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Regional Project

Integrated Systems for the Treatment and Recycling of Waste Water in Latin America: Reality and Potential

IDRC–PAHO/HEP/CEPIS Agreement
2000-2002

Executive summary

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1. Summary

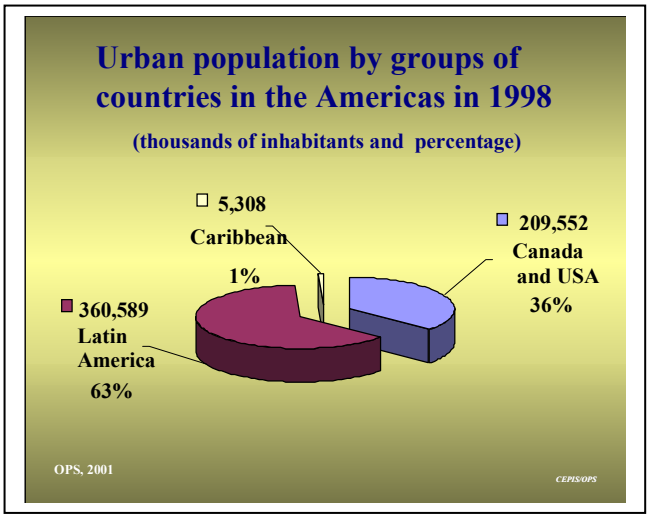
Latin America is one of the regions with greater population density in urban areas, where more than 360 million inhabitants live (74% of its total population in 1998). The coverage of domestic wastewater treatment is only 14%. More than 500,000 ha of crops are irrigated with raw wastewater, which implies a high risk of enteric disease dissemination. Taking into account this context, the International Development Research Centre of Canada (IDRC) and the Pan American Health Organization (PAHO/WHO) signed an arrangement for the execution of the project **Integrated Systems for the Treatment and Recycling of Waste Water in Latin America: Reality and Potential,** to be carried out by the Pan American Center for Sanitary Engineering and Environmental Sciences (PAHO/CEPIS) during 2000 and 2002. The project was aimed at analyzing wastewater management experiences in Latin America, recommending strategies for the design and implementation of such systems, and identifying new opportunities.

The project has concluded that in the 11 countries that participated in the Regional Inventory of Domestic Wastewater Management, sewerage coverage has received more attention than wastewater treatment. The use of wastewater for irrigation of crops not used for direct human consumption, like fodder and industrial crops, was confirmed by the Project. The case studies have shown that farmers minimize the importance of or are not aware of the health risks associated with irrigation using raw wastewater. Furthermore, few recognize the value of the nutrients present in these waters. In all cases, agricultural activity is carried out without considering treatment requirements and there are no coordination mechanisms among water utilities and other participating institutions. Most of the countries in the Region lack regulation for wastewater use.

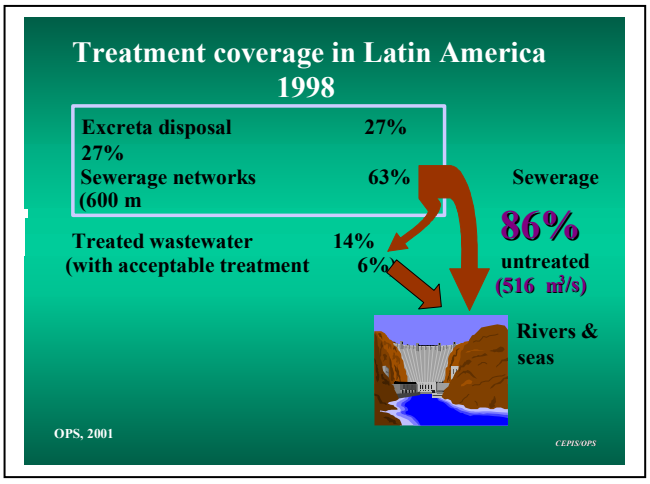
The experiences in wastewater use developed by PAHO/CEPIS and other institutions of the Region, and systematized by this project, have sustained the proposal of a model to integrate wastewater treatment and reuse. The Project has identified key factors for the design, implementation, and management of integrated systems for domestic wastewater treatment and use. Furthermore, strategies have been defined to change the current situation of domestic wastewater management in the Region towards the implementation of integrated systems. The guidelines prepared by the project will help achieve this objective.

2. Background and justification

In 1950, approximately 150 million inhabitants of Latin America lived in cities. This number has increased to more than 360 million by the end of the 20th century (73.6% of its total population), owing to the intense migration of the rural population. In many cases, the increasing pressure of this population on water and soil resources has outweigh the efforts of the governments to plan urban growth and has prioritized drinking water and sewerage services only. Consequently, wastewater treatment and solid waste disposal have been left behind.



According to PAHO/WHO (2001) in 1998 less than 14% of the 600 m^3/s of domestic wastewater collected in Latin America had some treatment before being disposed of in rivers and seas, and only 6% had an acceptable treatment. Besides, considering that 40% of the urban population in the Region suffers infectious diseases related to water, the disposal of raw sewage demands urgent attention since it represents an important source of parasites, bacteria, and pathogenic viruses.

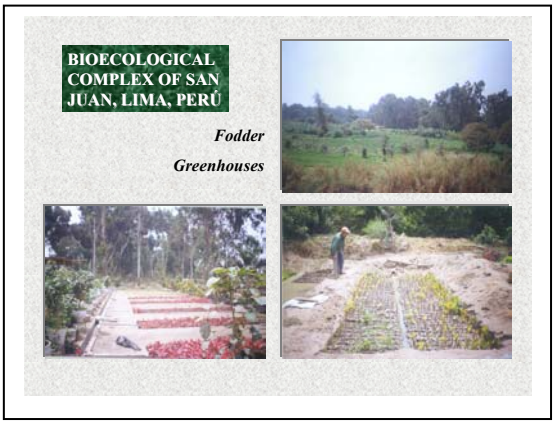


The explosive urban growth has generated a rapid and chaotic urbanization of farmlands and has prioritized the use of surface waters for human consumption and the industrial sector. Consequently, the agricultural activity located around the periphery of the cities has been seriously affected and wastewater use has been the only survival alternative. This is reflected on the existence of more than 500,000 ha of agricultural lands irrigated directly with untreated wastewater (Bartone, 1990). A greater concern is the irrigation of a much larger area with surface water contaminated by urban sewage that do not meet the

water quality standards for irrigation (fecal coliforms and nematodes) recommended by the World Health Organization (WHO, 1989).

The Assessment of Drinking Water and Sanitation 2000 in the Americas (PAHO, 2001) states that the most noticeable failure in Latin America has been the low coverage of sanitation and wastewater treatment services. This failure is partly attributed to the application of technologies designed for socioeconomic, cultural, and technological realities of developed countries. The application of such technologies has caused unsustainable conditions because developing countries cannot afford their high investment and operation costs.

25 years ago, PAHO/CEPIS launched the Wastewater Treatment and Reuse Program to help increase the coverage of domestic wastewater treatment in the Region through the implementation of appropriate technologies for pathogen removal rather than organic matter removal only. So far, PAHO/CEPIS and several Peruvian institutions have conducted research projects on wastewater treatment and use in the Bioecological Complex of San Juan, located in the South of Lima, Peru. These and other experiences carried out by different countries of the Region have enabled PAHO/CEPIS to prepare a model for the implementation of integrated projects for domestic wastewater treatment and reuse. The model uses technologies compatible with the technological capacity, human resources, and socioeconomic situation of the Region and are being transferred by PAHO/CEPIS to national institutions through technical assistance and training programs.



3. Objectives and results

In 2000, the International Development Research Centre (IDRC) of Canada and the Pan American Health Organization (PAHO/WHO) signed an agreement to enable the Pan American Center for Sanitary Engineering and Environmental Sciences (PAHO/CEPIS) to carry during 30 months the Research Project **Integrated Systems for the Treatment and Recycling of Waste Water in Latin America: Reality and Potential**, with the following objectives and results:

3.1 General objective

Document and analyze Latin American experiences regarding domestic wastewater treatment and its sanitary use in urban agriculture to recommend design and implementation strategies for integrated systems and identify new opportunities.

3.2 Specific objectives

- Establish and document an inventory and typology of domestic wastewater treatment and reuse systems in the Region.
- Describe and analyze, in general terms, 20 selected cases of wastewater management systems (using the following variables: with or without treatment and with or without reuse), including aspects related to its adaptation to meet local technical and economic requirements.
- Describe and analyze, in detail, 10 out of the 20 cases, considering the above-mentioned criteria, and prepare a more detailed analysis about the ecological, economic, and social impact issues, emphasizing regulative, institutional, and socioeconomic conditions for these systems to succeed.
- Prepare four representative feasibility studies of the prevailing situations in the Region to implement or improve integrated systems for wastewater treatment and use.
- Identify key elements that should be strengthened in the planning and management of new integrated systems, emphasizing regulative, institutional, and socioeconomic aspects.
- Develop and verify criteria and methodologies to evaluate integrated systems for wastewater treatment and use.
- Disseminate the research results and project recommendations throughout the Region.
- Strengthen the Latin American Network of Urban Agriculture (ÁGUILA), through the incorporation of the researchers involved in the project during the execution and dissemination phases.

