2. PROBLEM FORMULATION

2.1. PRACTICAL PROBLEM

One of the hardest lessons for the WSS sector is that making the initial capital investment is often the easiest part of the job.

WSSCC (2000a)

2.1.1 Definition

Evaluations have shown that very often, the existing WSS systems do not give the expected benefits to the users, especially in small settlements and informal cities. The evaluations of the WSS Decade concluded that many projects had failed because they focused on infrastructure and did not strengthen the local capacities. Thus, it is common that a WSS system does not function or function with important deficiencies a short period after the starting up of technology.

2.1.2 Evidence

We live and work models of society that do not recognise the increasing complexity of the real society in which we are immersed. Thus, we observe the hectic and obsessive work of technocrats, who design solutions before having identified the real problems.

Max-Neef et al. (1986)

Some evaluations have shown that many WSS systems are not sustainable in small municipalities or rural and peri-urban areas because they actually do not function or provide efficient services (Box 1). Furthermore, the decentralisation process in Colombia and other Latin American countries places the responsibility for guaranteeing basic services on the municipalities but does not specify any process for strengthening their capacities. In general, "the municipalities do not know their needs and cannot prioritise them satisfactorily" (DNP-2532, 1991a). Consequently, project formulation is poor and the resources are either not used or are wasted because the projects do not function after construction is finished. In Colombia,

some of the causes of these deficiencies include (DNP-2241, 1986; DNP-2282, 1986; DNP-2532, 1991a):

Box 1 A forgotten water treatment plant

A social report by the national institution in charge of WSS in small municipalities showed the water treatment plant constructed in Jenesano (Boyacá), a conventional one that was given drinking water to the urban area. However, nobody knew it in Jenesano. The Mayor, who had been born and grown up in the town, said that many years before, a contractor did many things in the water supply system. People only remembered the innumerable holes in the streets left by the contractor. When asked, the caretaker said that there were several tanks in a hill near to the urban area. He cleaned them every six months and he considered that some of them impeded the good water circulating as they had barriers. Furthermore, the plant had a complete laboratory that nobody used and he was afraid that those valuable things could be stolen.

Work experience by the researcher (1982)

a) Deficiencies in the project identification, formulation, development, and evaluation at the local level,

b) Lack of information about local conditions that can guide the planning process,

c) Incongruity between investment and local planning,

d) Institutional instability in the water supply and sanitation sector,

e) Institutional weaknesses at the local level to address the decentralisation process,

f) Technical, administrative, and financial weaknesses at the local level,

g) Lack of community participation in the projects, and

h) Lack of analysis, review, updating of the technical, financial, and operative criteria used by institutions.

Evaluations, for example those undertaken in Latin American countries such as Ecuador, Bolivia, Colombia, and Nicaragua (Visscher *et al.*, 1996; MinVivienda *et al.*, 1997; CINARA *et al.*, 1998a; García, 2001) (Photograph 1), have identified many problems in the WSS systems. In addition, the Vision for Water for the 21st Century for South America (GWP-SAMTAC, 2000), and the electronic conference on WSS in small settlements run in February 2000 in its Latin American component, among others, identified problems in WSS in small settlements. The most important problems are:

Photograph 1 Ecological sanitation using "appropriate technologies" not functioning properly in Nicaragua

Source: García (2001)

- Water quantity and quality deterioration,
- Inappropriate institutional frameworks,
- Anthropogenic effects on the water cycle are not considered as part of the natural water cycle,

- Supply and recipient basins are not considered as part of the water supply and sanitation systems,
- The impossibility of fulfilling the legal and regulatory frameworks technically and economically at the local level,
- Developing projects without community participation. This applies especially to decision-making processes undertaken in the initial stages of the project cycle,
- Technology selection not taking the local conditions into account,
- Weaknesses in technical and managerial issues,
- Lack of continued and sustainable support particularly in administration and operation and maintenance (O&M),
- Social inequity,
- Gender inequities,
- Considering water as social good, but failing to recognise its economic value,
- Endless conflicts among stakeholders,
- Problem scattering, and
- Lost investments.

2.1.2.1 Evaluation in Colombia

The Regional Development Agency (FINDETER) is the institution that finances municipal development in Colombia. In 1996, FINDETER contracted an evaluation of 49 projects carried out in the Water and Sanitation Programme (PAS), a Programme financed by a World Bank credit. Figure 2 shows the main results. The limitations identified were:

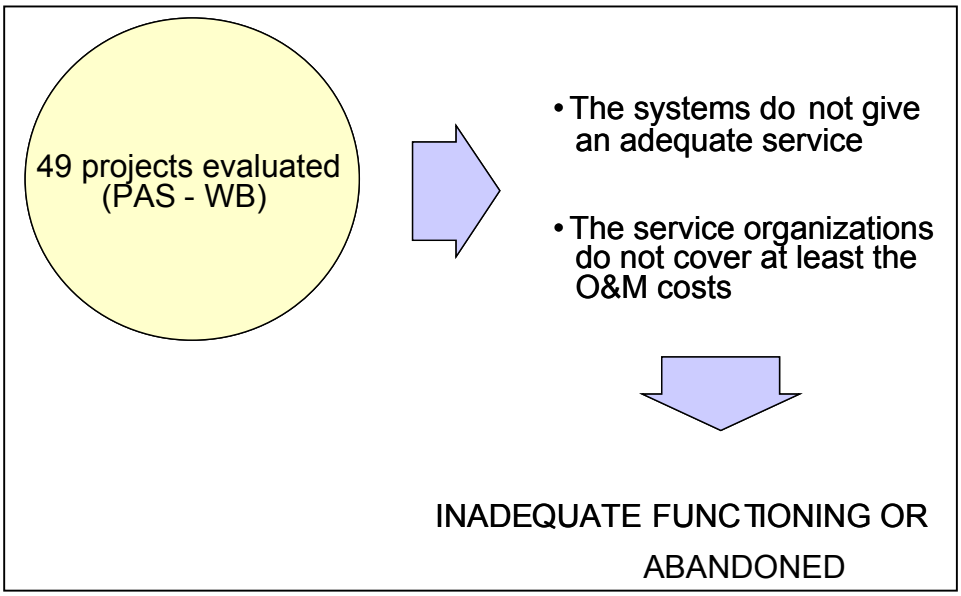

Figure 2 Evaluation by FINDETER in Colombia

Source: FINDETER (1996)

- Limitations in developing and adapting technology options,
- Inadequate technology selection,
- Inadequate capacity to administer, operate and maintain the WSS systems,
- Lack of training, and
- Insufficient institutional advice and control.

2.1.2.2 MinDesarrollo Inventory

The Ministry of Economic and Social Development (MinDesarrollo) is responsible for the WSS sector in Colombia which operates under the Directorate of WSS. An inventory carried out by MinDesarrollo in 1998 revealed that of the 1,050 municipalities then existing in Colombia, there were drinking water treatment plants in 630 urban areas. Almost 30% of these plants were not functioning, and in the remaining 70% functioning was deficient (Figure 3). The inventory showed that the vast majority of the treatment plants relied on rapid filtration

of chemically coagulated water, a technology imported from the industrialised countries and taught to Colombian professionals during their training. However, this technology was applied without taking into account the local conditions.

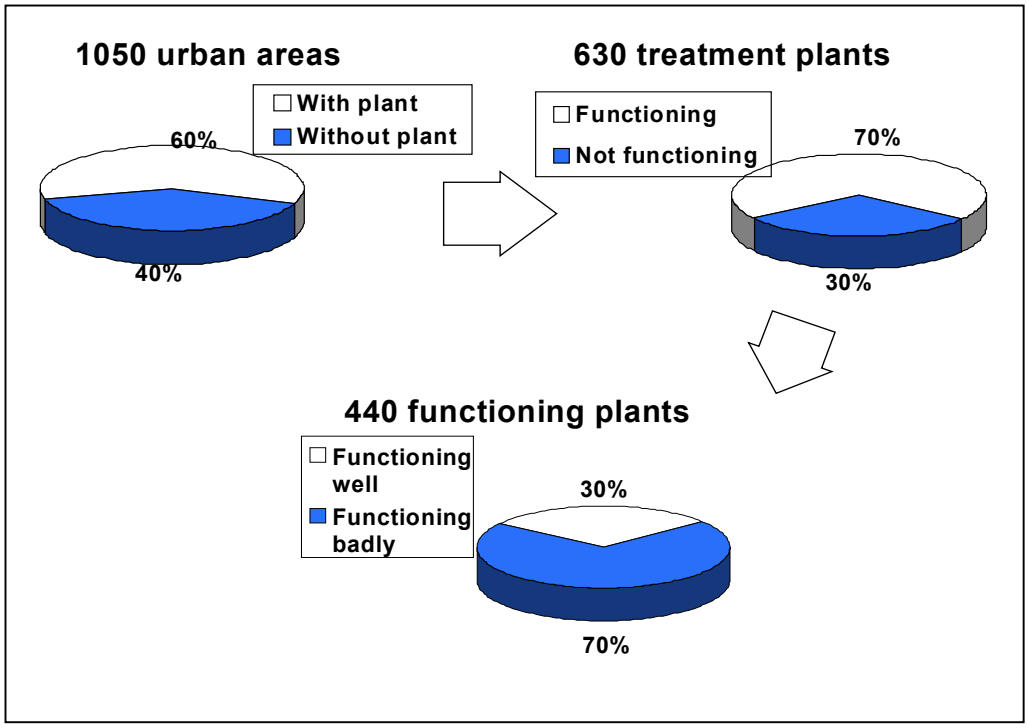

Figure 3 Drinking-water treatment in urban areas in Colombia

Source: MinDesarrollo (1998)

2.1.2.3 Evaluation of 40 WSS systems in Ecuador

In 1995, the International Water and Sanitation Centre (IRC), CINARA, and the NGO CARE-Ecuador evaluated 40 WSS systems in Ecuador, which had been constructed by CARE, the Sub-secretary of Environmental Sanitation (SSA), and the Public Agency of Telephone, Drinking Water and Sanitation (ETAPA) between 1978 and 1993. The systems studied were located in eight provinces in the Andean Region where CARE, SSA, and ETAPA had developed joint projects. The evaluation concluded that the projects had been focused on infrastructure. Because the Government had been a provider of the necessary funds, this had generated dependency. Furthermore, the technologies were selected without taking into

account the local conditions and the communities had participated only at the construction phase. Table 1 presents the main results (Visscher *et al.,* 1996).

