydrological resources are very important. The management must be within the territorial planning rules. To succeed it has to be backed by political willingness and a long-term view, which is not the case now. The uncontrolled development of Managua is critical. Although there is planning it does not consider the balance of the aquifer and the quality of the groundwater. An expansion to the east and west would have been more appropriate than the expansion now taking place to the south, threatening the recharge and the quality of groundwater."

With the urbanisation large infiltration areas are lost. Asphalt and concrete form an impermeable cap, which prevents infiltration. An appropriate evacuation system for surface water is needed when the torrential rains come. The system in Managua now contains gutters, which are cemented in the bottom with the result that the storm water is simply washed away and not properly infiltrated to the aquifer. This is a ironic since geologically the soil in Managua has excellent properties for fast absorption of great volume of water.

Recommendation:

It is recommended, in particular for consideration of the Municipality of Managua to consider an adequate type of infiltration system. Gutters that lead into a concrete construction with a centre chamber for infiltration, which opens up to, a pit filled with sand approximately 5 m deep in all (3m sand). The infiltration chamber should be supported by one or two (depending of flow size) sedimentation chambers where the water flows through and where trash and sediments are stopped. These chambers are cleaned ahead of each year's rains. (At intervals the sand also has to be cleaned). There should also be a requisite for homeowners to build a simplified model of the infiltration well on their property. This would consist of a cement tubing or square construction followed by a pit of 2–3 m filled with sand. In Miami the state law obliges people to install such wells. Such measures should be complemented with a programme for solid waste disposal.

As a cost comparison it should be noted that the cost of water pumped from the aquifer is roughly 50 cents the cubic meter. Through infiltration approximately 100–1000 million cubic meter could be infiltrated in Managua having a corresponding value of 50–500 M \$ (depending on the definition of the size of the Managua infiltration area.). Cost per municipal infiltration system is approximately 150 US\$ and for households less than 100 US\$.

Extract from replies to evaluation team's questions:

"This should all be contained within a plan to protect the water resources both in volume and quality, surface as well as groundwater. Take Lake Tiscapa as an example. We need evaluations of the present stage and future needs and the costs of alternatives. There is a need to change the mentality of the population towards these matters, to make them aware. At first hand the urbanised areas should be considered, less so or not at all the poor barrios because of their lower contamination potential and the more open soil conditions. We see technical capacity, and the willingness of technical people but no political willingness. We are unfortunately living with a vision which is only focused on a particular sector and with a complete lack of knowledge"

Recommendation:

In order to optimise the use of resources and the benefits derived it is recommended to base planning on an integrated catchment area management approach. Since groundwater if not controlled to extraction volumes and quality can be the bottleneck to further economic expansion it makes sense to use integrated catchment area management as a principle for future planning. Also, there is a risk of increased conflicts between stakeholders, target groups and municipalities that could have political implications, if the current uncoordinated approach continues.

Recommendation:

MARENA being the regulating office of all resources could be the generator of commissions at the level of the catchment area in order to co-ordinate all sectors concerned by the groundwater resource.

Recommendation:

It is recommended that municipalities in the catchment area define their territorial planning. This is urgent due to the demographic pressure and the disorderly urbanisation, which could otherwise result. At present there is a degradation of the basin due to the advancement of the agricultural zone (farmers selling lower lands to developers) to higher locations (infiltration areas) and deforestation. The municipality of Managua, as a more powerful and better-equipped municipality to take the lead sharing experiences and create co-ordinated efforts with the municipalities to the south (Ticuantepé, Nindirí etc.)

Recommendation:

It is recommended to develop a monitoring system to be co-ordinated between MARENA, ENACAL, INAA, INETER and MINSA based in MARENA. The system will serve as a platform for follow up of the SUWaR project. The whole aquifer should be monitored in terms of quantity and quality of groundwater. Special emphasis to be put on occurrence of nitrates and pesticides.

3.5.5 Observations in view of Replication

SUWaR lends itself for replication in other Central American countries. Most countries are adopting an approach based on integrated management of catchment areas, which is more suitable for implementation of the SUWaR framework.

In order to accept the framework as a policy for countries SUWaR and its results could be presented to the Central American Commission for Environment and Development (Commission Centroamericana de Ambiente y Desarrollo, CCAD), and the Dirección Centroamericana del Medio Ambiente, DGMA, (DGMA-SICA). In the Council of Central American Ministers of Environment the general policy lines are defined as well as a strategic plan of CCAD and its follow up.

3.5.6 New attitudes towards Groundwater Contamination and training of Staff within the co-operating Nicaraguan Institutions (C)

Lead organisation in this area has been the National Engineering University, UNI. This part of the Immediate Objectives has been fully delivered.

The Project during its second phase carried out a large number of interviews with stakeholders in order to analyse barriers to introducing protection measures. There were also a number of activities directed towards awareness raising, education in groundwater pollution and activities in general to increase the knowledge in the population for environmental protection. These activities were centred to Ticuantepé and Nindirí, that had been selected as the sample area.

The activities have included:

- Presentations and discussion meetings (Charlas)
- Workshops
- Interviews
- Meetings
- Seminars
- Courses

The purpose of the activities was to involve the local population, stakeholders and target groups, raising awareness and knowledge of groundwater pollution as well as providing some education. The work has resulted in a number of papers relating the experience and the findings.

Work has been carried out in the following areas:

Awareness raising:

- application of educational methodologies for water resources protection with emphasis on groundwater;
- development of information brochure explaining the project;
- development of pads for primary and secondary school teachers with information on groundwater protection;
- development and distribution of didactic material to schoolteachers
- production of video.