3.3 Results

- The development of a regional inventory and typology of wastewater treatment and reuse systems taking into account the principal differences, institutional and legal characteristics, and their influence (whether positive or negative) on the local ecological, social, economic, and financial conditions.
- Eighteen general studies of wastewater management, including the technical and economic aspects of the four representative situations.
- Eleven detailed studies (complementary to the general ones) on wastewater management, including environmental, social, legal, institutional, and economic aspects of the four representative situations.
- Seven feasibility studies of representative cases of different situations to consolidate the previous studies and draw conclusions and recommendations with regard to the social, economic, institutional, and legal adjustments required in the design and operation of the typical systems reviewed. The objective is to improve its performance while adapting the integrated system model.
- A consolidated report on the role and development possibilities of integrated systems for domestic wastewater treatment and use in Latin America. The report describes the current situation in the Region, summarizes the results of the case studies and defines the technical, socioeconomic, institutional, and legal aspects that should be taken into account to effectively plan and manage the incorporation of reuse strategies into treatment systems. It includes the description of the defined methodology for the feasibility studies.
- Four publications on the Project results: Consolidated report, Executive summary, Guidelines for wastewater treatment and reuse, and Guidelines for the formulation of projects.
- Seven feasibility studies issued as working documents, published by the responsible organizations in each country.
- A Latin American Round Table on "Viability of Domestic Wastewater Reuse" linked to the Assembly of the Águila Network to present and disseminate the results of the Project.
- A specialized web page with the Project publications and working papers in full text.
- Six national seminars in the countries that have reached the stage of Feasibility Studies: Bolivia, Brazil, Colombia, Costa Rica, Peru, and Venezuela.

4. Methodology

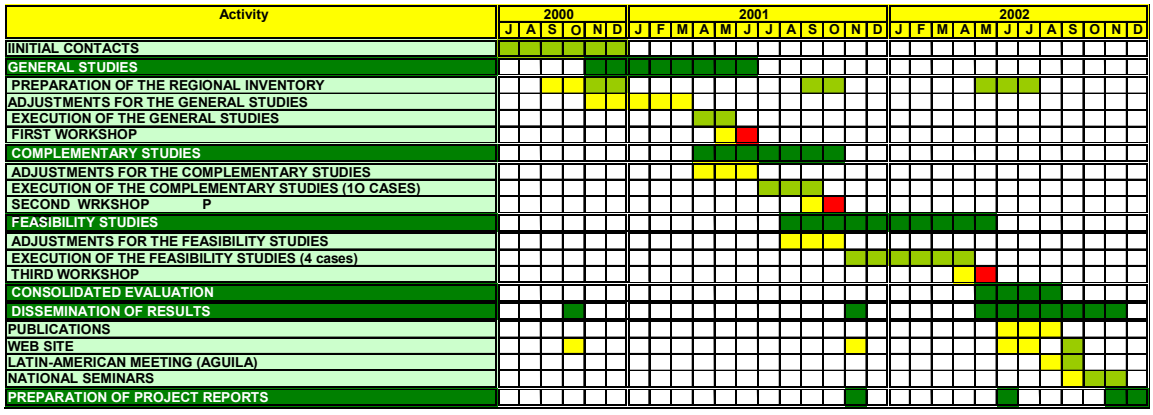
Evaluated aspects

Aspects	Inventory	General Studies	Complem. Studies	Feasibility Studies
Statistical	+++			
Technological	+	++0	+	000
Economic		++0	++0	0
Environmental		+	++0	000
Sociocultural		+	++0	0
Institutional		+	++0	0
Legal		+	++0	0

+ = evaluation 0 = proposal

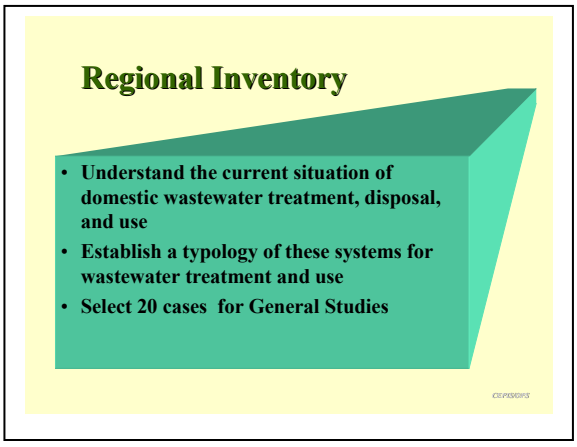
The Project is promoting the preparation of a regional inventory of operating treatment systems and agricultural activities associated with wastewater reuse. The first 20 selected cases represent the four situations of wastewater management: cities where wastewater is treated and reused for agricultural irrigation (With T-With R); cities where wastewater is treated but not reused (With T- Without R); cities where raw wastewater is used for irrigation (Without T- With R); and cities where wastewater is neither treated nor reused for agricultural irrigation (Without T- Without R).

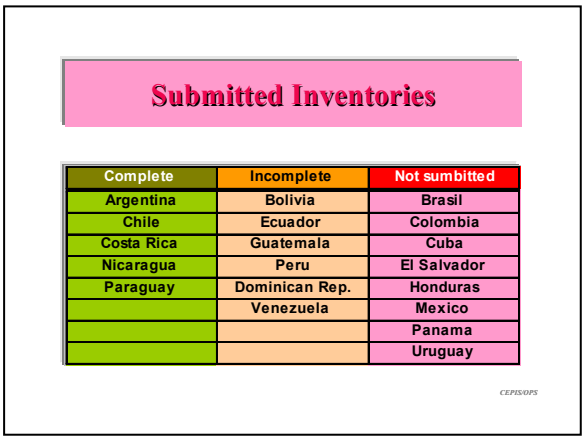
The Project has been executed in three stages of information collection and analysis. In the first stage, called **General Studies**, the general technical and economic aspects of 18 cases were addressed (the cases of Mezquital and San Martín could not be carried out). Then, 11 out of the 18 cases were selected to carry out the second stage, **Complementary Studies,** which included the evaluation of the environmental, social, cultural, institutional, and legal aspects, as well as the preparation of the preliminary proposal for the integration of wastewater treatment and reuse in agriculture. During the third and last stage, **Feasibility Studies,** 7 out of the 11 cases were selected and the socialization and development of the proposal with the principal local actors was promoted. The last activities of the Project were the preparation and dissemination of guidelines for the Region, as well as a series of national seminars and tables of donors to obtain funds to implement the projects.



5. Trends of wastewater management in the Region

The preparation of a regional inventory detailing the situation of domestic wastewater treatment, disposal, and use in Latin American countries was the first activity of the Project. The purpose was to establish a typology of wastewater treatment and use systems operating in the Region.



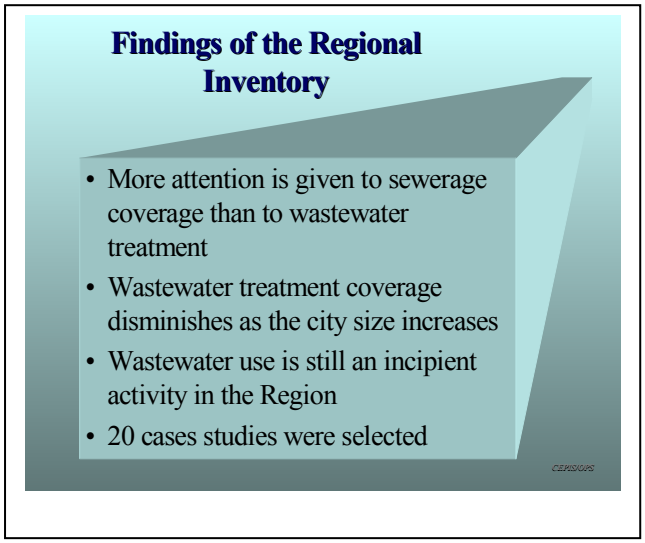


The difficult task of compiling and processing basic information has limited considerably the estimates, observations, and inferences of the regional inventory, since it is restricted to **11 countries** that sent complete or partial information**.** Some countries of the Region were not able to provide complete and reliable information because they lack systematized information or, in some cases, did not want to reveal compromising information. In the short run, it is expected to obtain the national inventories of the other countries –especially from Brazil, Colombia, Mexico, and Peru– to complete the information required for the regional inventory. To this end, the following stage of the Project will consider allocating a budget to contract specialized consulting firms, which will support the countries that still do not have their inventory. Likewise, the issue of wastewater management will be incorporated into the Inter-American Environmental Sanitation Information System (SISAM), which will soon be implemented by PAHO in the Region.