Table 1 Results of the evaluation of 40 WSS systems in Ecuador

PARAMETER	RESULTS
Quantity	20% of the systems demanded more water than the water available in the catchment area The standards established 25-100 l/p*d. However, 80% of the systems had an average of 250 l/p*d, maximum 1,800 l/p*d 60% of the systems did not have micro-measurement
Quality	50% of the basins were in critical condition with high sanitary risk 60% of the systems did not have water treatment 40% of the systems had water treatment with O&M problems
Continuity	In 50% of the basins, the water flow decreased in summer 75% of the systems presented insufficiencies due to the lack of water in the basin or damages in the pipe network
Coverage	Average 78%. Minimum 25%
Costs	Average tariff: US$ 0.50/household*month Bad debtors: 30% 100% of systems presented a good balance between incomes and expenses
Use	65% of communities used water for irrigation and livestock 55% of household wasted water due to damaged taps 44% of losses of water
O&M	A Community Committee administered 100% of the systems

Source: Visscher *et al.* (1996)

2.1.2.4 Evaluation of 15 WSS systems in Bolivia

In 1996, IRC and CINARA evaluated 15 WSS systems in 15 small settlements in Bolivia in conjunction with the country's Ministry of Housing and the Water Supply and Sanitation Programme (WSP) – World Bank (WB)/Andean Region. The settlements were located in the Departments of Chuquisaca (Presto, Sopachuy, Zudañez, Yamparaez, Yotala and Villa Serrano), La Paz (Caranavi, Chulumani and Sorata), and Cochabamba (Capinota, Tolata, Quiroga, Anzaldo, Mizque and Tarata), and all had less than 10,000 inhabitants. Table 2 presents the main results (MinVivienda *et al.*, 1997). Although the evaluation concluded that the water supply systems and most of the sanitation systems were functioning, there were limitations and deficiencies, which were reflected in the low satisfaction felt by users. The problems identified were related to issues such as limited participation of the users in the

project cycle; reduction of water quantity; water wastage; poor administration; lack of sufficient participation by women; and limited methodologies for working with communities, among others.

Table 2 Results of the evaluation of 15 WSS systems in Bolivia

PARAMETER	RESULTS
Quantity	67% of the systems demanded more water than the water available in the basin The standard established 50-100 l/p*d, 80% of the systems give more quantity, maximum 500 l/p*d 66% of the systems did not have micro-measurement
Quality	60% of the systems took water from high-risk basins 40% of the systems took water from medium-risk basins 73% of the systems presented high risks of bacteriological contamination 93% of the systems did not include disinfection or the disinfection provision was not good enough
Continuity	73% of the basins showed a decreased capacity In winter, 33% of the systems suspended the service frequently during more than 1 day In summer, the systems that suspended the service increased to 73%
Coverage	Average 84%. Minimum 40% in one locality
Costs	100% of the systems presented a good balance between incomes and expenses Minor replacements were covered The systems did not generate savings
Use	40% of the localities used water for agriculture and livestock
O&M	The communities were organised to administer the systems Training was insufficient Support offered to the local organisations was sporadic and not organised

Source: MinVivienda *et al.* (1997)

2.1.2.5 Participatory Action-Learning Initiative

In 1999, the first phase of this initiative was carried out by IRC, financed by United Nations Development Programme (UNDP) – WSP–WB in five regions of the world; one of them was the Andean Region (Colombia, Ecuador, Peru, and Bolivia) in South America. In this Region, 16 water supply projects and eight sanitation projects were evaluated. One of the criteria for selecting a project was that the WSS projects were functioning for at least three years in communities with more than 50 users (CINARA-IRC, 1999). The results showed that users believed that the WSS systems were providing the expected benefits. However, the satisfaction level differed between men and women. Men used water for irrigation and

livestock so they wanted to have more water, while women were very satisfied with the water quantity. Women complained when the supply was interrupted because of excessive use of water for farm works. Furthermore, the programmed interruption of the service did not take into account the needs of women.

Settlements in Ecuador and Peru had the lowest level of bad debtors, with approximately 20% of the users falling into this category. Women expressed a low level of satisfaction with the management and administration. The Water Committees were able to carry out small repairs, however they needed to call on external resources to cope with more serious damage. The majority of Committees drew up budgets without bearing in mind the real cost, and the accounting was carried out informally. Very few Committees informed the users about the use of the resources they collected through tariffs. Although most of the systems in theory promoted equity and access to the poor, the poorest amongst the poor usually did not have access because they could not fulfil their project requirements during the construction phase; an example of this is households with a female head who had no money to pay for the household connection fee or men to provide labour in the construction phase.

Individual sanitation systems were implemented in some projects, although many people expressed their low satisfaction with the technology used. These systems did not have any technical support. The lowest coverage in sanitation, 52%, was reported in Bolivia, while in Ecuador it was more than 90%. The most significant adjustment was in two Ecuadorian localities where all the sanitation systems were changed. People bought conventional toilets and replaced the pour-flush toilets which had been provided by the projects.

2.1.2.6 Electronic conference on WSS in small settlements

In 2000, the Global Applied Research Network (GARNET) organised an electronic conference which was financed by the World Bank. The conference was divided in two parallel conferences: one in English and the other in Spanish. The latter was co-ordinated by CINARA in Colombia, and included 280 participants from all the Latin American countries as well as Spanish-speakers from other countries. The conference set out a definition of a small settlement which stated that a small settlement could be found in a rural area or in an urban area; it could be an urban area itself or it could be a peri-urban settlement; and that each

country could establish its own definition of size. The conference concluded that the main defining characteristic for a small settlement is the population, although other characteristics such as origin of the population, culture, geography, production activities, and WSS systems, amongst others, are also important. In Latin America legal and institutional frameworks do not differentiate between cities and other kind of settlements, and this can lead to serious problems. The participants highlighted the danger that the adjective "small" might be misinterpreted as being simple and easy. The WSS management in any human settlement depended on the country models and administrative frameworks given by governments. It was considered that small towns were not an attractive option for private companies and there was a need to investigate other models.

The main limitations identified in WSS in small towns were deficiencies in technical capabilities, lack of institutional support and tariff systems which did not take into account the real costs and the local characteristics. The following aspects, among others, were identified as key issues in delivering good WSS services in these settlements: leadership; autonomy; users' surveillance; sense of ownership by the users; awareness of water value; effective communication channels; legitimacy of the organisation in charge of the WSS services; decentralisation; flexibility; training; accountability; willingness of users to pay. Figure 4 illustrates the problem tree in which the main causes and consequences of the weaknesses at the local level are highlighted.

2.1.3 Context

The challenge is how to manage cities and other human settlements within an increasingly urbanising world.

UNCHS (1996)

By the year 2025, the world population will rise to 8.3 billion. In addition, the composition of the population is changing and urbanisation is increasing. The urban population alone is expected to be five billion; this is roughly equivalent to the current total world population (Buckley, 1996). In 2000, more than 40% of the population in developing countries and nearly a half of the world population lived in urban centres (Figure 5). In absolute numbers, the urban population in developing countries was more than twice the urban population in industrialised countries.