Stakeholders

- Studies on stakeholders, identification of stakeholder profiles
- Studies on barriers to introducing protection of groundwater resources

Education and Training

- Courses;
- Seminars

Research

Research at UNI has generated 3 thesis financed by SUWaR plus two thesis at MARENA, plus one post-graduate thesis without financing by SUWaR (see annex 4)

The introduction of a multidisciplinary approach to SUWaR has been very beneficial to all involved. The new way of working in interdisciplinary groups were commented as follows:

Extract from replies to evaluation team's questions:

“There has been an enormous value in SUWaR in that we had to carry out the job learning as we went along. We also learned how to work and perform in groups”

“Work between institutions became accepted and all shared the experience from our work. The normal situation before SUWaR was that one institution did a job, which was then not accepted by another institution, which had themselves to redo the job. This led to unnecessary delays, waste of time and money and created suspicion. This form of distrust disappeared”.

Recommendation:

It is recommended to introduce the concept of payments for an environmental service in order to establish a sustainable protection of the resource. This could be done by a special law “The Law of Environmental Services” which could subtract a minimum percentage (1% or 2%) of the current water tariffs applied to households, industry, agriculture including irrigation etc. Such funds to be used for awareness raising, training, environmental education and financing of protection plans. Such a law already exists in Central America, in Costa Rica and El Salvador.

Recommendation:

It is recommended to give emphasis to activities to keep the public informed through mass communication media. This should also include the use of a web site to inform and dialogue with people. The messages should be centred on problems of water and water contamination and on what could be done by the individual towards these ends.

Recommendation:

It is recommended to implement an educational plan (for formal and informal education) for the whole of the eastern sub-basin (the study area). The aim will be to later increasing the coverage to the whole Managua basin and Nicaragua as a whole, depending on the advancement of the protection plan. Such education should not follow the introduction of protection measures but be parallel with them or even in advance of their introduction. There is also the need to develop further didactic material.

3.5.7 General Conclusions and Recommendations concerning Stakeholders

Consumers: to create and strengthen water consumer groups. Liga de Consumidores de Nicaragua (LIDECONIC), the national consumer association should be involved;

Urban developers: to disseminate information relative to environmental controls (decreto 33-95) as well as preliminary norms concerning the protection area of the Managua I well field;

Municipalities: to carry out studies for territorial planning at local levels;

Industries: to study the initiative of MIFIN (No 006-98) to introduce tax exemptions for sectors that invest in environmental improvements;

Agriculture: to find ways of reducing application of pesticides, still maintaining the same production level;

NGOs: to work for improved institutional co-ordination at local level for activities supporting protection of groundwater resources;

Government: give emphasis to definitions of conservation zones for drinking water, the application of the Water Law, strategies to regulate the resources in general and well protection in particular and providing advice to the municipal sector.

3.5.8 Observations in case of Replication of a Barrier Study

In the SUWaR study each interviewer carried out six interviews spread over the sectors. Interviewers were screened and trained, mostly coming from technical sciences background with good knowledge of groundwater problems. The data collection method was described to interviewers, who also participated in formulating the questions based on their sector knowledge.

When doing the interviews it was clear that there is a complete ignorance in the population about groundwater and groundwater contamination issues. As a first reaction the persons to be interviewed were very suspicious (Nicaraguans are only used to this sort of contact in connection with tax matters

etc.) People in general think that there is no contamination going on with the water, eventually they could imagine some soil contamination. The first thing to do for the interviewer is therefore to acquire some sort of trust to be able to carry out the interviews.

Interview was carried out twice with the same person. There was a tremendous difference between the first and the second interview. The first encounter was one of suspicion the second of welcome and trust. The first interview provided little information, the next one a lot, also because the interviewers had analysed the sectors from the first round and knew what to ask for.

An interesting somewhat negative but well-known effect: When you get the trust everyone wants you to solve all his or her problems. This turns out to be embarrassing since your task is not to respond to all sort of problems, but to do a study. When this is made clear people then get somewhat disappointed and ask for something in exchange. Anyhow, everyone is interested in the results and *it is most important to feed back the results of the study and keep people up dated on the progress of SUWaR*. One such opportunity is the final seminar in October to which people who have been exposed to SUWaR should be invited.

3.6 Impact on Target Groups

The methods and instruments developed under SUWaR have had an impact on stakeholders.

- A. Vulnerability maps have been used by municipalities and urban planners;
- B. Maps and methods identifying risks have had an impact on stakeholders in Agriculture, Industry Municipalities, Government, NGOs and Petrol stations.

Maps and results have made it possible for institutions to make their own planning concerning aquifer protection. When this will be combined with the issuing of the Directives there will be a substantial contribution to planning. The impact of the results will be seen also in a time perspective. According to the Directives decisions concerning zones with high risks have to be concluded from now on and within two years. For medium risk zones decisions have to be taken within five years and for zones with low risk within eight years.

- C. There has also been a change in attitudes in all target groups, stakeholders as well users exposed to the work of extending the SUWaR framework through awareness raising, information and education.

People living in the protection zone now understand the concept of shared resources and the need to care for groundwater resources.

Schoolteachers in the protection zone are now developing activities to teach groundwater protection such as making terrain models, activities to plant trees, study tours etc.

Schoolchildren in the protection zone are transmitting the learnt messages to their homes, in often humble circumstances but with a pride to contribute something.

Farming associations and interest groups in the protection zone understand the concern and are discussing alternatives to fertilisers and pesticides and the reduction of quantities. More attention is given to tree planting, infiltration and also to improve marketing of products in order to compensate losses.

Municipalities are concerned and willing to contribute. However, there is a long list of demand for information and technical help to go into municipal planning, which does not come out timely from central authorities. Norms and regulations seen from their point of view are years behind schedule. The economic pressure of development can not be stopped by this lack of response and municipalities have to take the lead on there own for good or bad, even considering setting their own norms.

