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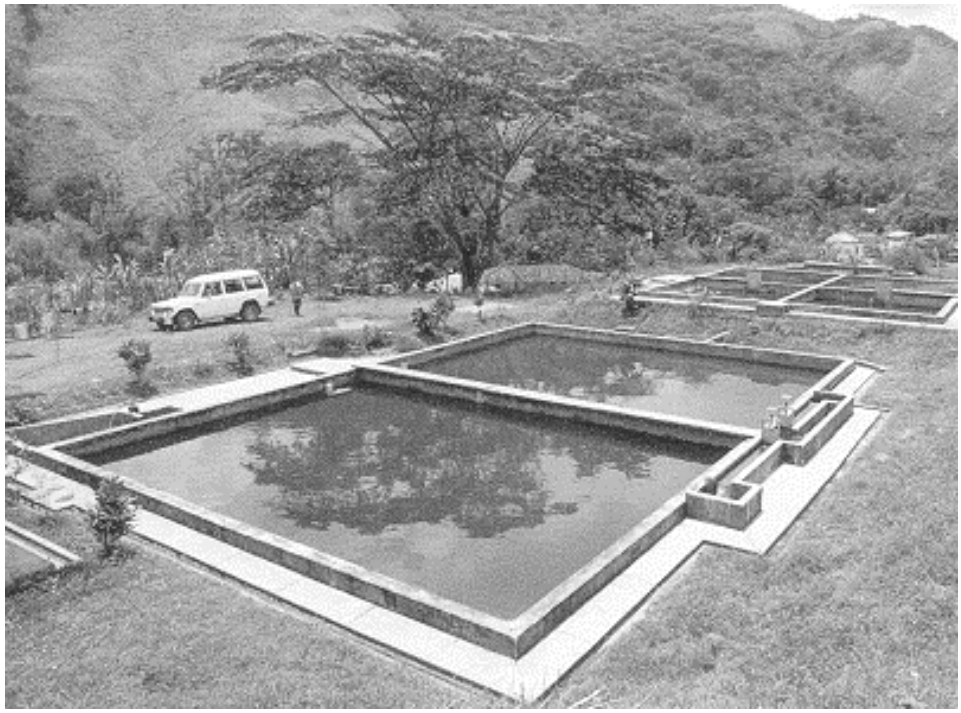
Technology Transfer in the Water Supply and Sanitation Sector: A Learning Experience from Colombia



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CINARA, is an Institute of Valle University involved in research, development and transfer of technologies and methodologies in the Water and Sanitation Sector. Its' focus is rural areas, small and medium size municipalities and low-income urban areas, facing important problems in the provision of good quality, efficient and environmental friendly water supply and sanitation services.

The staff of CINARA includes professionals with a technical, socio-economic and administrative background, who can draw on external advisors in specialised areas and work as an interdisciplinary team complementing each others knowledge and experience. This team fulfils a function of process facilitator and initiator, working closely with Sector institutions and communities to improve the sanitary conditions and the protection and conservation of the water resources, being a crucial element to better the quality of life of the communities.

CINARA interacts and receives support from a network of partner organizations national and international level based in countries such as the Netherlands, Great Britain, Switzerland and Brazil. which has enabled them to expand their support to a large number of regions in Colombia and to other countries including Bolivia, Ecuador, Guatemala and Pakistan, keeping the main premises that development is centred in people making communities the protectors and initiators of their own development.

IRC International Water and Sanitation Centre

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IRC supports capacity development and information development and exchange in water supply, sanitation and related environmental issues. Areas in which IRC's work is concentrated at present include: community financing; community management; community participation; gender issues; health and hygiene; information and communication; monitoring and evaluation; operation and maintenance; rural water supply; sanitation; social mobilization; urban water supply; water resources management; and water treatment.

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Cover photo: Multi-Stage Filtration System in Salonica, Colombia
and figures number 1, 5, 9 and 12 by Manuel Barona

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Abstract

Changing from technology transfer to technology sharing is essential to enhance the sustainability of interventions in the water and sanitation sector. This publication presents consolidated experiences from a technology transfer programme implemented in Colombia between 1989-1996. This programme introduced multi-stage filtration, an environmentally friendly water treatment technology, in eight different regions. A human-centred approach has been taken in this programme, which adopts joint learning projects for capacity building at institutional and community level. This approach is in line with current theory, and has a great potential to overcome some of the main problems in the sector. It breaks with the traditional top-down method of technology transfer and recognizes that technologies are embedded in the society were they were developed. In order to be sustainable, technology sharing is needed to ensure that the technology matches the new setting. The publication illustrates that a holistic joint learning project approach, as used over the past several years in Colombia, serves to develop this match and strongly supports capacity building in the sector. The publication comprises four main themes: a description of the programme and its results, a review of key issues in sustainable sector interventions, a discussion of theory and practice in technology transfer and an elaboration of the learning project approach.

Keywords: capacity building, decentralization, evaluation, multi-stage filtration, indicators, institutional development, learning concepts, sustainability, technology transfer.

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List of Acronyms and Abbreviations

CINARA	Instituto de Investigación y Desarrollo en Agua Potable, Saneamiento Básico y Conservación del Recurso Hídrico de la Universidad del Valle
CONPES	Consejo Nacional de Política Económica y Social
COP	Colombian peso
DNP	Departamento Nacional de Planeación
EMCALI	Empresas Públicas Municipales de la Ciudad de Cali
ESA	External Support Agency
FINDETER	Financiera de Desarrollo Territorial
FCU	Faecal Coliform Unit
IHE	International Institute for Infrastructural, Hydraulic and Environmental Engineering
IRC	IRC International Water and Sanitation Centre
IRWG	Inter-Institutional Regional Working Groups
INS	Instituto Nacional de Salud
JLP	Joint Learning Project
lps	Litres per Second
l/c/d	Litres per capita per day
MSF	Multi-Stage Filtration
NTU	Nephelometric Turbidity Unit
OECD/DAC	Organization for Economic Cooperation and Development Development Assistance Committee
NGO	Non Governmental Organization
O&M	Operation and Maintenance
REPIDISCA	Pan American Information Network on Environmental Health
SENA	Servicio Nacional de Aprendizaje
SSF	slow sand filtration
TRANSCOL	Technology Transfer Programme in Colombia
USD	United States Dollar
WHO	World Health Organization
WSS	Water Supply and Sanitation

Preface

This document has been developed in the context of the Technology Transfer Programme in Water Supply Treatment in Colombia (TRANSCOL), which was implemented between 1989 and 1996. This Programme set out to introduce water treatment by a combination of Gravel Filtration and Slow Sand Filtration, now known as Multi-Stage Filtration (MSF), to eight regions in Colombia. It was coordinated by the Instituto de Investigación y Desarrollo en Agua Potable, Saneamiento Básico y Conservación del Recurso Hídrico CINARA of Valle University, Cali, Colombia and the IRC International Water and Sanitation Centre, The Hague, The Netherlands. Support was received from the Department for Development Cooperation of the Government of the Netherlands and the Ministry of Economic Development, the Ministry of Health and the National Planning Department of the Government of Colombia. Support was also provided by the regional and local governments of the communities where the Programme was implemented.

TRANSCOL was implemented by a large multi-disciplinary team comprising social scientists, engineers, economists and architects working for CINARA and IRC. Staff from institutions in the Programme regions and community members also had their share in the work. Additionally, a group of advisors provided important support. To one of them Engineer Antonio Castilla one of the founders of CINARA, we would like to dedicate this publication. To our great regret he passed away in late 1996.

This document presents the experience generated in the TRANSCOL Programme. It is oriented towards professionals and managers involved in the water supply and sanitation (WSS) sector. It has been developed by different groups of authors, who discuss the Programme and three main themes that emerged from it, These themes are:

- an approach to search for sustainable solutions
- a model for technology sharing, and,
- learning projects for capacity building at institutional and community level.

Different combinations of authors, who all worked in the project, wrote the chapters. Jan Teun Visscher carried out the overall compilation and editing of the document.

This document exists thanks to the many people that contributed to the TRANSCOL Programme, in particular the members of the regional working groups, the local leaders and the participating communities. Although experience with the emerging themes is still very new, the approach meets with very enthusiastic reactions from the team members and the communities involved. Also, the water treatment systems are operating and the approach is being replicated in other projects and regions. It is therefore important to share this experience with sector professionals in other parts of the world as it may contribute to improving the living conditions, particularly the water and sanitation services, for the many millions who do not have access to potable water supply and adequate sanitation.

1. Introduction

J.T. Visscher

This publication presents consolidated experiences from the TRANSCOL Programme and presents lessons learned that can contribute to improving the situation in the WSS sector. Three important themes of relevance to sector development are discussed:

1. the search for sustainable solutions
2. the change from technology transfer to technology development and technology sharing
3. joint-learning projects for capacity building at institutional and community level.

It includes a description of the process and findings of the Programme and experience with the three themes obtained in projects that CINARA and IRC have been involved in, in Latin America. By documenting this experience and reflecting on it, the authors of the different sections hope to contribute to the discussion concerning new concepts and perspectives for more sustainable WSS interventions. This first chapter presents an overview of some of the problems and the thinking in the sector. It also provides the context for the following chapters and summarizes their main points. It concludes with the perspectives for further development, emphasizing the learning project approach that is emerging from the experience.

1.1 The sector situation

Adequate WSS facilities are essential for the health and well-being of mankind. In the International Water and Sanitation Decade (1981-1990) over 1,350 million people received new water supply facilities and 750 million received better sanitation services, at a cost of USD 9 to 10 billion per year (World Bank, 1990, cited in Alaerts et al., 1996). Despite these huge efforts, the sector still faces enormous problems because at least another 1,600 million people are in need of good water supply and some 2,600 million in need of adequate sanitation services (Najlis, 1996). The poorer sections of the community are suffering most. They are forced to make huge efforts to satisfy their daily water needs, collecting it from long distances (a task usually left to women and children). Many households also purchase water at considerable cost from local water vendors. Often this water involves a high sanitary risk, being contaminated during collection or transport, or because of insufficient protection of the water source.

While coverage figures have increased over the past years, it is false to conclude that we are on the right track. Many installed systems provide neither the continuity nor the water quantity or quality that is needed. This is partly because the organizations responsible for providing the service do not manage to cover even the cost of operation and maintenance. This leads to inadequate functioning and eventually to abandoning of systems, representing a considerable loss of investments.

A participatory evaluation of 40 water supply systems in Ecuador, carried out in 1996, showed that, in 55 percent of the villages, the community complained about frequent interruptions of the service and the low quantity of water they received (Visscher et al., 1996). The study also showed that all systems were producing water with

a medium or high sanitary risk. In Colombia, most communities below 12,000 population, representing some 90 percent of the municipalities in the country, receive water for only six hours per day (ACODAL, 1995). In 50 percent of these systems, partial treatment is provided and only in 4 percent does the water receive full treatment (DNP, 1995). In Bolivia, over 90 percent of the community water supply systems provide water that is relatively high in sanitary risk (PRORPAAL, 1995), and in Peru, Lloyd and Helmer (1991) report that, in their review of water supply systems in rural areas, not a single one met the WHO water quality standards. This entails a high risk of transmission of waterborne disease, as these systems supply water through taps in the homes, giving the false impression that the water is safe to drink.

These problems are often associated with deficiencies in the institutions responsible for policy development, service regulation and water surveillance and control, in addition to the limited management capacities of the organizations responsible for operating the systems. But perhaps even more important is that the focus on construction and coverage still dominates the sector, placing too little emphasis on sustainable functioning and effective use of the systems.

1.2 A change in perspective

It is clear that the problem of ensuring that everyone has access to sustainable water supply and sanitary facilities is huge, and that no real solution will be found without a considerable increase in the rate of progress, an infusion of funding and, above all, a change in perspective (Najlis, 1996). We have to learn from the past and not continue to do things as usual. Participants in the 1990 Conference in Puerto Rico reviewed the achievements of the Water Decade in Latin America and the Caribbean and concluded, for example, that it was necessary to:

- develop sustainable projects with more emphasis on water quality
- adapt the sector institutions and structures to facilitate a more efficient and effective handling of water and sanitation problems
- establish policies for integrated water resources management, which contemplate the protection, conservation, use and re-use of water, adopting the norms of each country
- stimulate research and application of appropriate technologies
- strive for larger community, particularly women's, involvement in problem-solving and project development.

Other organizations have drawn lessons from the Water Decade, clearly indicating the need for change. These lessons call for institutional development, capacity building, and inter-agency coordination and collaboration. Technological innovation will also remain essential for sector development as well as integration of water, sanitation and hygiene programmes (IRC, 1995).

In practice, the emphasis in the sector still appears to be on enhancing coverage through the construction of systems, because of political pressure and because doing things as usual is convenient. This approach generates short term results, but does not consider the negative impact of the resulting failures, and the deception of the communities involved when the investments do not fulfil their purpose. It appears,

however, that several governments and institutions are gradually initiating a process of change in which they adopt a more integrated and demand-responsive approach to problem solving, with adequate water resources management becoming a fundamental issue.

In a comprehensive response to the problems of water resources management as they affect drinking water supply, the Noordwijk Ministerial Conference for Drinking Water and Environmental Sanitation (1994) endorsed key principles to tackle the WSS issues included in United Nations Commission for Environment and Development's (UNCED) Agenda 21. These key principles, enriched with some points from the Organization fro Economic Cooperation and Development/Development Assistance Committee (OECD/DAC) meeting on Water Resources Management (Paris, 1994), are presented in Box 1.

Box 1: Key principles for the water sector

- **Integrated management of water**, taking into account all the implications that water has for health, the environment and social and economic policy, and the interaction between land and water.
- **Involvement of all stakeholders**, reflecting the different needs of men and, in particular, women, and involving all sections of society in resolving the problems that affect them. This can be facilitated by adopting the river basin as the natural boundary for water resources management.
- **Capacity building to develop an enabling institutional environment**, that optimizes the use of available resources, helps to establish responsibility for integrated management of water at the lowest appropriate level and accommodates a demand-driven approach.
- **Dealing with water resources as a social and economic commodity**, in order to ensure efficient allocation and effective use and protection of water.
- **Searching for innovations**, technological and non-technological, to bridge the gap between the physical, human and financial resources and the escalating demand for water and the need for sanitation in the developing world.

(Based on Saunders et al., 1996)

Comparing these principles with the recommendations of the Puerto Rico Conference, we see that progress is being made and so we have to remain alert on new developments. For example, the theme of women's involvement is clearly changing into a gender approach to ensure that influence, benefits and burdens are more equally shared between men, women and children (Wijk-Sijbesma, 1997).

1.3 Meeting the challenge

In this section key aspects of the TRANSCOL Programme and the three themes that emerged are addressed and put in perspective.

1.3.1 The origin and trust of the TRANSCOL Programme

In Colombia, a very interesting process of change was initiated that addressed several of the principles that were developed in the Water Decade. In 1989, the Technology Transfer Programme in Water Supply Treatment, TRANSCOL, started under an agreement between the Colombian and Netherlands governments. At that time, the

political, institutional and scientific settings in Colombia were still rather conventional; however, the first steps towards decentralization were in place, transferring political and administrative responsibilities particularly to the municipal level.

TRANSCOL was developed to transfer knowledge and experience concerning Multi-Stage Filtration (MSF), a water treatment technology that does not require chemicals (Figure 1). This project clearly responded to the call for water quality improvement in Latin America as raised, for example, in the Puerto Rico Conference. This call seems valid even though Esrey (1990), for example, indicates that the impact on diarrhoea mortality reduction is higher for interventions in hygiene and sanitation than for water quality improvement. He finds that the best results are obtained for programmes that combine water, sanitation and hygiene in their interventions. His conclusion is based on data from different parts of the world, including water supply systems such as handpumps with a high risk of recontamination between collection and use. However, in piped water supply systems with house or yard connections, as found in large numbers in many Latin American countries, a considerable impact may be expected from water quality improvements. These interventions are also attractive because basic water treatment often represents a limited part of the total system cost. Recent outbreaks of waterborne disease that occurred, for example, in the United States and United Kingdom, are a reminder that microbial pathogens continue to threaten water users also in industrialized countries if adequate water treatment is not provided (Craun et al., 1994).

Figure 1: Multi-Stage Filtration plant in los Chancos, Valle de Cauca, Colombia

TRANSCOL was established as an ambitious project, but soon became a Programme because the Colombian and Netherlands government allowed a lot of flexibility, provided activities remained within the agreed financial contribution from the Netherlands government. This 'freedom' made it possible to go beyond the initial objectives and follow a programmatic approach, which is essential for development projects. This approach makes it possible to respond to changing circumstances jointly with all Programme partners. This has been crucial for the positive results of the Programme in dealing with innovative concepts in the rapidly changing water and sanitation sector in Colombia. It was possible even to accommodate the considerable delays that several communities faced in funding of system improvements. It was also possible to develop and test methodologies and tools for technology transfer and to contribute to capacity building at institutional and community level.

In the end, the Programme carried on for seven years, attracted a much larger national, regional and local contribution, and was able to record the following achievements:

- It established a place for MSF technology in Colombia and Latin America.
- It promoted and developed a base for consolidating and replicating the MSF technology and technology transfer methodology in CINARA and IRC and at the institutional and community levels in the regions in which the Programme was implemented.
- It developed and promoted a new approach to technology transfer and capacity building that placed emphasis on the human element. The approach stimulates the political, managerial, technical and community levels to jointly search for ways of overcoming the limitations that prevent sector interventions from fully achieving their objectives in a sustainable way.
- It strengthened CINARA and developed it into a resource centre for the water and sanitation sector. This development responds very well to the Colombian policy of enhancing the capacity of universities to support the productive sector in the country and to comply with their social mission to assist in the development of society.

1.3.2 Towards more sustainable sector interventions

TRANSCOL provided an important opportunity for CINARA and IRC to explore the concept of sustainability and to develop a theoretical framework that is helpful for the analysis of existing systems and the development of new ones. In this framework, three dimensions are distinguished within an existing institutional setting: the environment, the community and the technology. This is addressed in Chapter 3. The picture that is emerging is that sustainability is best seen as a process in which the existing levels of development are enhanced by external or internal interventions. When the intervention stops, the process continues and is sustainable if the development level is maintained or increased.

Sustainability needs to be addressed at the very start of a project, in order to ensure that interventions will result in adequate WSS facilities that are functioning and are efficiently used. Actors involved including communities and agencies contribute to sustainability and need to be taken into account in integrated planning. Seven main themes for WSS service provision are distinguished in Chapter 3:

1. coverage
2. supply quantity
3. continuity of service
4. water quality
5. cost
6. management capacity
7. water culture.

For each of these themes practical indicators are presented that can be used to review existing schemes. They can also be used to agree with the community on the requirements of a new system, and facilitate the performance measurement of new projects.

The ideas concerning sustainability gradually emerged in the Programme. Initially, the focus was very much on water treatment, but gradually it was found that a broader approach was needed. The review of the sustainability of the systems reflects this, as it shows that the treatment plants are performing well but that overall system performance can be improved. Thus a new programme would start with a systematic review of the situation using the seven themes as a framework for analysis. This would very much help to clarify the problems and solutions with the different actors or stakeholders involved and better enhance the sustainability of sector interventions.

1.3.3 From technology transfer to technology sharing

Chapter 4 clearly shows that technology transfer is not a linear process, but much more a process of sharing experience and information. The essence is that agencies and communities jointly find a good match between the technology and the environment in which it has to function. However, this view does not yet seem to be generally shared in the sector; technology still seems to be seen more as the technique, the hardware, that is needed to solve a specific problem - a problem often perceived only by the external intervention agents, and not necessarily by the end users.

Experience shows that technology transfer is best done in a systematic way by adopting a systems approach, dealing with technology in the broader context in which it has to function and the achievements it has to bring about. The key components of the approach that emerge from the experience in the TRANSCOL Programme comprise:

- a leading organization
- a platform for decision making
- a participatory analysis of the identified problems in their broader context together with communities and institutions
- joint identification, and if needed, testing of solutions through applied research
- participatory evaluation and focused information exchange.

It may be concluded from the TRANSCOL experience that improving understanding of, and the methods by which, technology is transferred in the sector will contribute to the sustainability of sector interventions and help to make them more effective. Adopting the concept of technology sharing facilitates the process of matching the technology and the environment in which it has to function.

1.3.4 Developing a learning approach

Chapter 5 presents an approach to capacity building, the issue that is being recognized more and more as crucial to sector improvement and more sustainable interventions. Joint learning projects, a concept applied and further developed in TRANSCOL and other projects implemented by CINARA and IRC, show positive results in building the capacities of participants in the process. The creation of joint learning opportunities enable the participants to validate and adapt technologies and methodologies, training tools and working strategies to local conditions and to come to grips with them in a creative way. These 'learning spaces' or projects can both serve as demonstration projects and for establishing human capacity in the institutions and the communities. They help partners to build self-esteem and find their own ways in problem solving and communication. The results are promising because partners in these projects now are multiplying the approach and have adopted new views, particularly concerning the importance of local experience, conditions, customs and culture.

The experience obtained can be very helpful for countries that emphasize decentralization of tasks and responsibilities in the sector. Decentralization may indeed lead to improvements in the efficiency, effectiveness and sustainability of sector interventions, provided we learn to join forces between sector institutions, local government, users and users' organizations. Joint learning projects, as established in TRANSCOL, open up the space to explore how this can be done. They help agencies and communities to agree together on a course of action and to take decisions in a horizontal and transparent way. They also facilitate leadership development at different levels and the strengthening of institutional and individual capacities that help to improve the planning and management of the sector. It is not only the space to learn and experiment that makes the difference. It is the way in which capacity building is organized.

The chapter strongly underscores the importance of changing the paradigm centred on the technology and of adopting a paradigm centred on people, using dialogue and experience as the basis for learning. This clearly changes the concept of the external advisor knowing it all, to a process where all the actors together take development in hand. It is also stressed that problems need to be viewed in a systemic way, questioning them in a broader context with inter-disciplinary teams.

A special feature of the working methodology is the emphasis on the use of artistic and creative techniques, to enhance the perception and sensitivity of the actors involved, thus providing a basis for change of behaviour. It is clearly not enough to train people or provide information; people need to become sensitive and willing to do things better. Enhancing their creativity greatly contributes to creating an environment in which change can take place.

1.4 Perspectives

Although the concepts of MSF technology and learning projects are still very new, both seem very promising as they receive a very positive response from the sector. The learning projects for transferring MSF technology in TRANSCOL provided the opportunity for the communities and the agencies to jointly identify problems and experiment with solutions. The potential of MSF treatment was established, and now sector professionals are available to carry this technology further in Colombia, the Andean region and even beyond, as CINARA and IRC supported activities with the

Agha Khan Foundation on MSF technology in Pakistan and CINARA and the Centre for Health and Engineering supported activities in Nepal.