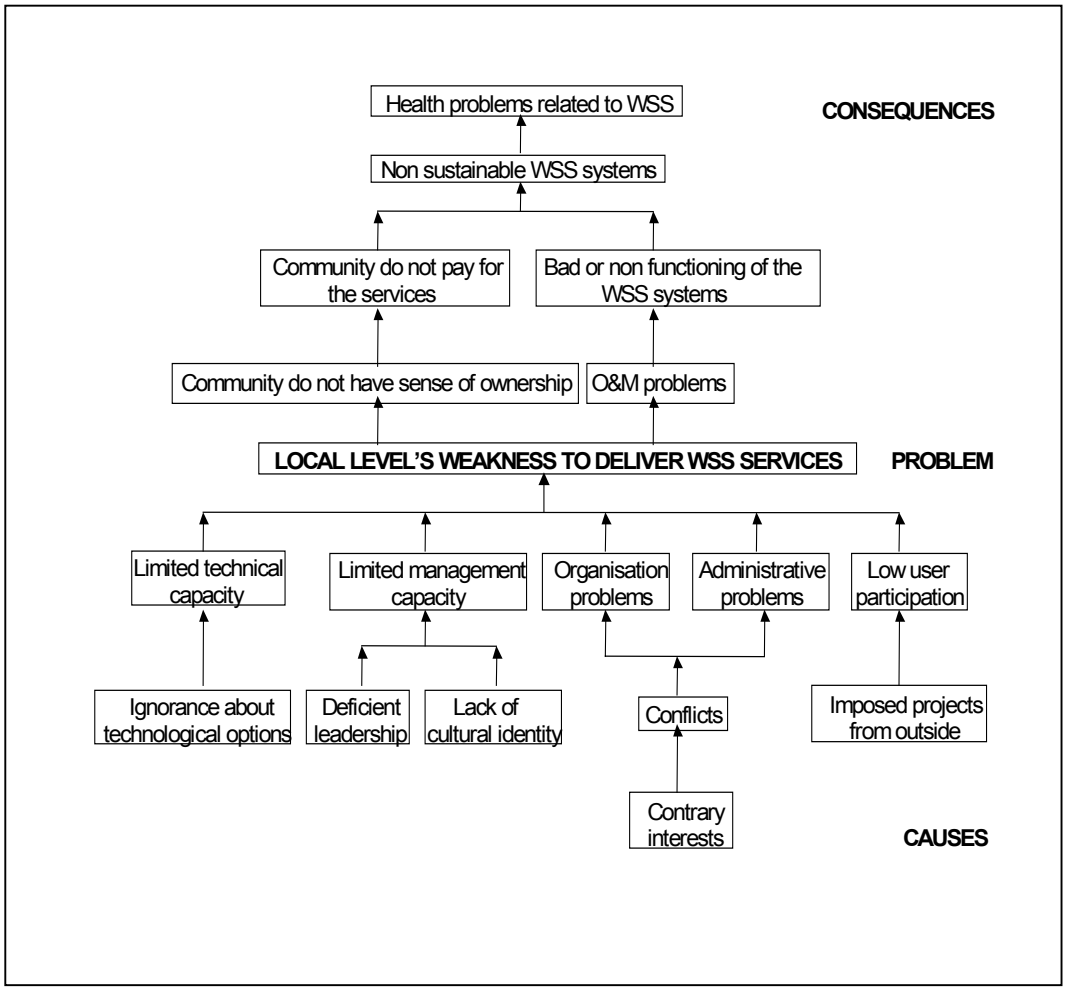

Figure 4 Main causes and consequences of the problem

Source: CINARA *et al.* (1998a)

2.1.3.1 Water supply and sanitation

2.1.3.1.1 The world situation

> *A clean and healthy world: A world in which every person has safe and adequate water and sanitation and lives in a hygienic environment.*
>
> *(WSSCC, 2000a)*

Although hygienic conditions and safe water and sanitation are recognised as fundamental human rights (WSSCC, 2000a), 1.1 billion people in the world lack safe water

and 2.4 billion do not have access to adequate sanitation. Ninety percent of the people without safe water and 93% of people lacking adequate sanitation live in Asia and Africa (Table 3). Eighty-three percent of people without adequate sanitation live in rural areas, almost a half of them in China and India (WSSCC, 2000b). People in urban areas are more likely than people in rural areas to have access to safe water and sanitation. However, 173 million urban dwellers lack safe water and 403 million do not have adequate sanitation. Less attention has been paid to sanitation than to access to water. Large cities tend to have better sanitation than smaller cities (UNDP, 1997). The 0.4 billion of urban dwellers lacking sanitation usually live in peri-urban areas where the health risks are higher because of high population density (Esrey, 1996a; Hogrewe *et al.*, 1993; Cairncross *et al.*, 1990; Harpman *et al.*, 1988; Arthur and Tayler, 1987).

2.1.3.1.2 WSS in Latin America

Latin America is an urbanised sub-continent with 75% of the population living in urban areas. The WSS situation is better in Latin America than in Africa and Asia because 85% of the countries in Latin America have more than 70% of coverage for both water supply and sanitation (Table 4). However, there are still 76 million people in Latin America without safe water and 112 million lacking adequate sanitation. Of these 47 million who lack safe water and 63 million who lack sanitation live in rural areas.

During the 1990s, the rural water coverage increased while urban coverage remained almost constant. However, the sanitation coverage in the region decreased by 6% (GWP, 1997), which probably explained the cholera outbreaks in many Latin American countries in that decade (OPS, 1998). In Colombia, only 4% of the wastewater is treated and about 15.5 million people in rural areas have inadequate wastewater disposal. The Cauca and Magdalena basins receive more that 80% of the wastewater; and Colombia is the greatest source of contamination in the Caribbean region (WSSCC, 1999). The coverage of WSS services in Latin America is affected by natural disasters such as hurricanes, earthquakes, landslides and floods, which are frequent in the Region (Box 2).

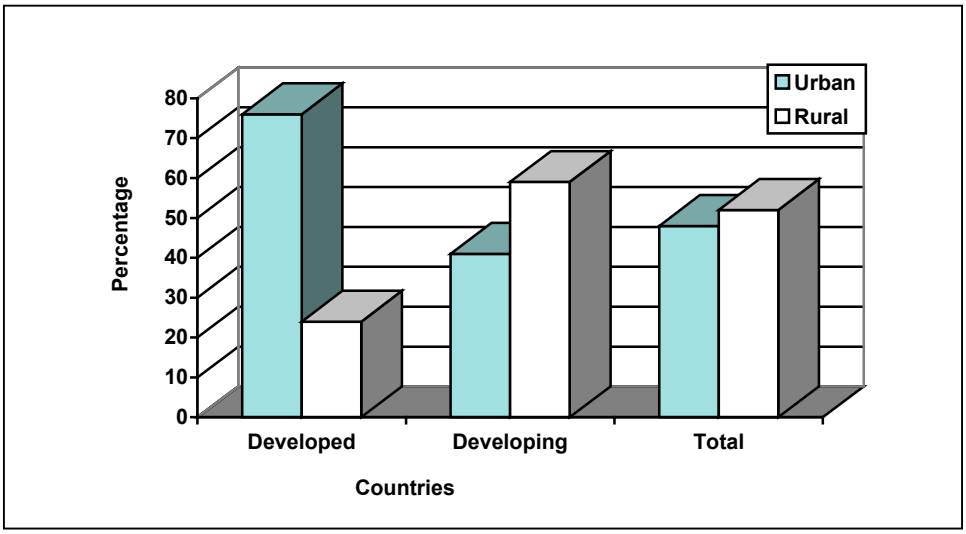

Figure 5 World population by the year 2000

Source: UNCHS (1996)

Box 2 Consequences of natural disasters on WSS in Latin America

In 1998, Hurricane Mitch caused US$ 58 million of damage in Honduras alone. The devastation included the destruction of 85000 latrines and 1683 rural water mains. This meant that 75% of the population –approximately 4.5 million people- lost access to drinking water. Devastation such as that caused by Hurricane Mitch may last for months or even years.

Source: WSSCC (2000b: 57)

Table 3 World WSS situation in 2000

	Total population (millions)	Safe water				Adequate sanitation			
		Population served (millions)	%	Population unserved (millions)	%	Population served (millions)	%	Population unserved (millions)	%
Africa	784	484	62	300	38	471	60	313	40
Urban	297	253	85	44	15	251	84	46	16
Rural	487	231	47	256	53	220	45	267	55
Asia	3683	2990	81	693	19	1767	48	1916	52
Urban	1352	1254	93	98	7	1055	78	297	22
Rural	2331	1736	75	595	25	712	31	1619	69
Europe	729	703	96	26	4	674	92	55	8
Urban	545	542	99	3	1	537	99	8	1
Rural	184	161	87	23	13	137	74	47	26
LA&C	**519**	**441**	**85**	**78**	**78**	**402**	**78**	**117**	**22**
Urban	**391**	**362**	**93**	**29**	**29**	**340**	**87**	**51**	**13**
Rural	**128**	**79**	**62**	**49**	**49**	**62**	**49**	**66**	**51**
N.America	310	310	100	0	0	310	100	0	0
Urban	239	239	100	0	0	239	100	0	0
Rural	71	71	100	0	0	71	100	0	0
Oceania	30	27	88	3	12	28	93	2	7
Urban	21	21	98	0	2	21	99	0	1
Rural	9	6	63	3	37	7	81	2	19
Total	**6055**	**4956**	**82**	**1099**	**18**	**3652**	**60**	**2403**	**40**
Urban	**2845**	**2672**	**94**	**173**	**6**	**2442**	**86**	**403**	**14**
Rural	**3210**	**2284**	**71**	**926**	**29**	**1210**	**38**	**2000**	**62**
Total (%)	**100**	**82***	**100**	**18***	**100**	**60***	**100**	**40***	**100**
Urban (%)	**47**	**53**		**16**		**68**		**17**	
Rural (%)	**53**	**47**		**84**		**32**		**83**	

* With respect to the world total

Source: WSSCC (2000b)

2.1.3.1.3 Small settlements in Latin America

In Macondo, José Arcadio Buendia "had set up the placement of the houses in such a way that from all of them one could reach the river and draw water with the same effort" (García Márquez, 1978). The reference made by this Nobel laureate reflects how water is a vital issue in everyday life in small settlements (García *et al.*, 1997). The National Research Council (NRC) states that even in United States of America (USA), small systems face great difficulties in providing a continuous supply of safe water. These small systems account for a large percentage of the violations under the USA Safe Drinking Water Act (SDWA) (NRC, 1997; Stout and Bik, 1998 quoted by Galvis, 1999). In an attempt to provide solutions, the

1996 SDWA Amendments in USA contain provisions related to small water systems that recognise the differences between small systems and larger ones (Galvis, 1999). The problems related to WSS in small settlements are relevant to many developed and developing countries in the world. In some countries such as the United Kingdom and The Netherlands, the problems have been reduced by encouraging large cities to extend their water service to smaller surrounding communities or supporting small settlements by forming regional associations (Popov, 2000). However, USA has 51,159 small water supply systems (<10,000 inhabitants) operating separately. These serve 50 million people and suffer from most of the problems mentioned above (NRC, 1997 quoted by Galvis, 1999).