Extract from replies to evaluation team's questions:

"We (the municipality) are preparing a municipal development plan for urbanisation that is to be ready within three months. Will result in "ordenanzas municipales". We are desperate in need of information on norms and recommendations in order to do the plan and to advise the builders (urbanizadores). We feel left out and without any support. We need urgently norms. Specially concerning protection of wells. Houses are equipped now with septic tanks, but may be there are better alternatives? Builders need to know what type of services will be provided in terms of water, sanitation, electricity, telephone etc. Which level is expected as compared to standards in Managua? When ENACAL gives approval of solutions they are sometimes not appropriate, and the municipality is left with an impossible task to finance the maintenance of too costly technology. ENACAL should be obliged to resume maintenance responsibility to learn facts of life."

"There are now 43 requests for building permits. Amount of grey water not treated will increase and lead to contamination of the aquifer. There is no law to regulate this infrastructure; therefore we see a large risk of anarchy."

"What we need desperately:

- Positions of present and projected wells;
- Norms for industrial activities in food processing, chemical and pharmaceutical production and construction material which affects residual water and solid wastes;
- Co-ordination of environmental studies between MARENA and the Municipality concerning construction zones;
- Protection zoning for wells;
- Criteria for handling run off water;
- Criteria for disposal of domestic water;
- Criteria for disposal of industrial effluents;
- Get to know the second phase of SUWaR better;
- Broader based training in environmental protection in the community;
- Continued community participation and community information concerning groundwater protection"

Industry stake holders make the same observations. After the exposure to SUWaR there is an expressed willingness to go ahead with the needed changes, whether concerning handling of effluents or storing products or discarding solid wastes. However, norms and the regulations to carry out the job are not available and are urgently requested.

Urban developers (planners and construction companies) also provided a positive response and see the needs for a protection plan in order to present their development projects with details corresponding to the municipality rules. Regulations for excreta disposal and technical solutions for excreta disposal and effluents are requested. Agreed technical solution on different levels of costs and appropriateness are requested.

Other activity groups express similar concerns. Petrol stations is a dominant group. New petrol stations mostly have safety precautions incorporated, however older stations still is a threat and there is a need for regulation.

Research workers involved with SUWaR have experienced real life research situations and have been overly motivated through the contacts achieved with stakeholders. Voluntary given time has counted for a lot of the success in this part of the project. SUWaR work was many times carried out on top of regular work, but due to its interesting approach and the large potential to learn there was always time for SUWaR work.

3.7 Economic efficiency

The work of MARENA covered the three sub-basins. The first phase started with manually handled work in the eastern sub-basin. Then in the second phase the central and western sub-basin were covered. Consequently the whole area for Managua has been investigated (880 square km as opposed to 450 for only the Eastern sub-basin). The concept, which started in the first phase took the departure point in a catchment area approach, which at that time was the official approach to physical planning of resources. (Presidential decree of 1991). The project in those days had a much wider scope including also surface water and agricultural activities such as experimental banana cultivation in small test areas.

With the changes of approaches introduced by the new government in 1995 the catchment area approach was not longer pursued and MARENA had to reorient the work. SUWaR as well was reoriented in its second phase to comply with government regulations. This raises the question of whether the continued work to complete the methods of determining contamination load and risk assessment could not have been carried out by only using one (the eastern) of the sub-basins to reduce costs. This would be equal to the area of work selected by INAA/ENACAL and of the work carried out by UNI, which was concentrated to a sample in the eastern sub-basin?

The answer is no. The reason being the location of different contaminating activities. The by far most complicated and serious activity, the industry, is principally located in the Central sub-basin and the development of methods and the determination of contamination risk could not have been done without incorporating information from this area.

The pace of developments at first glance may seem slow counting the period from 1991 to 2000 to achieve the results. However, it should be remembered that the timing included the experimentation and testing and development of methods as well as training on the job. Also, staff was not full time on the project with some exceptions.

The project provided a development of insights and knowledge by a large number of staff, which could not have been achieved through formal education. Thus forming a critical mass of engineers and environmental research workers, which are as of today ready to replicate the methods elsewhere. Now with faster execution time and to lower costs.

Also it should be remembered that a process of consultation had to take place at governmental level, necessary but at times time consuming. The absence of clear co-ordinated directives such as the ones included in a water law was not available making further delays (and still making delays and counter-productive developments). With a law approved already in 1998-99 the base for institutional co-ordination and for regulation in the water sector would have speeded up the process of putting SUWaR to more extended use in Nicaragua.

4. Conclusions

Particularly the Pacific region of Nicaragua is dependent of sustainable quality groundwater supplies. Here as much as of 70% of the economy is dependent of this resource. With contamination of aquifers, populations, cattle industry and farming will be the first to suffer. This will have serious consequences since farming is the most important economic activity in the country. The results of SUWaR when implemented on a larger scale will play an important role in safeguarding the resource.

The successful development of SUWaR has left the following substantial contributions:

A) A *technical framework* for groundwater protection containing a number of tools and methods developed during the Projects second phase.

- tool for estimating vulnerability of groundwater;
- tool for estimating contamination sources and contamination load in aquifers;
- tool and procedures for estimating relative protection value of groundwater supply;

Each one of these methods has a value on its own and can be applied individually. In addition there is the value of combining the different methods. By overlaying the results further analysis can produce additional methods. One such method has been the development of risk identification.

This has resulted in a simple to understand pragmatic division of risk zones into three categories high, medium and low. The project identified a total of over 450 risks in the Managua area.

