4. RESEARCH DESIGN

The research goal was to generate the conceptual frameworks and tools aimed at improving the performance of WSS projects in small settlements.

4.1. HYPOTHESIS

This research focused on the interactions between the environment, the community and local institutions, and science and technology that influence sustainability. The hypothesis was that WSS projects which are conceived as learning spaces for all stakeholders lead to more sustainable technological solutions.

4.2. OBJECTIVES

a) To analyse systematically the factors, stakeholders and relationships that contribute to the success and failure of WSS projects,

b) To identify the key interactions between community and local institutions and science and technology that influence the sustainability of technological options in the WSS sector, and

c) To develop and validate a model for technology transfer that facilitates co-ordinated work between stakeholders and strengthens their capacities.

4.3. METHODOLOGY

This research used the principles of "systemic participatory action-research approach" (Luckett *et al.*, 2001) in which one of the methodologies is the Soft Systems Methodology. It is one of the Systems Methodologies applied to analyse complex problems with strong social components (Jackson, 2001). Soft Systems Methodology is "a process of inquiry and action for improving unstructured problem situations where the issues of concern are vaguely perceived but not clearly defined" (Luckett *et al.*, 2001). A system is defined as a set of components "that are interconnected to form an adaptive whole, to which can be ascribed a purpose" (Luckett *et al.*, 2001). The relationships between the components and the processes

are more important than the components themselves. Theoretically, the systems can be open or closed; however, the systems in real life are open with a strong interaction with their context. A system can adapt to perturbations produced by its own components or by the influence of the context; when a system cannot adapt to the changes it collapses and usually, a new system is created. A system has the following characteristics (Nakamori and Sawaragi, 2000):

☞ Both the conditions of the surroundings (context) and the structure of the system (components and their relationships) determine its functioning,

☞ A change in any of its components affects the entire system,

☞ All systems evolve, and

☞ All systems fluctuate.

There are several methods to analyse a system such as Systems Engineering, Systems Analysis, System Dynamics and Operational Research. However, they have limitations when applied to social systems because they are based on the researcher's "objectivity". Action research applied to system analysis becomes Soft Systems Methodology (SSM) which was developed by Checkland (1981). The main characteristics of SSM are (Checkland, 1981):

▪ The world consist of a complex of interacting systems,

▪ Human beings can attach different meanings to the same social acts, and

▪ SSM is a learning system.

Checkland (1981) proposed seven phases in the SSM (Figure 18), although following all the phases is not a requisite to use the methodology.
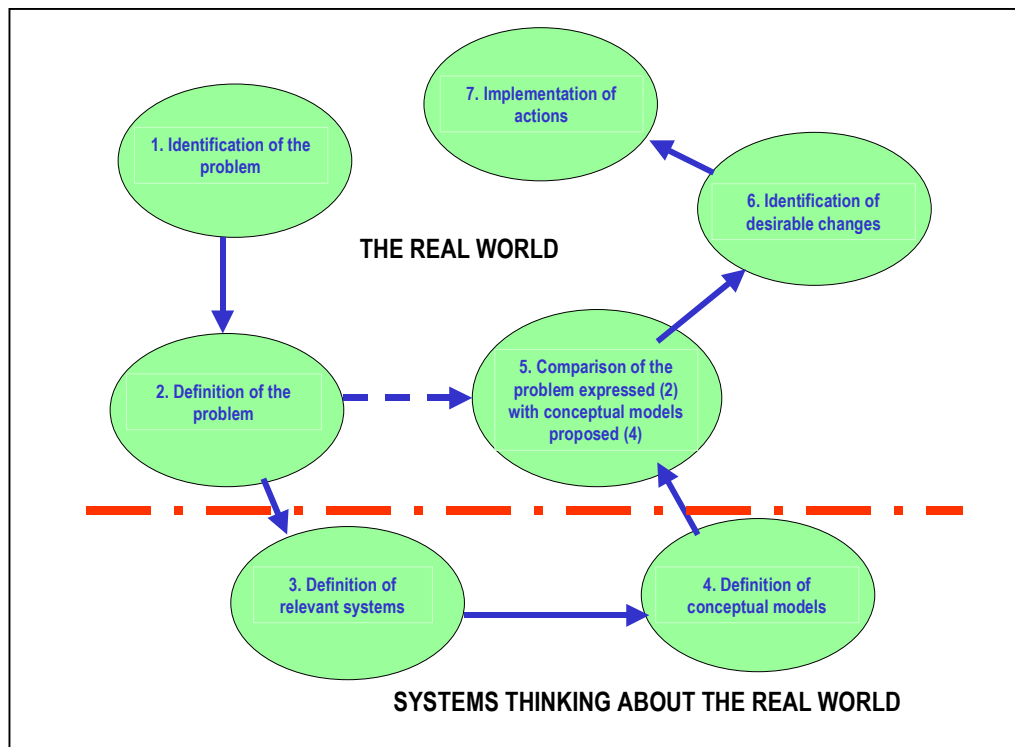
Figure 18   Phases in SSM