What is even more promising is the joint learning project approach that was established. This goes well beyond the issue of transferring MSF technology. It gradually moves towards a strategy that can successfully match human resources development with institutional development by creating an environment for experimenting with different approaches to solve sector problems in a holistic way. Learning projects bridge the gap between the national, regional and local levels who are involved in WSS projects. In involving the key actors and focusing on different levels of decision making, the projects also contribute to creating an enabling environment for policy development and for the adaptation of the legal framework to better suit workable sector solutions. The projects are particularly suited to tackling complex that require inter-disciplinary and inter-institutional approaches. The approach of holistic learning projects is dynamic and can therefore be enriched with new developments in the sector. These projects form a good way for sector professionals to learn to solve new problems and build new capacities in parallel with regular projects in which staff is involved. The approach needs further development, for example, adopt a better gender approach.

The governments of Bolivia, Colombia and Ecuador are now considering adopting learning projects as one of the mechanisms to improve the effectiveness of sector interventions. This positive feedback is stimulating CINARA and IRC to further develop this promising capacity building and technology transfer strategy, which can help to bring sustainable water supply and sanitation services within reach of a larger part of the population. It can also help to enhance the effectiveness of sector agencies and community based organizations.

In Bolivia and Ecuador participatory evaluations that involved different sector actors and communities have already been implemented with help of the review framework described in Chapter 3. The results of these evaluations clearly show that, although most systems do provide water to the communities, their service level needs to be improved and their sustainability enhanced. Proposals have therefore been developed by staff from the national sector institutions and other actors together with CINARA and IRC. These proposals for national Programmes comprise a combination of jointly reviewing sector problems in detail and jointly identifying, implementing and documenting solutions. In finding solutions for prevailing problems, technology transfer between different countries in the region adopting a learning project approach is also envisaged.

In Colombia a ‘Sustainability Programme’ was jointly established by the National Directorate for Drinking Water and Sanitation of the Ministry of Economic and Social Development (the sector co-ordinating institution), the financing institute FINDETER, the Urban Investment Fund (FIU), and CINARA. This Programme is embedded in the Water Plan, 1995-1998, of the Colombian government. This national plan sets out to modernize the sector, strengthen the national, regional and local levels involved, and orient sector funding with an emphasis on community participation and management. It is developed in the context of the national policy for Sustainability in the Drinking Water Supply and Sanitation Sector. This project involves the national and regional entities of the Ministries of Internal Affairs, Health and Environment, the Superintendency of Public Services, and the Regulating Committee for Drinking Water and Basic Sanitation. In view of the character of the Programme, the Integrated Regional Development Fund

(DRI) and the Caja Agraria, in charge of promotion of activities in communities and rural areas, are also likely to participate.

These programmes will make it possible to take the development of the joint learning project approach a step further. They will create learning opportunities for development actors in the sector including communities, sector institutions, and universities. It will help them to understand, develop and adapt technologies and methodologies adopting an inter-institutional and inter-disciplinary approach.

Each of the programmes that have been developed includes the following five strategic components that have a main impact in the sustainability of water supply and sanitation systems:

1. the active and creative participation of communities and sector institutions in the whole project cycle by working together in a transparent relationship
2. the enhancement of the management of community-based organizations to provide sustainable drinking water and sanitation services, adhering to principles of quality, efficiency and environmental soundness
3. the development of water surveillance and control practices, as an important sector planning and support tool, closely involving the community in these activities
4. the support and strengthening of training programmes for technical and social sector staff, technicians, operators and members of the community to enhance the capacity of the sector
5. the support and strengthening of the scientific and technological capacity of the sector, in such a way that it feeds back into the project cycle as well as into the curricula of sector training institutions.

The intervention horizons of the three programmes are different. In Ecuador and Bolivia the emphasis is on communities between 500 and 5,000 population, whereas in Colombia the focus is on concentrated settlements in rural communities and municipalities and in sections of low-income areas in large cities. The population size of the communities where these interventions are envisaged ranges between 1,000 and 12,500 people.

The Colombian programme will include twenty Joint Learning Projects (JLPs) in ten regional areas of FINDETER that are spread over the country. It will be attempt to include JLPs in different stages of development, to ensure the widest development of experience related to the planning, design, tendering, construction, operation and maintenance and management of systems, placing particular emphasis on community involvement and community management. The choice of the JLPs involves selection criteria that include population size, political will, need for improvement, accessibility, availability of a basic infrastructure in water supply and sanitation and availability of financial resources. Financing may include local resources and external funding such as credit systems.

The Programme is already underway, and the Colombian government has provided the funding for the first phase - a precedent that may induce considerable change in the sector. In Bolivia and Ecuador, external funding is being sought and positive indications are being given, particularly in the case of Bolivia.

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2. Experience and Results of the TRANSCOL Programme

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The TRANSCOL Programme was initiated in 1989 to transfer the knowledge and experience obtained with gravel filtration and slow sand filtration in the Valle del Cauca region to eight other regions in Colombia. In the course of the Programme this technology developed into the concept of Multi-Stage Filtration (MSF). The goal of TRANSCOL was to contribute to the development of methodologies and tools for technology transfer, and to capacity building at institutional and community levels. This chapter presents the context in which the Programme took place and presents its approach and results, as well as its advantages and limitations.

2.1 Background

2.1.1 The water and sanitation sector in Colombia

At the beginning of the 20th century, Colombia had a population of three million and a rural-based economy. Basic water supply and sanitation technology was used, that was often managed by municipalities. By the 1950s, direct intervention by the state in development activities had increased because of political changes. Large investments were made, primarily in urban water supply and sanitation, and new legislation was developed.

The government institute INSFOPAL (Instituto de Fomento Municipal) was created in 1957 to deal with the urban sector, defined as communities with a population of over 2500. Furthermore, the Programme for Basic Sanitation was established in 1962 under the coordination of the Instituto Nacional de Salud (INS) to take care of the smaller communities. The aim of both institutions was to enhance coverage, an ambitious challenge in a time of rapid urbanization and population growth.

In 1986 a process was initiated to abolish these institutions, because the efficiency of their programmes was considered too low and too influenced by political pressures. The results were not sufficient to improve the living conditions of the Colombian population that, by this time, had grown to 27.5 million. The need for action was reinforced by international trends towards a reduction of the role of the central government and the transfer of responsibilities to the local level. The policy of decentralization, was actively pursued, as shown by Law 11 of 1986, which stipulated that national and regional governments could delegate administrative functions related to service delivery and system implementation to the municipalities. This law created the legal framework for community involvement in public services and for the election of governors, mayors and Local Administrative Committees (Juntas Administradoras Locales).

In 1987, the Colombian government formulated a plan to modify the sector (Plan de Ajuste del Sector de Agua Potable y Saneamiento Básico) and passed the responsibility for public services to the municipalities (Law 77 of 1987). An office was established in the Ministry of Works to provide support to these municipalities and develop service standards. The government confirmed the role of the Ministry of Health in water surveillance and control. The plan started to move from focusing solely on coverage to

include an emphasis on water quality improvement in both existing and new systems (DNP, 1991).

Early in the 1990s another institutional change was made by the Colombian government through the National Planning Department. The sector was brought under the Directorate of Water Supply and Basic Sanitation in the Ministry of Economic Development and a Regulating Commission for Water Supply and Basic Sanitation was formed in addition to a Superintendency of Public Services, to ensure the proper implementation of norms, subsidies and tariffs. This is supported by Law 142, established in 1994 to regulate the provision of public services. For the management of international loans, FINDETER was established as an autonomous institution to support the development of the infrastructure in the municipalities. Furthermore, Law 60 of 1993 stipulated that the municipalities had to invest 20 percent of the national resources they received, in water supply and sanitation facilities.

2.1.2 Sector investment and coverage

Between 1975 and 1993, USD 2,795 million was invested in the sector and national coverage figures increased by 25 percent for water supply and 26 percent for sewerage systems (Table 1). Nevertheless, in 1994, 8.7 million Colombians still did not have a good water supply and 13.4 million lacked access to sewerage systems. The situation was worst in rural areas, with only 44 percent of the population having access to piped water supply and 19 percent being connected to sewers (DNP, 1986, 1991 and 1995). These figures do not include non-conventional sanitation options such as latrines, so in fact a larger part of the population had an effective method of excreta disposal but were not included in the national statistics.

Table 1: Sector investment and WSS coverage in Colombia (1975-1993)

Description	1975-1985	1985-1990	1990-1993
Investment (USD million)	1400	990	405
Average Annual Investment (USD million/year)	117	198	135
Increase in coverage in water supply (beginning and end of period)	51% - 57%	57% - 66%	66% - 76%
Average annual increase in water supply in the period	0.5%	1.8%	3.3%
Increase in sewerage coverage (beginning and end of period)	38% - 47%	47% - 51%	51% - 64%
Average annual increase in sewerage coverage in the period	0,75%	0,8%	4.3%

Based on: DNP (1991, 1995)

If water quality is taken into account, coverage figures are lower because only 62 percent of the urban and 10 percent of the rural population was estimated to have access to potable water (Minsalud, 1992).

The investment over the total period equals 0.4 percent of the GNP (Gross National Product), with 55 percent being spent in large cities and 38 percent in medium sized cities. Only 7 percent was invested in smaller communities with a population of less than 12,000, despite their representing approximately 858 of the 1009 municipalities existing in 1990. This low investment in rural areas matches the international trend in the Water Decade, where on average, 80 percent of the sector resources were invested in urban areas (IRC, 1995).

We can conclude that in 1990, at the end of the Water Decade, a critical situation existed in Colombia, with municipalities being charged with the responsibility for the provision of water supply and sanitation services, without training or a support programme to strengthen their technical, administrative and financial capacities (DNP, 1991).

2.1.3 The origin of the TRANSCOL Programme

In 1987, the new mayors, elected by the communities and bound by promises concerning the improvement of water supply and sanitation services, started to expand coverage and to introduce water treatment systems. Often they chose rapid sand filtration and chemical coagulation, complex water treatment technology that can be found in many communities in Colombia and other countries in Latin America. While these technologies may counter the sanitary risk present in the available water sources, they do not match the local management capacity. The end result has been a series of costly failures leading to a loss of investment and an increase in the number of poorly-managed water supply systems that present a health risk for their users. It has also raised the number of disillusioned communities that are becoming more sceptical about the capacity of the State and its institutions.

In this critical period CINARA, with support from IRC, and in collaboration with regional institutions in the Valle region (such as the Servicio Seccional de Salud and the Comité de Cafeteros), initiated the implementation of water supply treatment systems using slow sand filtration (SSF) and gravel filtration. These first plants clearly showed the potential of this technology to solve water quality problems under difficult conditions and with limited resources in terms of trained manpower. This initial work also facilitated design improvements, and cost reduction, and showed the potential of gravel filtration to widen the application of SSF (CINARA and IRC, 1989).

The promising results generated considerable demand from municipalities, who approached CINARA for support in applying this type of solution to their problems. In response to this demand, which CINARA could not satisfy alone, the TRANSCOL Programme was developed. The main hypothesis was that regional and local institutions participating in the implementation of projects can learn about the technology and its application, with the staff involved in the learning becoming facilitators in future activities.

2.1.4 The Programme objectives and location

The overall objective of TRANSCOL was to offer technical solutions that really matched the operational capacity of small and medium municipalities and fitted the decentralization policy of the government. The specific objectives included:

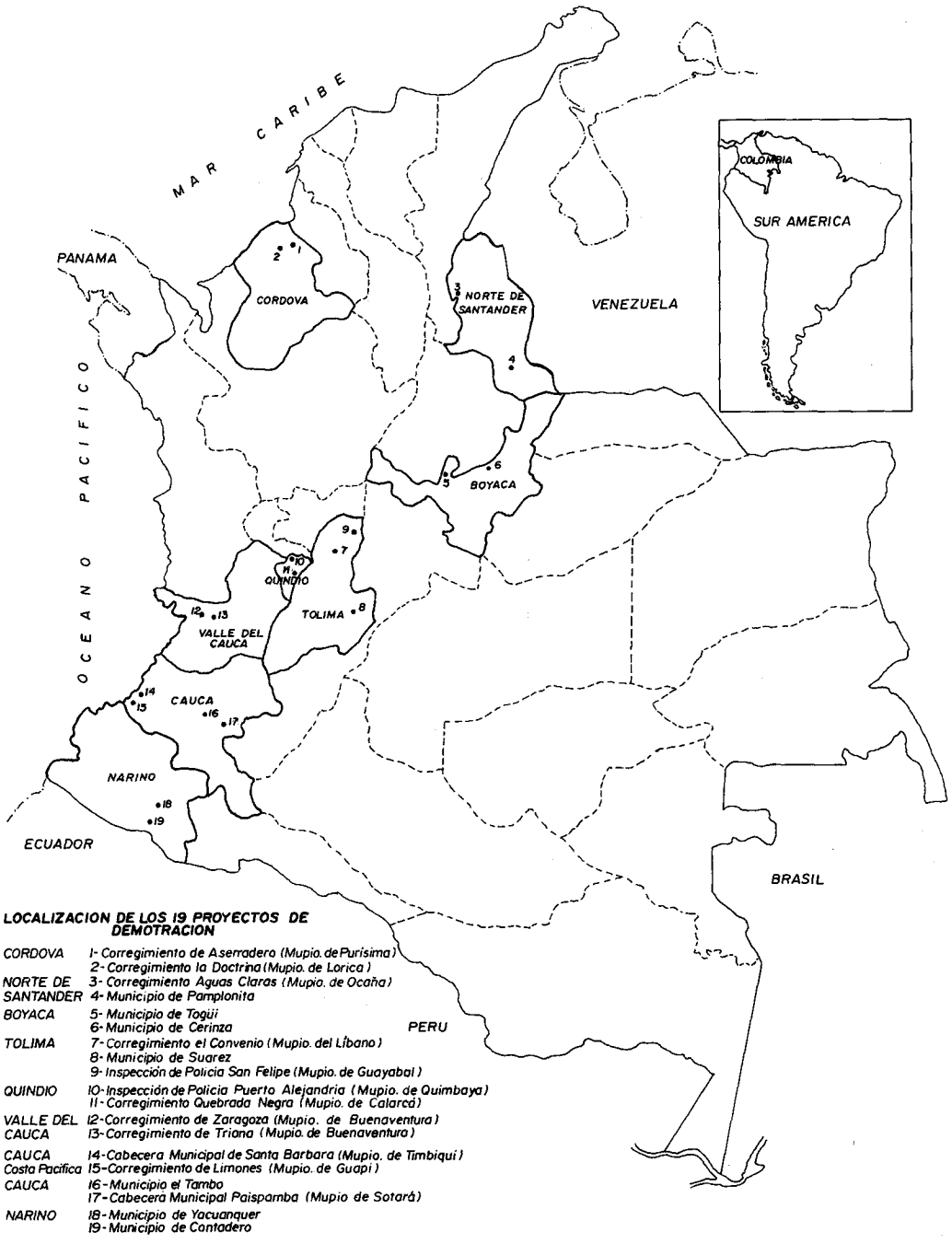

Figure 2: Locations and regions where TRANSCOL has been implemented

- the introduction of SSF technology, combined with pre-treatment systems in eight regions of Colombia
- the training of staff in the introduction and use of this technology
- the promotion of working groups in each region to serve as multipliers
- support to the development of CINARA as a 'sector resource centre' in Colombia
- the introduction and evaluation of community-supported water surveillance and control activities.

The Programme was developed in the departments of Boyacá, Cauca, Córdoba, Nariño, Norte de Santander, Tolima and Quindio and the Pacific Coast region of the departments of Cauca and Valle del Cauca (Figure 2). These departments were selected on the basis of a number of reasons, including the interest expressed by sector leaders in the region and their being representative with regards to social, economical, cultural, technical and environmental conditions in the country.

2.2 Methodology

2.2.1 Key elements of TRANSCOL

The main activities of TRANSCOL comprised the organization of **Inter-institutional Regional Working Groups (IRWGs)** and the development of **demonstration projects.**

The IRWGs were established to promote inter-disciplinary and inter-institutional teamwork and strengthen the capacity of the institutions in MSF technology and participatory approaches. In each of the eight regions a group of professionals was formed. Technical and social staff members from participating institutions volunteered for these teams and obtained permission from their management. In some regions, such as Tolima, the team also included private consultants.

The team approach helped sector professionals from different institutions to jointly learn about a new technology and new methodologies. A hands-on approach enabled them to learn by doing and feel the difference that a multi-disciplinary and critical approach can make in making sector interventions more sustainable. Through the team members, a contribution was made to strengthening the institutional capacity in the region and to gaining greater appreciation of applied research.

Demonstration projects were established to experiment with the technology and create the space for collaboration between the institutions and the communities. This implied the active involvement of agency staff , local authorities and members from the community. In each region two projects were selected together with the IRWGs, adopting the criteria presented in Table 2. These criteria aimed at ensuring that the plant site could be visited easily to enhance the demonstration potential. Furthermore, they tried to match a favourable environment for MSF treatment with conditions that were representative for the respective regions. By guaranteeing the availability of training facilities close to the plant, project implementation was made easy and future capacity building activities were more easily organized.

The concept of demonstration projects stems from the technology transfer approach used by IRC in the International Development and Demonstration Project on SSF (see also Chapter 4). This project followed a demonstration with a rather one-way approach, leaving limited room for learning as the national 'advisors' were transferring their experience to sector staff. In the TRANSCOL Programme, however, the concept was adjusted into a much more two-way exchange and development process. The teams that

were introducing the MSF treatment were confronted with a range of problems, including tendering difficulties, selection of operators and conflict management by the community for which they did not have ready made answers. This changed the demonstration projects into learning projects in which it was recognised that the communities and the agencies needed to solve problems together through dialogue and needed to experiment to find the best solutions (see Chapters 4 and 5). This change also made it possible to learn how to adapt to the fundamental political and institutional changes in the sector in Colombia.

Some problems, such as water leakage, only became apparent towards the end of the Programme when the treatment plants were put into operation. This was too late to introduce major improvements, particularly as changes in the distribution system often involve considerable cost. So here there still exists scope for improvement.

Table 2: Selection criteria for demonstration projects

Themes	***Criteria***
Easy access	short distance between the Regional Centre and the community
	good access roads in summer and winter
	short travel time to the community
	availability of communication means
Necessity and viability of the treatment	year round availability of water in the source
	moderate turbidity and colour levels
	prevalence of water borne diseases in the community
Ease of application of the technology	population below 5,000
	existence of piped water supply system
	availability of construction material including filter sand and gravel
	community request to improve water quality
	presence of sector institutions in the community
	existence of a water committee or other community organizations
	existence of investment plans for water supply and sanitation
Sanitary conditions and availability of a health infrastructure	existence of excreta disposal facilities
	availability of a waste collection system
	presence of a functioning health infrastructure
Good training facilities	existence of schools or other training facilities
	availability of hostels and restaurants
	availability of electricity

2.2.2 Process and strategy

From the start, the acceptance and support of the departmental government and the management of the participating institutions was sought. Staff from these institutions became involved on a voluntary and part-time basis. The participatory process in the project helped to develop their capacity to critically analyse the situation and stimulated their creativity and responsibility to take action. An approach of inter-active training was adopted, comprising training workshops and field work. This type of training is based on a recognition of the fact that both participants and facilitators have important

information, knowledge and experience that needs to be shared. The workshops always included training in participatory techniques. They also covered technical aspects of the planning, design, implementation, construction and management of MSF systems. The learning continued in the field, where the IRWGs were accompanied by CINARA staff members, broadening the process to also include community members.

In the communities, horizontal working relations were strived for, respecting different opinions and recognising that everybody has contributions to make. First, contacts were always established with the local formal and informal leaders. This was followed by a community meeting to inform as many community members as possible about the Programme. Dialogue and interaction between agency staff and communities was stimulated through participatory tools and techniques that helped people to gain insight in their own situation. The approach recognized the cultural identity of each community and supported the reconstruction of their own history. The main activities at community level included: house visits, observations, focal group meetings, structured and semi-structured interviews, creative workshops and the formation of support groups. These groups assisted the community organization responsible for the system to shape the project and monitor the implementation of concerted activities.

The Programme did not yet adopt a gender approach as is now being promoted in the sector, but did make special efforts to stimulate, involvement of women through house visits and by organizing meetings at times and places that did not much interfere with their daily work. Creative workshops also proved an excellent mechanism for this and for team building. Other forms of communication such as painting, music, theatre, modelling and poetry, were used in these workshops to bring the participants closer together and stimulate sharing of experience. This also helped the less vocal participants to gain self-confidence and 'voice' opinions, sentiments, preferences, objections and ideas in public. These workshops were held on several occasions during the project, enabling joint decision making and helping to focus on the long-term sustainability of the activities.

Main Programme Activities

The approach that was followed in TRANSCOL comprised the following steps:

1. **Selection of the region**, taking into account its potential for the application of the technology and the existence of political and institutional will to participate in the process, giving preference to regions with a lower level of technical development.
2. **Introduction of TRANSCOL in the region**, by discussing its implications and support requirements. After meeting with political and institutional leaders involved in the sector, a regional seminar was held to present the Programme, its objectives, philosophy, strategies and organization. Also general information on sector policies, and the way the Programme activities related to them was presented. Emphasis was placed on the important role research and scientific development can play in enhancing the effectiveness and efficiency of the sector in truly providing answers to prevailing problems in the region. This seminar resulted in the establishment of IRWGs formed by participants from the different sector institutions, and in agreements concerning the provision of support by these institutions in terms of finance, transport and subsistence.

3. **Pre-selection of communities**, starting with a review of information available in the participating institutions concerning communities with the potential to become a demonstration project. This review was initiated by bringing staff of the participating institutions together in a workshop to support team building, strengthen the inter-institutional and inter-disciplinary work approach and discuss the selection criteria for demonstration projects. The review provided the basis for the pre-selection of communities. A one day visit was then made to each of them to discuss with the communities their interest in possibly participating in the Programme and to verify and complement the information obtained. Another workshop was held to select two communities as the main locations for the demonstration projects, applying the criteria in Table 2. Two more were chosen as possible replacements in case one of the first two proved not to be feasible.
4. **Evaluation and selection of Programme communities** began with a training workshop in which the IRWGs expanded their understanding of the philosophy and methodology of the Programme and the water treatment technology involved. This enabled the teams to implement a three day participatory evaluation in the two communities. They discussed the Programme with the community, explored their interest and developed key information with them, including information on water sources and possible plant locations. The evaluation was repeated in one of the other two communities, in case one of the first communities did not want to participate or did not comply with the requirements of a demonstration project.
5. **Planning and design** started with a two week workshop in Cali for members of the IRWGs. This helped to familiarize them with MSF technology and inter-disciplinary project development. They brought with them the information collected in the communities, including socio-economic and technical data (including population size and distribution, topography and soil conditions on the possible plant site). Together with the advisors from CINARA this was reviewed and the results used to make an outline design for the water treatment plant and to outline a socio-educative plan for working with the community in the different project phases. Thereafter the workshop participants returned to their regions, where together with CINARA staff they initiated the activities in the communities. The work began with a creative workshop in which community members, both men and women, reflected on the potential health benefits of water quality improvement, and reviewed and approved the treatment plant design and the socio-educative plan. They also discussed the costs and their possible implications for the water tariff needed to sustain the system.
6. **Financing, tendering and construction** started with the verification of available resources in the communities and agencies, and the levels of credit required. Tender documents were made by the IRWGs and tender procedures implemented mostly through the municipalities. Contracts were made between the municipalities and construction companies. Construction of the works was organized in consultation with the community and included their participation in an official civilian monitoring committee. This committee is now obligatory for construction works that are partly financed with public funds. The contractor and committee members received a short training concerning the construction requirements. Both water committees and operators were already in place in the communities, but they had little experience because the existing systems did not include treatment. Training of the water committee and the operator started during construction in order to prepare

them for operating the treatment system. Construction was completed with a leakage test of the structures before putting the gravel and sand in the tanks and starting the operation.