B) The Project has provided education and on the job training. A critical mass of technical personnel in different co-operating organisations is now available and ready to implement the results and to extend and replicate the work in other areas of Nicaragua.

C) The SUWaR project has dealt with dissemination of results and awareness raising. Studies of barriers to implementing results were also carried out. This work is leading to what the evaluation team has defined as a *communication framework* for groundwater protection. The main areas include:

- Awareness raising;
- Identification of stakeholders;
- Identification of barriers to groundwater protection;
- Education and knowledge raising;
- Communication materials and dissemination methods;

These two frameworks (technical and communication) act in parallel to produce future impact to protect the groundwater resources.

The project, so far, did not achieve the implementation of a protection plan as envisaged at the start of Phase II in 1996. This is mainly due to the lack of a coherent legal framework (Water Law) and institutional changes. The Water Action Plan (Plan de Accion de Recursos Hidricos) supported by Danida has not been implemented so far which is a mayor draw back. However, protection measures have been implemented in an informal way as a part of the advisory work.

The tasks still pending under the Project, which are now being emphasised are:

A) A groundwater protection plan to be called Directives for Groundwater Protection will be the next step towards implementation. Different ministries and organisations using the Directives and the recommendations from the institutional and communication framework will convert the process into implementation through incorporation in their regular programmes.

The Directives will be based on the findings of SUWaR from the projects II phase and respond to a number of laws that already regulates environmental quality. However, there are still a number of areas not covered by legal regulation. Due to these circumstances the Directives requires a formal approval process at national level. Recommended steps to be taken from mid 2000 include:

1. Consultation with concerned institutions (that would ultimately apply norms);
2. Presentation of draft Directives to National Water Commission
3. Approval of Directives
4. Decision that MARENA as parent organisation will guide implementation;
5. Decision of institutionalisation of Directives within MARENA (providing budget and staffing)
6. Information and consultation with all involved parties in the Project's final seminar 4 October 2000;
7. Adaptation of the Directives by institutions (specifying the norms to be used to regulate the work in each individual institution or organisation);
8. Specifying and adjusting programmes in institutions and organisations to implement the norms interpreted from the directives.

It should be noted that the project falls well within the mandate of the National Water Commission. The project needs to be presented to the Commission urgently in view of the final seminar in October

B) Urgent work to be carried out by ENACAL:

- A plan for use and management of water resources in the eastern sub-aquifer including rules for well field protection zones.
- A monitoring system for water quality and quantity in the sub aquifer;
- An extraction plan for the three Managua sub-aquifers including rules for land use
(See 3.5.3)

The SUWaR methodology should now come to use. There is no more need for development on the methods per se but an urgent need to apply the results in a fast and pragmatic way. An updating of the methods is required earliest in three years time (3–5 years). All useful techniques acquired using computers etc. should not develop into ends for their own purpose but should be seen as tools for more important actions

5. Recommendations

There is a need to institutionalise the Project within MARENA. This requires adding an organisational unit. It is especially important since MARENA does not have a water unit or department.

A budget must be added as well as personnel selected from the staff with experience from the Project. SUWaR is presently “floating” due to the fact that it is placed under the department for norms and regulations.

1. To create an entity called “Proteccion Ambiental de Agua” environmental protection of water within MARENA, with a budget and personnel, in charge of institutionalising and co-ordinating the results of SUWaR. The objective of the entity would be to mount a national plan for protection of groundwater in Nicaragua.
2. To present the results of SUWaR to the National Water Commission with the purpose of obtaining an authorisation to disseminate results from the Project and to institutionalise the results in the institutions, which are relevant to the work. (See 5.3.4)
3. That MARENA, ENACAL and INAA enter into inter institutional co-ordination to implement the existing legal framework concerning the protection of the resource. (See 3.5.4)
4. Through the support of the National Water Commission to analyse the draft Water Law from the viewpoint of reinforcing aspects of groundwater protection. (See 3.5.4)
5. To meet with business leaders (Chamber of Commerce) and other influential interest organisations representing sectors such as agriculture and construction. This would be an important next step in the consultation process that should now also involve MARENA and ENACAL;
6. To introduce integrated planning and implementation on an catchment level management approach (See 3.5.4)
7. MARENA to be the generator of commissions at the level of catchment areas in order to co-ordinate all sectors concerned by the groundwater resource. (See 3.5.4)
8. To develop a monitoring system co-ordinated between MARENA, ENACAL, INAA and MINSA based in MARENA and forming a platform for follow up of the SUWaR project. The whole aquifer to be monitored in terms of quantity and quality of groundwater. Special emphasis to be put on occurrence of nitrates and pesticides. (See 3.5.4)
9. To make a hydrological study on the possible risks in connection with unbalanced extraction and risks in connection with natural phenomena in connection with the Masaya volcano. (See 3.5.3)
10. To carry out a study on the value of water as an economic good. (See 3.5.4)
11. To introduce the concept of payments for an environmental service in order to establish a sustainable protection of the resource. (See 3.5.5)
12. Another possible development to look into is the initiative of MIFIN (No 006-98) to introduce tax exemptions for sectors, which invest in environmental improvements. (See 3.5.4)
13. That municipalities in the catchment area define their territorial planning. (See 3.5.4)
14. To consider adequate technical solutions for storm water infiltration in Managua. (See 3.5.4)
15. To define in more detail the Communications Framework. (See 3.5.4)
16. To give emphasis to activities to keep the public informed through mass media. (See 3.5.5)
17. To implement an educational plan for formal and informal education. (See 3.5.5)
18. To feed back the results from studies and SUWaR work to all parties involved in interviews, meetings and seminars etc (see 3.5.2 and 3.5.8)

6. Lessons learned

On sustainability in the human resource base

There is a substantial positive value if training is carried out through doing things yourself. The experiences from working on developing the methods have left broad and deep knowledge, especially the knowledge how to carry out things and a good amount of motivation. This leaves a guarantee for a sustainable human resource base, if the work is continued. However, on the negative side the achievement requires substantial time.