The provisional results from the regional inventory show that countries pay more attention to sewerage coverage rather than to wastewater treatment. However, some countries have begun to consider the obligation of including wastewater treatment in any sewerage project, which would represent an effective increase in treatment coverage.

As a regional tendency, it has been noted that there is greater coverage of sewerage in large cities (with more than one million inhabitants) than in small cities (between two thousand and ten thousand inhabitants). In the case of large cities, it is due to the magnitude of the problem; and in the latter, because of the application of other wastewater disposal options.

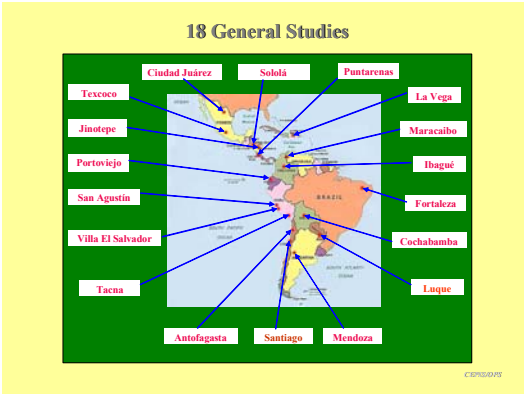
Regarding wastewater treatment, the regional trend shows less coverage as the size of the city increases, probably because greater financial investment and larger areas are required to install wastewater treatment systems.



In comparison with other sanitary issues, wastewater use is the least documented topic in the majority of the national inventories. Thus, we have had to resort to information from the General Studies prepared for the Project, mainly from Mexico and Colombia. It may be stated that the use of wastewater in agriculture is still an incipient practice. This does not necessarily mean that people are reluctant to use wastewater, but knowledge on this alternative is very limited.

Irrigated agricultural areas in Argentina, Peru, and the Dominican Republic are used in the following way: 45.1% for vegetables; 29.2% for industrial crops; and 21.1% for fodder. Fruit crops and forests are also reported to a lesser extent. Considering that a significant proportion of this wastewater is not treated or does not meet the adequate quality for irrigation, a preliminary conclusion may be that this practice could be related to the spread of gastrointestinal diseases when it is applied to vegetables that are eaten raw.

6. Contributions of the case studies



Cases that participated in every stage of the Project

Situation	City	Country	General S.	Complem.S.	Feasibility S.
T-WR	Texcoco	Mexico			
	Juárez	Mexico			
	Tacna	Peru			
	Villa El Salvador	Peru			
	Mendoza	Argentina			
	Antofagasta	Chile			
	Cochabamba	Bolivia			
	La Vega	R. Dominicana			
UT-WR	Mezquital	Mexico			
	San Agustin	Peru			
	San Martin	Argentina			
	Santiago	Chile			
T-WR	Fortaleza	Brazil			
	Puntarenas/Liberia	Costa Rica	Puntarenas	Liberia	
	Maracaibo	Venezuela			
	Portoviejo	Ecuador			
UT-WR	Ibague	Colombia			
	Sololá	Guatemala			
	Jinotepe	Nicaragua			
	Luque	Paraguay			

Case studies, unlike the inventory data, show that wastewater is mainly used for irrigation of fodder and industrial crops. Wastewater is usually the only source of supply, since they are located preferably in arid or semiarid areas. However, this scarce resource is applied to the fields principally through flood irrigation.

In general, farmers minimize or are not aware of the health risks associated with wastewater irrigation and few recognize the benefits of the nutrients that these waters contain. In all cases, this agricultural activity does not comply with wastewater treatment requirements and there are no coordinating mechanisms among water companies and other involved institutions. These characteristics may be considered typical of subsistence agriculture cases (marginal farmers); nevertheless, several cases show high levels of technical and economic efficiency.

In most of the countries of the Region there is no legislation for wastewater use. The guidelines defined by the Project may be an important reference to foster the creation of standards and strict regulations that at the same time promote development.

The case studies have also allowed the set up and training of multidisciplinary technical teams to prepare projects that have reached the feasibility stage, based on protocols and terms of reference developed throughout the Project. These teams may be able to assume other similar studies in their countries. Furthermore, the Costa Rican team has committed itself to strengthen the Guatemala team in the creation of a similar project in that country.

Case studies have become a tool to open up a political space that enable various participating institutions to discuss wastewater management related issues. In those cases that have reached the feasibility stage, processes of consensus building have started. Nevertheless, this exercise is still difficult to implement owing to the conservative management style that certain Latin American institutions maintain.

The incorporation of the cases "without experience in reuse" in the Project has allowed the start of a conceptual transfer process related to integrated systems, so that they may be considered for domestic wastewater management in the countries where this alternative is not known yet. In such cases, a pilot project will be promoted to evaluate the advantages, establish requirements, and facilitate the acceptability of the proposal.

Principal contributions of the case studies

Agricultural:

- *Sewage is the only source for irrigation*
- *Irrigation of industrial crops and fodder*
- *Little recognition of nutrients*

Sanitary:

- *Treatment not linked with reuse*
- *Standards do not consider human pathogens*
- *Lack of awareness of risks related to wastewater irrigation*

Social:

- *Regulation does not consider reuse*
- *Cities do not assume treatment costs*
- *Institutions do not coordinate*
- *Lack of concertation practices*

Economic:

- *Tariffs do not include treatment*
- *Lack of payment capability*
- *Referential cost of treatment: $0,05/m^3*
- *Subsistence and commercial agriculture*

7. Critical aspects of the systems

The Project has identified the following critical aspects of the systems, which should be taken into account for the design, implementation, and management of integrated systems for domestic wastewater treatment and use.

- Little relevance is given to institutional (land property and tenancy, needs and interests of the actors, agricultural organization and management mechanisms of integrated systems) and socioeconomic requirements (acceptance of reuse, ability to pay, collecting mechanisms, financing strategy).

- Neither mechanisms nor coordination or concertation spaces exist among regulatory agencies, people who manage domestic wastewater, user groups, or those affected by sewage discharge, especially when raw wastewater is used.

- Legislation in most of the countries of the Region, does not consider the sanitary quality of wastewater in terms of human pathogens and when it does, it is not applied owing to lack of or weak capacity of supervision and control. For example, in Mexico, legislation allows a permissible limit of five nematode eggs per liter of treated wastewater because their activated sludge plants cannot reach the level of less than one egg, recommended by the WHO.

- Most decisions related to water quality control parameters, wastewater treatment technology, cost allocation, disposal of wastewater and its use for irrigation are unilaterally made and without participation of the other stakeholders.

- The majority of the institutions responsible for the management of domestic wastewater in the Region do not have the financial capacity to afford operative costs for the treatment. This is because neither the cities nor their authorities have understood or assumed the responsibility of treating the wastewater they generate.

- The treatment cost, when it exists, has not been included in the water and sanitation tariff, except in special cases like Mendoza (Argentina) and partially in Cochabamba (Bolivia). Many authorities are reluctant to include these treatment costs to the cost of living of the city and only assume costs related to drinking water supply and sewerage.

- The growing conflict of interests among technology providers from industrialized countries, operators of wastewater treatment systems and the communities, is leading to the lack of sustainability of these systems. In Cochabamba (Bolivia), the private company that tried to install an activated-sludge plant had to leave the country because the population reacted strongly against the significant rate increase to finance it. The situation is even more critical in Villa El Salvador (Peru) because the water company cannot afford the high operative costs of the aerated-pond system built by the State.

- Few experiences come close to the Project proposal for integrating wastewater treatment and its agricultural use. In Mendoza (Argentina), two thousand ha of crops are irrigated with treated effluents in 300 ha of stabilization ponds, which receive 1.400 l/s from 320.000 inhabitants. More than 460 ha produce grapes for wine, additionaly, 102 ha produce peaches and pears. A furniture company controls 205 ha of poplar trees to produce pressed wood. Alfalfa for fodder is cultivated in 340 ha. Finally, 814 ha are used for the production of garlic, artichoke, tomatoes, and pumpkins. Nevertheless, in this case the treatment and agricultural use are controlled by private entities without any coordination among them, which risks the sustainability of this valuable experience.

- The companies responsible for domestic wastewater treatment in Colombia are subject to strong penalties whenever they contaminate natural waters with pollutants that surpass the limits established in the legislation. In Ibagué, a city with a population of 430.000 inhabitants, untreated wastewaters are disposed of into rivers that cross the city, later on, those waters are used to irrigate 26.000 ha of rice crops. The water company is considering the installation of an activated sludge plant. Furthermore, with the initiative of the Project, negotiations have begun with the rice grower's association to treat their wastewaters up to the required sanitary quality level to prevent health risks among farmers. Likewise, they will use part of their rice crops to complement the treatment before disposal of their effluents into water bodies.