7. **Starting up the plant** began by accompanying the operator and the water committee in the process to initiate plant operation, filling the units with water, putting them in operation and gradually increasing the flow velocity when maturation of the biological layers proceeded. In this phase, efforts were also made to stimulate the community to improve the protection of the catchment area, enhance efficient water use and reduce the sanitary risks associated with the system.
8. **Monitoring and evaluation** comprised several visits from the IRWG and CINARA staff to support the water committee and the operator, monitor the performance of the system and analyse possible problems with its functioning and use. This monitoring is being continued by the operators, but they need some support which requires institutional capacity which does not yet exist in the region. As part of the overall evaluation of the Programme, a national workshop was organised in which staff from CINARA and the IRWGs, as well as community members, participated. The participants reviewed the findings and achievements and prepared plans to further develop activities and overcome some of the limitations they had identified.
9. **Presentations of results and experiences** were made by IRWG members and community representatives in a national seminar aimed particularly at the political and management level involved in the sector in Colombia. This meeting was also used by FINDETER, in conjunction with the Ministry for Economic Development and CINARA, to launch a new Programme that strives for sustainable solutions for key problems in Colombia's water and sanitation sector.

2.3 Organization and financing of the Programme

2.3.1 Organization

The Programme has been developed and co-ordinated by CINARA and IRC as shown in Figure 3. It received support from the Netherlands government through the Directorate General for International Cooperation (DGIS). The government of Colombia provided support through the Ministries for Economic Development and Health and the National Planning Department. Considerable support was received from regional and local governments and from the communities in which the Programme was implemented.

For Programme implementation, interdisciplinary groups were established in CINARA and in the regions (IRWGs). The CINARA team included engineers, social scientists, economists, social workers, and architects. It was supported by external advisors in some key areas such as soil mechanics and construction. For each region a technical and a socio-economic staff member of CINARA were nominated to coordinate the activities with the IRWG, the municipalities and the Programme communities. The CINARA team facilitated the implementation of the Programme and assisted in the generation of financial resources for plant construction. At the regional level, coordination and implementation was in the hands of the IRWGs. These included staff from the regional health services, universities, regional corporations, public service organizations and departmental planning offices. These institutions provided logistic and financial support for the participation of their staff and in several cases also for construction. The coordination of each IRWG was delegated by the regional Governor to

one of the organizations. At the local level the activities have been coordinated by the IRWGs in close collaboration with CINARA, the municipal administrations and the water committees.

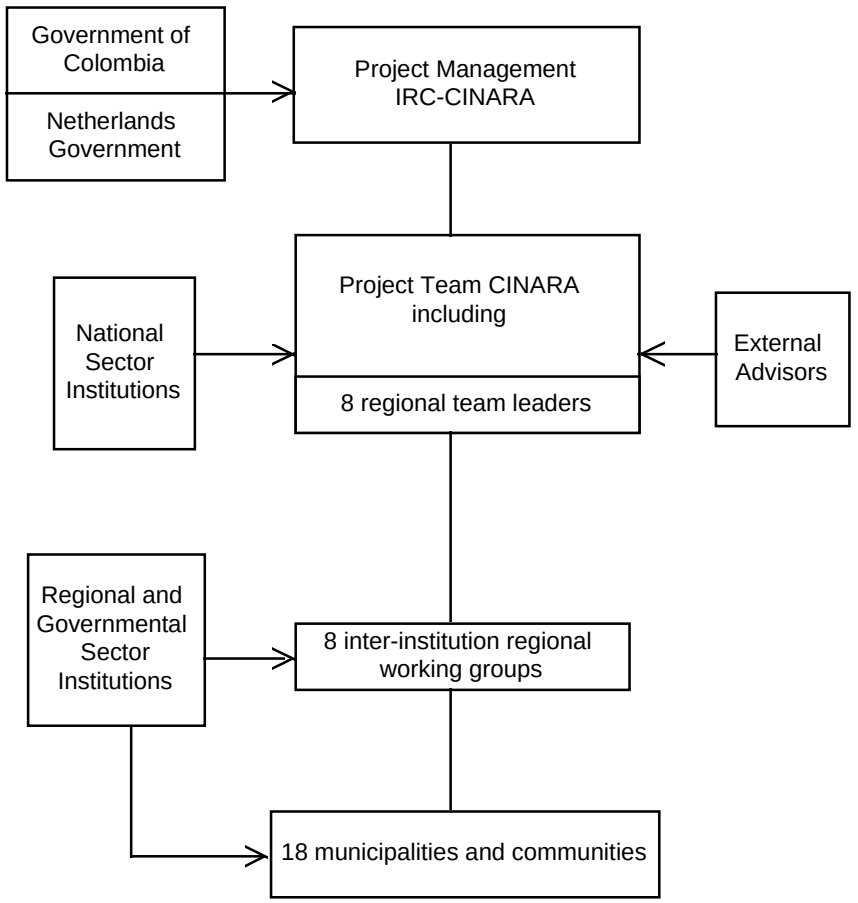

Figure 3: Organizational chart of TRANSCOL

2.3.2 Financing

TRANSCOL received a total of NLF 4,655,155 (USD 2.9 million as at December 1995) from the Netherlands government. The national, regional and local contribution amounted to USD 3.2 million, including an investment in infrastructure of COP 2 billion (USD 2 million) and another COP 1.2 billion (USD 1.2 million) in salaries, logistic support, travel and subsistance. This contribution came from different sources. The Ministry of Health agreed with CINARA to co-finance the Programme and FINDETER made credit available for the municipalities involved. The municipalities also made resources available that together with the inputs from community members, provided for 34 percent of the construction cost.

The key to this considerable contribution was a combination of interest from communities and authorities, continuous fund raising support by CINARA and the

regional teams, and a flexible Programme approach that made it possible to adjust to changes in the sector. The distribution of the total Programme expenditures is presented in Figure 4.

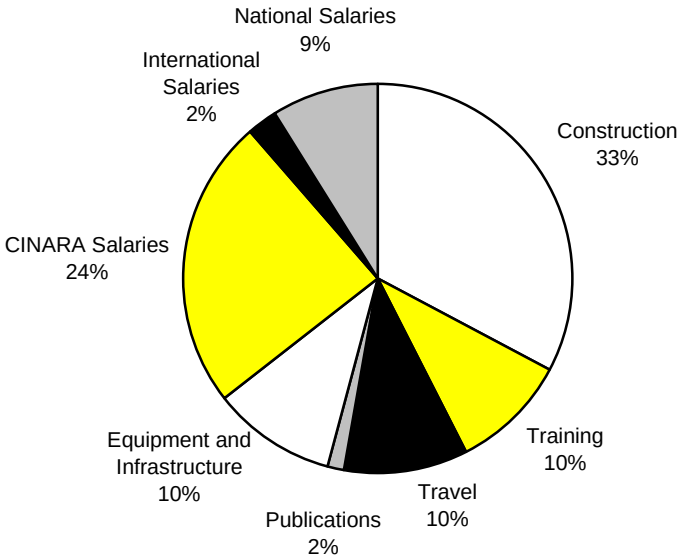

Figure 4: Distribution of Programme expenditures (USD 6,121,000)

2.4 Results and experience

TRANSCOL has been an enriching experience for all involved, with important achievements and lessons for the sector. The results are summarised below under the following headings:

- successful introduction of the technology and methodology
- establishment of Interdisciplinary and Inter-institutional working groups
- a space for a new methodology and type of engineering
- CINARA developed into a Sector Resource Centre.

2.4.1 Successful introduction of the technology and methodology

Eighteen community managed MSF systems have been established in eight regions. The MSF technology was introduced by constructing eighteen demonstration projects (Figure 5). In two regions, three projects instead of two, were developed in response to requests from these regions (Table 3). Initially Limones, a community in the Pacific Coast, was also included, but here the planned system could not be constructed because of water quantity problems and funding limitations. Construction costs differed considerably between projects because of the variation in design capacity (65 to 500 l/c/d), availability of construction material, transport cost and the number of treatment barriers needed to cope with the different levels of hygiene risk related to the water

resources. Also the percentage of ACP (Administration, Contingencies and Profit) that contractors can claim varies between regions from 15 percent in Tolima to 32 percent in the Pacific Coast. The limited experience of the contractors with MSF construction implied relatively high cost, but that will reduce when experience and competition become larger. Finally, because it concerns demonstration schemes, the design of the systems has been conservative. This is more costly but ensures good treatment results, building in a safety margin to cope with unexpected water quality problems.

Figure 5: The MSF plant in Paispamba, Cauca, Colombia, one of the demonstration systems

The eighteen communities have populations of between 161 and 3,528. Nine are concentrated rural settlements and nine are municipalities. The systems are managed by the local operators, sometimes with help of their wives. In Puerto Alejandría (Quindio), the plant is operated by a female operator. In some communities, the present operators have had little training because they have replaced trained operators as a result of political changes.

Table 3: General information concerning the demonstration projects

Locality	*Type*	*Region*	*Population*	*Design Capacity (Lps)*	*Cost Total (1000 USD)*	*Cost per Lps (1000 USD/lps)*
Cerinza	Municipality	Boyacá	1304	7.5	85.6	11.4
Togui	Municipality		855	2.2	28.0	12.7
Paispamba	Municipality	Cauca	498	2.2	25.8	11.7
El Tambo	Municipality		3528	14.2	66.0	4.6
Aserradero-El Hueso	Rural area	Córdoba	1068	2.2	50.0	22.7
La Doctrina	Rural area		3500	4.5	88.0	19.5
Triana	Rural area	Costa	390	1.5	60.0	40.0
Zaragoza	Rural area	Pacífica	750	1.0	45.0	45.0
Santa Bárbara	Municipality	Costa Pacífica	2782	5.6	145.0	25.9
Contadero	Municipality	Nariño	1081	3.5	28.0	8.0
Yacuanquer	Municipality		2.500	5.0	43.0	8.6
Aguasclaras	Rural area	Norte de	543	2.3	27.0	11.7
Pamplonita	Municipality	Santander	750	2.5	25.5	10.2
Puerto Alejandría	Rural area	Quindío	161	0.7	30.0	42.8
Quebrada Negra	Rural area		361	2.0	50.0	25.0
El Convenio	Rural area		2200	11.5	70.0	6.0
San Felipe	Rural area	Tolima	900	3.5	20.0	5.7
Suárez	Municipality		1283	6.0	65.0	10.8

Fifteen (83 percent) of the community-operated MSF systems were constructed one and four years between. These are functioning well with average filtration periods (time between cleanings) of more than three months. The water they deliver is, for most of the plants, reaching the standard required WHO water quality guidelines (Chapter 3). In Cordoba, the construction of the two systems was slow, and by the end of 1996 they had not entered into operation. A water group formed at the University of Cordoba, by members of the IRWG, is supporting the process of putting these plants in operation. This group has also initiated an evaluation of seven slow sand filters that exist in the region but face difficulties in their operation. In the Pacific Coast region, the construction of the MSF plant in Santa Bárbara de Timbiquí, delayed because of political interference and limited institutional support, was completed in early 1997.

The vast majority of the systems draw only a small part of the water available in the water source which they tap. Only one system has water shortage problems in the dry season. Nevertheless, inefficient water use and high leakage prevail in most of the communities. To compensate for this, operators overload the treatment plants, causing a higher work load for themselves. On the positive side we see that, although these plants are overcharged and sometimes operate at flow velocities that are 50 percent above the design rate, they are consistently producing water low in hygiene risk.

The picture that emerges shows that operators and communities have limitations, and that their capacity to manage their systems needs to be improved. Their ‘water enterprise’ needs to be strengthened to ensure that it can function as an independent organization. There is also a need to formalize a training programme for operators, towards which the national education service SENA, together with CINARA, is taking steps.

Other problems that need attention include the quality of construction, particularly of distribution networks, and the insufficient protection of water catchment areas that may lead to future deterioration in water quality.

2.4.2 Establishment of interdisciplinary and inter-institutional working groups

Eight regional working groups were formed, comprising staff from different institutions. TRANSCOL started with 161 staff members from 86 institutions. Six years later, 43 staff members from 34 institutions were still active in the working groups. This includes staff from key institutions such as the Regional Health Services and the regional planning office, have been involved throughout.

Participation in the groups gradually reduced over the seven years of the Programme because the changing roles of the sector institutions created uncertainty and unstable jobs. With the projects already in an advanced stage it proved difficult to involve newcomers. In most of the groups, personal commitment and enthusiasm for the approach were perhaps the main reasons for many of the participants to continue their participation, but this in itself was not always sufficient if their institutions did not put it high on their priority list. Other causes can be found in some of the points raised in the participatory evaluation of the Programme as reflected in Table 4. An important lesson is that a technology transfer programme has to establish institutional commitment from the very beginning and formalize the expected inputs and results in an agreement between the organizations involved in the Programme.

Replication of the technology and methodology has been achieved. Working group members are replicating the methodology and technology in other communities in their region, including the development of new WSS projects and training of operators and community leaders. In the course of the Programme, the vast potential of MSF technology was established. Already eleven plants are under construction in the regions and another 51 are being planned (CINARA and IRC, 1996). In Boyacá, members of the IRWG promote the implementation of a plan that aims at the optimization of 21 SSF plants in the region. These systems were constructed several years ago, do not include pre-treatment and are facing design, operation and maintenance problems that need to be overcome.

MSF has less potential for most communities in the Pacific Coast. The flat topography makes it necessary to pump the water to the treatment plant and thereafter to pump it into the distribution system. This double pumping is far too costly for the local communities, which have very low income levels. An alternative in this region is the promotion of rainwater harvesting, as rainfall is very high, up to 11 metres per year, with very short dry periods.

Replication is also starting in other regions that have not been involved in the Programme. For example, in Risaralda, four institutions (Servicio de Salud, Comité de Cafeteros, Corporación de Desarrollo and Empresas Públicas de Pereira) together with CINARA, are realizing a programme to transfer MSF technology, assuming all costs involved and ensuring that their staff have sufficient time to participate in the activities while receiving full support from their superiors.

Table 4: Strengths and limitations of the IRWGs

Strengths	*Limitations*
Continuity of staff members of some institutions forming a core group in the region	Insufficient institutional commitment
Continuous presence of health sector institutions	Changes of the directors and other leading staff in the institutions
Institutions not objecting to the participation of their staff and providing support for travel and subsistence	Lack of continuity in staff because of unstable positions in some of the institutions
Effectiveness of the interdisciplinary and inter-institutional approach gained respect at political and institutional levels	Lack of continuity for some institutions because of changes in the Sector
Commitment of staff.	Friction between institutions
Recognition of the IRWG by the communities and sector institutions	Few professionals with a socio-economic background in the institutions and the IRWGs
Establishment by the IRWGs of an environment for the diffusion of the methodology and the technology in the region	No representation of the communities in the IRWGs
IRWGs showing capacity to implement MSF as a reliable alternative and to introduce a new process approach to project implementation	

Source: CINARA/IRC, 1996

A learning opportunity was established at institutional and community level. In total, 73 events have taken place in which over 600 staff members of different institutions learned about the technology and the methodology. Some 30 percent of them were women. Another 1,500 persons from the eighteen communities (water committee members, operators and local leaders) have participated in more than 76 learning events organized by the IRWGs and CINARA. Here, on average, men's participation was only somewhat stronger than that of women, with strong differences in some communities. In a participatory evaluation of the Programme it was established that, on average, women accounted for 52 percent of the community members involved in planning and design (range 40 to 80 percent), 32 percent of those involved in construction (range 20 to 50 percent) and 40 percent of those concerned with operation, maintenance and management (range 10 to 60 percent) (CINARA and IRC, 1996).

While the Programme did include some special activities to reach out to women in the communities, it did not yet follow a gender-specific approach that distinguishes between the roles and realities of men and women and reviews the consequences for and with each of these groups. What has become clear from the participatory evaluation is that women have played an important role in the Programme. In Zaragoza (Costa Pacífica del Valle), women living in the part of the community that could not benefit from the treatment plant because of the topography, participated in the design of rainwater-harvesting structures and, together with the men, also took an active part in monitoring. A good example of female leadership is in La Doctrina (Córdoba) where a grandmother coordinated the work of the community support group to reconstruct the history of their water supply system. Paíspamba (Cauca) is an example showing that activities go beyond

the Programme. Here a women's committee is promoting the improvement of the water catchment area that is facing deforestation problems. Other examples include La Doctrina and Aserradero-El Hueso (Córdoba), where women's groups are promoting latrine construction, and Triana (Costa Pacífica), where a women's group is leading a new sanitation and hygiene programme with support from UNICEF and CINARA.

However, there are still limitations in involving women as full partners in the process, as can be seen, for example, in Yacuanquer (Nariño). Women established a list for the election of the water committee with only female candidates. At the time of the elections, however, nobody voted for this list, not even the founders. So it is still very important to further develop methods and approaches to strengthen the involvement of women, as was done, for example, in a workshop on involvement of women held in Cali in 1995 (Cáceres et al, 1993). Methods should go beyond women involvement and adopt a gender perspective, catering for specific activities related to men, women and children, and focusing on the different roles they play in their communities.

Support material was developed for technology and methodology diffusion. The material was prepared for the activities with the IRWGs and the communities, taking into account the different educational levels of the participants. These materials include manuals, posters, videos, workshop materials, a design and construction manual for MSF technology, a series of presentations in national and international events and articles in a range of national and international journals.

Water surveillance and control with community involvement was introduced. In nine of the demonstration projects, in Tolima, Nariño, Costa Pacífica and Boyacá this was done together with a project supported by the Ministry of Health. The IRWGs and the respective communities were closely involved in monitoring the treatment plant and the water supply system as a whole. Mapping of the system with the community helped to identify problems and limitations and the underlying causes. This made it possible to initiate activities to improve the situation, with different community members taking responsibilities in different phases of the process. It also enabled setting of priorities for investments to enhance the sustainability of the systems. Furthermore, a visual method was introduced for water quality monitoring. This methodology and these tools are now available for the institutions that play a role in the monitoring, conservation and protection of water resources and water quality. The approach facilitates an active involvement of the community in water surveillance and stimulates better protection of their water supply system and the water catchment areas. The agency response is positive, and their staff start to see the value of a more horizontal relationship with the communities. On the other hand the institutions still have a very limited capacity to really make things happen in the regions.

2.4.3 A space for a new methodology and type of engineering

A new technology transfer method was developed. An important result, not related to any of the specific objectives, was the development of learning projects to transfer technology and contribute to capacity building (Chapters 4 and 5). This approach was gradually developed by CINARA and IRC, starting from the projects in TRANSCOL. Another important project that has contributed important lessons was organized with the municipality of Cali through its municipal works organization (EMCALI). This project aimed at the improvement of WSS services in the rural and peri-urban areas of Cali. Important experience was also established in the MSF project in Risaralda and the

participatory evaluations of 40 WSS systems in Ecuador (Visscher et al., 1996) and fifteen in Bolivia (Quiroga et al., 1997).

The results are included in different university programmes. A new type of engineering emerged in the Programme that is consistent with the recent policy of the Colombian government to enhance the scientific and technical capacity of the universities and strengthen their links with the productive sector and the institutions involved in the development of the country. Members of the IRWGs, working in five universities in Cali, Córdoba, Boyacá, Norte de Santander and Quindío, have included MSF technology and the working strategy with the community in their university curriculum. They are also using the methodology and techniques in new projects and are promoting the development of work groups for research and technology development in their regions.

The experience obtained by CINARA staff has also been the basis for the development of the Post Graduate Programme in Sanitary and Environmental Engineering in Valle University that is being implemented with support from the Netherlands government through the International Institute for Infrastructural, Hydraulic and Environmental Engineering (IHE) and the Delft University of Technology. Several CINARA staff members lecture in this Programme, using their experience of TRANSCOL. In the first three years (1994, 1995 and 1996), 45 students from Colombia and other countries in the region participated in the Programme, fifteen aiming at a specialization and 30 opting for an Msc.

2.4.4 CINARA developed into a Sector Resource Centre

The Programme facilitated the establishment of the CINARA Foundation and the CINARA Institute as part of Valle University. CINARA started as a working group in the University but it was needed to also establish a foundation to be able to organize and manage a Programme of the magnitude of TRANSCOL. At the end of the Programme, CINARA has become an organization with a clear profile in Colombia and the Latin American region, and is being recognised as a useful resource for the WSS Sector (DNP, 1991). It has the status of both a foundation and a University institute. TRANSCOL also made it possible to develop concepts that are in line with the policy of the Colombian government. This policy aims at better organizing the role of science, strengthening institutional capacities and facilitating technological innovation. Another result is that CINARA has become part of a network of institutions and professionals from a range of countries including Argentina, Brazil, Bolivia, Canada, Ecuador, England, Guatemala, India, Nepal, the Netherlands, Nicaragua, Pakistan Panama, Peru, Spain, Switzerland, USA, and Venezuela, as well as within Colombia at the national, regional and local level. Of great importance has been the use by CINARA of the Programme and its international contacts to invest in its staff, its main resource (Box 2).

Box 2: Staff development in CINARA

CINARA's full-time professional staff increased from fifteen to 47 between 1989 and 1996, five of them being nominated as teachers at the Valle University. This staff includes sanitary engineers, architects, sociologists, social workers, psychologists, communication specialists, a historian, an economist, a chemist and a biologist. Fourteen have a Master's degree, three have a specialization and five are PhD candidates. In 2000 they expect another six Masters and three new PhD candidates. Half of the academic staff are women, four of whom are involved in leading management tasks. They also have 27 technical staff and five advisors.

CINARA has made a great effort to train its staff, to help overcome the shortage of trained professionals and researchers in the sector. In 1995, for example, USD 194,000 was invested in training, of which USD 82,000 (42 percent) came from its own resources and USD 109,000 (57 percent) from international projects and agreements.

Furthermore, some 25 students have been participating in CINARA projects to obtain their academic degree or Masters title. Students from other countries in the region, as well as from Europe, are also coming to implement research activities in CINARA.

In Valle University the CINARA model is now used as an example of how scientific and technical activities can consolidate networks and core units of development, and enable the university to work in support of the productive sector in the country.

The Programme also supported the development of the infrastructure of CINARA in the university and in its research and technology transfer station in Puerto Mallarino, the premises of the main water treatment plant of EMCALI.