On anchoring projects within the national development scenario

In Nicaragua development projects with external financing can be set up in three different ways:

1. As investment projects i.e. SUWaR was set up after the project started with Nicaraguan financed counterparts in MARENA, with budget and staff. This guaranteed dedicated work to develop the project and to prepare the foundation for sustainability. The difficulty will arise at the end of the project when the counterpart funding ceases. Continuation of activities requires an institutionalisation within MARENA
2. As an add-on activity to regular institutional work e.g. The way SUWaR was set up within ENACAL was of the type where a project relies on an institution's own resources in personnel. This is a next best solution. However, there could be conflicts of timing and resources with normal institutional work, that would require attention in the first place. Initially before provisions of counterpart funds the MARENA execution was of this type. The staff belonged to the former watershed department at MARENA.
3. Project where the donor agency assumes all the costs and at occasion carry out the work with their own personnel. An example would be PARH (Plan Agua y Recursos Hidricos) based in MARENA. There is most likely fast execution and delivery of results. However the problem arises when it comes to integrating the results and to sustain continued operation after closure of the project (problems of "anchoring the project").

On value of communication

When carrying out the interviews and data collection with stakeholders for estimating contamination load it was discovered how important communication and contact between parties are. The same was true when carrying out the work on defining stakeholder profiles and defining barriers to change. Contacts opened new perspectives of co-operation, understanding and reduction of potential conflicts. It also showed a way to break a top down approach emerging from central authorities, that are isolated from the requirements of stakeholders and users in general.

Communication is not restricted only to open a dialogue. It is also concerned with reporting and follow-up. This is an often forgotten aspect in a project and in the work of authorities. The cost of follow-up is relatively small compared to the investment made to open the dialogue. However, the benefits are important.

On value of a cross-fertilisation among different disciplines

From the start SUWaR was concentrating on a technical approach. With the second phase support listed from different sciences were introduced in connection with the study of barriers to change such as sociology (in particular interviewing techniques) economics and studies of institutions. This cross-fertilisation proved to be very productive giving clues to how the implementation process may best succeed.

On difficulties of institutionalise new methods

Initially it was thought that implementation of protection measures would be based on a legal acceptance of the strategy and the protection plan. However, it was experienced how complicated the situation can be in a situation without a clear legal structure. The lack of a Water Law to regulate overall co-ordination led to difficulties.

On the application of LFA

In the planning stage and when using the LFA the most important part of the analysis rests with the External Factors. These are sometimes referred to as the “assumptions” made. Particularly important are the “assumption” which are made for reaching the level of Immediate Objectives from the level of Expected Results. In the SUWaR case the only “assumption” made to move from methods and result of methods (Expected Results) to implementation of a protection plan (Immediate Objective) was:

“The Nicaraguan institutions involved in the project, continues to give priority to the protection work, and assign staff to work with the implementation phase”

It is difficult to judge the situation ex-post and it is not sure that a more thorough analysis of the “assumptions” to be made would have solved the problem. However, the parties involved would probably have had a much clearer picture of what difficulties were to be expected.

Appendix 1

Terms of Reference

Terminos de Referencia para una evaluación final del proyecto “Sustainable Use of Groundwater Resources” (SUWaR) – Nicaragua

1 Antecedentes

Objetivos del proyecto

El objetivo principal del proyecto SUWaR es el poder desarrollar métodos de protección y manejo sostenible de recursos hídricos. El proyecto está percibido como un proyecto metodológico piloto, y por lo tanto se destaca la importancia de desarrollar métodos de protección de agua que se puede aplicar en otros acuíferos. Como area piloto se ha elegido el acuífero de Managua.

En una primera fase del proyecto (1992–96) se desarrolló una estrategia general de protección y una propuesta de plan para la sub-cuenca oriental del acuífero de Managua.

La actual evaluación solo contempla la segunda fase (1997–1999), la cual tiene los siguientes objetivos:

Mejorar la protección del agua subterránea a través de:

- El desarrollo de métodos para la elaboración de planes de protección de agua subterránea
- Iniciar la implementación del plan de protección para el acuífero de Managua
- La sensibilización sobre el problema de contaminación del agua subterránea
- Capacitar a profesionales de las instituciones participantes en la ejecución de planes de protección

En resumen, el proyecto toma en cuenta todos los aspectos de la línea de protección de agua, que va desde la concientización del problema hasta generar métodos para prevenir la contaminación.

Ejecutores del proyecto

El proyecto se desarrolla en estrecha colaboración entre KTHy LiU como contrapartes suecas, y MARENA, INAA y UNI como contrapartes nicaragüenses. Debido a un cambio en la administración pública en Nicaragua en el año 1999, INAA es reemplazado por ENACAL, en calidad de contraparte del proyecto.

Duración

El proyecto (segunda fase) comienza en Julio 1997 y debe, según el contrato con KTH, terminar sus actividades en Diciembre 1999. Acordandose en Noviembre 1999 prorrogar este contrato hasta Diciembre 2000, teniendo como motivo el poder realizar algunas actividades en los tres primeros meses del año, entre ellos un seminario final, y ejecutar una evaluación y un seguimiento de los seis meses posteriores a la finalización de las actividades.

2 Objetivos de la evaluación

El objetivo principal de la evaluación es que sirva como un aporte al proceso de aprendizaje. El resultado de la evaluación debe servir para generar los ajustes necesarios a los métodos técnicos y administrativos de protección de agua, como también en la forma de trabajar en el proceso de sensibilización de la sociedad en general y con grupos claves en particular.