- There is not sufficient epidemiological information about the incidence of diseases associated with the management, cultivation, and consumption of crops irrigated with wastewater in the Region.

8. Achievements of the intervention

8.1 Human resources development

One of the most important activities of the Project has been the improvement of the institutions capability to participate in the execution of the studies because the technical teams of each country have been trained.

The 11 technical visits to the different localities made it possible to hold work meetings to explain the concepts of the integrated systems, the work methodology for the studies and to carry out a broad analysis of the local situation and its potential. During the feasibility studies, in the technical visits, thorough discussions were held about the proposals made by the technical teams responsible for the studies.

In the last technical visit to Costa Rica a Course-Workshop on Wastewater Reuse was delivered in Liberia. Costa Rican technicians and two from Guatemala, who are carrying out a similar study in their country, attended the Course. During the technical visits to Ibagué, Jinotepe, and Cochabamba, lectures on the productive use of domestic wastewater were given in the Corporación Universitaria de Ibagué (Coruniversitaria), the Universidad de Ingeniería de Nicaragua, and the Universidad de San Simón, respectively. Part of the Jinotepe (Nicaragua) complementary study has been used as a research project for graduates in the Universidad Nacional de Ingeniería de Nicaragua.

All the complementary and feasibility studies held workshops to socialize the projects with different local actors. Furthermore, during the technical visits to Ibagué, Cochabamba, Maracaibo, and Fortaleza meetings were also held with farmers to explain the benefits of the Project and know their expectations. Similar meetings were held in Lima with farmers of San Agustin.

8.2 Strengthening of the institutional capacity

All the institutions that directly participated in the execution of the General, Complementary, and Feasibility Studies (universities, water companies, development agencies, and NGOs) have developed a very important experience that enables them to consolidate themselves as the most appropriate institutions to execute similar projects in other localities of their respective countries. As an example, the Instituto Costarricense de Acueductos y Alcantarillado (AyA) currently supports the preparation of a similar study in Guatemala.

The documentation produced by the Regional Project, as terms of reference and methodologies for the studies, has been distributed to all the technical teams responsible for the case studies. Furthermore, the material has been posted in the portal of the Project in the PAHO/CEPIS web site (http://www.cepis.ops-oms.org), which is available to all users of the Region.

8.3 Effectiveness of the local collaboration with other institutions

The Project has found that the limited capacity for interaction is the main obstacle to implement the proposals among the institutions involved in wastewater management in the localities under study. Accordingly, most of the effort during the last two stages of the studies (complementary and feasibility) has been oriented to the socialization of these proposals. In the majority of the cases, an advanced level of negotiation has been achieved to commit the support of local institutions to implement the proposals. However, we believe that it is still necessary to continue this line of work to consolidate such commitments in some cases.

8.4 Contribution to the multidisciplinary approach

The issue of integrated systems for domestic wastewater treatment and use encompasses various disciplines like sanitary, environmental, and agricultural engineering; economy; sociology; management; and law. Thus, complementary and, especially, feasibility studies, required multidisciplinary technical teams from its onset. At least, these teams should include professionals from the following fields: water treatment, agriculture, sociology, and economy. The training has provided these teams with a holistic vision of the issue and has taught them to work in teams.

8.5 Methodological and scientific advances

Traditionally, domestic wastewater has been directly disposed of into rivers and seas without treatment. However, in recent decades, it is being treated prior to its disposal to protect these environments. Moreover, water limitations force many farmers to use untreated wastewater for irrigation. This implies a high risk of contaminating the products and, thus, spread infectious diseases.

The global proposal of the project on integrated systems for treatment and use of domestic wastewater constitutes an innovative design, since it turns this water into a resource that can be used again.

This proposal has been continuously promoted along the Project and has been the main topic in the training of the teams responsible for the studies. An important tool has been the REUSO software, prepared by PAHO/CEPIS, to formulate this kind of projects. This software has been provided to the technical teams that have participated in the workshops and courses.

8.6 Use of the results

The technical visits to the different localities made it possible to make lectures, course-workshops, and work meetings with the various participating actors to discuss the proposals formulated by the technical teams of the studies. Such proposals were based on the model of integrated systems for wastewater treatment and recycling.

These activities have allowed political interventions, since institutions like municipalities, universities, water utilities, and farmers have participated. In many cases, it was possible to conciliate the interests and the commitment to participate in the implementation of the proposals. The following are among the cases that deserve a special comment:

- The Prefectura de Fortaleza (Municipality) has assumed the project, has provided resources for the studies and has undertaken several actions for implementation.
- The Instituto Costarricense de Acueductos y Alcantarrillado (AyA) has provided economic and human resources, and has offered economic support for the implementation of the model project.
- The Instituto Ibagueño de Acueductos y Alcantarrillado (IBAL) has incorporated the reuse model in its Master Plan for domestic wastewater management.

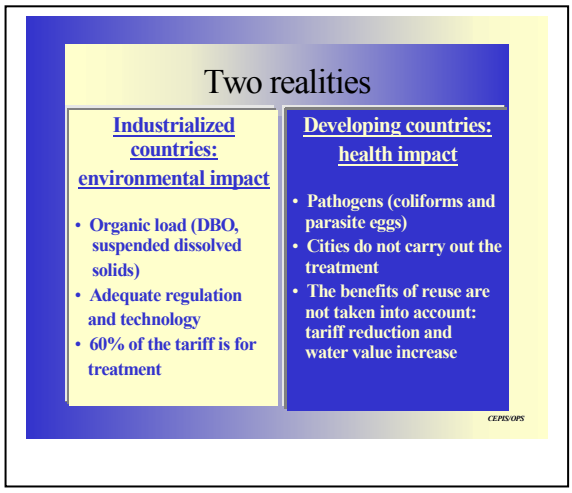
It is worth mentioning that the Urban Management Program for Latin America and the Caribbean (UMP-LAC led by Habitat of United Nations) has started a process of regional consultation to outline the formulation of municipal policies for urban agriculture. This includes wastewater treatment and reuse, which was suggested by the Project of Integrated Systems. As a consequence, on September 13, 2002, the authorities of several municipalities of the Region signed the Political Declaration of Villa Maria del Triunfo on the Promotion of Agriculture, which encompasses wastewater use.

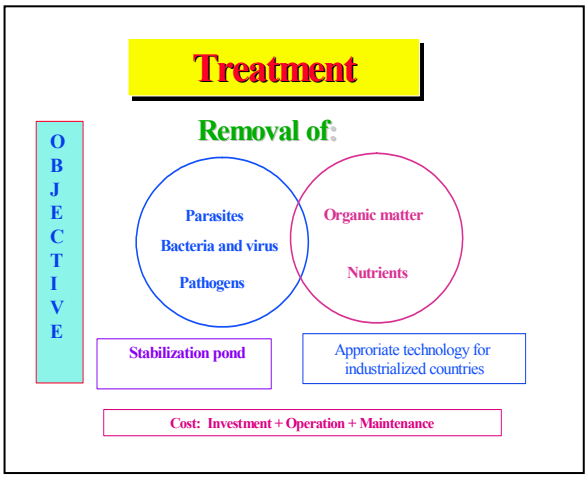
The greatest contribution of the project is the technological intervention, since proposals based on the integrated system model have been developed, even in cases where a treatment system and a practice of irrigation with wastewater already existed. In this regard, it is important to mention the case of San Agustín, which produces 20% of the vegetables that are consumed in Lima and are irrigated with untreated wastewater. Awareness of the health risks that this practice involves has been raised among farmers, thus obtaining their support to invest resources for the treatment of the waters they use.