2.5 Conclusions and perspectives

The results obtained in the TRANSCOL Programme show that the methodology and the technology transfer process enabled the improvement of the water supply in the participating communities in which the demonstration projects had been established. The Programme helped to enhance the availability of the drinking water supply and created an approach in which the political, management, professional, technical and community levels have together identified and agreed on activities to overcome limitations in the existing water supply systems. The following conclusions emerge as most relevant for the sector:

1. **A place in the market was created for the MSF technology**, demonstrating that this water treatment technology can be easily adapted to local conditions. Its requirements and simplicity match the diverse conditions in the regions in the country. The technology seems to have less potential in the Pacific Coast because of the flat topography which makes double pumping necessary. Rainwater harvesting seems to have much better potential in this area, which has a its very high and evenly distributed rainfall.
2. **The technology and methodology can be replicated**, because professionals in the regions learned the trade in TRANSCOL and are beginning to have an impact as regional advisors in new projects. Thus the staff exist who can spread the technology and the participatory approach. They can create a multiplier effect in guiding the selection, design, construction operation and management of MSF systems.

   The base however, is still small and not sufficiently institutionalized to cope with the changes that resulted from the decentralization process, including the much larger role in decision making and management by the local administrations. These changes created a vacuum for these municipalities at the support level, which still exists in several regions. Furthermore, the Regional Health Services, that are legally

responsible for water surveillance and control, have staff limitations and are being reorganized as a result of the changes in the sector. On the positive side, several staff members of the IRWGs are being involved in the Departmental Water and Sanitation Units that are being established to support the municipalities.

Members of the IRWG who are related to universities in Córdoba, Boyacá, Norte de Santander, Quindío and Valle del Cauca have included MSF technology and participatory approaches in the university curriculum and are establishing working groups that are involved in research and development in their region. Also, the training materials, training modules, videos, publications and leaflets that were developed are valuable tools for the training of human resources at different levels. These materials are available for the sector and are being used in courses and training activities by CINARA, IRC and other institutions.

3. **A new strategy for technology transfer was developed**. Although the process is still recent and full of uncertainties and learning opportunities, it seems that a new technology transfer strategy is emerging. This approach creates a learning environment where institutions and communities collaborate and make new technologies and methodologies their own, emphasizing sustainability issues and adopting a human-centred orientation. CINARA developed into a sector resource centre. The Programme has helped CINARA to establish close linkages with sector institutions at the national, regional and local level and to support them in their social missions without taking over. In recent years support has been extended to include documentation services, as CINARA has established a documentation unit specialized in water supply and sanitation issues. This support role is a good response to the government's policy to promote and develop science and technology in the country and strengthen the link between the university and the private sector.

   CINARA's close collaboration with IRC and other international and national institutions facilitates access to key information and helps its staff to exchange experience with counterparts in other countries. As a result, their recognition has increased and governmental and non-governmental institutions in Bolivia, Colombia, Ecuador, Guatemala, Nepal and Pakistan are enhancing their contacts and exploring ways to enter into technology-transfer programmes with CINARA and IRC.

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3. Searching for Sustainable Solutions

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The concept of sustainability outlined in this chapter gradually gains importance in the sector and helps to orient the search for better solutions at the local level. A good link between sector institutions and communities is needed to safeguard the investments in the sector. This is particularly important in the context of the decentralization process that is taking place in many countries around the world, and particularly in Latin America. Decentralization places the responsibility for public service delivery, including water supply and sanitation, in the hands of municipalities and communities. Often this responsibility is assigned without strengthening the local level in technical, financial and administrative terms.

The chapter conclude with a discussion of themes and indicators to analyse the performance of water supply and sanitation systems and establish verifiable objectives concerning the level and type of service to be provided. Special emphasis is placed on issues related to the functioning, use and management of water supply schemes.

3.1 Introduction

Following a request from the General Assembly of the United Nations, the World Commission for Environment and Development discussed the implications of the Sustainable Development Concept in their 1987 report. This discussion has had considerable implications in all development sectors. The main thrust of the concept is that activities by the present generation should not compromise the resources, nor the environmental conditions of future generations.

The OECD/DAC, in reaction to this orientation, indicated in 1988 that it considers a development programme to be sustainable when it can provide an appropriate level of benefits over an extensive period of time after the financial, administrative or technical support of an external agency has ended (OECD/DAC, 1988, cited by MDF, 1992). This definition includes a clear donor perspective reflecting the approach OECD member countries use in handing over completed projects to the recipient governments or communities. Warner (1990) presents the same concept, orienting it more to the community level by stating that ‘the success or sustainability of a project is achieved when it meets its objectives and is maintained by its users over a significant period of time’.

It is important to note that both definitions do not make a clear reference to the safeguarding of the environment, which is becoming more and more the bottleneck in many water supply and sanitation systems. A system may be maintained by the community for many years, producing benefits for the present generation, but its side effects may compromise the environment and so the wellbeing of future generations. This is not sustainable for the World Commission for Environment and Development but does meet the criteria of the OECD/DAC. Also it may not be reasonable to expect, as Warner appears to suggest, that the users should be left entirely on their own in keeping up their system. Although governments are changing their role from provider to facilitator (IRC, 1995), several tasks remain that cannot be catered for at the community level.

Consequently some external inputs will be necessary to sustain the systems, but these should not lead to outsiders taking over the roles of men, women and children in the communities.

Institutions are struggling with the changing conditions and are searching for their role in the new political and juridical context in Colombia. This involves certain limitations that make it very important to initiate a learning process together with the communities. The obvious limitations, that the local level will easily recognise, include problems related to funding, training and technical assistance. Less obvious for them may be limitations to implementing research and carrying out water surveillance and control activities. Overcoming these limitations goes well beyond the local level and requires joint activities of different sector institutions and other development actors.

3.2 Sustainable water supply and sanitation services

Following the new developments in the sector, and taking into account the experience of CINARA and IRC, the following approximation of sustainable water supply and sanitation systems emerges: *a water supply or sanitation system is sustainable when it:*

- *continuously provides an efficient and reliable service at a level which is desired*
- *can be financed or co-financed by the users with limited but feasible external support and technical assistance and*
- *is being used in an efficient way, without negatively affecting the environment.*

This definition encompasses the aspects brought forward by the OECD and by Warner (1990) and is in harmony with the WHO Minimum Evaluation Procedures, which stress functioning and use as the main issues to be reviewed (WHO, 1983).

The definition indicates that sustainability implies a match between the political, legal and institutional frameworks in which the systems need to operate, and that it involves three strategic inter-linking dimensions (Figure 6).

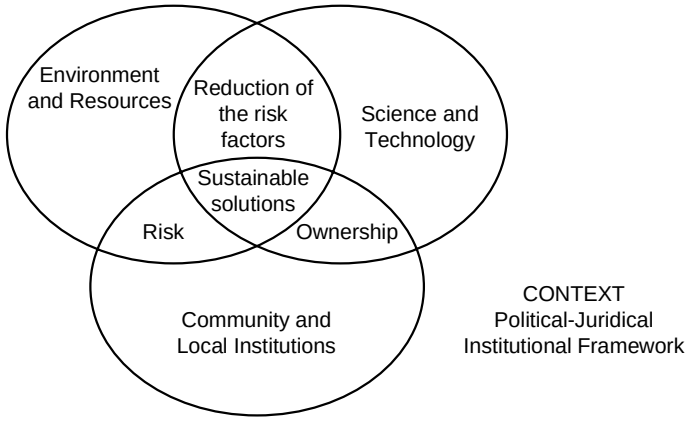

Figure 6: Conceptual framework underpinning the search for sustainability (Galvis, 1993; Galvis et al., 1994)

The first dimension is the **community and the local government**, a group of people with some common but also some conflicting interests and ideas and different socio-economic and cultural backgrounds (Figure 7). The water supply system may be one such common interest, but at the same time can be a major source of conflict. The identity of the people in the communities is shaped by their history and their socio-economic and environmental conditions. Some of them, often the economically better off, may be better informed, may know more of the world, but may on the other hand, have certain interests in keeping the status quo and therefore may not be willing to solve certain problems. Women may have interests different from those of men and may not have been heard in the past, or their position may make it difficult to achieve changes on their own.

Figure 7: The community often involves different interest groups that all need to be involved, Paispamba, Cauca, Colombia

The community dimension includes issues such as the capacity and willingness to pay for the required service level, management capacities and local capacity to promote development projects, manage conflicts and team up with sector institutions. This dimension also includes the role of the institutions in co-financing systems and in providing support and assistance, not by taking over the role of the community and local government, but strengthening them to do a better job.

The second dimension is the **environment**, the boundary that shapes the community and dictates the risks it faces and the **local resources** it can draw from to meet its needs. In water supply projects these risks often relate to issues such as: the available water resources; their pattern over the year; their level of pollution; sanitation practices of the

community; and land and water use. The possible effect a water supply system may have on the environment, for example, by producing wastewater and chemical sludge, also needs to be reviewed.

The interface between environment and community represents the risk the community has to overcome in relation to, for example, its water supply. The risk-analysis helps to establish and prioritize actions to reduce the risks that will depend on the level of deterioration of the local environment. The action may focus on the reduction of the pollution level by water source protection or by introducing treatment, for example, adopting a multi-barrier treatment concept (Galvis et al., 1997).

The third dimension concerns **science and technology**, the combination of hardware and the knowledge to develop and sustain it. This latter dimension represents the possibilities and tools actors can use to reduce the environmental risks the community is facing. This risk reduction however, can only be sustainable if the community adopts the solution and gains ownership of it by making it their own.

The interface between environment and technology represents the availability of knowledge and practical options to reduce the risk, either through technical matters or, change in behaviour. It deals with the viability, effectiveness and efficiency of solutions and their effect on the environment. The interface between technology and community deals with the type of solutions the community is expecting, is willing and able to manage and sustain and that are in line with the technical, socio-economical and environmental conditions and capacities of the community.

Solutions that match the three interfaces and the overall political, legal and institutional framework are most promising in terms of sustainability. This requires joint problem solving with the different actors involved and a clear role of the community and the local level in decision making. The conceptual framework presented in Figure 6, is a simplification of the elements involved in the process and serves to illustrate the diversity of the variables. This is often underestimated because of lack of information, restrictions in the interdisciplinary approach and difficulties in introducing research and development activities in the sector. Although science may not be able to provide immediate solutions in a specific project environment, it does provide the tools and techniques to initiate the search for them and ensure quality results. The resulting benefits of such research activities, if properly shared with sector agencies and communities, often outweigh by far the investment required to undertake them. Development programmes in the WSS Sector thus need to enhance the research and development capacity of the institutions involved, and strengthen the network of organizations in search of sustainable solutions.

Some of the answers may already exist in the communities or local institutions. This calls for good communication between the actors and stimulation of their creativity and initiative. Technologies that are traditionally used in a region often are an important part of the solution, calling for a participatory review of local experience. If ‘new’ technology has to be introduced, testing is needed to allow for the necessary adaptation to the local conditions and to ensure that adequate operation and maintenance can be taken care of, before promoting large scale application. This also includes a review and adaptation of training materials for the different levels of education involved in the use of the technology.

3.3 Sustainability factors

Different stages can be identified in the development level of a community in the course of a project intervention (Figure 8).

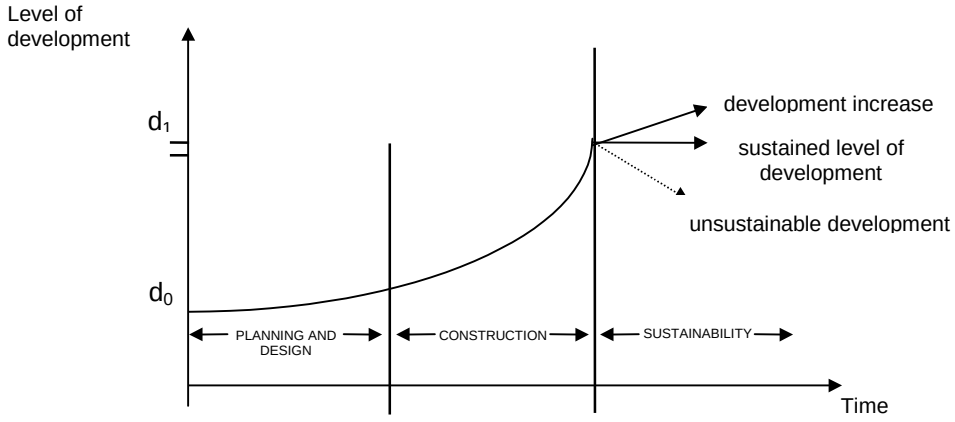

Figure 8: Sustainability Diagram

When a community identifies its priority needs these are initially at a development level d_0. The project then starts with planning and design, perhaps slightly increasing the level as the community gains experience and is involved in decision making. The level increases more quickly when the physical construction takes place, finally reaching level d_1. The process is sustainable if this level is maintained or increased after the external intervention ends. If the level starts to decrease however, this may create a domino effect also negatively influencing the sustainability of other projects (Abrams, 1996) .

Different views exist on the factors that are of key importance for sustainability. We share the view that, for the conditions in Latin America, the following factors are essential (García, 1996; Duque et al., 1996):

- integrated planning
- community participation and management adopting a gender perspective
- technology selection
- community financing
- operation and maintenance
- water resources management
- continued institutional support.

These factors need to be taken into account from the planning stage, because what happens to a project after construction depends very much on its development process.

3.3.1 Integrated planning

Integrated planning is needed to ensure that the potential benefits of water supply and sanitation systems are obtained. Esrey (1990), shows that water quality improvements need to be combined with activities related to personal hygiene, basic sanitation and

environmental education, to ensure a better and more sustained health impact. Integrated planning also has to address the basic requirements indicated in Box 3.

Box 3: Requirements of WSS service provision

- **Coverage** that permits equal distribution of benefits.
- **Quantity** sufficient to satisfy the community demand within reason and ensure health benefits.
- **Continuity** offering access to service at the required time and location.
- **Quality** needed to obtain health benefits.
- **Cost**, not only in line with the communities' willingness to pay, but also matching a rational and efficient use of resources, with special care for the environment.
- **Management Capacity** of the community, enabling it to participate in the whole project including problem identification, planning, implementation, operation, maintenance, management, surveillance, control and evaluation.
- **Culture,** recognizing that development refers to persons, not things and that the possibilities to improve the quality of life depend on the real potential of the community to satisfy its needs using the knowledge and experience of the founders.

3.3.2 Community participation and management with a gender perspective

Water supply and sanitation interventions are undertaken to ensure that systems not only are built, but, more importantly, are used. They are thus concerned with the area of development that refers to persons and not to things (Max-Neef, 1992). A participatory reconstruction of the local history and the local culture as they relate to the management of water resources and to excreta and solid waste disposal is a good way to initiate a project. During the process the community should take the decisions, starting from the needs assessment and working towards problem solving and implementation. This implies, amongst other things the development of management capacity in the community that is related to its potential to:

- identify, characterize and assign priorities to its needs
- distribute scarce resources between different needs
- develop procedures to solve identified problems
- develop initiatives to manage crisis situations
- implement control and community monitoring functions
- plan and construct the required systems to satisfy the community demands in an equitable, efficient and integrated way
- operate, maintain and evaluate the systems and programme in such a way that their sustained functioning is guaranteed
- establish commitment and mediate between the different community interests, keeping in mind a respect for differences, consensus building, consultation and a rational use of power
- decide in a democratic way on the actions to be taken.

A working strategy reflecting respect for the cultural identity of the community groups involved takes into account that:

- water supply and sanitation provision implies dealing with social problems
- mankind constructs its present on the basis of its history which therefore needs to be understood and taken into account
- communities are not homogeneous; different social interests exist within them

- all human groups have internal conflicts that need to be confronted because avoiding them will merely increase them
- human collectives have established a perception of the world and some instruments to interpret their reality, and thus have knowledge
- participation implies becoming part of the thinking, the desires, the decision making, and the recognizing of equity in gender, race and religion
- participatory processes need to involve learning.

Developing community services involves sharing contributions and benefits, without favouring or excluding groups in the community. Women are often mainly responsible for water supply, sanitation and hygiene education at the household level and in the community. In recent years their active participation in this type of project has been strongly promoted perhaps to such an extent that their workload has increased. It must be recognized that the needs and interests of men and women are often different, and therefore gender specific approaches are required to ensure that the views of all groups are duly taken into account and burdens and benefits equally shared.

3.3.3 Technology selection

An appropriate use of technology implies that it is in harmony with the local culture, that it matches the technical and financial capacity of the community and that it is in line with the available natural resources. If it does not meet the community demand it will be abandoned quickly, thus leading to a loss of investment and efforts. Every technology that is being installed in conditions different from where it was developed needs to be tested, evaluated and, if required, adapted, to ensure its compatibility with the new situation in which it will be used. Its cost needs to be in harmony with the benefits as perceived by the user communities and had to match their willingness to pay.

It is essential to consider the technology (the hardware), as well as its requirements for operation, maintenance and management (Figure 9), the type of staff needed and the training they require, and finally its environmental impact. This facilitates its assimilation by the community and enhances the possibility of guaranteeing its adequate operation and maintenance. When the technology promotes the autonomy of the community with respect to external resources and assistance, particularly in operation and maintenance, the chances of sustainability are increased.

3.3.4 Community financing

Sustainability requires a continuous flow of funds that covers the cost of operation, maintenance and replacement of the systems. An important asset of community management is to guarantee this flow of funds through the periodic collection of users contributions, or other forms of local payment. The decentralization process is positive in that it provides larger responsibilities and power to the local level to mobilize resources for water supply and sanitation. It makes it possible to establish community-based organizations that can manage their systems in a more sustainable way.

Figure 9: Operation and maintenance requirements are essential in technology selection, los Chancos, Valle del Cauca, Colombia

Water is, in principle, an economic and social commodity that has a cost to which the users need to contribute. More and more users are willing to pay for water, provided they get a quality service that provides the expected benefits. This often relates to perceived assets such as convenience and economic benefits, and much less to less tangible health benefits.

A tariff is needed to cover the costs involved in operation and maintenance and to recover all or part of the investment cost. A progressive tariff system has the big advantage that it discourages excessive use but leaves the possibility open to charge a minimum contribution for the lowest acceptable consumption level. This lowest level could even be partly subsidized to help the poor in the community. It should not be fully subsidized to avoid encouraging users to depend on government payments for basic needs.

Current thinking in international circles is that tariffs for excreta and solid and liquid waste disposal should be based on the polluter-pays principle. This presupposes that the community agrees that it is fair to charge more to persons who pollute more and sees the benefits involved in the reduction and control of waste disposal. Decisions on tariffs are best taken in consultation with the community or their representatives, to avoid problems of payment. This is an important reason to involve them from the beginning of a project.

3.3.5 Operation and maintenance

Taking operation and maintenance into account in the design phase makes it possible to agree about the implications with the community organization responsible for the management of the system. Local conditions and resources are best known to community members and they have to sustain the system after it has been completed. So they are best placed to take the decisions within the boundaries and regulations set by the government. Reasonable decisions can only be made by the community or their representatives if they are sufficiently informed about the full implications, thus placing agency staff in the role of information provider and facilitator. Development of proper management arrangements for a water supply system includes making informed decisions on the following issues:

- who will be responsible for the operation and who will do the maintenance?
- when will these activities be undertaken?
- how will they be implemented?
    - where and with what materials, equipment and methods?
    - what will be the cost and when will funds be needed?
    - who will contribute, in what form and when?

These decisions need to take into account the available resources, the technological capacity, the local culture, the community's resistance to change, the available support capacity, and gender implications. Sharing operation and maintenance between men and women has proved more effective and efficient in a number of cases and resulted in benefits being more equally distributed (Wijk-Sijbesma, 1997).

3.3.6 Water resources management

Water and sanitation projects may have an important impact on the water resources. Their management and efficient use needs to be put high on the agenda, as growing population pressure and misuse of natural resources is an increasing threat. This has been shown, for example, in many Latin America countries, with water sources strongly reducing in flow and rapidly decreasing in quality, thus having an immediate impact on the sustainability of the systems.

3.3.7 Continuous institutional support

Long term sustainability requires an adequate institutional framework that specifies the social mission of the sector institutions and clarifies who:

- provides credit and finance for the infrastructure in the sector
- supports and trains staff for operation and maintenance
- advises and assists in water resource management
- copes with water surveillance and control.

An important part of durable and effective institutional arrangements involves good communication between the institutions, the community and the organization providing the water supply or sanitation service.

3.4 Sustainability aspects and indicators

Advance in construction and the depletion of the budget are important monitoring indicators, but do not say much about the sustainability of project's achievements. This requires an emphasis on other aspects of the system, as mentioned in Section 3.3. For these different aspects, indicators can be established that are being presented in three groups:

- the quality and level of service, clearly related to the functioning of the system
- the efficient use of water, related to the way the community is using the resource
- the management of the service.

These are the main aspects to use in the evaluation of water supply systems (Visscher et al., 1996; IRC, 1991). Having clear indicators facilitates decision making with the community and the funding agencies concerning the service level that a new system needs to provide to the users. For each theme, specific indicators are needed to quantify the required benefits a system has to provide and establish the implied management and support requirements.

3.4.1 The quality and the level of service

To establish the level of service of water supply systems, the following indicators can be used (adapted from Lloyd et al., 1987):

Coverage

Coverage refers to the access that people in the community have to the water supply system. For many people, it seems to be the most important indicator, but, the conclusions from the Water Decade show that to obtain health and social benefits it is not enough to focus on this aspect alone. The water service should be equally distributed to the greatest number of users possible. If water availability is a problem, users from high and low income zones should receive identical quantities. If sufficient water is available, people who want to have more water can obtain this extra service, but at a higher price.

Coverage can be expressed as the percentage of households in a locality that are connected to the system or that have fair access to potable water, thus also including households with access to other protected water sources. Coverage is also a management indicator, as its change over time can indicate if the community water agency has been able to maintain or increase the existing number of connections without affecting the service supply.

Continuity

Continuity should be ensured in order to avoid risk of recontamination of water in the distribution network or in storage tanks in the households. Systems with more than one line of treatment should be planned where possible, as this avoids the suspension of service for maintenance reasons. In localities where water cannot be supplied continuously, the risk of recontamination in the distribution network should be investigated very carefully. Also the hours of water supply should be specified in consultation with the users.

The continuity of the service can be reviewed by considering the hours of supply per day, the variation in supply over the year and by area, and the number of service

suspensions lasting, for instance, longer than half a day per month. The latter can be related, for example, to intermittent electricity supply or lack of fuel in pumped systems, or with water source problems in the dry season, erosion problems or flooding. Continuity can be a problem that affects only part of the community and particularly those living on higher ground.

Quantity

This is an important factor for health improvement. Enough water should be provided for drinking, cooking, food preparation and good personal and household hygiene. Bringing water close to the user reduces the time and efforts involved in water collection, a benefit which is particularly important for women and children. However, the inclusion of other demands, such as watering cattle, requires a full discussion with the community that includes an analysis of the environmental and socio-economic consequences. If the community is prepared to finance other types of use, and if the source and the existing sanitation conditions permit it, further personal demands can be considered at cost, provided the community understands the negative impact of excessive demands and water wastage. Making provision for such additional uses, although more expensive as it requires a larger system, may be very important to gain full acceptance by, and continuous support from the users. Existing standards used for system designs assign global norms to water consumption, but may not be in line with the demands and capacities of the users. Therefore it is essential to discuss the implications with the community and if needed to deviate from the existing norms.