Table 4 WSS in Latin America in 2000

Country	Population (millions)			WS coverage (%)			Sanitation coverage (%)		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Argentina	37.0	33.3	3.7	79	85	30	85	89	48
Bolivia	8.3	5.2	3.1	79	93	55	66	82	38
Brazil	170.1	138.3	31.8	87	95	54	77	85	40
Chile	15.2	13.0	2.2	94	99	66	97	98	93
Colombia	42.3	31.3	11.0	91	98	73	85	97	51
Costa Rica	4.0	1.9	2.1	98	98	98	96	98	95
Cuba	11.2	8.4	2.8	95	99	82	95	96	91
Ecuador	12.6	8.3	4.4	71	81	51	59	70	37
El Salvador	6.2	2.9	3.3	74	88	61	83	88	78
Guatemala	11.3	4.5	6.9	92	97	88	85	98	76
Haiti	8.2	2.9	5.3	46	49	45	28	50	16
Honduras	6.5	3.4	3.1	90	97	82	77	94	57
Mexico	98.9	73.6	25.3	86	94	63	73	87	32
Nicaragua	5.1	2.8	2.2	79	95	59	84	96	68
Panama	2.8	1.6	1.2	87	88	86	94	99	87
Paraguay	5.5	3.1	2.4	79	95	58	95	95	95
Peru	25.7	18.7	7.0	77	87	51	76	90	40
Uruguay	3.3	3.0	0.3	98	98	93	95	96	89
Venezuela	24.2	21.0	3.2	84	88	58	74	75	69
Total	498.4	377.2	121.0	84.9	92.8	61.6	77.6	86.9	48.3

Source: WSSCC (2000b)

There are 14,028 municipalities in 19 Latin American countries, 10,429 of them (74.3%) with less than 20,000 inhabitants (Mascareño and Balbi, 1995). For instance, Colombia has 1,091 municipalities and 80% of them have less than 12,000 inhabitants, representing 34% of the national population. Ecuador has 193 counties of which 71% (136)

have county capitals with less than 10,000 inhabitants and 106 of them have less than 5,000 inhabitants. In Bolivia, 89% (575) of the localities have between 250 and 5,000 inhabitants. In Mexico, 98% of localities have less than 2,500 inhabitants and they are considered rural areas. These settlements represent 29% of the total Mexican population (Oswald, 2000) and have increased from 96,611 in 1970 to 198,311 in 1995 (Biswas, 2000).

Once the winds of decentralisation reached Latin America, many changes were made that affect the WSS sector, for example, privatisation of WSS services has been implemented by multinational agencies, and the WSS sector was separated from the Health sector. For example, in Colombia the WSS sector was transferred to the Ministry of Economic and Social Development. Traditionally strong national and provincial institutions were suppressed. Most of the changes were probably good for large urban areas. However, small settlements -mainly those classified as urban settlements- have been forgotten for nearly a decade. Meanwhile large cities have benefited from an increased flow of resources, services, and WSS coverage. Most of these small settlements face WSS deficiencies because, in Latin America, the decentralisation process led to increased problems in service delivery to small settlements. The decentralisation assigned responsibility for the WSS services at the local level but did not provide a process to strengthen local capacity. In addition, the institutions that had been created to support this kind of WSS systems were suppressed. The consequences have been dramatic: cholera outbreaks began in those settlements where water supply and sanitation were deficient. As an example, in Colombia, a National Inventory showed that among the 936 drinking-water treatment plants existing in the country, 60% functioned less than 25% of the time; this included 109 plants which did not function at all (MinDesarrollo, 1998). Additionally, water quality has deteriorated because of the continuous deterioration of the water sources which are mainly contaminated by domestic wastewater and non-point sources such as agrochemical runoff (MinSalud, 1998). One reason for the deterioration in water quality is that supply and recipient basins are not considered as part of the water supply and sanitation systems; this is because the anthropogenic effects on the water cycle are not analysed in conjunction with the natural water cycle. Consequently, the protection of water sources, reduction of the water consumption using low-consumption household technologies, and reuse of wastewater are not analysed by the WSS and farmer's organisations.

2.1.3.1.4 WSS in small settlements in Colombia

It is remarkable that there is a great difference in coverage between cities with more than 100,000 inhabitants and other urban areas, and between urban areas and rural areas (Table 5). The quality of life declines as the size of the municipality diminishes (Figure 6). On the other hand, indicators such as quality and continuity are alarmingly low in small towns and rural areas. The Second National Inventory of Water Quality carried out by the Ministry of Health (1998) showed that towns with less than 50,000 inhabitants have higher average disease indices associated with the water quality than the national average. These towns consume unsafe water (Table 6) and it is estimated that the situation in rural areas is worse. The national average of water continuity is 21 hours per day. However, in capital cities with less than 100,000 inhabitants and urban areas with less than 12,000 the average is 16 hours per day (MinDesarrollo, 2000) (Photograph 2).

Table 5 WSS in Colombia in 1997

MUNICIPALITY RANK	No. MUNICIPALITIES	POPULATION (MILLONS)	PIPED WATER SUPPLY (%)	SEWERAGE (%)
Urban centres				
Metropolitan areas (centre and outskirts)	46	15.4	95.8	89.3
Capitals >100,000 inhabitants	12	3.4	94.2	77.7
Capitals <100,000 inhabitants	11	0.4	70.6	44.8
Other urban centres> 30,000 inhabitants	62	3.8	92.2	71.3
Urban centres 12,001-30,000 inhabitants	94	1.8	89.2	62.1
Urban centres <12,000 inhabitants	866	3.2	87.9	64.4
Total urban	1,091	28.2	94.1	80.8
Rural area				
Rural areas		12.0	38.1	13.0
Total	1,091	40.2	77.0	60.2

Source: MinDesarrollo (2000)

Table 6 Safe water coverage in small towns

RANK OF POPULATION	% SAFE WATER
<2,500 inhabitants	9.56
2,500 – 10,000 inhabitants	17.49
10,000 – 50,000 inhabitants	30.95

Source: MinSalud (1998)

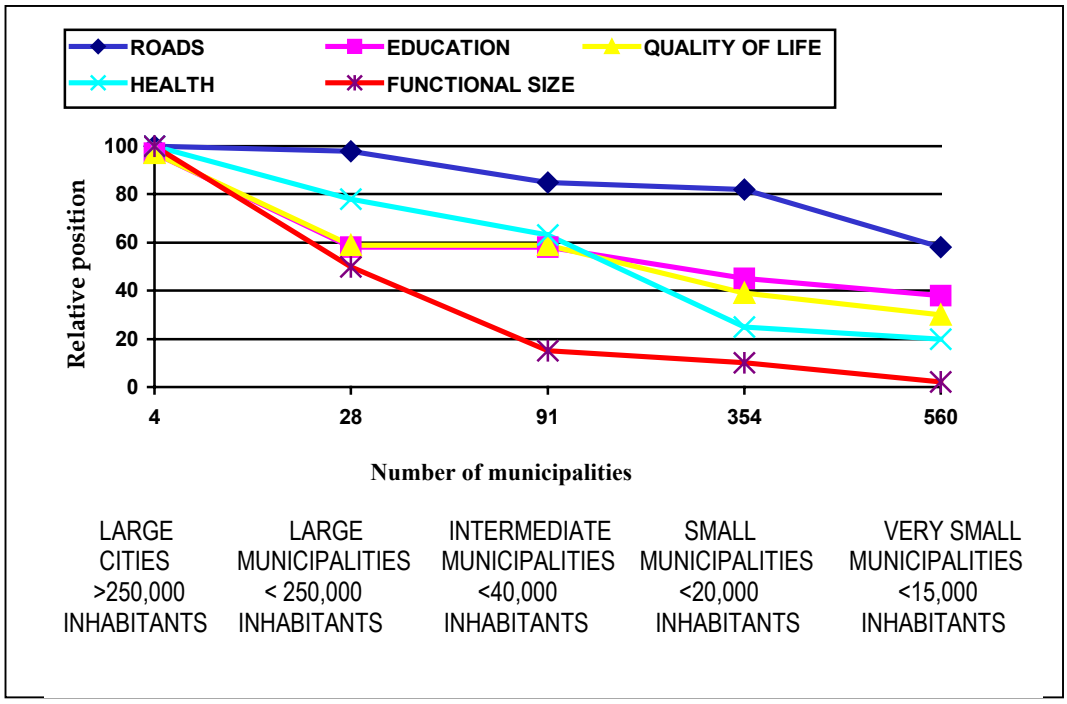

Figure 6 Comparative analysis of Colombian municipalities

Source: CINARA (1996)

The Inventory identified the health risk index (Annex 1) related to sanitary conditions, including water supply, wastewater, and solid waste disposal in a sample of 641 of the 1,068 existing urban areas in Colombia. The results were alarming (Table 7): 87% of urban centres were classified with a health risk over medium, covering 58% of the population in the sample. On the other hand, nearly 10 million people, 44% of the population in the sample, lived in towns where the environment is unhealthy. Although the study did not cover rural areas, it was estimated that the health risk in these settlements was higher given the deficiencies in water supply and sanitation. It was notable that 50% of the population in urban areas with less than 2,500 inhabitants lived in towns with unhealthy conditions. Furthermore, 62% of the population in towns between 2,500-10,000 inhabitants lived in towns where the health risk is medium-high or high (Table 8). This means that it was necessary to give high priority to water supply and sanitation in these settlements.