Workshop with farmers in Maracaibo

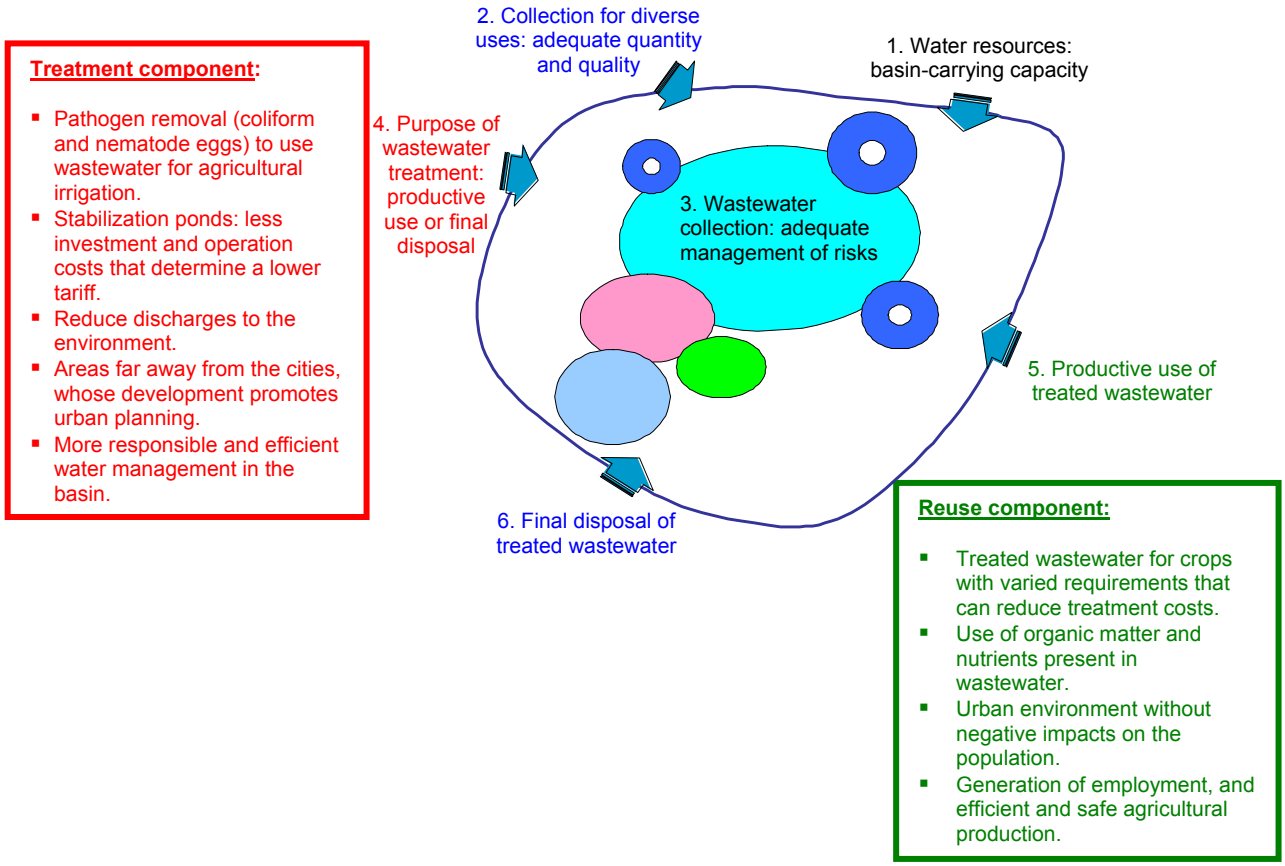
9. Model for Integrated Systems

The experiences of wastewater use developed by PAHO/CEPIS and other institutions of the Region, systematized through this Project, have made it possible to propose a model to integrate wastewater treatment and use. The proposal consists in an integrated system that adapts domestic wastewater treatment for its productive use. This implies prioritizing pathogen removal to protect public health, instead of the removal of organic matter and nutrients, which are important for agriculture.





Stabilization ponds are the most appropriate technology to achieve this objective. Besides, they only require 20% of the investment and 10% of the operation costs that other technologies require. The use of these waters for industrial crops and fodder, which do not require a high quality wastewater, would significantly reduce treatment costs. Furthermore, the use of treated wastewater for irrigation means reducing and even eliminating discharges that always generate negative impacts on the environment. This proposal intends to incorporate the integrated system to the efficient water management in the basin. The following figure shows the treatment and reuse components and its location in the basin water cycle.



Stabilization ponds and the agricultural area to be irrigated require available and inexpensive land located on the outskirts of the cities. Therefore, the integrated system generates a minimum negative impact on the population and the environment, and the collection system promotes a planned urban development.

In compliance with the principle “the polluter pays”, cities should pay the treatment cost of the wastewater they generate. However, many authorities are reluctant to add these treatment costs to the cost of living of the city and only assume costs related to drinking water supply and sewerage. The potential for integrating wastewater treatment and agricultural use of wastewater as a mechanism to reduce investment and operational costs in both activities has not been fully understood yet. The use of treated water in productive activities, like agriculture, creates an opportunity for consensus-building between the city, which would have adequate low-cost treatment systems; and potential users, who could pay part of the treatment costs having therefore, access to water for their activities. Accordingly, the integrated systems would prevent tariffs from increasing significantly when the treatment cost is included, therefore, guaranteeing the service sustainability.

Finally, the acceptance of this model implies that the community will assume responsibility for the treatment using appropriate technologies, and recognition of its benefits like health and environment protection, generation of employment, and production of high quality food.

10. Factors that determine the feasibility of integrated systems

The principal focus of the integrated system is the use of treated wastewater in a productive manner. Consequently and depending on the particular situation of every case, efforts will be oriented towards defining the feasibility of the integrated proposal, which involves the exploration of real and potential options on the part of those responsible for the study. The analysis of the case studies promoted by the Regional Project on Reuse has made it possible to identify 35 factors that determine the feasibility and sustainability of the integrated systems. These factors have been grouped into the following four general aspects and nine specific aspects:

Factors that determine the feasibility of integrated systems

General aspects	Specific aspects	Determining factors
Techniccal	Water and land resources	Land availability
		Capability for agricultural use
		Wastewater demand for irrigation (water and nutrients)
	Agricultural activity	Markets and commercialization channels
		Experience in productive activities
		Agronomic management techniques using wastewater
		Productive efficiency (productivity and costs)
	Wastewater treatment	Wastewater management policy of the water company
		Sanitary, environmental, and agronomic quality requirements of the effluent
		Technology selection
		Location and design of the treatment system
		Sustainability of the operation and maintenance of the plant (technical capability and tariffs)
Environmental	Legal context	Regulatory and legal framework for environmental planning
		Quality parameters for domestic wastewater disposal and use
		Technical standards for domestic wastewater treatment
		Technical standards for agricultural use of domestic wastewater
		Rights for the use of treated wastewater
	Management	Assessment of significant environmental impacts
		Monitoring wastewater and agricultural product quality
		Management of sludge and wastewater surplus
		Management of hazards and contingencies
Social	Cultural	Identification and characteristics of the actors (direct, indirect, groups of interest, competitive and affected groups)
		Knowledge of the actors about wastewater treatment and use
		Acceptance level of the integrated model by the actors
	Institutional	Land tenure
		Actors' needs, interests, and relationships
		Communal or private organization of the farmers
		Management mechanisms of the integrated system
Economic	Capabilities	Investment, borrowing, and operation capability of the systems
		Users' affordability and collection mechanisms
		Financing strategy for integrated systems
	Indicators	Economic valuation of environmental impacts
		Economic profitability
		Financial profitability
		Sensitivity analysis (range of costs and prices)

10.1 Land availability

Any agricultural activity (including livestock and aquaculture) or non-productive activity (urban landscape) that uses treated wastewater should have sufficient land to take full advantage of the available effluent. Moreover, the expected increases of this resource should be considered. It is thus necessary to locate the project in an agricultural or appropriate area for that type of activity. By no means should a place near to urban areas be considered, since the likelihood of urbanization would make it very limited and expensive. Finally, this area should include the required space to install the treatment plant.

10.2 Capability for agricultural use

The agronomic quality of the soils should guarantee good productivity. Soils are classified, among other criteria, according to their potential to sustain crop production and its limitations, which is known as the land capability. The following are among the most important and frequent aspects that intervene in this classification: the inherent fertility of the soil, limitations posed by the chemical nature of the soils and its management, natural limitations like poor drainage or high water table and, finally, soil reaction to the water used in irrigation.

10.3 Wastewater demand for irrigation

An integrated proposal for wastewater treatment and use should ensure the demand in such a way that the investment becomes profitable. That is, the need for wastewater should be identified. In agriculture, water demand for irrigation may occur because there is lack of water resources, but also because of the season or distribution of water supply during the year. In areas with rain fed agriculture, for example, wastewater enables cultivation the entire year if it rains only during certain times (although water storage in rainy seasons may also be required, when soils are saturated).

Wastewater is frequently appreciated owing to its contribution of nutrients that can be analyzed through its contents of organic matter and major and minor nutrients indispensable to the plant. Organic matter is essential to improve soil quality in physical, chemical, and biological terms. Moreover, in Latin America, concentrations of organic matter in agricultural soils are usually low and manure is the product most frequently added to soil, though it is becoming increasingly scarce, expensive, and inadequate.