An initial estimate of the quantity of water that is being supplied in a system can be defined from the daily production measured in the storage tank, and the number of users that it supplies. This value is greater than the per capita consumption, as it includes visible and invisible losses that occur within the system. The quantity supplied can only be analysed in detail if the reading of meters that register consumption is carried out. An alternative to estimate water consumption is to carry out a survey by installing a few water meters in randomly selected households, provided water quality permits the use of meters. Another option is to carry out a users survey asking about daily water consumption. This may not produce fully accurate results, however, as users may not inform properly about water use for activities such as irrigation or watering cattle.

Another key point for a sustainable service relates to the capacity of the water source. The supply volume should preferably be considerably less than the capacity of the source during the critical dry period. The greater the difference the better, particularly if the source is also used for other purposes, such as irrigation.

Quality

The water supplied should be free of chemical substances and micro-organisms that can result in rejection or disease amongst the users, or in the deterioration of the storage systems, distribution network, and domestic utensils. National water quality norms are available in most countries and the WHO has published its water quality guidelines that are very helpful.

The contamination of a water source with excreta from people or animals introduces a great variety of bacteria, viruses, protozoa and worms. Insufficient protection of water sources, or inadequate treatment, thus puts the community at risk of contracting infectious diseases. Poor water quality may be particularly harmful for

children and old people with defects in their immune systems. For these two groups the infectious dose is significantly lower than for the rest of the population (WHO, 1993).

There are few chemical components that produce an acute risk for the users, except for situations where accidents occur in industry or through the spraying of pesticides and herbicides. In such cases, though, the water is often rejected by the consumers. Chemical pollution may, however, imply a chronic health risk associated with long periods of exposure. Its control is therefore important, but of a secondary order in water supply systems that are subject to severe bacteriological contamination (WHO, 1993; Craun et al., 1994).

Particularly in countries with a less developed infrastructure, the acute risk associated with bacteriological contamination is more important than the chronic risk related to chemical components. The community may, however, perceive it differently, and may consider having a water supply as being more important than its bacteriological quality. This situation is gradually changing in Latin America and the Caribbean due to cholera prevention programmes that, among other things, create greater awareness of the importance of water quality.

The WHO has established an approach for assessing and monitoring water quality in rural communities and municipalities with limitations in infrastructure (WHO, 1993). They propose a combination of the use of a few water quality parameters and the implementation of sanitary inspections. The parameters include:

- *E. coli* counts, or, as an alternative, thermotolerant coliform counts, usually referred to as faecal coliform counts
- residual chlorine (if applied)
- pH (if chlorine is applied)
- turbidity.

The measurement of these parameters is based on spot samples that may not be representative of the situation. The combination with a sanitary inspection is therefore very important. This inspection consists of a systematic review of the water catchment area, the water source and the water supply system, preferably by experienced sector staff, together with community members involved in the management of the system. The inspection aims at identifying all the potential factors in the catchment area and the water supply system (intake, transmission main, treatment, storage and distribution), that may put the users at risk (Lloyd and Helmer, 1991; WHO 1996).

The sanitary inspection and the water quality analysis are complementary activities that are preferably combined. Whereas the sanitary inspection identifies potential risks, the water quality analysis shows if and to what level the water was contaminated at the time of sampling. The inspection is essential for the interpretation of the laboratory results and to prioritize remedial actions. Against the background of the problems with water quality testing it is suggested to place more emphasis on the sanitary inspection. Further research however, is needed to establish effective indicators that permit the monitoring of community-managed systems with little external support.

Concerning surface water sources, the hydrological cycle may have a considerable influence on quantity and quality. Waste water discharge in the dry season may have a strong impact on water quality and also the first runoff in the beginning of the rainy season may create high bacteriological, and sometimes chemical, pollution. In micro-catchments these changes are sometimes of short duration and therefore difficult to detect with occasional water quality testing (Figure 10).

Cost

The cost of systems will be largely determined by the water quality risk associated with the source, and the geomorphologic and geographical conditions. Sometimes a combination of water sources may be feasible to reduce the cost, as was done in the Costa Pacífica. A piped supply was provided to the lower part of the community whereas the higher part was served with rainwater harvesting systems to avoid costly pumping. The implemented technology should, if possible, be in harmony with the socio-economic conditions and above all with the willingness of the users of the system to pay. As a minimum the tariff should cover aspects such as operation and maintenance, and, if the level of co-financing requires it under the criteria agreed upon between the financing body and the users, recovery of the initial investment. Furthermore, if possible, it should be able to cover unforeseen costs and future expansions. At the international level, it is considered that monthly tariffs should preferably not exceed 3 to 5 percent of the average monthly income of the user. As an indicator of the willingness to pay, the percentage of the users that have not paid the tariff in the last 2 or 3 months can be utilized.

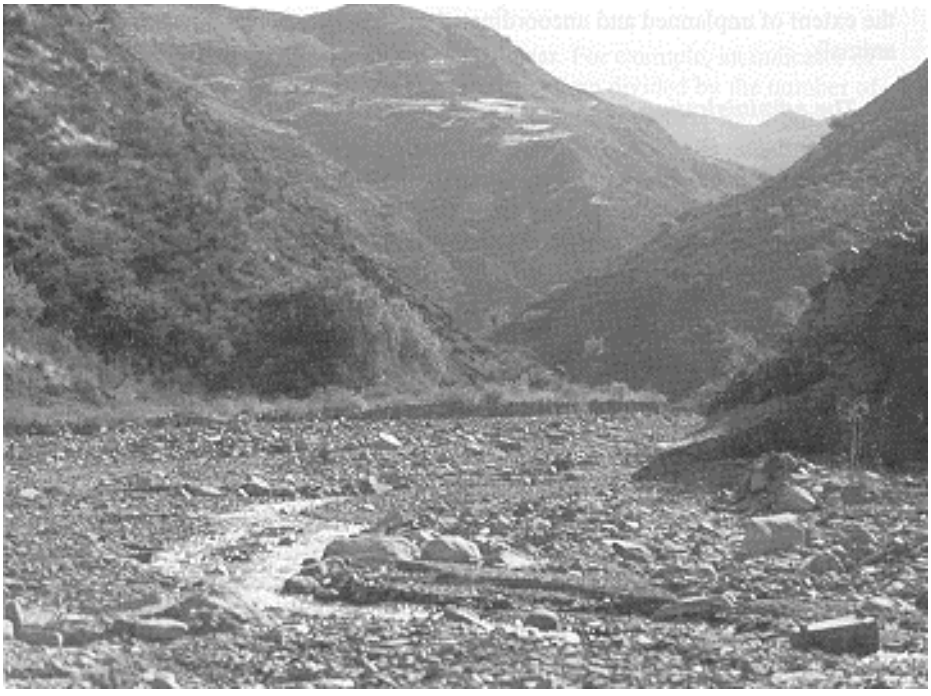

Figure 10: Water quality changes may be very quick and increase treatment cost particularly in unprotected catchment areas

3.4.2 The efficient use of water

The attitudes of different stakeholders towards the environment in general and especially to the water resources, are essential aspects to review with them. This will help to understand the 'water culture', the form in which these groups see and use their resource. This is often related to history and local conditions and helps in understanding the beliefs, and local customs related to the utilization, protection, and care of the water supply sources. This review process can also help to raise the understanding of the different groups for better source protection, and can serve as a basis for changing attitudes and practices.

The water culture may differ considerably. In the Andean region, some communities have per capita demands of between 400 and 600 l/c/d, and yet others only use 20 l/c/d. Partly this results from different climatic conditions or differences in water use, with the high consumption figures including, for example, domestic consumption, watering animals and irrigation. A lot of the high level demand stems also from water wastage because of taps that are left open, toilets that keep running and high leakage in the distribution network. The indicators that can be used to evaluate the efficient use of water include:

- the volume of water used per consumer
- the percentage of people that use water from other sources with a high sanitary risk for human consumption
- the percentage of households with taps and flush toilets that are leaking
- the extent of unplanned and uncoordinated use for irrigation and watering of animals.

3.4.3 The administration

To ensure that the level of service is sustained over time, as discussed in Section 3.3, it is necessary that the management capacity at the local level matches the operation and maintenance requirements of the system, requiring only a minimum of support from government or external institutions. The administrative entity should have knowledge of the staff and material required to maintain its system in optimal condition. It requires a good accounting system (register of income and expenditure) and adequate communication channels to share information with the community and supporting agencies. It is important that the community trusts the administration and the supporting agencies in technical, managerial and financial matters. This may require special efforts to gradually build this trust. The administration should be accountable and open, particularly concerning expenditures and contracts with third parties, having, for example, clear criteria for contract procedures. An annual meeting, with *stock taking* of last year's management and planning next year's budget, and a review of the books by an independent audit committee, also contributes to building trust.

The support institutions have to provide assistance while ensuring that they do not take over the role and function of the local or municipal administration. It is also important not to combine the support activities and the control function in the same support institution.

The capacity to manage the system can be analysed by making use of some indirect indicators such as:

- the number of years of experience of staff and the training received
- participation of men and women and their roles in the administrative body
- the number of meetings between the members of the administration and the community or their representatives
- the type and frequency of supervision that is carried out on the work of the operators
- the number and type of problems resolved with the users
- the existence of a monitoring system for system performance and user payments.

Good functioning of the system and a high degree of punctuality in payments are other more direct indicators of management capacity, but are useful only if full control over these aspects is in the hands of the local organization. If this is not the case, issues such as opportune calling upon external institutions and active search for training opportunities and advice are indications of committed management.

3.4.4 Monitoring and evaluation

Monitoring and evaluation of system performance are helpful tools to ensure sustainability and obtain insight into project achievements. A condition for an effective evaluation is that the community and the agencies involved agree on the expected results before a project is started. This can best be done by defining and agreeing upon indicators that properly represent project results. Table 5 presents a series of indicators adapted from an evaluation of the sustainability of 40 water supply and sanitation systems in Ecuador (Visscher et al., 1996).

The definition of the indicators should be clear. For example, an indicator of coverage is the number of users connected to the system divided by the number of families in a community. However, in dispersed settlements where some families own protected wells or springs, a piped water supply does not necessarily have to achieve 100 percent coverage. Users with their own sources may not need to be connected to the system. In such cases, the indicator of water supply coverage that could be agreed upon might be the number of families with access to potable water within a distance, for example, of 200 metres from their house, divided by the number of families in the community.

The desired levels of achievement indicated in Table 5 are an example, and were developed by taking into account the situation in the zone where the evaluation was applied. For other conditions they need to be adjusted, and other indicators can be included. For example, if sufficient water quality data are available, it may be possible to use some of the values that are included in the national standards, such as the desired level of iron.

The indicators presented in Table 5 can also serve for the development of a monitoring system, constituting a vital tool for the management of a water supply service. The system should indicate the margin within which an indicator may fluctuate and define actions for when this margin is not attained.

The levels indicated in Table 5 are desirable, but it may not be possible to always achieve them. Sometimes lower levels can be accepted if, for example, the hygiene risk associated with the water sources is low. It may also be the case that people always boil water or purchase bottled water, in which case bacteriological standards may be somewhat relaxed.

Table 5: Indicators for the evaluation of water supply systems

	Theme	*Indicator*	*Desired level*
1.	Coverage	No. of connected households / Total no. of households	100%
2.	Available quantity	Max. flow in the system / Min. flow in the source	Less than 50%
2.1	Production	Actual flow in the system / Design flow	Less than 100%
2.2	Quantity of use	Supply quantity per user / Design capacity per user	Less than 100%
3.	Continuity	Number of supply hours per day	24 hours
3.1	Continuity in the source	Reduction over time	No reduction
4.	Quality	Turbidity Residual Chlorine in distribution net	Less than 5 NTU 0.3 - 0.6 mg/l
5.	Use of other water sources	No. of persons using other sources / No. of persons interviewed	0%
5.1	Efficient water use	No. of houses with leaking taps / No. of houses visited	0%
6.	Management capacity	No. of indebted users / Total no. of users	Less than 5%
		Supervision of the operator	Yes
6.1	O&M capacity	Trained operator with work tools	Yes
6.2	Representation of women	No. of trained women in the committee / No. of trained committee members	50%
7.	Cost	Monthly revenue / Monthly expenditures	More than one
7.1	Tariffs	Monthly tariff / Monthly family income	Less than 3%

Source: (Visscher et al., 1996)

3.5 The sustainability of the TRANSCOL projects

Fifteen of the nineteen planned MSF demonstration projects in operation under TRANSCOL are managed by the communities, while three are being completed and one could not be constructed for lack of funds. Fourteen of the plants that are functioning include Dynamic Roughing Filters (DRF), thirteen include Upflow Roughing Filters in Layers (URFL) and two include Upflow Roughing Filters in Series (UFRS2). In all plants SSF units are included. The performance of these plants, operating for, on average, some 3 years was reviewed with the indicators presented in Section 3.4 during visits by the teams from CINARA and the IRWGs.

3.5.1 Quality and level of service

The systems are properly operating and provide a service that the majority of the users qualify as good. Clearly the availability of good quality drinking water has increased and it is being provided on a continuous basis. The data can be summarized as follows:

Coverage

Out of fifteen systems, fourteen (93 percent) have a coverage of between 90 and 100 percent and one a coverage of 83 percent.

Quantity

Ten out of fifteen (67 percent) treatment plants are overloaded, some operating at 1.5 times the design flow that was established for a fifteen years projection. The other five are operating on or below the design flow.

Continuity

Ten systems (67 percent) provide 24 hours water supply, one 20 hours per day, two operate for 12 hours per day and on two systems no recent information exists.

Quality

Although the majority of the plants are operated on very high flow velocities, they are consistently producing good quality water that is low in sanitary risk. The limited water quality data that exist suggest that in twelve of the systems the turbidity is continuously below 5 NTU and coliform levels below 1 FCU/100ml. This clearly shows that MSF technology adapts very well to the local conditions and can be operated by local operators with low schooling levels.

In one project (Aguas Claras-Norte de Santander) water quality problems exist because of the poor water quality at the source. In another (Yacuanquer-Nariño) the treatment plant is almost completely by-passed, operating at only 16 percent of its design capacity. This is because the community thinks that the treatment plant is the cause of discontinuity in the supply. A sanitary inspection, however, showed that the true problem is water wastage and inefficient water use.

Cost

In most systems a considerable increase in the tariffs has been obtained. Initially the tariffs were on average COP 200 per month (USD0.20) and ranged between COP 5 and Cop 300. The current situation is that in ten communities, tariffs range between COP 1000 and 1800 per month (USD1-1.8/month). The other five, that are still below COP 500 per month, are in the process of tariff revision. The increase in tariffs has been decided in conjunction with the communities and was well accepted by them. In some systems where water meters exist, differential tariffs are being established with higher charges for higher consumption levels.

The tariffs cover the operation and maintenance costs and in some cases a reserve has been established that can be used for repairs, as is the case in San Felipe, Tolima, where the reserve now amounts to COP 12 million (USD12,000).

3.5.2 Efficient water use

In three systems the volume of water leaving the storage tanks ranges from 150 to 200 l/c/d, in seven from 200 to 300, and in five over 300 l/c/d is being supplied. The average is well above the national norms (FINDETER, 1991).

An important limitation and an important lesson of the Programme has been that it focused primarily on water quality improvement. It did not include an integrated analysis of the water supply system and, in particular, did not review design and operational problems in the distribution systems, nor the way the community uses the water. This largely explains why problems in the systems and water management were not detected. Gradually these problems are being taken up, by including among other things, raising awareness concerning the need for more efficient water use.

3.5.3 Management of the systems

The systems are managed by community water committees that are partly influenced by political parties. At the municipal level, committees or user associations have been established, with the mayor as the chairman. Usually two persons from the community are elected members and the local government is represented by two delegates. In most cases a fifth person is contracted to take care of the administration. In rural communities, administrative committees are formed with a chairman selected by a users assembly.

An important risk to the sustainability of the systems is that the administrative committees lack consolidation. These committees face organizational problems, have limited management skills and lack institutional support that makes it difficult to quickly solve the operational problems in the systems. In several communities these problems are being recognized, and efforts are under way to try to overcome them. In San Felipe (Tolima) for example, it has been decided to assume the cost involved in training a new operator in order to ensure proper operation and maintenance of the system, as water surveillance indicated that the water quality did not match the prevailing norms.

3.6 General considerations

Sustainable systems require integrated solutions that take the three dimensions (community and local institutions, science and technology and environment and the overall context) into account. It is essential that a system provides an efficient and reliable service and meets the expectations of the users, without causing a negative effect on the environment. A project needs to be a tool to strengthen the management capacity and self-esteem of the communities and the participating institutions. The service also needs to match the prevailing sanitary problems, the local culture, the financial possibilities and the willingness to pay. Furthermore, it is essential to integrate interventions in water supply, sanitation and hygiene promotion, to prevent pollution of water sources and raise awareness of the importance of water quality improvement.

By establishing indicators, it becomes possible to verify in a transparent way the objectives that have been agreed upon by the agency and the community or their representatives. These indicators help to clarify the expected results and to assign clear responsibilities to the parties involved. They need to relate to the three dimensions of sustainability discussed in this chapter; quality and level of service, the management of the systems and efficient water use.

The TRANSCOL Programme showed that water quality improvements alone are not sufficient, and need to be combined with a complete review of the systems as a

whole, including not only the technical aspects, but also management and water use. These elements are very important, as they can put in jeopardy the effectiveness and efficiency of the selected solutions.

Sustainability further requires the availability of funds for operation and maintenance of the system, including the purchase of spare parts. Water is not a free service but an economic and social commodity. The establishment of community water enterprises, as has been done in Ceylan, Colombia, can greatly contribute to the financial sustainability of water supply systems.

A collaborative effort from the institutions and the communities is needed to establish sustainable projects. A gender perspective is important to ensure that the different interests of men and women are properly met. Sustainability is enhanced if the community can be the author of its own development; implies informed decision making in line with the available resources, and possible external support from government and non-government institutions. Community members are often well aware of their situation, their resources and the type of solutions they would like to pursue. Interests are, however, not the same for all individuals and groups, so a transparent process and informed decision making can prevent that the 'winner takes all'. The ongoing decentralization in several countries stimulates the process by which decisions, responsibilities and resources are assigned to the lowest possible level that can adequately assume them.

A number of activities cannot be sustained by the community, but need inputs from a supporting agency. This support is usually related to activities that may happen occasionally, such as possible extension of the system or unexpected water quality deterioration, but also to more regular water quality surveillance that goes beyond the capacity of the community. This support may also be very important when the water enterprise has a conflict with the users. Such support does not necessarily have to be provided by government institutions, but could also be placed in the hands of the private sector.

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4. From Technology Transfer to Technology Sharing

Jan Teun Visscher; Edgar Quiroga R.; Mariela García V. and Gerardo Galvis C.

Technology transfer has played an important role in the WSS sector and has met with different rates of success. It has been at the heart of several projects that CINARA and IRC have implemented in Colombia. Important lessons have been learned which are reflected in this chapter showing clearly that technology transfer is not as simple as just transferring the technique and the 'know-how'. Technologies are embedded in the society where they were developed and carry this fingerprint with them when they are transferred to another setting. The match with the new setting will thus depend on the similarities with the setting in which the technology was developed, the available knowledge and experience and the ease of adaptation of the technique. This chapter presents common theory concerning technology transfer. It highlights key experience in the transfer of multi-stage filtration, a water treatment technology and concludes with a structuring of the elements that are essential to the process of technology transfer in the sector.

4.1 Introduction

Technology is often associated with a tangible element such as a device or machine to carry out certain jobs. In essence, however, it implies knowledge that can be used to produce a good or a service (Chatterji, 1991). Galtung (1978), underscores this by arguing that 'an ingenuous way to understand technology is to consider it as a question of tools (equipment) and aptitudes and knowledge (programmes)'.

Aase (1991) indicates that technology is the process a team of people adopt, using tools to solve certain tasks. A tool has no meaning if it is not related to people and is not used to solve specific problems. The use of equipment requires competence and skills that usually can be obtained through theoretical study and training (Olsen, 1989, cited in Chatterji, 1991). The relation between tools and tasks generates a tangible or intangible product, that has been produced because the team had a fundamental reason to solve a problem or comply with an assignment to reach a specific goal.

The technology (team, tools and tasks) is an instrument that needs to contribute to the social and economic development of a country. In this respect, technology transfer and promotion of innovation are not aims in themselves, but utensils in the development of a society.

Galtung (1978) indicates that the technique only represents the surface of the technology, similar to the tip of an iceberg. Few people realize that the technology comprises a related structure, a social, organizational and mental base on which it is built. The technique is thus the top of a pyramid that needs to be largely in place to make it work.

4.2 Technology transfer in the WSS sector

Technology transfer in the sector is primarily characterized by a classic approach, comprising efforts to transfer equipment and tools accompanied by training of local staff in operation and maintenance. Rarely does it include development and innovation

elements that bring in local experience and help to adapt the technology to the local conditions.

Early experiences with technology transfer related more to individual efforts, such as the introduction of rapid filtration and chemical coagulation in Cali, Colombia with the help of an Englishman, George Bunker, at the end of the 1920s.

In the 1950s, the 'classic' technology transfer model was adopted in the sector in a massive way, with the initiation of large scale support programmes by countries in the USA and Europe. This concerned, for example, the introduction of handpumps in a large number of developing countries. Initially, the process was limited to the introduction of the equipment, without taking local conditions into account, often resulting in costly mistakes that still have a negative impact in the sector. Package plants for chemical water treatment used successfully, for example, in England, France, the Netherlands and the USA, proved a complete failure in countries with limited technical skills and funding limitations. Less demanding technologies such as slow sand filtration also failed in countries such as Brazil (Hespanhol, 1969) and Peru (Lloyd et al., 1987).

These experiences gradually made external support agencies (ESAs) aware that transferring the technique, the equipment, is not sufficient. They started to combine the transfer with the training of communities in some aspects related to operation and maintenance. So ESAs began to clarify how to operate the equipment, but rarely transferred the knowledge and understanding of why and how the system operates. The information that Lotherington (1991) indicates as crucial to adapt and develop technology.

Against this background, it is obvious why Reid (1978) suggested that the main obstacles to technology transfer are the economic, social and organizational limitations of the recipients, blaming them for the failures. This concept has been very persistent, and is used by many authors in their analysis of sector developments (Vaa, 1990). Apparently the need for a different approach, in which national institutions in the recipient countries are helped to find their own interpretation and application of 'new' technologies, has not been questioned. Nor has research been brought forward as a key element that permits the adaptation or invention of technologies. On the contrary, Reid (1978) indicates that it would be a waste of resources to try and re-invent existing technologies that are readily available to be copied. This view clearly does not take into account the revolutionary power of research and technology development and adaptation, which builds creativity in people and enables them to learn how to cope with new challenges.

Technology transfer in the sector has been taken as the process that includes the collection, documentation and dissemination of technical and scientific information. Most of the literature limits even this to technical and economical aspects alone and rarely to social or institutional issues (Vaa, 1990). Most of the literature about the sector discusses technology transfer as if it were a linear process in which technology is transferred and its adoption promoted. Nevertheless, the person receiving the information will review, adapt, accept or reject it, according to his or her own conceptual framework and experience and the influences of others. Thus technology transfer is not a linear process, but a much more complex phenomenon (Röling, 1988).