Photograph 2 **Continuity problems in Montebello (Cali), a rural settlement with 10,000 inhabitants**

Source: CINARA – EMCALI (1999)

Table 7 **Health risk index (HRI) in urban areas (sample: 641 municipalities)**

RISK	VALUE OF HRI	URBAN AREAS (No.)	%	POPULATION	%
Medium-high	35-49	91	14	759,030	4
High	50-59	232	36	2,060,783	10
Excessively high*	60-100	237	37	9,527,783	44
Total		560	87	12,347,596	58

* Not feasible for human habitation

Source: MinSalud (1998)

Table 8 Percentage of population according to kind of health risk (HRI) and town size (sample: 641 municipalities)

RANK OF POPULATION	% POPULATION		
	MEDIUM – HIGH RISK (35-49)	HIGH RISK (50-59)	EXCESSIVELY HIGH* (60-100)
< 2,500	7	1	50
2,500-10,000	44	18	3
10,000-50,000	25	6	6

* Not feasible for human habitation

Source: MinSalud (1998)

People living in settlements with less than 12,000 inhabitants, about 12 million people, represent more than one third of the total population of Colombia. According to the MinSalud study these people face a potentially high risk of health problems as a result of problems with water supply, wastewater and solid waste disposal. However, because this population group is widely scattered –these people live in 837 towns and more than 20,000 rural settlements (Table 9)- it is impossible for institutions to have a direct presence in each of the localities. Alternative mechanisms are required for capacity building in local institutions, communities, service delivery organisations, and users (PSI, 2000).

Table 9 Distribution of urban areas with less than 12,000 inhabitants

RANK OF POPULATION	REGION					
	CARIBEAN COAST	WEST	CENTRE-EAST	ORINOQUEAN AREA	AMAZONIAN AREA	TOTAL
< 2,500 inhabitants	7	88	251	27	8	381
2,501-5,000 inhabitants	34	86	86	19	9	234
5,001-12,000 inhabitants	68	82	58	5	9	222
TOTAL	109	256	395	51	26	837
%	13	31	47	6	3	100

Source: MinSalud (1998)

2.1.3.1.5 The informal city

It could be said that the unnamed millions who built, organise and plan illegally are the most important organisers, builders and planners of Third World cities.

Hardoy and Satterthwhaite (1989)

The informal city is one of the products of the urbanisation process. "Informal cities" – so called low-income settlements or shanty towns- are composed of settlements which do not obey the regulations set out by local authorities. United Nations Centre for Human Settlements (HABITAT) (UNCHS) (1984) defines a low-income settlement as a place that does not provide the living conditions that ensure its inhabitants have a healthy life. Although in developing countries urbanisation is associated with increases in a nation's wealth, it is also associated with increases in squatters and slums which lack the minimum living conditions. The population in illegal settlements in some cities is shown in Table 10. The average population living in informal settlements in Latin America is around 30%. This is lower than in Africa and Asia, although some cities, for instance Bogotá, register a high proportion of their population in illegal settlements.

Table 10 Population in illegal settlements

City (Country)	Total population 1990*	Population in illegal settlements	% of the city population
Lima (Peru)	5,826,000	1,922,000	33
Bogotá (Colombia)	4,970,000	2,932,000	59
Alexandria (Egypt)	3'212,000	2,184,000	68
Caracas (Venezuela)	2,867,000	0,974,000	34
Recife (Brazil)	2'810,000	1,405,000	50
Addis Ababa (Ethiopia)	1,793,000	1,524,000	85
Luanda (Angola)	1,606,000	1,124,000	70
Guayaquil (Ecuador)	1'491,000	894,000	60
Nairobi (Kenya)	1,403,000	561,000	40

*Data from UNCHS (2001)

Source: Pugh (1996), Gilbert (1996); Green (1991); Hardoy and Satterthwaite (1989)

Because illegal settlements are not recognised by governments (Box 3), the informal city usually does not include suitable –or indeed any- provision for services such as safe water, sanitation, garbage disposal, roads, storm water drainage, electricity, public transport, schools and health centres. Nevertheless, people living there have to find ways to accommodate their needs (Beall, 1995). As a result, water comes from unauthorised sources. It may be taken illegally from the water mains or purchased from vendors at very high prices. Wastewater is disposed of outside the plot. Electricity is obtained by connecting to the closest pylon, thereby constructing an informal electricity network (Photograph 3). People who provide health services for the poor are usually not licensed. Additionally, illegal vehicles are one of the common ways of transport (Cairncross *et al.*, 1990; Hardoy and Satterthwaite, 1989). Gilbert (1994) commented that, with the exception of Cuba, very few governments in Latin America have made efforts to reduce inequality in the urban context. Illegal land is often the only option of housing for the poor. The deficit of housing in much of the Third World has led to the building of cities by the informal sector. On average, 30% of the urban population live in illegal settlements, and most neighbourhoods of the cities began as illegal settlements (Gilbert, 1994).

Box 3 Government attitudes

As Hardoy and Satterthwaite (1989) comment, often the squatter settlements are represented in formal maps as no-urbanised areas as if thousands of households did not exit. In a project carried out in Cali (Colombia), an illegal settlement of 2,000 inhabitants established 25 years ago does not exist in the formal map of the city. The planning institution has designed a wide road over the settlement in spite of the fact that another governmental institution had provided public services such as electricity and water supply.

Source: Hardoy and Satterthwaite (1989), CINARA-EMCALI (1997b)

Photograph 3 Typical informal settlement (Altos de Menga, Cali)

Source: CINARA – EMCALI (1997b)

The main problems in the immediate environment of the informal city are shown in Table 11. Basic services are the first point of negotiation when a squatter settlement begins. Water supply, sanitation, roads, and transport are the most urgent needs (Cairncross *et al.*, 1990). Transport is important because people usually work in the city centre, far away from the settlements, which are generally located outside the urban perimeter. Many studies suggest that people feel legalised through the services provided by the governmental institutions (WSSCC, 1995; Fedevivienda, 1994 and 1993; Hogrewe *et al.*, 1993; Environment and Urbanization, 1990).

Sanitation in the informal city is as bad as it is in rural areas (Sinnatamby, 1990). However, the health problems could be worse because it is difficult to avoid contact with excreta due to the high densities of the settlements. Table 12 presents the magnitude of the sanitation problem in some cities. In the informal city, the waste ends up in rivers, canals, and streets without treatment. In some places, people use on-site sanitation, but the emptying of the pits is difficult and fresh sludge is usually disposed of near to the neighbourhood

(Sinnatamby, 1990; Hogrewe *et al.*, 1993; Hardoy *et al.*, 1992, Cairncross *et al.*, 1990). When the soil stability is inadequate, even the cheapest sanitation solutions such as pit latrines or pour-flush latrines may cause problems (CINARA-EMCALI, 1992). Additionally, if people have an in-house water supply, sullage also becomes a problem because it is disposed of in streets and canals. In tropical countries, stagnant water increases the potential for malaria and/or filariasis infection because it provides breeding reservoirs for mosquitoes.

Table 11 Problems in the immediate environment in the informal city

Deficiency	Links with health
Malnutrition	Availability of food is related to the nutrition level. Adequate nutrition is an important factor in disease resistance, especially in children
Unsafe water	Most diseases are related to water quality or water quantity. Communicable diseases are associated with pathogens while non-communicable diseases are associated with chemicals
Inadequate sanitation	Usually, the pathogens originate in human and animal excreta. They contaminate water and soil and cause bacterial and non-bacterial diseases. A variety of intestinal parasites also cause illnesses
Inadequate wastewater and rainwater disposal	There are many diseases caused by water-related vectors. Of these malaria causes the most deaths
Overcrowding	Poor housing conditions exacerbate the transmission of diseases such as tuberculosis and many other diseases for which vaccines exist. Additionally, many mental illnesses and psychosocial disorders are associated with poor housing conditions
Air pollution	Smoke from poorly design and/or poorly made stoves increases respiratory problems, especially in children
Inadequate garbage disposal	The diseases related to garbage disposal are usually associated with vectors such as insects and rodents
Inadequate cooking conditions	Injures such as accidental burns and scalds are associated with the poor cooking conditions. In addition, there are diseases related to food handing, preparation, and storage.

Source: Satterthwaite *et al.* (1996); Mara and Alabaster (1995); Hardoy *et al.* (1992); Hardoy and Satterthwaite (1989)

Because of the health and environmental consequences, sanitation is an urgent need in the informal city. Both the community and the government recognise this need (CINARA-EMCALI, 1997b). According to Cotton and Franceys (1994) and Cotton *et al.* (1990), the most significant factor, in terms of cost, for the improvement of the informal city is sanitation. The dimension of the sanitation problems in the informal city can overwhelm both institutional and community capacities, especially if they work separately. On the other hand, conventional solutions used in the formal city are expensive and difficult to implement in the informal city

given the strict regulations often imposed by the planning authorities. In addition, the settlements lack legal recognition, which makes it more difficult for institutions, communities and NGOs to take action to solve problems. However, some countries, for instance Brazil, have introduced successful approaches to implement sanitation interventions in the informal city which are supported by new regulation.

Table 12 Population without adequate sanitation in some cities

City (Country)	% urban population without adequate sanitation
Luanda (Angola)	71
Bogotá (Colombia)	45
Ankara (Turkey)	24
Tunis (Tunisia)	30
Lusaka (Zambia)	66
Manila (Philippines)	35
Mexico City (Mexico)	30
Karachi (Pakistan)	51
Caracas (Venezuela)	30
Nairobi (Kenya)	35
Lima (Peru)	33
Sao Paulo (Brazil)	32

Source: Cairncross *et al.* (1990:128)

2.1.3.2 Environmental health considerations

The effects of deficient WSS services are reflected in children's health and in the deterioration of the environment. The most important group of diseases in developing countries are communicable diseases related to water supply and sanitation. These "are responsible for some 25 million deaths each year and around 80% of all morbidity" (Mara and Alabaster, 1995).