10.4 Markets and commercialization channels

An integrated system project should not be aimed only at ensuring water for agricultural activity, but also at promoting changes in agriculture, which means that often it is necessary to adequately identify the crops with greater demand in the market. The existence of adequate marketing channels also refers to the integration of agrarian activities with processes that add value to the product, as agro-industrial processing or adequate post-harvest techniques that diminish deterioration. It should not be ruled out that integrated systems may be recognized through certification processes and quality stamps to their

products in the future, since these systems are more environmentally sensitive, as is the case of organic systems or those that apply good agricultural practices (GAPs).

10.5 Experience in productive activities

An integrated system should not just maintain the agrarian *status quo*, but increase production through improved techniques and focus on farmer training, which is vital for a competitive agriculture and an efficient and sustainable integrated system. Regarding the use of wastewater, it is necessary to strengthen farmer training in the efficient use of water, improved irrigation systems, fertilization plans taking into account the contribution of wastewater nutrients, integrated pest and disease management, and the selection of crops according to market demands.

10.6 Agronomic management techniques using wastewater

The use of wastewater in agriculture requires an adequate analysis of its impact on soils and crops, and the necessary interventions in the agronomic management. Greater potential impacts are normally related to crop selection, use of water and irrigation systems, and fertilization plans.

10.7 Productive efficiency

The use of wastewater in integrated systems is aimed at achieving the greatest productivity in real (yield per unit of area and quality of the product) and economical terms (profitability). Therefore, those systems that maximize water use efficiency and take advantage of wastewater nutrients will be in a better situation. Agricultural systems are increasingly evaluated according to their ecological sustainability. This means that the level of substitution of agrochemicals for technologies that are less polluting and less expensive will be a very valuable factor in the future. In this regard, treated wastewater can make a significant contribution to the system profitability. However, high productivity not only depends on water and nutrient management, but also on agronomic techniques well designed and included in an agricultural process in accordance with good agricultural practices.

10.8 Wastewater management policy of the water company

The policy of the majority of water and sanitation companies in Latin America only considers sewerage service to dispose of domestic effluents without previous treatment. A smaller group has introduced wastewater treatment to reduce environmental impacts, but they do not include the management of public health risks posed by pathogens contained in these waters. Nevertheless, the role of wastewater treatment is still incipient in the Region. In this context, when preparing an integrated wastewater treatment and use project, it is essential to evaluate beforehand the policy of the water and sanitation company. The city's master plan is the first document that makes the plans of the company known. Information will be completed during the work meetings with the executive board of the company.

10.9 Sanitary, environmental, and agronomic quality requirements of the effluent

The implementation of integrated systems for domestic wastewater treatment and use should consider water quality in its three dimensions: sanitary, agronomic, and environmental. Sanitary quality will depend on the level of parasite concentration, represented by the number of helminth eggs and fecal coliforms as indicator of the levels of bacteria and virus that cause enteric diseases to human beings. The agronomic quality will be related to the concentration of nutrients (nitrogen, phosphorus, potassium and oligoelements), salinity, and excessive levels of boron, heavy metals and other elements that are toxic for agriculture. All the aforementioned parameters should be considered when evaluating environmental quality, in practice, more attention is given to the concentration of solids, organic matter, nutrients, and toxic elements that can generate negative impacts on the water bodies.

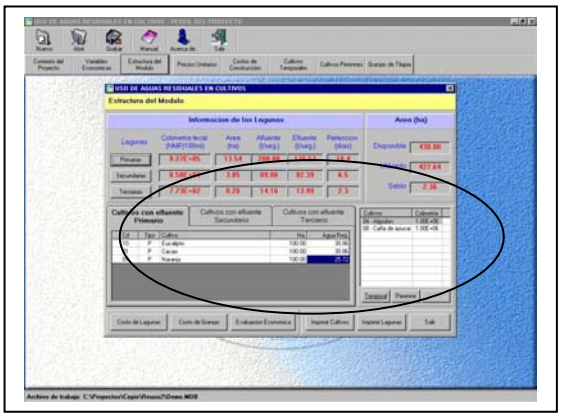
In an integrated system, the quality of the plant effluents shall meet the sanitary and agronomic requirements of the selected agricultural crops, aquaculture, and forest activities. Obviously, the water quality a forest can tolerate is lower than the quality required for lettuce production. In this regard, in an integrated system effluents should be treated according to the sanitary requirements of the crops to be irrigated. Parasites should be completely removed from water to protect the health of the workers at the treatment plant and the health of the farmers who irrigate the land.

10.10 Technology selection

The technology to be selected depends on the objective of the domestic wastewater treatment for final disposal. Domestic wastewater in Latin American countries has high concentrations of enteric pathogen germs, thus, when disposed of into water bodies, they pose a high risk of transmission of communicable diseases, like diarrhea, typhoid, and cholera. For that reason, the treatment technology should be very efficient in pathogen removal. Stabilization ponds are the most appropriate technology to achieve this objective. They remove pathogens efficiently without any disinfection process and do not require equipment or energy, except for solar radiation; generated sludges are not permanently processed or disposed of; its operation and maintenance are very simple; and only require from 20 to 50% of unskilled personnel in comparison with other technologies.

10.11 Location and design of the treatment system

The integrated system concept proposes to combine treatment and reuse operations in the same plant. To this end, the plant shall have large areas located in the outskirts of the city, where land availability is easier and costs are lower. Obviously, this condition will determine a more extensive wastewater collection system, a greater cost that could be compensated for the lower costs of the land located far from the city. In addition, the wastewater collection system can be an open channel in the outer areas of the city. The route of the wastewater collection system will also promote planned urban development, since new urban areas can be connected to the system.



The design of the treatment plant will depend on wastewater characteristics, climatic conditions (temperature), and sanitary quality requirements of the selected activities in the agricultural plan. Accordingly, the concept of traditional design, based exclusively on applicable organic matter loads, has been expanded with the incorporation of the levels of parasites and pathogenic germs removal (represented by fecal coliforms) that are required for the different types of crops selected in an integrated project. The model of REUSE 2.1, prepared by PAHO/CEPIS, makes it possible to adjust the plant operation in stages to obtain effluents with appropriate levels of sanitary quality for different crops.

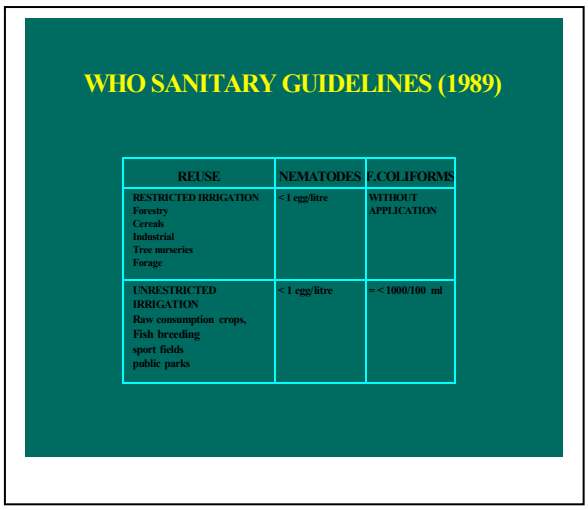
10.12 Sustainability of the operation and maintenance of the plant

Although several reasons may explain the deficient operation of treatment plants, the majority of the companies adduce economic limitations to justify this situation. Thus, the real economic and financial capacity of the water companies should be objectively assessed to decide what resources can be allocated to the operation and maintenance of the wastewater treatment plant. Most of the companies still do not include the treatment cost in the tariff, which means that the implementation of the integrated systems will force them to incorporate this cost. Consequently, it will be necessary to select a technology that demands low investment and operation and maintenance costs to ensure the sustainability of the system.

10.13 Regulatory and legal framework for environmental planning

Unplanned urban growth is the main threat to green areas conservation (or expansion) in and around the cities. Lack of planning also affects land availability that could be used for wastewater treatment plant infrastructure. For this reason, it is important to identify the regulation and legal instruments that define the criteria and mechanisms of land management, especially those related to urban development and conservation or creation of green areas in the locality. Integrated systems require that areas allocated to treatment plants and crops be intangible to guarantee the fulfillment of specific environmental purposes (treatment and agricultural production).

10.14 Quality parameters for domestic wastewater disposal and use



Most of the countries of the Region still have not adopted quality standards for wastewater disposal in water bodies or for irrigation. In the few cases that regulation exists, it is oriented to impact management, but does not consider wastewater use in agriculture. Among quality control parameters for disposal, the issue of pathogens is only partially addressed (in terms of fecal coliforms) or it is simply ignored (in terms of helminth eggs).

Despite the negative impact that unrestricted use of wastewater has on public health, no country has incorporated WHO guidelines for domestic wastewater use in crop irrigation into its legal standards. To promote health risk management posed by wastewater use in agriculture, projects should at least consider these guidelines, which establish parameters to protect public health, even when there are no legal standards to regulate the quality of discharges.