The view that technology transfer is a linear top-down communication process resembles the classic model of diffusion of innovations presented by Rogers (1995), where members of a social system are reached through different channels. Following

this idea, technology transfer starts with the development of the technology (the innovation), which thereafter is transferred to another place and often to other countries. Technology, however, has the limitation in that it is not a universal scientific law, but always has its roots in the society that developed it to solve a specific problem (Reddy, 1977, cited in García et al., 1996). Transferring technology to another society thus implies cutting the roots. This may be an important reason for the large number of systems that do not function or are functioning at a substandard and are poorly utilized (Figure 11). The aim should thus be to develop a re-rooting process, using the experience already existing on the technology and matching it with the local conditions, instead of trying to re-invent the wheel.

Figure 11: Failing water treatment in Boyacá, Colombia, because the solution was not rooted in the society

The ease of adapting a 'new' technology is not the only factor determining its transfer potential. What is equally important is the uncertainty implied in its application. If an idea or a technology is new to a person, it is an innovation, implying various uncertainties. This person will only accept the innovation if convinced that it serves his or her interest and has seen evidence that it works on full scale. Technology transfer thus works if the interests of the clients coincide or come close to the goal of the institution that promotes the innovation (Röling, 1988).

4.3 Exploring new perspectives

Sector staff in general transfer technologies they know and feel confident with, but which do not necessarily provide the best and most efficient solution for the given problem in the prevailing context. An even bigger problem is that technologies are selected to solve their, the outsiders, perception of the problem. Many engineers working in the sector live in an urban environment and have been trained primarily to work in that environment, and so have an urban perception of problems. This may result in proposals, such as conventional sewerage systems for small rural communities, or service levels that fit the urban more than the rural context and do not match the needs and financial capacity of the recipients.

Technology transfer has, in a way, always included a paternalistic element as in many countries the government, together with some ESAs, has taken the responsibility to satisfy the needs and regulate the behaviour of the people under their direct influence (Saunders, 1983). Almost everywhere governmental institutions and ESAs have taken decisions about technology selection and service levels without truly involving the community in decision making. Nevertheless, in the end, people in the community decide whether they will use and maintain the service, as can be seen from the many systems that are not properly used today.

On the other hand, most national institutions are not autonomous and can hardly handle the problems in a different way as the financing institutions and their international advisors have a lot of power, which they use to introduce their perception of problems and solutions. An additional complication is that most advisors stay for a short period only and are rarely confronted with the failures of their interventions, nor does this have any implication on their professional careers. Other problems includes political pressure, limitations in staff availability and experience, and the lack of knowledge of local conditions which makes decisions taken at central level value doubtful (Vaa, 1990).

This situation will change, however, as a result of the new philosophy that users will have to pay for the service. This implies that users will insist more and more on playing a meaningful role in informed decision making concerning the systems for which they pay. If the community has to come to grips with their systems, as is now proposed and strived for at the international level (IRC, 1995), the concept of technology transfer will have to change and move towards a concept of technology sharing. This enables the community and the local government to ‘own’ the technology, and will require a stronger emphasis on research and development by creating opportunities to initiate learning processes with the different institutions and persons that are involved (See Chapter 5).

So the idea is not to introduce solutions from an ‘outsiders’ perspective, but to start to work in an approach that resembles Plato’s idea, when he stated: ‘If one poses the proper questions, people by themselves, will discover the truth about every issue’. This implies an approach that also uses the ideas of Paulo Freire (1972) concerning learning processes. He indicated that these processes should not assume that students are empty vessels, but present them with problems and encourage them to find their own solutions. This learning process in general will include the following steps: experimenting, processing (reflection, discussion), generalization and application (García et al, 1996). This approach represents a huge change, particularly for engineers, who have been trained to solve straightforward problems in a systematic way. The problems in the sector, however, are not so straightforward and need a more holistic approach as both the

problems and the solutions may be interpreted differently by the stakeholders involved (Checkland, 1989).

4.4 Transferring SSF and MSF technology

Important lessons concerning technology transfer have been learned in the technology transfer programme TRANSCOL in Colombia and its predecessor the International Research and Demonstration Project on Slow Sand Filtration (SSF Project).

4.4.1 The Slow Sand Filtration project

The SSF project was initiated in 1976 with support from IRC in six countries throughout the world. Its overall objective was to develop and promote community-based water treatment by SSF in order to reduce disease transmission and improve the living conditions particularly in small and medium sized communities in rural areas in the South. SSF is a technology that lends itself very well to an approach in which the community is actively involved in all project stages and in which they can also take responsibility for the operation of the system (IRC, 1991). In SSF, water, taken from sources that are often polluted, percolates slowly through a shallow bed of sand. During the passage of the water, impurities are removed by a combination of filtration, sedimentation, bio-chemical and biological processes. A thin layer of slime that is formed on the surface of the sand contains a great variety of very active micro-organisms that feed on organic material and bacteria, thus reducing the load of contamination (Visscher et al., 1987).

The project started with laboratory research in six different countries in Africa, Asia and Latin America, to establish the reliability of the SSF process under tropical conditions. A range of experiments were carried out by national partner institutions including a review of the effect of higher temperatures, covering of the filters, sand-bed thickness and grain size of the sand. These experiments very much helped local organizations to enhance their knowledge and experience and to prepare them for wider implementation of the technology. After the reliability of the process was proved, demonstration schemes incorporating SSF units were built in selected villages by agencies responsible for water supply in the respective countries with help of the staff from the institutions involved in the earlier research. At this stage the community-based character of the project was established by closely involving the recipient communities.

The results of the project clearly showed that SSF is an effective, reliable and cost-efficient treatment method for surface water. However, this water will often require pre-treatment to ensure the proper functioning of the filters. SSF does not involve chemicals or complex equipment and therefore is an environmentally friendly technology, that after some training can be managed by community members, with occasional back-up support from supervisors (Visscher et al., 1987). Perhaps even more important was the finding that helping local professionals and organizations in developing countries to develop their own capacities and establish their own experience is an excellent mechanism for technology transfer and adaptation.

In 1978, Colombia, through its National Health Institute (INS), entered into the second phase of the SSF project with the construction of two demonstration systems in Puerto Asis and Alto de los Idolos. The plants were completed and put into operation, but operational problems were referred back to IRC as the staff of INS had not benefited from the learning experience of implementing applied research. This was remedied in

1984 in the last phase of the SSF, project which emphasized operation and maintenance of the system and explored potential pre-treatment systems to enhance plant performance. In this phase, a working group of young professionals in the University of Valle in Cali took the lead in Colombia in collaboration with IRC and INS.

This enthusiastic group helped to construct an SSF plant close to the university and at the same time started research on the potential of gravel filtration to reduce the load of suspended solids before passing the water to the SSF units. The pilot test results proved very effective and founded the basis for an important research project in pre-treatment technology. The group actively involved lead agencies in the water sector in building the plant and in the pilot research, and discussed achievements as well as problems with them. As a result these agencies became interested and agreed to also initiate demonstration projects in their working areas, with close involvement of the communities concerned.

Autonomous diffusion of SSF technology. Because of the positive results, sector institutions, consulting firms and communities became interested in the technology and started not only to copy designs from the demonstration plants in Colombia, but also to adopt designs from other parts of the world. These designs were made available, for example, through REPIDISCA, an information network in Latin America. Not all of them were appropriate, and some appear not to have been tested. Furthermore, many engineers did not have a background in SSF, which was not taught in most universities. They did not take water quality criteria sufficiently into account, nor the need to ensure adequate pre-treatment. In additional, the copying was not always accurate as the changes made sometimes had a negative influence on plant performance. This indiscriminate copying of designs is a rather common practice, often resulting from the fact that design work is not paid for, but provided free as part of plant construction. Also, design engineers are not involved in maintenance and rarely visit plants they have designed to learn about possible difficulties in performance, thus depriving themselves of possibly exploring ideas for design improvements. A workshop on SSF design organized by CINARA and IRC in 1987, bringing together different design engineers, proved to be an eye-opener as participants reviewed their own designs and identified a wide range of mistakes (CINARA and IRC, 1987). The tone of the workshop was set by CINARA and IRC staff demonstrating their own design mistakes made in the past and what steps had been taken to overcome them. It was also demonstrated that sometimes correcting mistakes resulted in cost-effective innovations, such as the ‘goose neck’ to drain supernatant water from the SSF, a tool now used in all new SSF plants in Colombia (Galvis et al., 1997). The self-critical attitude of the workshop leaders proved to be very positive and stimulated the participants to be critical themselves.

An important limitation on the diffusion of the technology at that time was that the concept was not rooted in society, nor was there an institution in Colombia that really mastered the technology. At INS, only a few staff members had been involved, mostly in construction, and the CINARA team was just starting. We may say that the autonomous diffusion of SSF technology in Colombia, as in other places, was not very successful. Institutional experience with the technology was not sufficiently developed, and the match between the technology and the environmental and institutional settings are not yet established. What was transferred was the technique and to some extent the know-how to operate and maintain it, but clearly not what Lotherington (1991) calls the ‘know-why’, the knowledge necessary to be able to adapt and develop the technique. As a result, we

can find several SSF plants, such as those in the Boyacá region in Colombia, built in the mid-1980s, that are grossly over-designed, poorly functioning and difficult to maintain.

Organizing the diffusion process. Balancing, on the one hand, the problems associated with the autonomous diffusion of SSF technology, and, on the other, the interest of sector institutions and the very good research results with pre-treatment technologies, three important steps were taken:

- the pre-treatment project was initiated to compare different pre-treatment technologies at the technical and full scale level
- the TRANSCOL Programme was started in order to introduce the technology into eight regions in Colombia
- the working group at the university was transformed into the independent foundation, CINARA.

At that time it was felt that TRANSCOL was the key to the diffusion of the technology, but in retrospect it was the combination of the three steps, taken at the same time, that made the difference. The interaction between the project teams, in particular strengthened the technology transfer process and facilitated innovation and building capacity in sector staff.

4.4.2 The research project on pre-treatment technologies

The pre-treatment project comprised of a comparative study of different MSF systems, each consisting of a combination of two-stage roughing filtration and SSF. The first two phases of this project were implemented in Colombia between 1989 and 1996, and received support from several national and international organizations, including the Servicio Seccional de Salud and the Comité de Cafeteros. This broad support was important because it provided a vehicle to distribute the research findings to the sector. A research station was established at the premises of the public utility of Cali, EMCALI, that included technical scale units with a total capacity of 6 lps (Figure 12). Indepth research was implemented both in this station and in full scale plants at different locations in the Valle del Cauca region.

The project has clearly established that MSF can treat surface water that cannot be treated by SSF alone, thus widening the possibilities for community water supply treatment (Box 4). It has proved that applying a multi-barrier concept to water treatment without using chemicals and using a low-dose disinfection as a final safety measure is feasible. Even if this last measure fails, a water low in sanitary risk is being produced. This is very important because chemical treatment of water, so far the only alternative for highly polluted surface water sources, has a poor performance record outside larger cities. This is a problem in a country like Colombia, where 40 percent of the population live in communities of below 12,000 people. The research findings thus bring reliable water treatment within the reach of many people also now have to rely on deteriorating surface water sources (Galvis et al., 1997).

Figure 12: Comparing different MSF options in the research station in Puerto Mallerino, Cali, Colombia

The pre-treatment project enabled CINARA staff to explore the performance of the technology under different conditions, as the MSF systems in the research station and the full scale plants are treating water with different levels of contamination, ranging from lowly polluted highland rivers to highly polluted lowland rivers. Furthermore, they helped to solve problems in the systems that had been constructed in the TRANSCOL Programme. This interactive approach has been a very good way of adapting the technology to different settings and building the capacity of both CINARA staff and staff from its partner institutions. It also facilitated the development of training materials and training and learning programmes for plant operators and water committees responsible for the management of the systems. This was particularly important because the situation in the water sector in Colombia has changed enormously over the past few years as a result of the decentralization process that was initiated in 1987. The vast majority of municipalities were charged with the responsibility for water supply and sanitation without any handing-over process that would have enabled them to obtain the necessary experience and the technical, administrative and financial capacity to take on this assignment (DNP, 1991). In addition, the sector agencies were not able to provide the required back-up support. The worst situation was faced by the small municipalities in rural areas (Duque, 1994). The research results on MSF however, offered them a water treatment technology that matched the local conditions and could be readily applied without requiring extensive staff training, thus providing a clear alternative for chemical water treatment.

Box 4: The Multi-Stage Filtration concept

MSF is a water treatment process that combines gravel pre-treatment with SSF. Usually the process needs to be complemented with terminal disinfection, as a safety measure to protect the water prior to consumption. If the MSF system is properly designed, constructed, operated and maintained, it will produce water low in turbidity, without the presence of unpleasant impurities and most importantly, virtually free from harmful bacterias, viruses and protozoa (Galvis et al., 1997).

MSF stems from the search for pre-treatment options for surface water carrying a load in suspended solids that interfere with the functioning or surpass the removal capacity, of SSF. The initial impulse to the development of the technology has been given by research in horizontal roughing filtration in different countries and the review of down-flow roughing filters in Peru. The research and demonstration project on pre-treatment systems coordinated by CINARA and IRC consolidated this experience and gave it a new dimension with support from the Netherlands and the Colombian governments and several international and national organizations. In the pre-treatment project, different upflow, downflow and horizontal flow roughing filtration alternatives were compared. In all systems a drainage system has been included, a vital innovation that highly facilitates cleaning. The research established Upflow Roughing Filtration (URF) as the option that would be preferred in most situations (Galvis et al., 1997). Another important development brought about by the project has been the Dynamic Roughing Filter, a downflow filter that functions as a first treatment measure and as a safety valve that closes automatically when peaks in the load of suspended solids reach the treatment plant.

MSF has been well received in Colombia and some 50 plants are already constructed, some already operating for more than seven years. They have produced excellent results with respect to their removal efficiency and low operation and maintenance cost, and always produced good quality water that is low in hygiene risk. The systems are managed by community-based organizations and operated by local operators with low levels of formal education, receiving little support from sector institutions.

4.4.3 Transfer of MSF technology in TRANSCOL

The TRANSCOL Programme set out to transfer SSF and pre-treatment experience and developments to eight regions in Colombia. In the course of the Programme this goal was changed to one of transferring MSF technology, because of the close link with the pre-treatment project.

The transfer process was designed to facilitate the exchange of experience and knowledge between the communities and institutions involved, to demonstrate that they could really come to grips with the technology and the methodology and apply it in community schemes. The process was organized in such a way that the political, managerial, professional, technical and communal levels, together with the research institutions, identified and agreed on solutions to overcome prevailing limitations so as to ensure that sector interventions and investments meet their objectives and are sustained over time. This is very much related to recent ideas on technology transfer, recognizing that it is not a linear process and that interaction is needed between the technology, the local conditions and the people that will use it and benefit from it.

The combination of TRANSCOL and the pre-treatment project made it possible, first to analyse in depth the application of MSF, secondly to enable a better adaptation to the local conditions and thirdly to promote a better understanding of the pre-requisites to ensure adequate operation and maintenance. The research focused on both the functioning of the technology and its acceptance in the communities. The latter was reviewed in an evaluation workshop held with agency staff and communities involved in the Programme (Table 6). In this workshop it was found that the views of the agency staff and the community representatives concerning the technology were very similar. They very much recognized that the technology had a great potential for rural communities and small to medium size

municipalities, and could be operated and managed by members of the communities at low cost, with limited back-up support from sector institutions. The workshop showed that the community appreciated the technology, but also that it was not a panacea as it cannot cope with all water quality problems, particularly the problems of high levels of colour in the water to be treated (Chapter 2).

Table 6: Community and agency views on advantages and limitations of MSF

Advantages	***Limitations***
Accepts changes in water quality and quantity	Limitation in removal of high colour levels in some plants
Produces good quality water that contributes to a reduction in disease in the community	High peaks in turbidity may affect performance
Easy to operate and maintain, requiring a limited number of staff	Water from storage reservoirs presents problems with colour and algae
Low operation and maintenance cost, no usage of chemicals or sophisticated equipment	Difficulties in the operation of the fast drainage valves
Ease of construction and reasonable investment costs	Loss of sand during washing

Source: CINARA and IRC, 1996.

A national institution guiding the transfer process in the country. The strengthening of CINARA, the national institution that has taken the lead in the development of MSF and its adaptation to the local conditions, has been a key factor in the technology transfer process. The recognition CINARA has gained, with support from IRC, originates from the orientation that team-work with government institutions at national, regional and local levels is essential. This teaming-up helps these institutions to fulfil their social mission without their role being taken over.

Furthermore, CINARA retained an independent position by not promoting a specific technology, and by clearly orienting itself to serve the sector in the country. The working strategy had two basic principles; the participation of the community and an interdisciplinary and inter-institutional approach. These elements helped to establish trust among the participants, making it possible for the projects to be transformed into learning environments, creating a forum for resolving conflicts, and facilitating development of communities and institutions.

Others are now also benefiting from this approach, including organizations in Bolivia, Ecuador and Pakistan. The pre-treatment project and the TRANSCOL Programme have provided CINARA with the necessary opportunity to gain experience and credibility in the sector. Furthermore, the MSF technology made it possible to focus on community water supply, an area traditionally associated with limitations on adequate service provision. Both projects also enabled the establishment of links with a large number of organizations at the departmental, national and international levels.

4.5 Development of a technology-sharing strategy

The consolidated experience of the development and transfer of MSF in Colombia provides the basis for a systematic approach to technology-sharing in the water supply and sanitation sector (Box 5). The key ingredients of this approach are further discussed here.

Box 5: Key ingredients to establish technology-sharing

- a leading organization
- a platform for decision making among stakeholders
- a participatory problem analysis with communities and institutions
- informed decision making on and, if needed, testing of solutions
- participatory evaluation and focused information exchange.

4.5.1 A leading organization with access to key information

Innovations can be carried out by different actors. A sector agency can introduce changes in community water supply. But if the changes are big and involve considerable uncertainty, and if the organization has little credit with the communities, it will be much more effective to involve an independent organization to take the lead. This organization should be seen as independent, with 'no strings attached'. Organizations that are linked to specific suppliers or governments have more difficulties providing independent judgement, and even if they manage to be impartial, the other parties involved in the transfer may still feel otherwise. The organization should also be able to make long term commitments, as the introduction of a technology or methodology takes time during which interested sector institutions and communities need access to the necessary expertise and information. In view of the complexity of the sector issues, the leading organization needs to have a multi-disciplinary staff.

The organization needs to have good links with other sector agencies, and be respected by them. It is therefore helpful if the organization has linkages with international organizations, as this enables it to draw on external information sources and call in expertise if required, and may thus enhance its credibility and visibility. A close link with a university is an additional benefit, as this can ensure the availability of the necessary research capacity and the introduction of the innovation in the university curriculum (provided that a hands-on approach is acceptable to the course leaders). In the case of CINARA, the link with the Valle University is obvious; however, through the TRANSCOL Programme, linkages with another four universities in Colombia were established. In some countries, instead of a university, we may find a foundation or association of water companies and although these usually are tied in with the larger water companies they may sometimes be willing and able also to include water supply for smaller communities. Government agencies may be less suited to take up for example technology development and transfer because they are often facing relatively rapid staff changes, as a result of elections.

The leading organization should avoid trying to take over the 'social mission' of others as this will immediately reduce their effectiveness as process facilitators. Also it should adopt the principle of being a learning organization. As posed by David Korten, 'aware of their limitations of their knowledge, members of this type of organization look on error as a vital source of data for making adjustments to achieve a better fit with reality' (Korten, 1982, cited in Korten and Klaus, 1984). Members of these organizations

see difficulties as opportunities to learn and improve. It is more important to recognise a mistake than to publicise a thousand successes. The staff needs to have a very open attitude and accept changes in the process because as Manfred Max-Neef (1992) indicated

> '....every person that exactly knows where to go, is precisely the person that never will discover anything. The person that knows were to go has only two obsessions: the point of departure and the point to reach, and everything in between is an obstacle that needs to be overcome as quickly as possible, whereas the possibility of discovery is enclosed in this obstacle'.

Following this philosophy, implies that even if we know the solutions, implementing them with an open and alert mind may still lead to the development of new ideas and innovations.

4.5.2 A platform for decision making

With the new understanding that technology is deeply rooted in society, technology development and transfer needs close linkages with the society and particularly with the prime actors in the Sector. These actors can be divided into those at:

- the national and international political level, who take decisions at the macro level
- the institutional level who are involved in decision making at operational level, and
- the community level, the end-users with their expectations and possibilities to sustain the service.

All three levels need to be involved to ensure that solutions to problems are made in concert and are being reviewed from different perceptions.

In his discussion about resource negotiation, Röling (1994) introduces the concept of a platform of decision making, which he defines as a nodl point of social interaction between stakeholders to allow for integral decision making about a resource they perceive to be in need of management. He argues that stakeholders coming together in a platform to manage an ecosystem must learn from scratch about the system, agree on its boundaries, share concepts about its sustainable management, develop indicators for success and methods for making things visible (Röling, 1994). This has very interesting parallels with the water sector, where communities establish water committees that serve as platforms to manage and take decisions concerning their water supply systems, including the sensitive water catchment areas. This platform may also serve sector agencies that increasingly must enter into negotiations with communities about the service that they want. These agencies however, also need a platform at a higher level to debate and negotiate with other government agencies, development banks and ESAs about water supply and sanitation systems, water allocation and water pollution control.

It depends very much on the type of technology that needs to be transferred as to which decision-making platform is most suitable. If it concerns a simple improvement of an existing and well respected technology that is fully rooted in society, (for example, a new brand of chemicals for coagulation), it may be sufficient to obtain legal approval and then introduce it into the sector through existing sector institutions. If the technology concerns a more complex innovation, such as the introduction of MSF into communities that have not yet fully adopted the need for bacteriological safe drinking water, or to a region in which the sector agencies have not yet had experience with the technology, then

a much broader platform, or even different platforms, are needed. These platforms range from those catering for the involvement and approval of the political and institutional level, to those that operate at the interface between the institutions and the individual community and users' level.

4.5.3 Joint problem analysis

It is essential to obtain a good understanding of the problem and its causes and to share these perceptions between the institutions and the communities involved. Non-usage of new water systems or enforced sanitary installations such as latrines need not arise from technical flaws, but rather from the fact that the intended beneficiaries perceive the benefits as negligible (Vaa, 1990). In dealing with problems in the sector, a multiplicity of views on both the problem and its potential solutions will emerge, with as Checkland (1989) indicates,

> 'alternative interpretations fighting it out on the basis not only of logic but also of power, politics and personality. Any situation in which human beings try to act together will be complex simply because individuals are autonomous. Shared concepts, essential for corporate action, will have to be established, negotiated, argued and tested in a complex social process. The facts and logic will never supply a complete description of a human situation. Equally important will be the myths and meanings by means which human beings make sense of their worlds. What we share is communication of the worlds we experience, we do not share a common experiential world' (Russell, 1986 in Ison, 1993).