Although there has been considerable improvement in the economic and social indicators during the last four decades, many problems still remain in developing countries. It is very difficult to measure the social improvements. However, it is generally considered that there are some indicators that reflect the two different aspects of welfare; these are (i) those related directly to health (such as life expectancy at birth and infant and under-5 mortality rates), and (ii) those only indirectly related to health (such as income and housing quality). The

best indicator is life expectancy at birth "which is probably the indicator that most accurately reflects the quality of housing, living conditions and provision for basic services" (UNCHS, 1996).

Some indicators, such as infant and child mortality rates, are substantially influenced in developing countries by levels of poverty and the conditions of health care, water, and sanitation. Additionally, these indicators influence life expectancy at birth. For instance, those countries that have had the largest increases in this indicator during the last three decades were those with the largest decreases in infant and child mortality rates (UNCHS, 1996). Table 13 shows worldwide life expectancy at birth and infant mortality rate.

Table 13 Worldwide life expectancy at birth and infant mortality

	Life expectancy at birth (years)			Infant mortality rate[1]		
	1960	1992	increase	1960	1992	decrease
The world	53.2	65.6	12.4	128	60	68
The South	46.2	63.0	16.8	149	69	80
The North	69.0	74.5	5.5	35	13	22
Least developed countries	39.0	50.1	11.1	170	112	68

[1] No. of infants who die between birth and the age of one per 1,000 live births

Source: UNCHS (1996)

Life expectancy at birth says much about the overall performance of a country as it is impossible to improve this indicator without most of the population having good quality housing including adequate water and sanitation facilities (UNCHS, 1996). One half of Latin American countries has had an increase of more than 10 years in life expectancy at birth during the last three decades (Figure 7). Honduras had the highest increase, while Paraguay had the lowest increase. Additionally, Costa Rica, Cuba, and Chile showed the highest life expectancy in the Region. The life expectancy at birth is more than 70 years in 75% of the countries. This is comparable with the life expectancy at birth reached in industrialised countries. Although the increases in life expectancy are associated with increases in per capita income, in developing countries economic growth is an important factor only if its benefits are distributed equitably amongst its people and there are investments in social services. UNCHS (1996) affirms that "countries with the highest life expectancies are

generally those with the smallest gap between the highest and the lowest income groups". A study that examined the influence of different factors in the improvement of life expectancy in 22 low-income countries revealed that "one-third of the increase was due to reduced poverty and two-thirds to increased spending on social services associated with higher incomes" (UNCHS, 1996).

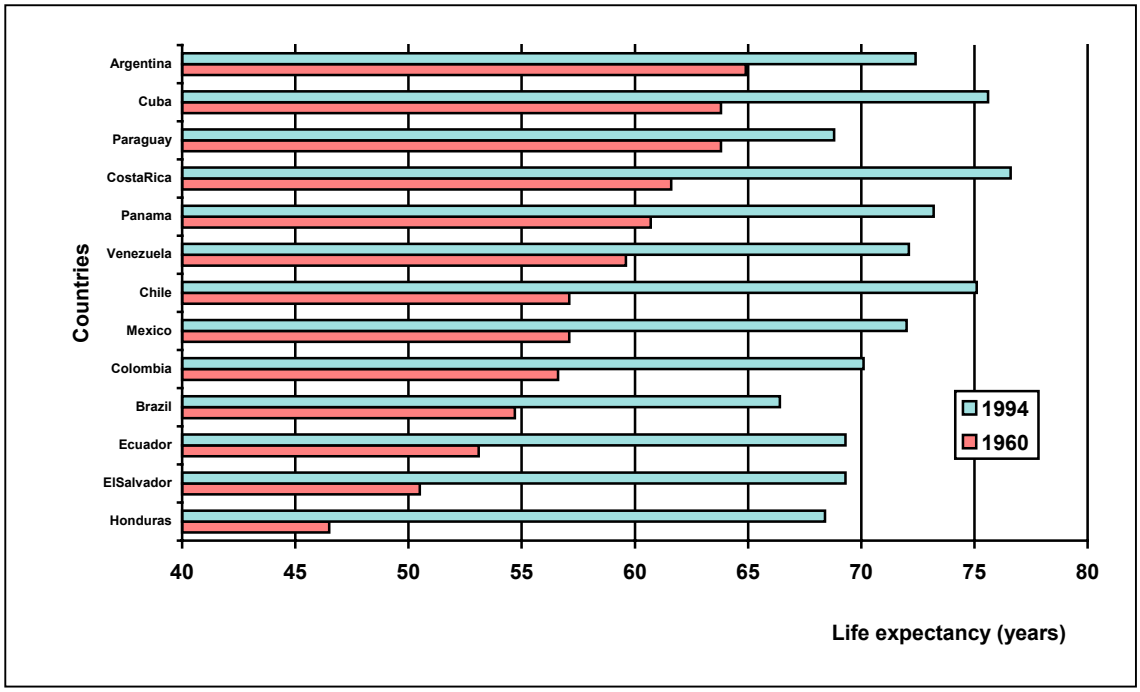

Figure 7 **Changes in life expectancy at birth in some Latin American countries. 1960 - 1994**

Source: UNCHS (1996)

Figure 8 shows the changes in the infant mortality rate in Latin America. Cuba and Costa Rica achieved the lowest rates, but infant mortality rates remain very high in Bolivia and Haiti. Except Paraguay and Haiti, all countries have had a reduction of more than 60% in their infant mortality rate between 1960 and 1990. Nevertheless, the average life expectancy at birth and infant mortality rate say nothing about the differences between regions and social groups within the country. These differences are more evident in developing countries. For instance, in Colombia, the Pacific Coast, the poorest region in the country, has an infant mortality rate twice the national average (DNP, 1992). In Porto Alegre (Brazil), infant mortality

rates in shanty towns were three times higher than in the formal city, while in Sao Paulo it was 175 in poor urban areas compared with 42 in the core area (Hardoy *et al.*, 1992). Disaggregated statistics give a more truthful vision of the situation in a country. According to Rossi-Espagnet, quoted by Harpham *et al.* (1988), "A systematic study of intra-urban differentials and health-related conditions has not been carried out anywhere in the developing world".

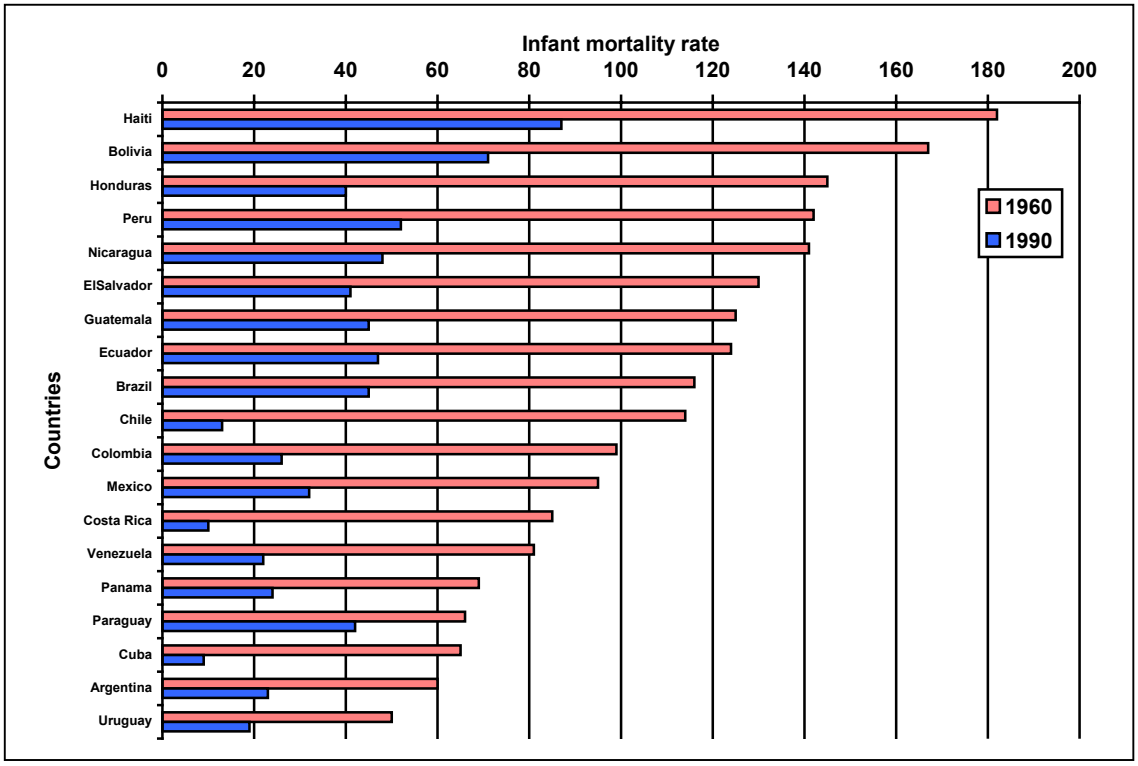

Figure 8 Infant mortality rate in Latin America

Source: UNCHS (1996)

Environmental factors at the local level that influence health are strongly linked to each other (Figure 9). Water-related diseases are still the main causes of morbidity and mortality in many countries, especially in the Andean Region (OPS, 1998). In the 1990s, cholera outbreaks alerted communities and governments in Latin America to the problems of water-related diseases. In 1990, water-and-sanitation-related diseases caused about 135,000 deaths and 8% of disability-adjusted life years (DALYS) lost in Latin America (Mara, 1998). According to PAHO (2000), cholera became endemic in some countries with 1.3 million cases,

of which 11,500 resulted in deaths. Meanwhile, water quality and quantity deterioration is jeopardising the regional development because only 4% of wastewater is treated in the region. It is estimated that 1,200 tons of untreated industrial-wastewater flow daily to surface waters in Latin America (GWP-SAMTAC, 2000). The sudden suspension of tourism and exports because of the cholera epidemic in Peru led to losses of one billion dollars in just 10 weeks. The economic cost was three times higher than the total investment on WSS made by the country during the 1980s (OPS, 2000). As Hardoy and Satterthwaite (1989) pointed out, "it would seem appropriate to put human excrement as the most serious 'toxic waste' -and, indeed, one whose safe disposal is relatively cheap".