El carácter metodológico del proyecto piloto hace particularmente importante el evaluar hasta qué punto las experiencias desarrolladas son aplicables en otros acuíferos de Nicaragua, como también en otros países de la región y del mundo.

No hay planes de seguir apoyando la protección del agua en el acuífero de Managua, por parte de Asdi.

El objetivo del proyecto ha sido dotar a las instituciones nicaragüenses participantes de herramientas que le permitan continuar con el trabajo permanente de protección de aguas subterráneas, por tal razón es de interés el evaluar la sostenibilidad a través de una visita de seguimiento por parte de un evaluador externo, con posterioridad a la finalización del proyecto.

Las observaciones y recomendaciones de la evaluación participativa serán usadas por las partes nicaragüenses (MARENA, UNI, ENACAL) en su futuro trabajo y para la divulgación del método. También servirá a las partes suecas (KTH y LiU) y a Asdi en futuros proyectos de protección de agua.

3 Asignación (asuntos que deben ser cubiertos por la evaluación)

Relevancia

Es adecuada la intervención en relación a los objetivos generales desarrollados en los programas de acción de Asdi:

- Reducción de la pobreza
- Paz, democracia y derechos humanos
- Desarrollo ambientalmente sostenible
- Equidad de género

Cumplimientos de los objetivos

Se evaluará hasta qué punto se han cumplido con las actividades planificadas y con las metas propuestas en el proyecto.

Impacto en los grupos destinatarios

Se debe hacer un análisis de causas y efectos y describir los impactos intencionales y no intencionales de las actividades desarrolladas. ¿Cuáles son los efectos inmediatos y a largo plazo? Aquí se debe tomar en cuenta diferentes grupos de interés y a la vez si el impacto está relacionado con el género o influye en la equidad de género.

Eficiencia económica

Se debe evaluar el impacto en relación a los costos del proyecto. ¿Habría sido posible de alcanzar el mismo impacto con menos recursos?

Sostenibilidad de resultados

La sostenibilidad de los resultados se evaluará principalmente en el informe de seguimiento.

Resultados en relación a los programas de acción

Un requisito de todas las evaluaciones realizadas a pedido de Asdi, es de evaluar el impacto y los resultados en relación a los cuatro programas de acción de Asdi, arriba mencionados.

4 Metodología, grupo de evaluación, plan de trabajo

Metodología

La evaluación se hará con un método participativo. Las partes nicaragüenses nombrarán representantes a un grupo de evaluación entre las personas que están participando en la ejecución del proyecto. Cada institución nombrará a una persona. Un evaluador externo contratado por Asdi funcionará como jefe de equipo (“team leader”). Un borrador de informe final del proyecto será base para la evaluación. El grupo de evaluación se hará cargo de la planificación de la visita evaluativa.

KTH hará una introducción sobre los antecedentes del proyecto y proporcionará al evaluador los documentos necesarios, entre otros los informes y manuales producidos dentro del proyecto. Asdi se hará responsable de orientar al evaluador de los criterios generales de desarrollo de Asdi y de la política de evaluaciones (Sida’s Evaluation Policy).

El evaluador hará una primera visita de aproximadamente dos semanas a Nicaragua en mayo 2000. Con el fin de tener una sobrevista del alcance y impacto del proyecto, la evaluación comenzará con su participación en el seminario final de proyecto, cuyo objetivo es de divulgar y promover los resultados del proyecto a un grupo invitados del país y de la región centroamericana. Luego el evaluador recorrerá la zona del proyecto junto con el grupo de evaluación, realizando entrevistas con personal clave en MARENA, ENACAL y UNI, y con otros grupos y personas claves de la sociedad civil. Antes de salir del país presentará sus conclusiones preliminares en una reunión con los tres contrapartes nicaragüenses.

Aptitudes del evaluador externo

El evaluador debe tener conocimientos suficientes para evaluar la importancia y eficiencia de los métodos desarrollados, tanto sobre la problemática de riesgos de contaminación de aguas subterráneas como de metodologías para involucrar portadores de interés al proceso de manejo y protección. También debe tener experiencia de ordenamiento territorial y ejecución de planes de protección de aguas subterráneas. Otros criterios importantes son experiencia de proyectos de desarrollo y el buen dominio del español como idioma de trabajo.

Plan de trabajo de evaluador externo

Preparación	2 días antes del viaje a Nicaragua
Visita de campo	2 semanas en mayo 2000, empezando con el seminario final del proyecto
Preparación de informe	1 semana
Visita de seguimiento	1 semana en septiembre 2000
Preparación de informe	3 días

5 Informes

Informe de evaluación

El informe de evaluación debe ser escrito en inglés y traducido en español, con un resumen. En su totalidad no debe exceder de 40 páginas excluyendo anexos. El formato y la disposición debe seguir lo indicado en Sida Evaluation Report – a Standardized Format (vease Anexo 1). Tres copias borrador de informe deben ser enviados a Asdi a más tardar el 31 de Mayo 2000 en inglés de Abril de 2000. A las tres semanas de haber recibido los comentarios sobre el borrador por parte de Asdi, un informe definitivo será enviado a Asdi en cinco copias y en diskette.

Asdi se guarda el derecho de publicar y distribuir el informe dentro de la serie de Informes de Evaluaciones (Sida Evaluations). El informe debe ser escrito en Word 6.0 para Windows (o en su defecto en un formato compatible) y presentado en una forma que permite publicación sin posterior diagramación.