10.15 Technical standards for domestic wastewater treatment

Since legislation obliges the removal of organic matter and nutrients from domestic or industrial wastewater, the majority of technical standards for the design, construction, and operation of treatment plants are oriented toward the control of physical (temperature, pH, total solids, suspended solids), chemical (metals, oils, polymers, anions, and cations), and biological (biochemical oxygen demand (DBO_5) and dissolved oxygen) parameters. Recently, only some standards include the detection of pathogenic bacteria (total and thermotolerant coliforms), but to date no technical standard considers the determination of nematode eggs, despite the high rate of parasite incidence in the population. If it does not exist, the project should consider the proposal of a technical standard for wastewater treatment, including the proper management of health risks through the removal of pathogenic bacteria and parasite cysts.

10.16 Technical standards for agricultural use of domestic wastewater

Technical standards for agricultural use of domestic wastewater have not been identified. As stated earlier, the characteristics of these discharges differ notably from the water used in agricultural activity. The project should take into account these characteristics to recommend irrigation techniques, use of agrochemicals, and wastewater management that incorporates public health criteria (to protect farmers), the content of particles (for irrigation systems), nutrients (for the application of agrochemicals), and pathogens (for irrigation management). Likewise, the proposal of a technical standard for agricultural use of domestic wastewater should be considered for integrated system projects.

10.17 Rights for the use of treated wastewater

The right of access and eventual charge for wastewater, regardless of its treatment level need a clear legal definition to manage wastewater adequately. None of the case studies clearly defines these rights and people responsible for the treatment do not supervise wastewater use or disposal outside from their facilities, since their legislation does not consider mechanisms to adequately collect treatment costs for the treatment service or treated wastewater. An essential requirement to define the right of access and consequently, the payment for wastewater use is the responsibility on the quality of the effluent. Just as the legislation regulates other services, like drinking water supply and assigns an entity the responsibility of the service and the collection of charges, it should also regulate the production and charge wastewater treatment costs according to the quality of the effluent. Therefore, the project should consider that wastewater production with the quality required by the farmers implies a cost. Although a payment by the farmers for access to this resource with the required quality is acceptable, the population in general also has the responsibility to cover the cost of wastewater treatment.

10.18 Assessment of significant environmental impacts

Every activity (whether productive or not) generates environmental impacts that need to be classified in accordance with its direction (positive or negative), temporariness (provisory or permanent) and extension (local or regional) to identify those considered as significant owing to their magnitude and temporariness. Significant environmental impacts represent the principal environmental strengths and weaknesses of the project and require special attention in its management because the project viability and sustainability rely on this. The assessment of significant environmental impact implies quantifying the real benefits or damages (those generated by the project) or potential (those generated as a consequence of the development of the project) and proposing actions that either sustain or increase the benefits, or reduce or eliminate the damages. The group of these actions organized within a time span is called the Environmental Management Plan.

10.19 Monitoring wastewater and agricultural product quality

Monitoring the quality of treatment plant effluents and the products irrigated with these waters has received little or no interest from the authorities and those responsible for wastewater treatment and use. Quality control is essential for managing impacts (real or potential) on health associated with wastewater management. Quality control should focus on the relevant parameters for health: infectious agents present in wastewater and agricultural products (pathogen bacteria and parasites). In the treatment component, the critical points are the inflow of raw wastewater and the effluent of the plant; those responsible for the treatment should monitor the quality of the effluent along the entire process. The purpose of quality control in this component of the integrated system is aimed at ensuring the delivery of treated wastewater with the adequate sanitary and agronomic quality required for the crops to be irrigated. In the reuse component, the critical control points are the irrigation system, including the infrastructure and irrigation practices, the products sold, and post-harvest practices. The purpose of the control in this component of

the integrated system is to protect farmers' and consumers' health regarding the products irrigated with treated wastewater.

10.20 Management of sludge and wastewater surplus

Every wastewater treatment system produces sludge, whose volume and composition varies according to the wastewater source and treatment technology. Wastewater treatment technologies generate large volumes of sludge that usually do not receive adequate treatment and, thus, originate serious environmental problems. The project should consider a sludge management program, including the calculation of sludge volume, its stabilization in adequate environments, and its final disposal, whether in agricultural lands or sanitary landfills.

A surplus of wastewater can occur when other sources outweigh the demand of agricultural soils, for example, during rainy seasons. In these cases, it is necessary to foresee options to handle the consequent surplus of treated wastewater, since it will not be used for irrigation. These options should consider the volume in excess and the duration of the situation. The storage in reservoirs with final treatment before its use in irrigation is a good alternative and it may also be used for fish production.

10.21 Management of hazards and contingencies

Since large volumes of wastewater are considered for treatment and use, it is necessary to identify associated risks and prepare a risk management plan. The stability of the infrastructure of the treatment plant (especially of stabilization ponds), storage reservoirs, and collection and irrigation channels should also be observed, as well as any unforeseen overflow in the plant or irrigation system. The management of these risks and contingencies should be explicitly dealt with in the Environmental Management Plan. It should also be part of the training of the staff in charge of the treatment system and the agricultural activity.

10.22 Identification and characteristics of the actors

The objective is to identify and characterize the population and institutions of the area of study ─mainly those directly involved─ and locate them within the local, regional, and national framework. Thus, data on local conditions and the social, cultural, economic, organizational, infrastructure, and service context should be compiled.

10.23 Knowledge of the actors about wastewater treatment and use

To propose training actions that enable people and institutions to carry out an adequate management of the processes, it is necessary to know the level of knowledge the various actors have regarding wastewater treatment and use.

Since training needs may differ according to each type of actor, a differentiated survey should be carried out to know their knowledge level in order to define future needs

for dissemination, training, and technical assistance. Once the needs have been identified, a training plan should be established and executed throughout the project.

10.24 Acceptance level of the integrated model by the actors

Actors' perceptions of what an integrated system of wastewater treatment and productive use is may vary on an individual basis. Perceptions related to potential risks may lead to acceptance, indifference, or rejection of the project proposals. To achieve a good acceptance level, it is essential that the actors know the risks, potential, and benefits of the proposal implementation. Clear information, showing all elements of the situation, turns perception into willingness, and willingness into acceptance.

10.25 Land tenure

The system requires two types of land: one for treatment plants and the other for production. Bordering areas are important as well as the possibilities of urban expansion or contraction. In all cases, for the proposal to be feasible and sustainable it is necessary to know the type of property or tenure, the land physical and legal situation, its management policy, the existence of current and potential conflicts, the alternatives to solve them, or the options to use other lands if such conflicts can not be overcome. These factors should be analyzed exhaustively in every case to ensure a sustainable physical basis for the project and consequently for its efforts and investment.

10.26 Actors' needs, interests, and relationships

Actors should be classified by organized groups, including the organized community and public or private institutions; the community in general should be considered if their needs and interests emerge as crucial elements of the project. This classification, in each project, is the basis to prepare a map of actors, defining the principal groups and entities involved, their needs and interests, and their relationships with other actors. This map should demonstrate existing and foreseeable alliances among them, as well as their current and potential conflicts.

The preparation of this map will clarify the intersectoral and interinstitutional situation of the proposal and will also provide key elements for the definition of strategies to consolidate alliances, minimize conflicts, and strengthen synergies among groups. This will build concertation lines and consensus that will lead to the signing of agreements.

10.27 Communal or private organization of farmers

It is important to know how farmers are organized in the project area because they are directly involved in the productive reuse and they will play a key role in the success of the integrated system proposal. Therefore, it is essential to know their organizations, characteristics, needs, and projections; the strengthening of these organizations should be regarded as one of the development axis of the project.

10.28 Management mechanisms of the integrated system

The integrated system also requires an integrated management. The selection of the model and the mechanisms for each case should depend on the operation and sustainability of the proposal. To this end, the management design should include, among other components, a leader entity to promote the system; participation and coordination mechanisms; a management area for wastewater treatment; a management area for wastewater productive use; and forms of articulation, coordination, regulation, planning and convergence for both areas. Besides, it should consider the incorporation of both areas into the general management; a global management strategy for the integrated system; the preparation of an operation plan and a timetable of the strategy; a monitoring, follow-up, and assessment plan; and a strategy for changes in the operation plan, in accordance with the assessment results.

10.29 Investment, borrowing, and operation capability of the system

To assume the responsibility for wastewater treatment, water and sanitation utilities should have enough solvency to finance the works and guarantee their operation. This solvency is determined by the proportion of their available resources (liquidity) with respect to their commitments (liabilities), borrowing capacity assigned by the financial system according to its cash flow, and payment performance.

10.30 Users' affordability and collection mechanisms

In Latin America, few sanitation companies include treatment costs in their tariffs. It is mainly due to lack of knowledge of urban dwellers about their responsibility for the treatment of the wastewater they generate and lack of capacity to afford a higher cost of living.