This implies that both the institutions and the end users should be involved in problem analysis, while the community in particular needs to be able to make informed decisions because they are experiencing the problems and need to sustain the solutions.

The use of participatory techniques such as mapping and Venn diagramming, to be discussed in Chapter 5, is very useful in enabling community members to visualise problems and joint analysis. In general, three levels of problems can be distinguished:

1. **Problems with known solutions** that have been satisfactorily applied in the area and have been adopted by the communities or the institutions in the region.
2. **Problems with solutions that have been applied in other regions** with similar institutional conditions, but that have not yet been applied in the area of work. These types of solutions need to be evaluated and possibly adapted to ensure that they function properly.
3. **Problems that are related to new areas of development** or that have been applied in a completely different institutional environment, thus requiring coordination at political and institutional level, in such way that testing may include other institutional arrangements than have so far been applied in the region.

The strategies for solving the three types of problems differ. The first type of problems and solutions can be discussed with the community in a detailed way, as all short: medium and long-term implications are known. This enables informed decision making, understanding and acceptance of the consequences. Sector agencies can usually manage this type of problem with their own staff.

The second problem level also allows a discussion of its implications, but at a lower level of certainty as the technology or methodology may require changes. Thus a period of experimentation and adaptation is needed before large scale application can be taken up. For this type of problem, learning projects are a very good development strategy that permits experimentation with the technology and capacity building at the same time, as discussed in Chapter 5. The involvement of an independent institution in dealing with this type of problem is very appropriate, particularly universities, being independent and able to draw on their Masters students and staff to implement research.

The third type of problem requires more indepth research and development activities. This may involve PhD students, and even go as far as requiring sector reform to be solved in a sustainable manner. In this case, it will not be possible to inform the community nor the institutions of the implications of changes as they will only become apparent in the process of development. These types of problems can also be taken up in learning projects, but an assessment is first required of the feasibility of the changes needed in the recipient society.

4.5.4 The identification, priorization and adoption of the solutions

The identification, priorization and adoption of solutions includes different elements. First the community has to agree on which problem is most urgent. This is not easy as a range of sometimes conflicting interests exists among the different groups in the community. An independent facilitator can be of great help in addressing problems and may also provide the objective information needed to make choices. It is also necessary, at the institutional level, to identify which are the most urgent generic problems. The institutions possessing information regarding different communities are in a good position to identify what types of problems are frequently experienced and which are the most serious. A database then needs to be established with systematic information concerning possible solutions for the identified problems. Here we can distinguish between:

- Information existing in the sector's regional or national institutions or research centres that is rarely available in a systematic form.
- Relevant information existing in projects in the working area or similar areas of the country, that is usually poorly documented and requires field visits to go through it systematically.
- Information available in international institutions and institutions that may already be available in a systematic form and is quickly becoming more accessible through electronic means such as e-mail.

Once the possible solutions have been decided upon, the institution has to develop a report describing the advantages and limitations of each, and the requirements in terms of operation, maintenance, management and cost. To facilitate the discussions with the community, this documentation needs to be easy to understand and should include illustrations or other visual materials such as scale models. The community should also participate in developing the solution as they have the most detailed knowledge of the local conditions, thus making it even more important to facilitate the process that will enable them to fully realize the implications of the proposed solutions. This requires a structured approach, as it is not always clear from the outset where the jointly developed solution will lead.

It is very important to ensure that all sections of the community are represented in the problem analysis and the identification of solutions. In El Convenio in Tolima, for example, a large part of the community came to the first meetings, and because there were so many it was assumed that all sections of the community were represented. Later on in the process it was found that nobody from the centre of the community had participated, because their water supply was reasonably good. When solutions were implemented, their water supply was affected and they opposed the solutions, creating a complicated situation which took time to resolve.

4.5.5 Evaluation and exchange of experience

Before implementing new technologies on a wide scale, their impact needs to be evaluated together with the communities and the sector agencies. To ensure that this is done in an independent way, proper indicators need to be established before the technology is put to the test. The indicators presented in Chapter 3 may serve as a guide to establishing detailed indicators for the assessment of the performance of the new technology.

Adequate documentation of the problems and the solutions very much facilitates the exchange of information and experience with other staff working in the sector. This information can be exchanged through publications and seminars, but it is also important that it is accessible in a systematic form, in a location that is itself easily accessible, such as an independent sector resource centre. Information may include data on sites that can be visited and where certain technologies have been applied. In practice these sites provide very convincing information concerning the application of new technologies and methodologies.

To ensure the best results from information dissemination, it needs to be tuned to the proposed target groups. In the context of the pre-treatment project and TRANSCOL, a range of documents, videos and training material has been produced concerning the development, design and management of MSF. This information is aimed at different levels of formal education and includes, for example, an operation and maintenance manual for the operator and also a design guide for engineers. Furthermore, several national and international seminars and training workshops have been established and the experience obtained has been integrated in the curricula of several universities in Colombia and the Netherlands.

4.6 General considerations

Adequate transfer of technologies and methodologies is a crucial element in increasing the sustainability of the interventions made in the sector. This transfer needs an institutional base that can facilitate the learning process involved and is easily accessed by sector institutions. Universities particularly, have a good possibility to take up this role, as they are usually seen as independent institutions. Furthermore, their social mission is very much in line with the required research, development and dissemination of technologies, strategies and methodologies, as important contributions to the development of society.

Technology transfer is not only the transfer of the technique, and the knowledge to operate it, but more importantly it is the understanding of how and why it functions, as this knowledge provides the basis for its adaptation to, and further development in, a specific context. Learning projects are an excellent approach to facilitate the adaptation

of technologies in a critical and creative manner and they enable experimentation under real-life conditions.

The change from introducing technical solutions to jointly developing them is based on the need to assist communities and institutions to identify and define their own problems and subsequently establish their own solutions matching the local environment and available experience. Thus the change is from technology transfer to technology-sharing, giving equal weight to the knowledge and experience of communities and agencies. This change does not happen overnight, and much depends on the attitude of the process facilitator to the communities and agencies, as will be further discussed in Chapter 5. Another important factor is that the process needs to be inter-institutional and inter-disciplinary as development problems are so wide-ranging and complex that interaction between different disciplines is needed.

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5. Capacity Building Through Joint Learning Projects

Mariela García V.; Jan Teun Visscher; Edgar Quiroga R.; Gerardo Galvis C.

This chapter discusses the strong call for capacity building in the sector and presents key principles that are included in the international discussion on this topic. The main thrust is the need to move away from the paradigm centred in the technology and adopt a development paradigm where the centre is transferred to the people. Soft System thinking is suggested as an important approach to review sector problems and identify solutions. A distinction is made between pilot projects, development and demonstration projects and learning projects as developed in the TRANSCOL Programme. These 'holistic joint learning projects' are a promising capacity building strategy that can be used to increase the effectiveness of sector interventions. In these projects participants of communities and agencies share experiences and learn by probing a problem and implementing a possible solution in a relatively protected setting that in essence reflects the real life conditions. The setting is 'protected' because all involved accept to be learners and take problems as opportunities to grow, allowing sufficient time for discussions among the political, institutional, professional and community levels. The chapter concludes with a working strategy for these projects.

5.1 Introduction

The Mar del Plata meeting (1978) already identified human resources development as a prerequisite to improve sector efficiency, suggesting a focus both on education and training and on the establishment of a stimulating institutional environment. This broad approach was not followed in practice, and human resource development was virtually limited to the implementation of a wide variety of training courses on a range of often unrelated technical issues. The effectiveness of this type of training, however, was not very clear and we still find many systems with design mistakes, that do not operate properly. Furthermore, this training does not seem to provide adequate answers to some of the main questions that resulted from the evaluations of the international water and sanitation decade: how to involve the different actors in the sector in capacity building; how to ensure that users are not just spectators; how to involve them in decision making; how to facilitate learning. One such evaluation was the 1991 end of Decade meeting in Delhi, which stressed the need for human resource development at all levels, from the local community to the political level. It was recommended not only to train participants in technical skills but also to enhance their self-esteem and their capacity to take responsibility.

The 1994 Ministerial Conference on Drinking Water Supply and Sanitation in Noordwijk reconfirmed that human resource development and a more human centred approach are perhaps the most crucial areas to ensure enhanced efficiency and the establishment of more sustainable systems. This meeting embraced the important shift of governments changing their role from provider to facilitator (IRC, 1995).

The fact that human resource development remains an important challenge implies that new alternatives are needed. The 'learning project approach' as developed in the TRANSCOL Programme appears to be such an alternative. It generates conditions in which institutions and communities enter a learning process, placing them on an equal

footing, whilst working in Programmes that respond to the specific conditions of their area. It also facilitates the development of leadership, the training of facilitators, the development of technologies and methodologies, and the strengthening of participatory processes between communities and institutions, and also gives an impulse to local development.

Campo Elias, a farmer from Cerinza in Colombia, characterized this approach in a workshop in Cali in 1996 as follows: 'In this Programme everybody is the teacher of everybody and everyone is learning from everyone'. The approach gives equal importance to academic and institutional knowledge and the knowledge and experience of the community. It values the interaction between the technical, socio-economic and environmental aspects, and strongly promotes critical creative capacity building among the men, women and children involved.

5.2 Human resources development

Capacity building, in the sense of increasing the capacity of institutions and people to improve the water sector planning and management processes, consists of three elements (Alaerts et al., 1991):

1. creating an enabling environment with appropriate policy and legal frameworks
2. institutional development, including community participation
3. human resource development and strengthening of managerial systems.

For in-country capacity building, Okun and Lauria (1991) distinguish between the national and the local level. The national level is as crucial for the development of policies, legislation and a regulatory framework. It is associated with professional organizations and national government agencies through which external assistance is generally provided. The local level is the level at which most projects are implemented, through different local actors including local government, local contractors and staff from non-governmental organizations (NGOs). Whereas this distinction is true in general terms, not enough emphasis seems to be placed on the crucial interaction between the two levels. Many institutions and politicians, as well as local leaders, involved in designing policies and implementing projects, have lost their credibility as a result of failing WSS systems - a situation which arises from a lack of such interaction. Furthermore, there is the widely held notion that most state agencies are centralized, authoritarian, formalistic and inefficient bureaucracies incapable of experimentation, learning or imaginative change (Mouzelis, 1994; Wunsch and Olowu, 1990 quoted in Thompson, 1995).

Another, perhaps even more important problem, is the fact that agency staff, universities and politicians have been trained to come up with solutions that often reflect their own perceptions of the problem rather than that of the communities. In addition, they often apply 'off the shelf' solutions they are familiar with, and do not search for the best match between problems and sustainable solutions.

On the positive side, however, we see increasing interest by public sector agencies in participatory approaches involving the community in their attempt to do more with less financial resources. They develop, for example, links with NGOs who have been using similar types of approaches. Another reason why government agencies are

searching for alternatives and are amenable to participatory approaches is that over the past two decades 'blueprint' development strategies have been shown to be ineffective in meeting the basic needs of large numbers of marginalized, vulnerable people (Thompson, 1995).

Given this situation today, the question many public sector institutions are asking is not *why* to adopt participatory approaches, but *how* to go about it. What is needed is a learning process that develops and promotes new methodologies and changes prevailing attitudes, behaviour, norms, skills and procedures within the agencies. Community involvement, and adopting an inter-disciplinary approach, imply modifications in the dynamic of projects, changing them into learning processes (Chambers, 1993).

The fact that most development funding flows through government channels underscores the importance of finding ways in which public sector agencies can learn to implement participatory approaches effectively (Thompson, 1995). Not only do agency staff need to learn to work with communities and to overcome the top-down approach of the past, but the communities themselves also need to come to grips with working with the agency staff in a horizontal relationship (Figure 13). These changing relationships are becoming even more important in the context of the strong push towards decentralization which is in place in many countries, and particularly in Latin America. In Colombia, the first steps towards decentralization dates back to 1986, when local governments became fully responsible for the provision of WSS services to their communities. This called for additional skills among their own staff and the agency staff which have to accompany them. Decentralisation requires new ways of thinking to improve the quality of decision making and to enhance sector efficiency and the effectiveness of project planning and implementation.

5.3 Basic concepts to change capacity building in the sector

The development paradigms that have been applied in the sector and are still pursued in many places focus upon technology as the way to improve the quality of life. This approach almost entirely overlooks the people involved and the context in which the development takes place. Today it is widely acknowledged that the problems are not merely technical, but are much more complex. It is believed therefore, that human resources development activities need to be reoriented. They clearly should encourage the involvement of the different actors in the sector, particularly the communities, and need to be adjusted to encompass the specific conditions of the setting in which they take place. Working towards this goal, CINARA and IRC have developed a capacity-building approach that is based on the concepts and views outlined below.

5.3.1 A paradigm centred in people

A paradigm centred in the technology makes it difficult to focus on capacity development in the actors. A development paradigm, where the centre of interest is transferred from the technology to the people (Korten and Klauss, 1984; Cernea 1991; Max-Neef 1986; Chambers, 1993), facilitates human resource development. It starts from the premise that the actors, both in the institutions and in the communities, posses knowledge and experience that can be built upon. In this concept, communities are not seen as beneficiaries, but as actors in search of their own development who will be

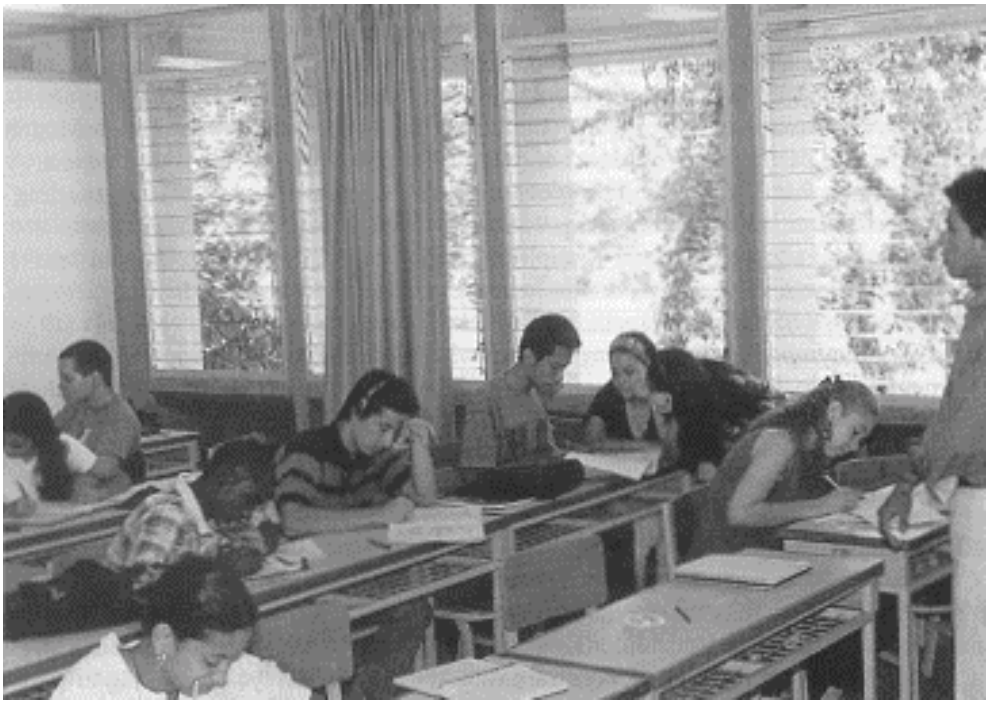

Figure 13: University students also have to work outside their classrooms to see problems in perspective

taking decisions throughout the development process. These actors have their own knowledge and views that they have developed as a result of the environment in which they live (Röling, 1988). On the other hand staff from sector institutions have knowledge and experience that will enable them, by using participatory techniques, to contribute to development and learn in a horizontal and transparent way to join forces with communities.

A project thus becomes what Engel (1995), calls a 'theatre of innovation' in which the actors are learning, receive training and are able to experiment in order to give a successful performance. It becomes a space where the authorities, the institutions and the community collaborate on an equal footing. This space enables the community to draw on their experience and to review the history of their community and their water and sanitation systems. Participatory techniques such as mapping help to visualise and clarify the situation and provide a basis for project development. In such a project, the active and creative participation of all members of the community (men, women and children) or their representatives needs to be strived for. This approach will show that differences exist between men and women in their access to resources, their involvement in decision making and in leadership - differences that need to be taken into account in a development programme.

The agency staff can greatly benefit if a project is viewed as a learning space. They are often facing a heavy work load with limited resources to experiment and find appropriate solutions. By making a project a development process, this will help to transform agency staff into facilitators and stimulate the communities to take the lead in

their own development. Such action implies recognizing cultural diversity and respect for each other, and emphasizing conflict management, joint construction of knowledge and the development of the critical and creative attitude of the participants in the process. This paradigm matches the suggestion of Nyerere (1973) who indicated that:

> 'It is not possible to develop a community, they have to develop themselves. It is possible for a stranger to build the house of a man, but not to give him the pride, confidence and self-esteem as a human being. These are virtues man has to develop himself by his own action. Man develops by what he does, by taking decisions, by enhancing his understanding of what he does and why; by increasing his own knowledge and ability and by participating fully in his community as one among equals'.

5.3.2 Dialogue and experience as the basis for learning

Adopting the view of Paulo Freire (1972) that 'students should not be considered empty vessels which need to be filled up with information', dramatically modifies the concept of the external agent who knows all, while the recipient community knows nothing. In the learning project approach the external agent becomes a facilitator, who knows some things but needs to learn as well. Hence the external agent can share in the exchange of experience and is empowering the community and the participating agencies to challenge the existing situation and model it to suit their own objectives. So what we then need to turn to is Freire's 'problem posing approach' in which the participants, community members and agency staff are challenged to use their creativity to identify problems and possible solutions and will be encouraged to take action accordingly. This brings us into the field of experiential learning (Packham et al., 1989) which follows the cycle of:

- experiencing: ----- doing an activity
- processing: -------- reflecting on and discussing the activity
- generalizing: ------ inferring from the experience at a higher level of abstraction some 'truth' about how things work
- applying: ---------- making use of the generalizations to become more effective.

Packham et al. (1989) use the metaphor of a swimming pool, which we borrow as it nicely clarifies the learning project approach. Participants are not thrown in the deep end and left to swim or drown! They are given instructions on the side. They see others swim in the pool, and they are encouraged to go in when they feel able. Some start at the shallow end, where they can touch the bottom, but all have eventually to get to the deep end. Some feel the water is cloudy, so when they come in they find others that they thought were swimming, really touching the bottom! Some wonder who is teaching whom, or saving whom from drowning.

5.3.3 A systemic orientation

'Hard' system thinking has been at the heart of the WSS sector for a long time, seeing technology as the main solution to a straightforward problem of people not having adequate water supply and sanitation facilities. According to Checkland (1989), hard system thinking assumes 'a relatively well structured problem in which there is virtual agreement on what constitutes the problem: it remains to organize how to deal with it'. The reasons why hard system thinking has been persistent in the sector include the dominance of engineers, who in their educational background are very well equipped to

think systematically and to focus on problem solving. What is needed, however, is to think in a systemic way, questioning the problem in its overall context and leaving room for different interpretations. Another reason for hard system dominance is the virtual absence of the users in discussions and decision making about problems and solutions. Usually the External Support Agency (ESA) and national government staff jointly decide on what they consider to be the problem, and often the ESA agency staff have the main voice because they hold the 'purse strings' on which the national staff depend. So problems and solutions 'invented' by the external actors are not shared with, or perhaps not even perceived by, the local receivers, the 'end users', who are perceived to be simply a passive audience. Yet in the end, the users do have a voice by actively rejecting the solutions through not using them or not maintaining them properly.

In practice, a multiplicity of views on both the problem and its potential solutions will emerge, suggesting that absolute truth does not exist (Engel, 1995). We deal with different interpretations of reality that are products of the experience, knowledge and views of participants: with

> 'Alternative interpretations fighting it out on the basis not only of logic but also of power, politics and personality. Any situation in which human beings try to act together will be complex simply because individuals are autonomous. Shared concepts, essential for corporate action, will have to be established, negotiated, argued and tested in a complex social process. The facts and logic will never supply a complete description of a human situation. Equally important will be the myths and meanings by means of which human beings make sense of their worlds' (Checkland, 1989).

This brings in the need to adopt a 'soft' system methodology, which is a learning system. The learning is about a complex human situation, and leads to understanding the situation and taking purposeful action aimed at improvement: action which seems sensible to those concerned. It articulates a process of enquiry which leads to action, which in turn changes the situation; hence inquiry can continue until you choose to end it. It is intrinsically a participatory process because it can only proceed via debate. The debate both defines the changes which would bring about improvement and seeks to motivate people to take action to implement them (Checkland, 1989).

5.3.4 Matching the disciplines

Development problems are of such magnitude that they cannot be resolved from the perspective of a single discipline or a single institution (Max-Neef, 1987). It is therefore needed to break the barriers and create a space where the different disciplines and the community can meet, review developments and contribute their experience. This permits all actors to jointly explore the causes of problems, identify solutions and establish commitment about their implementation. The experience in Colombia shows that a lot of professionals, as well as community members, working in this way have gained self-esteem and are dedicated to following the course of events to its conclusion. These professionals very much believe in the importance of interdisciplinary interaction, as was expressed by Virginia Chumacero, one of the participants in the participatory evaluation in Bolivia:

> 'This approach is much better than what normally happens, with engineers saying 'don't mix with my taps, just stay with your questionnaires. Here we have worked together and shared the information which gave us a much better base to understand the problems.'

The provision of water supply and sanitation services, and the protection and conservation of water resources, involve a range of issues (including legislation, regulation, financing and surveillance), that are under the jurisdiction of different institutions at national and regional level. Working in isolation, with a lack of coordination between the levels, involves a high risk of duplication of effort, the taking over of the roles and responsibilities of others, and the possible loss of credibility in sector institutions. Joining forces and working together helps to clarify the social missions and competence of the different organizations, and will help establish solutions that meet felt needs, with each institution contributing to or optimizing the utilisation of institutional and community resources in the sector.

5.4 The role of the facilitator

In view of the complexity of the problems and decisions in the field of human resources development, the facilitator plays a crucial role. If we take the view of Freire, who challenges the participants (members from the community and the institutions) to use their creativity to identify problems and possible solutions and take decisions accordingly, then a learning environment has been created in which participants can question and confront their view points and perceptions. In this approach the teacher, the expert, transforms into a process facilitator, stimulating the students to learn from experience in an efficient and effective way and to develop their own learning autonomy (Packham et al., 1989).

This change in role, from teacher or expert to facilitator, needs time and may meet with serious opposition, as established values and approaches often have a directive character. The facilitator needs to establish a horizontal attitude in which the teacher or expert does not have all the answers to the problems that are being encountered. Initially, experts may feel vulnerable, as they cannot follow their traditional role. They too have to learn and seek training to be able to act as effective process facilitators. This implies that they have to acquire experience with participatory techniques and learn how to give active and critical, but positive feedback.