La asignación de la evaluación incluye la producción de un resumen para el “Newsletter” según lo indicado en Sida Evaluations Newsletter – Guidelines for Evaluation Managers and Consultants (vease Anexo 2) igual a completar el formulario Sida Evaluations Data Work Sheet (vease Anexo 3). El resumen por separado y el formulario completado será enviado junto al borrador de informe.

Informe de seguimiento

Aparte del informe evaluativo la asignación también incluye un informe de seguimiento de aproximadamente 20 páginas excluyendo anexos. Tres copias del borrador del informe de seguimiento deben ser enviados a Asdi a más tardar tres semanas después de la visita de seguimiento teniendo como fecha límite el 30 de Octubre de 2000.

A las tres semanas después de haber recibido los comentarios sobre el borrador de Asdi, un informe definitivo será enviado a Asdi en cinco copias y en un diskette (en Word 6.0 para Windows).

El evaluador debe ser disponible para participar en un seminario en Asdi después de haber terminado la evaluación y el seguimiento.

Appendix 2

Evaluation Programme

Programa de trabajo de la Misión evaluadora encabezada por el Dr. Ingvar Ahman, Evaluador del Proyecto SUWaR por parte de Asdi

Jueves 4 de mayo

10 a 12 pm Reunión con la Gerencia del Proyecto.

Ing. Arcadio Choza L	MARENA
Ing. Sergio Gámez G	UNI
Lic. Aida Narvaez	ENACAL
Ing. Thomas Alveteg	KTH
Ing. Benedicto Valdéz	ENACAL

12 a 1.30 pm Almuerzo con la Gerencia

2 a 4 pm Presentación de los resultados del Proyecto por la Gerencia (MARENA)

4 a 5 pm Dr. Ingvar Ahman se reúne con integrante de la Misión evaluadora (Ing. Socorro Sotelo, Lic. Sagrario Espinal y Lic. Aida Narvaez).

Viernes 5

8 a 9 am Dr. Ingvar Ahman se reúne con personas claves de la Unidad Ambiental de INAA

10 a 12.30 pm Dr. Ingvar Ahman se reúne con personalidades de ENACAL

12.30 a 1.30 pm Dr. Ingvar Ahman se reúne con equipo técnico ejecutor del proyecto (lugar UNI)

Lunes 8

8 a 5 pm Gira de Campo a pozos de las Mercedes, visita Laguna de Masaya, visita volcán de Masaya

Martes 9

9 a 12 pm Entrevista con Ministro de MARENA y Directores General y Específicos

Ing. Roberto Stadhagen	Ministro
Ing. Leonel Wheelock	Director General Calidad Ambiental
Lic. Hilda Espinoza	Directora de Procesos Ambientales
Lic. Helio Zamora	Director de Seguimiento y Control
Ing. Norvin Sepúlveda	Asesor y Enlace técnico Corredor Mesoamericano

1 a 1.30 Almuerzo

2 a 5 pm Entrevistas con Rector y personalidades UNI

Miércoles 10

8 a 5 pm Misión Evaluadora se reúne con Alcaldía de Nindirí, Alcaldía de Ticuantepe y con Ing. Sergio Vado (Urbanizador en Masaya).

Jueves 11

8 a 5 pm Misión Evaluadora se reúne con Asociación de Piñeros de Ticuantepe, ONG CESADE y dos Colegios del Area del Proyecto.

Viernes 12

8 a 5 pm Misión Evaluadora se reúne con Ing. Luis Palacios Director de Hidrología de INETER y Ing. Carlos Laínez G, Consultor privado. Municipalidad de Mnagua con Dra. Alina Sálomon Santos.

Sabado 13

8 a 13 visita Asososca – Refinería

Lunes 15

8 a 5 pm Misión evaluadora prepara informe (lugar UNI)

Martes 16

8 a 12 pm Misión evaluadora prepara informe (lugar UNI)

13 a 5 pm Misión Evaluadora se reúne con Gerencia del Proyecó para presentar los resultados preliminares de la evaluación.

Appendix 3

Examples from the Directives

Matriz de regulaciones para fuentes existentes y futuras en el acuífero de Managua

ACTIVIDAD A REGULAR	ZONE DE ALTA SENSIBILIDAD NATURAL	ZONA DE MODERADA SENSIBILIDAD NATURAL
ACTIVIDAD AGRICOLA Problematicas Relevantes Bodegas de almacenamiento de agroquímicos sin las condiciones de seguridad necesarias Aplicación de grandes cantidades de agroquímicos Disposición de envases vacíos de agroquímicos	Actividades sujetas a prohibición: 1. El establecimiento de Monocultivos que implique la aplicación de grandes cantidades de agroquímicos en extensas áreas 2. El establecimiento de cultivos cuyo manejo requiera de la aplicación de agroquímicos móviles y de lenta degradación o que necesite de fuertes cantidades de aplicación para ejercer su efecto 3. Disposición de cualquier tipo de residuos vencidos en el suelo y subsuelo	4. Disposición de envases vacíos en zonas donde el nivel freático es menor de 30 mts Actividades sujetas a prohibición
	1. La disposición de residuos vencidos de sustancias de alta movilidad y lenta degradación Actividades sujetas a certificación 1. Bodegas de almacenamiento de agroquímicos que cumplan con suficientes condiciones de seguridad y con las restricciones que para esta zona apliquen	2. Rellenos de seguridad establecidos para la disposición de envases vacíos Actividades sujetas a certificación
	1. Rellenos de seguridad establecidos para la disposición de envases vacíos Actividades sujetas a notificación 2. Inventrios actualizados de las bodegas de almacenamiento de agroquímicos cada (determinar frecuencia)	3. Disposición de envases vacíos de agroquímicos Actividades sujetas a notificación 1. Inventrios actualizados de las bodegas de almacenamiento de agroquímicos cada (determinar frecuencia) 2. La aplicación de determinados agroquímicos (Especificar
	cuales son) en grandes cantidades (Especificar cuanta cantidad) Actividades sujetas a monitoreo 1. Estado de las instalaciones y condiciones de seguridad de las bodegas de	almacenamiento de agroquímicos cada (Determinar frecuencia) Actividades sujetas a monitoreo Estado de las instalaciones y condiciones de seguridad de las bodegas de almacenamiento de agroquímicos cada (Determinar frecuencia)