Source: Checkland (1981)

The core process in SSM is action research (See Figure 19), which is a process of joint learning where the participants discover their own realities and also create new realities (Ottosson, 2001). The objectives of action research are improvement and involving (Dickens and Watkings, 1999). Problems are solved by the participants by analysing the situations, planning and implementing actions jointly to solve problems, monitoring and evaluating the results and learning lessons in order to repeat the process with the new situations that emerge after actions are implemented (Morrinson and Lilford, 2001; Hampshire, 2000). It is thus a spiral process used in complex social situations where the process is unique and irreversible. In this method, data are obtained as they are produced by the participants; this is the opposite of most other qualitative research methods in social sciences where data are reconstructed retrospectively such as case-study methods. Participatory action research implies that the researcher plays a double role as a researcher and as a manager; the researcher also participates in the process (Ottonsson, 2001). The advantages and disadvantages of participatory action research are shown in Table 15.
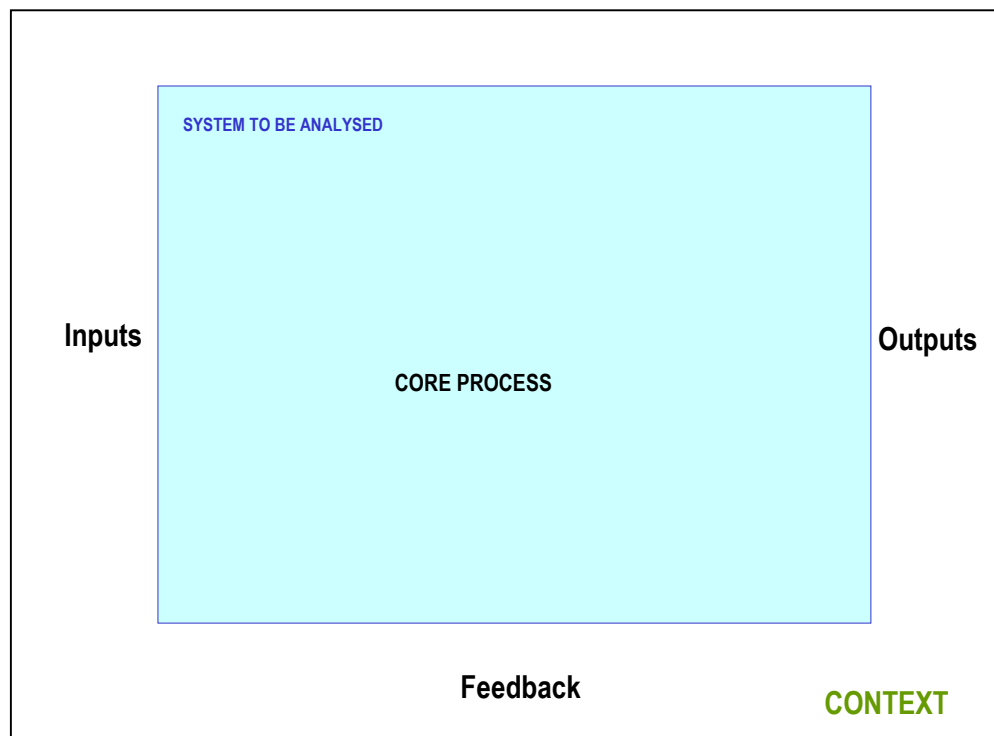
Figure 19   **The process of action research**

In the process of action research, a problem is identified in its context. Usually, an outsider facilitator helps the team to work together. The action researcher collects the data working as part of the team. Data can be obtained using techniques such as interviews, conducting surveys, and measuring, amongst others. The researcher can use any other technique that he/she considers useful. The team identifies the changes needed by analysing the data, planning the actions, and implementing them (Badger, 2000). While implementing the actions, monitoring is done in order to observe the changes and obtain feedback on the actions; evaluation of the changes is carried out to identify the impact of the actions, and the lessons learnt are identified to be applied in the new situation.