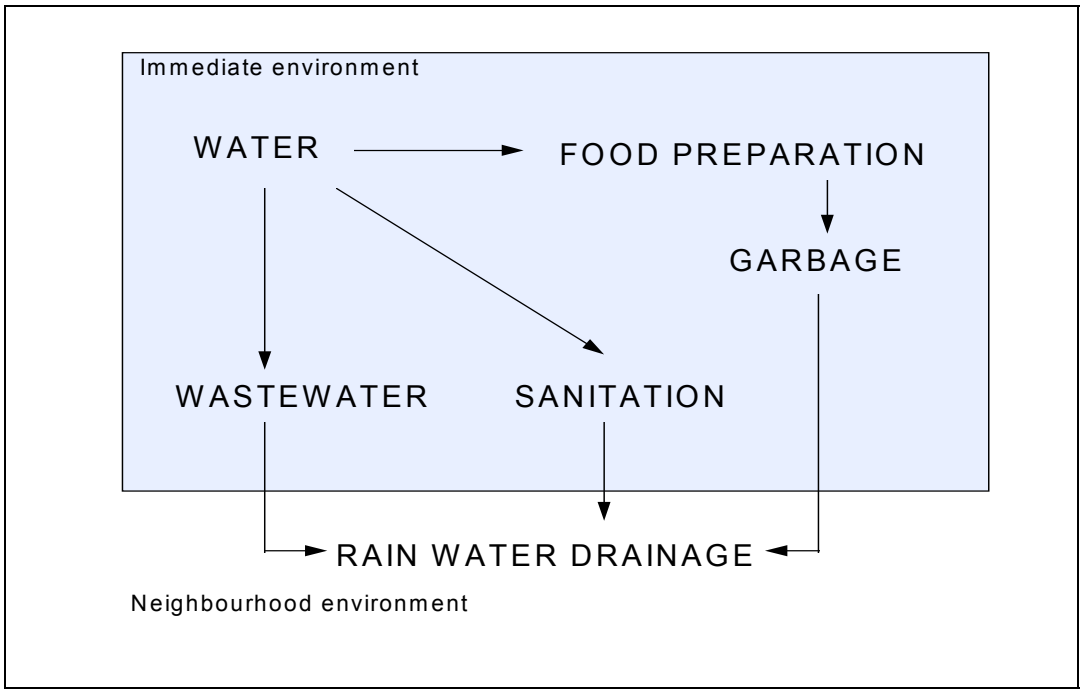

Figure 9 Links between health-related environmental factors at the household level

At least 53 diseases are related to the inadequate disposal of excreta and wastewater (Horan, 1995; Benenson, 1992; Hardoy and Satterthwaite, 1989). In addition, there are diseases related to the housing conditions and hygiene behaviours (Mara and Alabaster, 1995). Esrey (1996b, 1994) and Esrey *et al.* (1990) demonstrate the impact that integrated programmes have on the reduction of mortality caused by illnesses related to poor housing and hygiene. Esrey's studies show that the health effects due to sanitation programmes are

higher than the effects of improving water supply and "this evidence is more important in urban settlements than in rural ones" (Esrey, 1996a) (Box 4).

Box 4 Urban-rural differences in health conditions

"Studies which address comparisons between the health of urban poor and rural populations have usually found that there were more severely malnourished children in low-income urban than in rural populations.. Nelson and Mandl (1978) have analysed the reason for this. Although in South-East Asia and Latin America rural labourers largely depend on their landlords for their foods, many rural families, especially in Africa, own a small piece of land where they can grow part of their food, or where harvest surpluses are available: this is generally not possible for the food in the overcrowded cities. In the cities although salaries are higher, so also are the costs, with the result that the poor have a smaller proportion of their income available for food." An urban dweller in Cali (Colombia) expressed: In the countryside, you eat leaves, but one cannot eat stones in the city.

Source: Harpham et al. (1988); CINARA-EMCALI (1992)

2.2. RESEARCH PROBLEM

However, the question is not really what "appropriate" means .. but rather who decides what is deemed appropriate and on what basis do they take the decision?

Parr and Horan (1994)

2.2.1 Definition

The transfer process used in WSS projects in settlements with less than 12,000 inh. is wrong because it does not take into account environmental, social, and economic conditions at the local level and the relationships amongst the stakeholders involved, which affect the sustainability of WSS systems.

2.2.2 Evidence : The TRANSCOL Programme

The origin of this research was the Transfer Programme on Water Supply Treatment in Colombia (TRANSCOL), a programme for technology transfer financed by the Dutch and Colombian governments and developed by IRC and CINARA between 1989 and 1996. TRANSCOL originated in two events. The first event was the decentralisation process that began in Colombia in 1986 in which Municipal Mayors were popularly elected and given the legal responsibility for guaranteeing good quality WSS services. The second event was the research carried out by CINARA-IRC on slow sand filtration (SSF) with pre-treatment that gave promising results when it was applied to full-scale projects. The decentralisation process increased both the number of poorly managed water supply systems and the investment losses that resulted from buying technology that did not match the local conditions in small municipalities. However, the SSF technology with pre-treatment, which became multi-stage filtration (MSF) after the research by CINARA-IRC (Galvis, 1999), did not consume chemicals, had low O&M costs and low operational requirements, which were in accordance with the conditions in small settlements. The initial objectives of TRANSCOL were to:

- ✓ Promote the use of MSF in settlements with less than 10,000 inhabitants,
- ✓ Create a network of at least seven universities to research and develop technology on water supply,
- ✓ Produce educational material at professional, technical and operational levels to facilitate the technology transfer process,
- ✓ Introduce the technology within the regular courses given by the universities involved in the network,
- ✓ Test field equipment to control the O&M of MSF plants, and
- ✓ Improve the information on investment and O&M costs in this technology.

The Transfer Programme was developed through Regional Working Groups in eight Colombian Departments and 19 Demonstration Projects set up by these Departments (Figure 10). The Demonstration Projects have been the traditional way to transfer technology from developed to developing countries. However, these kinds of projects use a “one-way”

approach because they are implemented to demonstrate to others a technology that is well known by those promoting it. Although the Demonstration Projects were carefully selected, the CINARA team faced a range of problems during the course of the projects related to issues such as power issues, conflict management, local weaknesses and technical problems, for which they were unable to offer solutions (Table 14). The main problems in the Demonstration Projects were:

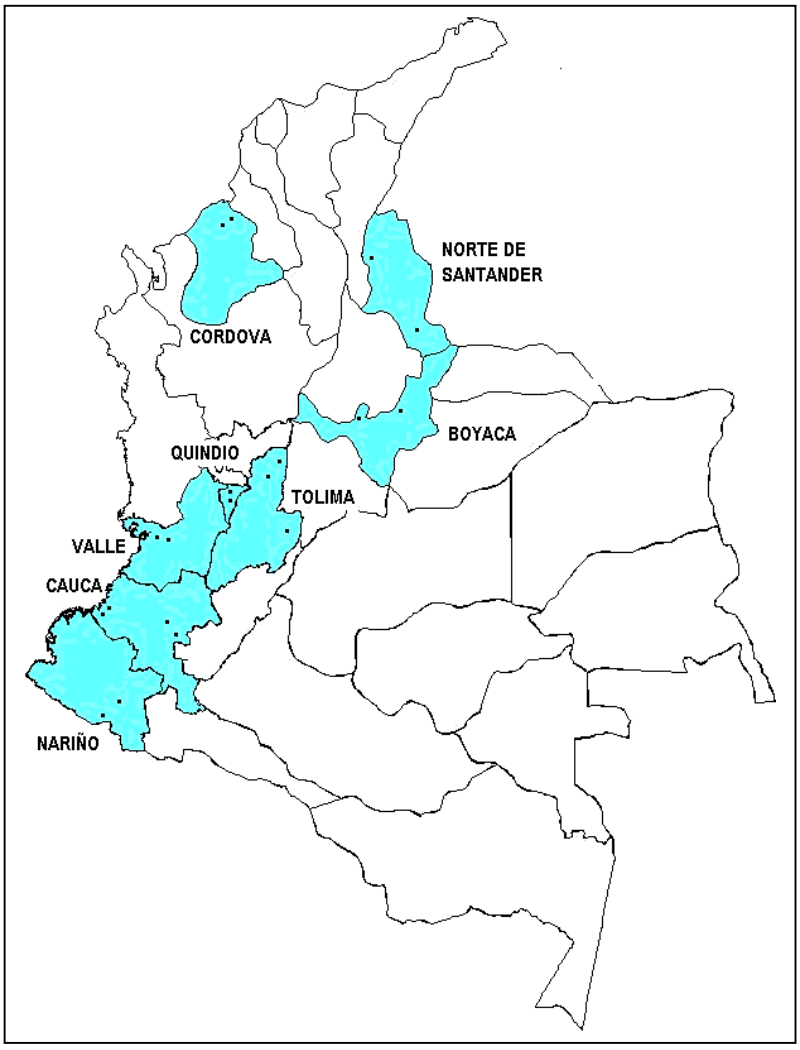

Figure 10 **Demonstration projects in eight Colombian Departments in the TRANSCOL Programme**