Appendix 4

Capacitacion 91–95

CURSO/TALLER	ORGANIZADO	ANO	PARTICIPANT	PAIS
PLANIF.MANEJO DE QUENCAS	SUWAR-MARENA-UNI	JUN-91	INTERINSTITUCIONAL	NIC
XXIII-CONG.INT S-AGUAS SUBTERR.	AIH	ABR-91	ALVETEG CHOSZA	ESPANA
I-SIMPOSIO S-PROT. DE LOS RR.HH.	SUWAR-MARENA-COMITE-I NTER	SEP-92	INTERINSTITUCIONAL	NIC
INTER-RELAC AGUAS SUBT-AGRIGUL	ALHSUD	OCT-92	CHOZA-SOTELO	VENEZ
APLICACION MOD-HEIC-1-HEIC2	UNI	OCT-92	MARTENEZ-SOTELO	NIC
TALLER EML	SUWAR-MARENA	FEB-93	EQUIPO SUWAR	NIC
FOT-INTERP IMAG.SATEL P-MON AMB	SUWAR-MARENA-UNA	ABR-93	ROJAS-CRUZ-DELGADO	NIC
TALLER S-DRP (MIC C)	SUWAR-MARENA-PASOLAC	JUN-93	INTERINSTITUCIONAL	NIC
TALLER SIG	CATIE	JUL-93	ROJAS-MARTINEZ	COSTA RICA
TALLER S-CONTAM AGUAS SUBT		JUL-93	CRUZ-SOTELO	COSTA RICA
SIMP.DE ESTOCK.S-EL AGUA		AGO-93	CHOZA-SAIREG	SUECIA
IDENT.Y CARACT.DE CONT.DE A.SUBT.	SUWAR-MARENA-UNI	NOV-93	INTERINSTITUCIONAL	NIC
SIG (IDRISI)	SUWAR-MARENA-UNA	MAY-94	INTERINSTITUCIONAL	NIC
TALLER ASESORIA(INGE BECK)	SUWAR-MARENA	JUN-94	EQUIPO SUWAR	NIC
TALLER CAPACITACION-PR.INDUSTUS	SUWAR-MARENA	AGO-94	EQUIPO SUWAR	NIC
CONTROL DE LA CONT. DE A. SUBT.	OPS-CEPIS-BGS	OCT-94	ALVET.- MARTIN.- ROJAS	DOMINIC.
TALLER GEOL. DE LA C. SUR	SUWAR-MARENA		EQUIPO SUWAR	NIC

Appendix 5

List of Abbreviations

ALMA	Alcadía de Managua/Municipality of Managua
Asdi/Sida	Autoridad Sueca para el Desarrollo Internacional/Swedish International Development Co-operation Agency
CCAD	Comisión Centroamerica de Ambiente y Desarrollo/Central American Commission for Environment and Development
CNRH	Comisión Nacional de Recursos Hídricos/National Commission for Water Resources
DGA	Dirección Nacional de Ambiente y los Recursos Hídricos/Directorate for Envionment and Water Resources (at MARENA)
DGMA	Dirección Centroamericana del Medio Ambiente/Cenral American Directorate for Environment
ENACAL	Empresa Nicaragüense de Acueductos y Alcantarillados/Nicaraguan Water Works Company
GIS	Geographical Information System/Sistema de Información Geográfica
INAA	Instituto Nicaragüense de Acueductos y Alcantarillados/Nicaraguan Institute af Aqueducts and Sewage Systems
INETER	Instituto Nicaragüense de Estudios Territoriales/Nicaraguan Institute of Territorial Studies
JICA	Japanese International Cooperation Agency/Agencia Japonesa de Cooperación Internacional
KTH	Kungliga Tekniska Högskolan/Royal Institute of Technology, Stockholm/Real Universidad Politécnica de Estocolmo
LIDECONIC	Liga de Consumidores de Nicaragua/Nicaraguan Consumers Association
LiU	Linköpings Universitet/University of Linköping, Sweden/Universidad de Linköping, Suecia
MARENA	Ministerio del Ambiente y los Recursos Naturales/Ministry of Natural Resources and Environment
MIFIC	Ministerio Fomento de Industria y Comercio/Ministry of Industrial and Commercial Development
MIFIN	Ministerio de Finanzas/Ministry of Finances
MINSA	Ministerio de Salud/Ministry of Health
OPS	Organización Panamericana de Salud/Panamerican Health Organisation

PIDMA	Programa de Investigación y Docencia en Medio Ambiente/
SUWaR	Sustainable Use of groundWater Resources/Usó Sostenible de los Recursos Hídricos
UCA	Universidad Centroamericana/Central American University
UNA	Universidad Nacional Agraria/National Agrarian University
UNAN	Universidad Nacional Autónoma de Nicaragua
UNI	Universidad Nacional de Ingeniería/National Engineering University
WHO	World Health Organisation/Organización Mundial de la Salud

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SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

S-105 25 Stockholm, Sweden

Tel: +46 (0)8-698 50 00. Fax: +46 (0)8-20 88 64

Telegram: sida stockholm. Postgiro: 1 56 34-9

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