Table 15   **Advantages and disadvantages of participatory action research**

ADVANTAGES	DISADVANTAGES
Data are obtained as they are produced	It is more demand and complex that other research methods in social sciences
Information is reliable because it is obtained without any filtering as soon as it is produced	It can be difficult not to be captured by the problems and details
Uns... uns...	
Finc... fast... inte...	e... er
Bett... part...	
The... rela...	
It is... ong...	th
The... kno...	
Dial...	...all
The... peo...	

In this research, processes were analysed in specific projects. The methodological framework is shown in Figure 20. The research was developed through CINARA projects with the participation of CINARA staff, local and regional institutions, and communities. Initially, the TRANSCOL Programme – Phase I provided the first elements by identifying some of the causes of successes and failures in water supply projects. In addition, the TRANSCOL Programme identified some of the problems associated with a transfer process that followed a model developed by industrialised countries. A second phase of the TRANSCOL Programme was funded to make it possible to correct the failures and to include important elements to complete WSS projects. As a result of the work carried out in the TRANSCOL Programme, many concepts were discussed in CINARA and new frameworks were developed. One of these was the concept of sustainability, which then was developed for several years until it reached the final stage shown in item 3.1. The conceptual products of the research described in this thesis (Chapter 7) were developed through action research projects applying SSM with the participation of the CINARA teams, the local, regional and national institutions, and the communities. These conceptual products were developed by the researcher based on the following programmes carried out by CINARA:

Figure 20   Methodological process

a) Programme for strengthening local capacities to deliver WSS services in the rural and hilly urban areas of Cali Municipality (See chapter 5).

The programme in Cali Municipality began in 1991 and lasted eight years. This programme was managed by the researcher and the TLPs were managed both by the researcher and her colleague, Mr Adolfo León Hoyos. The CINARA team throughout the programme included a Psychologist (Ms Jackeline Garavito), two Sociologists (Ms Cecilia Gómez and Mr Aníbal Valencia), a Social Worker (Ms Sandra Bastidas), five engineers (Mr Alberto Benavides, Mr Ivan Rivera, Mr Miguel Peña, Mr Alexander Aponte and Mr Adolfo León Hoyos), an Ecologist (Mr Alvaro Espinosa), two Economists (Mr Mario Pérez and Mr Jhonny Rojas). The CINARA team developed the planned actions jointly with communities and institutions. Both the conception of the programme and the conceptual frameworks emerging from this programme were developed by the researcher.

This programme was financed by the Municipal Service Agency (EMCALI) and was developed through specific projects identified by both CINARA and EMCALI. The sustainability framework that had been developed in the TRANSCOL Programme was applied and improved by the researcher who proposed a model to invest in WSS at the local level as part of her MSc thesis in Systems Engineering (Restrepo, 1995b). The model included a new concept, known as learning projects, which was accepted by the municipality. The first learning projects led to the development of the concept of Team Learning Projects (TLPs) as a strategy to contribute to the sustainability of WSS systems which was developed by the researcher between 1994 and 1998. TLPs are one of the concepts proposed in the present research. Additionally, based on the Cali programme, the researcher developed a new model for technology transfer - the *knowledge dialogue* model.

b) National Programme for the Sustainability of WSS Systems in Colombia (see chapter 6).