Source: Visscher (1997:14)

Table 14 Strengths and limitations of the Demonstration Projects

Strengths	Limitations
✓ Fulfil a transfer function as the projects continued receiving 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 coped very well with overloading and produce low-risk water	☛ Peaks in turbidity and colour were not sufficiently reduced in some treatment plants
✓ The technology had been accepted by community and institutions	☛ Insufficient improvement activities were implemented in water catchments
✓ The O&M were fully in the hands of local organisations, mainly community-based, with a minimum of external support	☛ Strategies to enhance efficient water use needed to be developed or strengthened
✓ The interest of local government and community, including fund raising, made the projects possible	☛ System management by community needed to be improved and better supported
✓ The systems became cultural and learning spaces for scholars and people from community	☛ Some operators were replaced because of political changes in the locality
✓ Increase in female participation in service-provider organisations	
✓ Better organisation within the community	

Source: Visscher (1997: 84)

- Deterioration of water catchments,
- Use of water for other purposes such as agriculture and livestock,
- Deficient pipe networks,
- Water wastage,
- Very weak water committees,
- Little interest in regional universities,
- Very weak Regional Working Groups,
- Political changes that implied changes in the participating staff, and
- People could not afford the service in some localities.

The analysis of the problems faced by the CINARA team in the Demonstration Projects led to a new phase in TRANSCOL and generated concepts around sustainability. The second phase included strengthening of both the service-provider organisations and the Regional Working Groups, implementation of sanitation systems, and improved dissemination of information to municipalities. It was clear in TRANSCOL that there were many factors affecting the possibility of improving water quality. These needed to be analysed from the very beginning. During the second phase, TRANSCOL interacted with other projects developed by CINARA, in particular with the programme that was beginning in Cali Municipality. This programme applied the lessons learnt in TRANSCOL and proposed a new kind of project -the learning project- whose purpose was to find out joint responses to unanswered questions.

2.2.3 Context: Conventional transfer process

> *The classical economic view of technology as a commodity holds that technology can be reproduced without cost and transmitted from one agent to another. In this view, technology transfer is as simple as making a photocopy of design documents or obtaining a working artefact.*
>
> *UNEP-WMO (2000)*

Mogavero and Shane (1982) proposed four models of technology transfer (Figure 11). The agents associated with technology transfer processes are users, manufacturers, government agencies, private sector, local organisations, and facilitators. In some processes, especially in the private sector, an entrepreneur is needed (Mogavero and Shane, 1982).

The different modes of technology transfer vary from the passive mode to the active mode. The active mode involves demonstration projects in which the facilitator plays an equally important role as users. The project 'demonstrates' to the users how to solve a problem at full scale. In many countries, and especially in industrialised countries, a research and development institution takes on the role of facilitator (Schechter, 1982). In the public sector, the final step of the transfer process is to institutionalise the solution, which provides the ability to use the product widely. Gruber and Marquis (1969) considered that the following human factors affected the technology transfer process: training and experience, personality characteristics, communication procedures, organisational effects, mission orientation, and motivation.

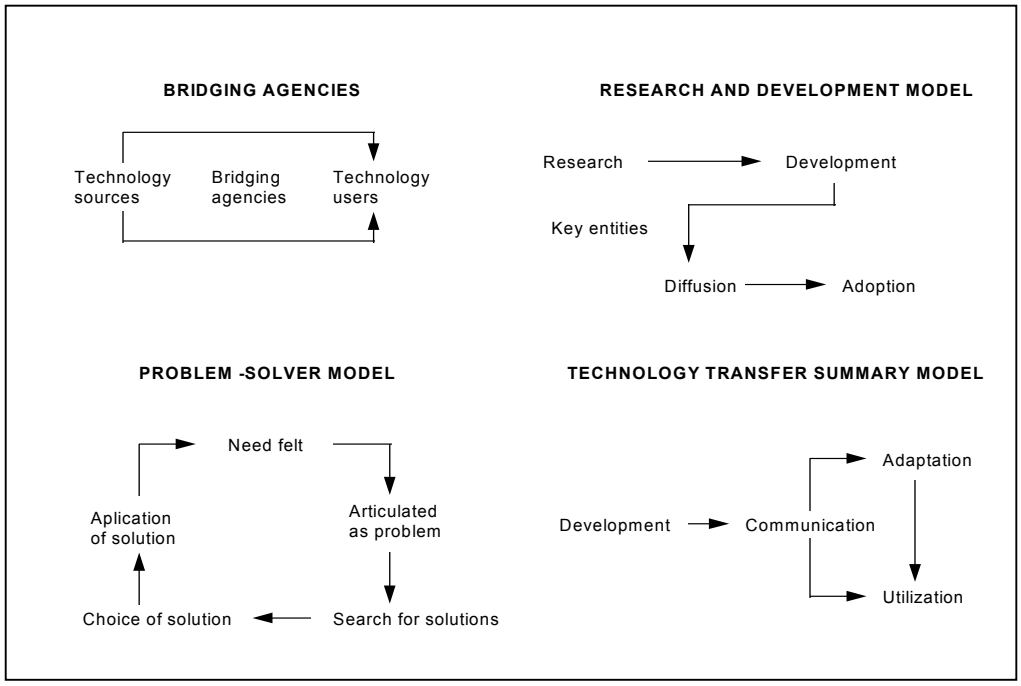

Figure 11 Models of technology transfer

Source: Mogavero and Shane (1982:2-3)

Many obstacles affect the technology transfer from developed to developing countries. A major problem associated with industrialised countries is that the organisations from these countries undertaking the technology transfer normally do not remain in the developing country long enough to assess the success or failure of the transferred technology. Also, international agencies force the use of specific technologies and manufacturers according to their own interest. However, developing countries, which are the recipients of this technology transfer process, face other problems. These include a resistance to change; inadequate infrastructure for Western technologies; even a lack of knowledge about local resources; inadequate skills to use such technologies; and a lack of training in their use (Visscher, 1997; Schechter, 1982). However, although the scientific base in developing countries is weak, it is essential to support innovation (Price *et al.*, 1969). On the other hand, technology transfer often occurs in the temporary framework of a development project, and this can act as a constraint against adoption and diffusion of the technology. As a result, problems associated with the maintenance of technical knowledge occur. Factors such as the level of technological education, the capacities of research and development within the

country and the ability to maintain the technology have to be considered (Aasen *et al.*, 1990; Cimoli and Dosi, 1990). Jaquier (1979) argued that technology fails because transfer processes are wrong. Until the 1970s, there was optimism about the role that Western technology could play to enhance development and to reduce poverty and diseases in developing countries. In the 1980s, it was clear that technology transfer from developed to developing countries had failed (Burch, 1987). Technology transfer, while solving some problems, created new problems such as dependency on foreign manufacturers. The operation of physical components of technology were transferred but the *software*, especially information about why and how technology functioned, which is the basis of innovation, was not transferred (Visscher, 1997).

New concepts are emerging. For instance, the Intergovernmental Panel on Climate Change defines "transfer" as including the learning process to "understand, utilise and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies" (UNEP-WMO, 2001). The important stakeholders in the transfer process identified by the Panel include:

- developers, for example, research institutions in the public and private sectors,
- owners,
- suppliers,
- buyers,
- recipients and users,
- financiers and donors,
- governments, which can create and enable environments for technology transfer processes,
- international institutions and NGOs, and
- community –based organisations.

Other barriers were also identified. These include insufficient information; economic barriers such as lack of full cost pricing; trade and policy barriers; insufficient legal protection and inadequate standards and regulations, among others. The Panel considers that the main dimensions in a technology transfer process are capacity building, an enabling environment and the mechanisms for transfer. Additionally, some important lessons have been learnt (UNEP-WMO, 2001): (i) Networking among stakeholders is essential, and (ii) A transfer process focused on products and techniques with multiple benefits is more effective.

Additionally, some of the lessons from the waste management sector can be applied in the WSS sector: (i) Because of the changes in the sector, each stakeholder plays new roles. Initiatives are being taken by private sector and community-based organisations with governments acting as facilitators; (ii) Although the private sector is increasing its participation, the need to involve community organisations is recognised because there is a relationship between sustainability and community participation; and (iii) The projects should implement local appropriate technologies so long as their use does not put public health and the environment at risk.

Brooks (1995) considered technology transfer as a cumulative learning process, which linked it to research and development. Bugliarello (1995) concluded that economic and social development in developing countries might be reached if these countries learn to use the global system that is producing and disseminating knowledge and develop mechanisms to put that knowledge into practice. However, a new strategy is needed to prevent developing countries from following the unsustainable model of industrialised countries. In this sense, Brooks (1995) considered that innovation, both methodological and technological, is an essential factor in a complex process in which technology transfer, research, and development are elements of socio-technical learning. Society needs these elements to make any innovation sustainable. This research is focused on methodological innovation in technology transfer that strengthens the linkage between transfer and research and development in developing countries.