It is not enough for a facilitator to learn new methodologies, new 'tricks'. It is more important that he or she adopts a learning attitude, and is able to establish an environment of respect for conflicting views, even to the extent that they go against his or her personal opinion. A facilitator thus needs to be a mediator of the discussion and stimulate the participants to express their views and ideas.

It is important for the facilitator to follow a collective learning process, that starts with dialogue, or an open exchange of ideas in the group. This permits the participants to discover their potential and perspectives, which is difficult for them to do alone. This dialogue differs from the more common discussion, which has its roots with 'percussion' and 'concussion', literally a heaving of ideas back and forth in a winner-takes all competition (Senge, 1990). Team learning develops the skills of groups of people to look beyond individual perspectives. It requires a positive learning environment. This is not easy, particularly in a politicized environment such as the water and sanitation sector in

Colombia. Not only are good facilitation and a variety of techniques required, but also leadership training for group members and a review of the historical developments with the community. Equally important is the need to review with the sector staff the social missions of their institutions and their own aspirations. This requires building confidence and trust, helping them to become self-confident and gain self-esteem. A guide to this process was already provided by Tao to Loa (700 BC):

> 'Go to the people, live among them, learn from them, love them, start with what they know, build on what they have. But of the best leaders when their task is accomplished, their work is done, the people all remark: We have done it ourselves'.

5.5 The training of actors in the learning process in TRANSCOL

In TRANSCOL an environment was established in which staff from the institutions learned about MSF technology and its application in community water supply projects. This was founded in the view that the perception of the problem and the solution were clear in the institutions that were promoting the technology. The challenge was thus limited to finding locations with adequate conditions for the implementation of the MSF technology. Nevertheless, in the course of the Programme, it became necessary to adjust the approach, searching for a wider learning strategy that made it possible to confront the diversity of problems encountered, and which clearly went beyond the initial objectives of the Programme.

5.5.1 The training process in the Regional Groups

Eight Regional Groups were formed in TRANSCOL, involving staff from at least three types of institutions, related to policy formulation, implementation and water surveillance and control. In practice, no staff from NGOs were involved as they do not play a strong role in the sector in Colombia. In each region a two person team from CINARA, with a technical and socio-economic background, acted as facilitator.

A process of training and learning was initiated with the Regional Groups that included a review of the social missions of the participating institutions and of the cultural differences existing in the regions concerned. The emphasis was on learning by doing, while being provided with consolidated information. It also encouraged participants to critically review their daily practice and explore possibilities for improvement. Specific training events were established both in CINARA in Cali and in the regions. These included events with separate and combined training sessions for the participants dividing them in two groups; one for persons with a technical background and one for those with a socio-economic background. Key elements in all the events included:

- integration of participants, to break the ice and establish an environment to learn and respect
- review of the experience of participants in the specific issue
- provision of information and combining this with participants experience to establish new views on the issue
- evaluation.

The use of techniques that called upon the creativity of participants (painting, modelling, music, poetry and theatre), as well as participatory techniques, was another constant factor (Figure 14). This enabled participants to discover or rediscover capacities that are under-utilised in their professional work and created openings to other forms of transfer of knowledge (e.g. instead of an oral presentation, participants made a map with the geographic, socio-economic and cultural characteristics of their region or community). This type of training helped the participants to adopt a different, more horizontal style of work in the training and with the communities.

Figure 14: A creative environment helps participants to share experience

Initially there was resistance to technical and socio-economic staff working together, but gradually this was accepted, becoming an enriching experience. As a result, this type of joint activity is now included in the curriculum of the postgraduate course in Sanitary and Environmental Engineering in Valle University, covering issues such as community, culture and society, community participation and leadership.

Taking into account that MSF technology did not form part of the university curriculum in Colombia, the training approach took as a starting point the critical review of the design parameters for this type of technology (water quality, supply volume, number of users etc.) and of the topography and other key aspects of the proposed site for the plants, including analysis of the carrying capacity of the soil. With this information, staff from the Regional Groups came to CINARA to make an outline design for two projects in their region with the help of the staff and advisors from CINARA. During their stay they also drafted a socio-educative plan to work with the communities on the basis of the conditions found in the communities.

5.5.2 Training in the communities

TRANSCOL ensured interaction between the community and the institutions during the project cycle, introducing more horizontal relationships and exchange of information as equal partners. Although the first contacts were with local authorities and formal leaders, early in the project the involvement of the community as a whole was promoted, through activities such as house visits and pamphlets that were distributed with the monthly receipts. The community were particularly encouraged to participate in the 'creativity workshops' (Box 6) that officially represented the start of the project in the community. In this workshop their views were sought on their water supply, and details of the project were explained. These workshops were repeated in the course of the project to discuss different project issues, including characteristics of the technology, construction contract, community monitoring, establishment of tariffs, operation and maintenance. In these workshops, agreements were established on actions to take in the immediate or near future and mural papers were produced by the participants as a means to inform other persons in the community.

Box 6: The Creativity Workshop as learning environment

The creativity workshop became the most important meeting place over the lifespan of the project. The workshop theme changed as new elements needed to be catered for in the project, but the approach was very similar, providing opportunities to enhance self-esteem, strengthen the cultural identity, give room for creativity and stimulate integration.

A considerable number of persons (say up to 50) can participate in this type of workshop that helps to stimulate the self-esteem of people and their feeling that they are part of a community with specific cultural characteristics.

Each workshop starts with a session of getting to know each other, using techniques of group dynamics, followed by a creative way of seeking the views of the participants on the theme at hand, through theatre play, painting, music, modelling or poetry. These views are further established by a discussion encouraged by the facilitator (a staff member of the Regional Group or CINARA). The workshop always concludes with proposed action points and the nomination of a person responsible to see they are put into practice.

Art is used in the workshop to enhance the perception and sensitivity of the participants, faculties often dormant or undervalued in modern society. These faculties (vision, sound, feeling, taste) provide the basis for change of behaviour which is often required in projects related to water supply, sanitation and protection of the environment. It is just not enough to provide information, people need to become sensitive to the need to do things better. This also provided a sound base for the intercultural dialogue that is often needed in technology transfer processes.

TRANSCOL did not include a specific gender perspective. Basically, activities focused on the community as a whole, but some specially focused on women. This enabled them to analyse their problems, needs and interests as related to water supply and sanitation, and to propose their own solutions. The Programme helped to create new leaders in the community, among whom were several women who established Support Groups that worked together with the Water Committees and are prepared to take over that role when their term in the committee is completed.

To clarify certain problems in the community, metaphors were used to enhance understanding. For example, to discuss the need to increase tariffs in order to be able to improve the service, the local bus was used as a metaphor, with community members taking up different roles (driver, passengers, mechanic etc.). This was followed by a discussion on why it was necessary to purchase a ticket to ride the bus, and what costs were included. Then a parallel was drawn with the water supply system, exploring what

costs were involved in its maintenance and who should bear these costs. The results have been more than promising, with community members readily accepting relatively steep increases in tariffs to ensure that the system is sustained, sometimes moving up from 100 COP (0.1 USD) to 1000 COP (1 USD) or more.

To enhance understanding about water quality and the function of water treatment, three glasses were filled with water from their water system, that usually did not include treatment. To one glass, some mud was added, to create turbidity, and to one, iodine was added to generate colour. Then the question was raised in small groups of some five persons which water they would drink. Most groups decided to drink the tap water from the glass that had not been tampered with. Then a microscope was used to review this water and most of the time a large number of living species were identified. This then provided the basis to proceed with the function of water treatment and the different components of the treatment plant. Another tool that was very much appreciated by the community was a scale model of a treatment plant.

The community was also prepared for the monitoring of the construction process (Figure 15). This is now an official requirement in Colombia if government funding is involved, as specified in the Constitution of 1991. Community members, trained by CINARA and staff from the Regional Group, worked together with the contractors in safeguarding the quality of construction, an approach in which little experience existed in the country. The reaction of the contractors was not always positive, particularly not in the beginning. Gradually they became to understand that providing good quality structures, that were to the satisfaction of the community, would open up new opportunities for them in the market.

In this stage the operators were selected and trained, partly together with members of the water committees. The operator was usually selected from the community members that had participated in the construction of the system. In the process, the importance of the water committee was clarified to the community, sometimes using a video on operation and maintenance. In some cases the newly emerging leaders were integrated in the water committees, helping them to take up a more dynamic role.

5.6 Evaluation of the strategy

An element that was not strongly developed in the Programme was the establishment of process indicators. The results were indicated in terms of products such as manuals, videos and treatment plants. This was partly overcome by reviewing the experience in a participatory workshop in which different programme levels were involved, including community members and staff from the Regional Groups. Those staff concluded that a truly integrated process had been followed and indicated that, perhaps for the first time, they had been working in an interdisciplinary and interinstitutional way in their region.

Figure 15: Joint review of achievements is a powerful tool for learning, El Retiro, Cali, Colombia

They also commended the horizontal and participatory process with the community as an enriching experience, greatly contributing to the success of the Programme. The reaction of the members of the community was also positive, but also included some elements that could be further improved (Table 7).

5.7 Learning projects as a strategy for technology transfer

Sector organizations often establish pilot projects as a means of introducing new technologies which they have also partly used to build the capacity of staff in developing countries. This was the case in the pilot research which CINARA and IRC have been carrying out on pre-treatment technology in the water treatment plant of El Retiro in Cali. Whereas these projects have been useful for the introduction of low cost technologies and create an important space for research, they usually end with the question of how to go to scale. Because the pilot project setting is fully controlled, it often does not really reflect the daily life situation of the country or region.

This brings us to development and demonstration projects, such as those applied by IRC and its partners to promote slow sand filtration technology in six different developing countries (Visscher et al., 1985). Whereas these projects serve their purpose in demonstration terms, their contribution to capacity building is often limited to the few staff directly involved, with others being reached through more conventional approaches such as training seminars.

Table 7: Strength and limitations of the learning process in TRANSCOL according to community representatives

Strengths	***Limitations***
The integration activities to join with the neighbours	Lack of understanding of some community members of the activities of their leaders
Capacity building to better handle the process in the community, and to better defend community rights	In some communities the tariff discussion created demotivation among some people
The exchange of information and experience with other communities having similar water supply problems	Changes in the municipal administration hampered continuity of the process
Awareness raising and sensibilization of the community	Political differences between the mayor and a large part of the community
Strengthening of community institutions and of their management capacity	
Joint establishment of new tariffs with the community	
The projects enabled adjustments of the technology and methodology to tune it to the local conditions	
Everybody is the teacher of everyone, it is a collective learning and training programme	

(CINARA and IRC, 1996)

TRANSCOL started as a development and demonstration programme to introduce MSF, selecting communities with the potential to apply this technology using the selection criteria indicated in Chapter 2. The strategy, however, went further because funding of the projects was not guaranteed and had to be found locally. This made the projects reflect the real life situation to a higher degree. One project, for example, was interrupted for two years because of a change in the municipal government. Table 8 indicates the views of the Programme participants from both the Regional Groups and the communities on this approach, clearly showing that the demonstration character of the projects was achieved. The projects are continuously receiving visitors that are interested in the technology and the working approach to integrate the community in the process.

In the course of the Programme, it proved impossible to concentrate just on introducing a water treatment component. A wide range of problems arose, some closely related to construction and management of the plant, others relating to the systems as a whole, including the protection of water sources and efficient water use. Problems included the poor quality of distribution systems, the lack of interest of some community members in water quality improvement, internal conflicts in the community and limited management capacity of communal systems. In response to these 'problems' a different approach emerged, which we now call 'holistic joint learning projects'. This type of project applies a holistic process in a relatively protected setting, in which participants can share experiences and learn by probing a problem and implementing and adapting possible solutions and methodologies. The setting is 'protected' because all involved accept to be learners and take problems as opportunities to grow, allowing sufficient time for discussions among political, institutional, professional and community levels. Learning projects, inspired by the concept of sustainable human development, create a space where sector professionals from different institutions and disciplines and communities practise and come to appreciate the great potential of discovery learning, learning by doing. This implies putting emphasis on communication, equally respecting

the knowledge and experience of the participants and ensuring their cooperation in decision making. The active and creative participation of the community (men, women and children) or their representatives in all project phases is especially strived for, adopting the concepts indicated in Section 5.3.

Table 8: Strengths and limitations of the demonstration projects (CINARA and IRC, 1996)

Strengths	***Limitations***
Fulfil a transfer function as the projects continue to receive visitors including authorities, agency staff and community members	The limited experience with MSF construction resulted in some projects having operational problems (that are being rectified)
The systems cope very well with overloading and produce water low in sanitary risk	In a few plants peaks in turbidity and colour are not sufficiently reduced
The technology has been accepted by communities and institutions	Insufficient improvement activities are implemented in the water catchments
Operation and maintenance is fully in the hands of the community with a minimum of external support	Strategies to enhance efficient water use need to be developed or strengthened
The inputs from local government and the community, including fund raising, made the projects possible	System management by the community needs to be improved and better supported
The community has been better organized	In some plants operators have been replaced because of political changes in the community
Women's participation in community organizations has been increased	
The systems have converted into cultural and learning spaces for scholars and people from the community	

The staff involved in learning projects quickly create a multiplier effect, as they also work in parallel in other projects, diffusing the experience continuously. This enables them to try out the new concepts in these parallel projects, with other communities and other colleagues, and to have the possibility to reflect and consult with the facilitators of the learning projects about possible problems in the parallel projects. The key to the approach is the building of trust, transparency and respect that stimulates the exchange of ideas between participants and enables their active participation in decision making.

Joint learning projects do not replace pilot projects or demonstration projects, as these have a role to play in an initial phase of the introduction of a technology, testing if it works and whetting the appetite of sector agencies. Once this initial development phase is over, joint learning projects offer a great opportunity to adapt technologies and methodologies, enhance the sustainability of project interventions and develop the capacities needed in the institutions to facilitate wide implementation of technologies and methodologies that have been developed, thus creating a multiplier effect through the capacities developed in their staff.

The new perspective is to go even further, and use the learning projects as a major tool to enhance sector efficiency. In this perspective the government, sector agencies and communities jointly develop and experiment with strategies and solutions to key sector

problems. This implies a scheme as indicated in Figure 16, in which sector learning projects are implemented in parallel with mainstream projects. Once a solution for a generic problem is consolidated this is introduced in these mainstream projects. Investments have an immediate impact, because tools developed in the learning projects are readily available and come with experienced staff who have used them in the field. When starting this process it is essential that the institutions guarantee the formation of a multi-disciplinary team with sufficient time to see the job completed.

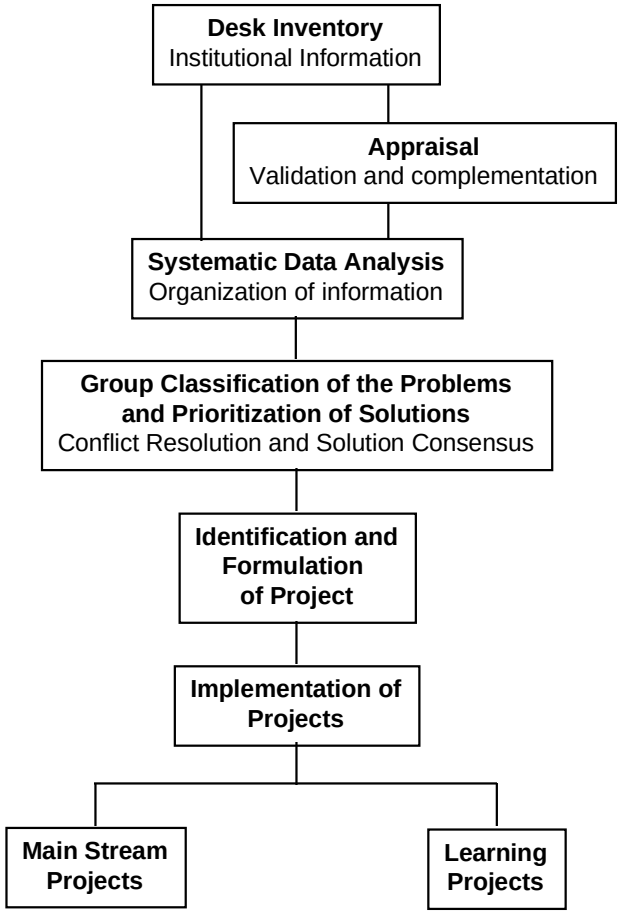

Figure 16: Learning projects identification and implementation

The experience obtained over the past years in Colombia provides the basis to structure the learning project approach as summarized below:

5.7.1 Identification of a facilitator

The facilitator or facilitating institution plays a crucial role and needs to be respected by the participants in the process (Section 5.4). It may be the case that one of the participating institutions has experienced staff that can assume the role of facilitator. If this institution is very much part of the problem however, it may be better to have an independent facilitator, and this is absolutely necessary if the communities do not have much trust in the leading organization. In the projects in TRANSCOL, CINARA staff initially took on the role of facilitator, as the regional teams did not have much experience in participatory processes, nor in MSF technology. CINARA was accepted by both the agencies and the communities, as they were clearly seen as an independent institute without a 'financial' interest to promote the MSF technology or favour certain decisions.

5.7.2 Establishment of the team and identification of priority problems

The development of a multi-disciplinary team is also an important element in the learning project approach. This team should comprise representatives of the key actors in the area of intervention, including governmental and non-governmental institutions as well as the community. It also needs to be very clear as to who to train as future facilitators, in order to sustain the multiplier effect. If a generic problem needs to be solved that involves research activities, it is very useful to involve a university as their social mission is to enhance knowledge.

The team members assume the responsibility to collect information on the area of intervention available in their institutions. Thereafter a more indepth participatory analysis of the problems will have to be made by the team, to specify and prioritize the problems and clearly establish the objectives and expected results from the 'Joint Learning Projects' that are to be developed. It is important to realize that problems related to water supply systems can be of a technical, socio-economic, environmental or managerial nature, thus underlining the importance of multi-disciplinary team work. When the project area is specified, working with communities can be intensified, as the activities, including the establishment of solutions, will be taken in hand and completed so their efforts will show results. Communities and institutions together review the local situation, including the condition of the water sources, the level and quality of water supply and sanitation service and the management and control of the systems, using the type of indicators presented in Section 3.4. In the situation analysis, not only will problems be detected, but also the opportunities and community resources needed to overcome them. It is very important that all sections of the community are represented in the process. If in the beginning certain sections do not participate, ways have to be found, together with those that are participating, to gradually involve them.
The participatory review process includes:

- A reconstruction of the history of the community and their water and sanitation systems.
- Mapping of the community and their water supply system, including an analysis of the socio-economic diversity and the main problems occurring in the system and the water catchment area.
- A sanitary inspection of the water catchment area to establish problems and risks of contamination and of deterioration of the area.
- A review of the use of the different water sources and of sanitation facilities.
- Interviews with selected users in different sections of the community and different locations in the distribution network.

Processing the information includes a comparison and tabulation of the data obtained through different means and from different groups. The data need to be discussed with the community at a time of day that both men and women of the different community sections can participate. At this meeting, priority problems can be identified using a selection matrix or another participatory technique. A first review of possible solutions can also be made, and preferably already in this meeting a first action plan will be developed, including activities that the community and the agency can undertake immediately to improve part of the situation as well as longer term action. For each activity, clear indicators have to be established in order to be able to agree on what is to be achieved and how this will be measured, and someone has to take the responsibility to coordinate the activity. This participatory review needs to be completed with a brief report that will usually have to be drafted by the agency staff for review and adjustment with community representatives, including the water committee, to ensure the reliability of and reconfirm the agreements.

5.7.3 The implementation and adaptation of solutions

When problems are identified that require a technology or methodology that is not known to the community, the agency staff review and select possible solutions that can match the socio-economic, cultural and environmental conditions of the community. These options are then presented to the community, with an explanation of their full implications, including the advantages and disadvantages, investment and operational costs, operation and maintenance requirements and their level of complexity, the basics of their functioning and the time and efforts involved in system construction. This will enable the community to make an informed choice concerning a system they will have to sustain.

Implementation of the solutions follows the normal project cycle, including the development of a detailed design and work plan, possible tendering, construction, operation. A difference exists, however, in the intensive interaction between the community and the agencies in a permanent training and learning process that establishes full understanding of all project phases and adequate community involvement in supervision of construction, both in technical and financial terms and in decision making.

This stage implies the integration of new actors, such as staff from constructing firms, that need to take part in the participatory process. This is helped by a joint periodic review of project progress, including an analysis of mistakes and ways to overcome them in the best possible way, and so taking them as an opportunity for development.

In this phase, the conditions are also established for the future operation and maintenance of the system. The enhanced understanding of the community provides a solid basis for more careful management, and the construction process can be used to select and initiate the training of system operators. An element that may highly contribute to good system performance is the promotion of a reflection process with the community on the importance of good system management, efficient water use and the establishment of a fair water tariff that needs to be promptly paid to be able to pay the cost involved in running the system. This can be combined with support activities that will strengthen the organizational structure and the management capacity.

5.7.4 Monitoring and evaluation

Monitoring and evaluation makes it possible to keep track of progress and review whether results are as expected or if changes are needed, as well as giving an indication what lessons can be learned. Establishing clear indicators at the start of the process will enable objective measurement of achievements. Making these processes participatory is also very important to enhance the feeling of truly joint activity, and it will be easier to make adjustments if needed, if all participants are involved.

The review should also include an analysis to assess whether the internal structure of the institutions is adequate to support the communities in their efforts to sustain their systems over time. Ideally, a minimum of external support is needed after the intensive project intervention has ended, but still this support should still be readily available; at the moment this is often not the case.

5.8 General considerations

Capacity building is recognized as one of the key elements in ensuring that sector investments and interventions are efficient and sustainable. It is clear, however, that a change in focus is needed, to ensure that a more human-centred approach is adopted, both in the institutions and the communities. A human-centred approach places emphasis on mutual respect, conflict management, joint construction of knowledge and development of the capacity of the participants in a creative way. It should be recognized that the work in the sector is taking place in a complex environment with important cultural, socio-economic and political differences, where uncertainty always is present. The enriching component is that considerable emphasis is placed on the process and not so much the product; learning how to fish instead of providing people with fish. This implies the development of a learning opportunity and a space where all participants learn in horizontal and transparent interactions. Learning projects represent this space and facilitate harmonization of different views and perspectives, development of understanding and joint decision making between agency staff and community members.

The development of learning projects makes it possible for the institutions to compare results with non-participatory projects, identifying the advantages and limitations of participatory processes through their own action and experience and to initiate changes in their organization. It will also help them to visualise that the sustainability of water supply systems is not gained through occasional inputs or provision of well designed systems, but in the quality of the process and the decision making with the communities involved.

A joint learning project is not a linear succession of activities, that progressively develop over time. On the contrary, it is an evolutionary process of trial and error, in

which errors are not hidden but are recognized as an important source of knowledge. Change is possible only if a flexible process is established that can confront problems when they present themselves. The process is open and technologies and methodologies are open to change if circumstances so require.

One concept that changes through learning projects is success and failure. For many working in the development field, it has been common to think of successful projects as projects that exclude failure or difficulties. This way of thinking needs to be changed as we can learn from errors and work on overcoming them by building thrust in the group that implements the learning project.

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