The programme was managed by Mr Edgar Quiroga, the Director of CINARA, who was part of the Water Supply Unit in CINARA in 1998, it lasted one year. The objective related

to the analysis of the WSS project cycle was managed by the researcher as it was part of her doctoral study. All the concepts related to the project cycle were developed by the researcher and the activities related to this objective were done by the researcher and her colleague Mr Luis Darío Sánchez. The TLPs in this programme were managed by Mr Carlos Madera (El Bordo), Mr Luis Darío Sánchez (Mistrató) and Ms Claudia Inés Jiménez (Ventaquemada). Ms Silena Vargas and Ms Claudia Inés Jiménez produced the tools for the project cycle. Ms Sandra Bastidas and Ms Silena Vargas were the Social professionals in the TLPs in El Bordo and Mistrató, respectively, Mr Alberto Benavides was the Technical professional in the TLP in Ventaquemada. The information system was based on the experience in the surveillance of a water quality project developed by CINARA, financed by Ministry of Health in 1991. The researcher developed the information system for monitoring the service quality presented I this research and helped Mr Alberto Benavides, the professional in charge of the surveillance-of-water-quality research area in CINARA, to write out the preliminary information system which was part of the Programme for Sustainability of WSS Systems. The researcher conceptualised the information system presented in this thesis which was tested in El Hormiguero (see Item 5.2.4) and Mondomo (see Item 8.1.1).

The project cycle followed by institutions was analysed through the National Programme for the Sustainability of WSS Systems, which was financed by the Ministry of Economic and Social Development (MinDesarrollo), the Regional Development Agency (FINDETER) and the Urban Infrastructure Fund (FIU), and a new cycle was proposed by the researcher. In addition, in the National Programme for Sustainability of WSS Systems, the TLPs were applied in different phases of the institutional project cycle in three urban areas (El Bordo, Mistrató and Ventaquemada), and some tools were developed.

Both programmes were documented. In the Cali TLPs, a final report, individual reports and photographic reports for each project and the evaluations made by each community and institutions were produced. Likewise, a video presenting the concepts about TLPs was filmed. In addition, some undergraduate and post-graduate students at the Universidad del Valle (UniValle) have carried out projects in the localities as part of their degree work. The water organisations met, and aided by CINARA, created a provincial association. The TLPs have acted as learning project templates for other localities, and other community-based organisations have made visits to observe them. CINARA visitors and students attending

CINARA courses also visit the settlements. The experience gained as a result of the TLPs is being disseminated at national and international levels. For example, a woman who serves as a community leader in El Hormiguero, was invited to participate in the workshop on Integrated Management of Water Resources organised by the International Institute for Infrastructure, Hydraulic and Environmental Engineering (IHE) and the Inter-American Development Bank (BID) in Bogotá (Colombia). Also, a community leader in Altos de Menga and a woman serving as an EMCALI official were invited to participate in the Andean Training Proposal Workshop promoted by United Nations Children's Fund (UNICEF) and UNDP/WB Programme in Lima (Peru). Additionally, articles about the TLPs have appeared in Colombian newspapers and academic papers have been presented at national and international events. The conceptual framework on sustainability of WSS systems developed by CINARA in the National Programme for the Sustainability of WSS projects was published as a book by the Ministry of Social and Economic Development. The tools developed were the basis for some of the manuals published by this Ministry.

The proposals made in this research have been validated in several projects carried out by CINARA. Some of these are discussed in chapter 8 of this thesis. These projects were managed by CINARA professionals where the researcher acted as adviser in subjects related to the TLPs strategy. The researcher directly worked in the project developed in Nicaragua (see Item 8.2), managed by Mr Jorge Latorre, because the analysis of the project cycle was part of her doctoral studies. As well, the researcher worked in the EDAR project (See Item 8.1.3) which was managed by her colleague Mr Luis Darío Sánchez.

Two of these projects have been nationally recognised: the TLP in Mondomo, managed by Ms Claudia Inés Jimenez, a Business Manager, won a prize for its contribution to the eradication of poverty through strategic alliances between the public sector, the private sector and local communities. The TLP in La Elvira, undertaken with primary school students and managed by the Mr Aníbal Valencia, a Sociologist, won a prize for its contribution in developing methodologies for the protection of the water resources (both presented in chapter 8).

The results of the research presented in this thesis have been discussed as part of different events and in articles published in journals (Annex 2). International recognition was

gained when United Nations Educational, Scientific and Cultural Organisation (UNESCO) published the video produced by the TLPs in the Cali programme, which is being distributed in Colombia and other Latin American countries (Annex 3). The TLPs are being successfully applied in most of the projects carried out by CINARA. At present, they are being applied in and transferred to Nicaragua, Mexico and Bolivia.