The project should estimate the treatment costs and propose its distribution among city users and irrigation beneficiaries. For the effective collection of the treatment cost, sanitation companies have efficient collection mechanisms that include the suspension of services (mainly drinking water supply) in case of pending debts. Similar collection mechanisms could be used in the case of treated wastewater.

10.31 Financing strategy for integrated systems

The ideal strategy to finance integrated systems requires the assessment of both components (treatment and agricultural use). If the financial entity considers the accomplishment of public health and agricultural production objectives separately, there is no way to guarantee that the assessment will be adequate and positive.

The project has no knowledge of credit line given to integrated systems. To be eligible, an integrated system proposal should subordinate one of the components. Those responsible for integrated system projects should report to the credit and cooperating

entities about the need to carry out the most adequate assessment according to their specific characteristics.

10.32 Economic valuation of environmental impacts

Integrated systems represent positive environmental impacts of great magnitude. The correct valuation of these impacts can determine an important economic profitability that justifies the implementation of the project. Environmental impacts that offer economic benefits include the reduction of infectious diseases, the minimization or elimination of polluting discharges, the increase of water supply for irrigation, greater supply of food, generation of employment, and the preservation of areas for wastewater treatment and crops.

10.33 Economic profitability

Economic profitability is understood as the (economic) balance between the benefits and social costs (economic and environmental) derived from the implementation of the project in a given context and term.

Economic profitability is mainly expressed through the current economic net present value (ENPV) and its complementary indicators, the economic internal rate of return (EIRR), and the benefit-cost ratio (BCR).

10.34 Financial profitability

Financial profitability is understood as the capability of the project to assume the return of a loan granted for its implementation and operation under certain lending terms. In another perspective, it measures the capability of the economic balance (difference between the benefits, and economic and environmental costs) to pay a loan.

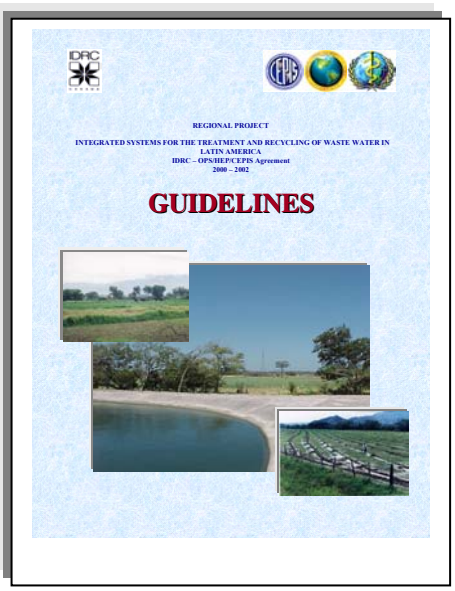
Financing profitability is mainly expressed through the financial net present value (FNPV) and its complementary indicators, the financial internal rate of return (FIRR) and the benefit-cost ratio (BCR).

10.35 Sensitivity analysis

Assessment of changes in economic and financing profitability indicators of the project, as a result of changes in the context, makes it possible to identify sensitive variables of the project. These simulations are useful to detect the project strengths and weaknesses regarding environmental changes and design strategies to alleviate its negative effects or strengthen the positive ones.

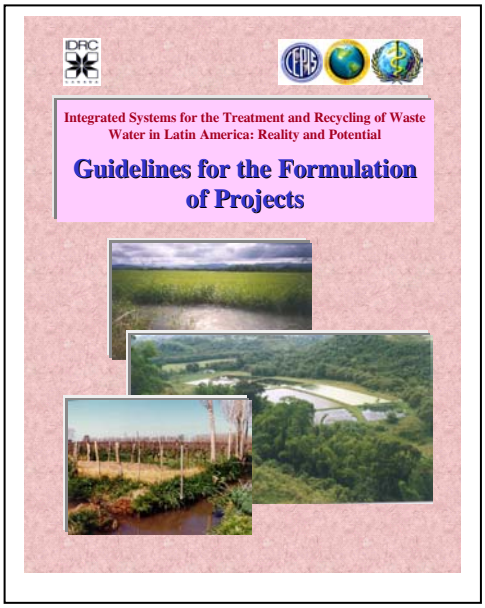
The most common variables to perform sensitivity analyses are product prices, quantity of the demand, costs of inputs and other resources, and contingency risks.

11. Guidelines



The Project final report has defined strategies to propose and implement integrated systems, which will be disseminated through several products. One of these products are the *Guidelines for wastewater treatment and use* that are being proposed to the countries, so that they can evaluate the convenience of incorporating them into their legislation. The document proposes strategies and guidelines to manage domestic wastewater treatment and use and supports the implementation of integrated systems. It also identifies differences between the integrated system "model" and current wastewater management situations to propose the strategies that would be applied in each case. It describes the principal guidelines and the relevant factors that support them, covering technical, environmental, social, and economic aspects of the projects. The following stage of the Project is aimed at disseminating these guidelines to facilitate the review of legal standards in the countries of the Region.

12. Guidelines for the formulation of projects



Another important product of the Project are the *Guidelines for the formulation of projects* on integrated systems for domestic wastewater treatment and use.

The guidelines include a practical methodology to address the technical, environmental, social, and economic aspects that determine the feasibility and sustainability of integrated systems for domestic wastewater treatment and use. It describes the logical sequence to address the evaluation of problems and the formulation of an adequate proposal. Finally, the guide suggests the terms of reference that should be considered in these studies.

13. Proposal for the second stage of the Project (2003-2005)

The first stage of the Project has made it possible to evaluate not only the situation of wastewater management in the Region, but also to identify and support the proposal of some cases that could be implemented if the required funding is obtained. Accordingly, the next stage of the Project would be aimed at consolidating integrated systems for domestic wastewater treatment and reuse in the Region through the supervision of the implementation of the proposals that have been formulated and the strengthening of the cases that did not achieve the proposal stage. Furthermore, it also intends to complete the regional inventory and to address the health impact of wastewater reuse, which is a key element to facilitate improvements in the legislation of the countries. Pending issues like sewerage and technological alternatives for domestic wastewater treatment would also be dealt with.

The proposed objectives for the Second Stage of the Project are:

- To continue the promotion of integrated systems for wastewater treatment and use in the Region through the implementation and monitoring of model systems in various countries.
- To strengthen local capability to facilitate the concertation of interests among actors involved in adequate wastewater management.
- To incorporate condominial sewerage as a feasible alternative for domestic wastewater collection and disposal to increase sewerage coverage.
- To evaluate other alternatives for domestic wastewater treatment and use when stablization ponds cannot be implemented.
- To review experiences related to wastewater use impact on public health and to sustain and promote the implementation or updating of legal and standardized mechanisms related to adequate wastewater management in the participating countries of the Region.

A significant support from PAHO/CEPIS to provide training and technical assistance to Latin American and Caribbean countries will be required during the second stage. Several manuals and other material will be useful to develop regional courses. This Program is envisaged to be carried out during 2003 and 2005 and will include the following components:

Regional database on wastewater management

- Creation of the Latin American Board for Wastewater
- Completion and updating of the national inventories
- Completion and updating of the Regional Inventory
- Information on wastewater management in the SISAM information system.

Condominial sewerage

- Assessment of the situation of sewerage systems in the Region
- Regional Seminar on Condominial Sewerage
- Technical assistance for project formulation in five localities
- Technical assistance for the implementation of the systems in the five selected localities
- Assessment of the outcomes of implemented cases
- Editing and publication of the Project results
- Regional Seminar on Project results.

Alternative technologies for wastewater treatment

- Collection of information about the technologies applied in the Region
- Comparative assessment of the advantages and costs of the applied technologies
- Editing and publication of the results.

Management of sludge generated during wastewater treatment

- Collection of information on sludge in septic tanks and treatment plants
- Technical visits to localities with septic tanks and treatment plants
- Evaluation of the sludge management situation in the Region
- Definition of technical guidelines for proper sludge management
- Editing and publication of the technical guidelines defined in the Project.

Sanitary guidelines for domestic wastewater management

- Literature review on related epidemiological studies
- Review of current sanitary standards in the countries of the Region
- Evaluation and opinion on current legislation
- Organization of a Regional Meeting of Experts to review WHO Health Guidelines for the use of wastewater in Agriculture and Aquaculture
- Proposal to update, edit, and publish the Guidelines
- Technical assistance to update the sanitary standards in five countries
- Organization of a Regional Seminar to Disseminate the WHO Guidelines and Sanitary Standards in 20 countries of the Region (with legal representatives of the health sector)
- National seminars in the 20 countries that participated in the regional seminar.

Formulation or implementation of integrated systems for wastewater treatment and reuse – second stage

- Convoke the countries to formulate feasibility studies
- Course-workshop on integrated systems in 12 countries of the Region
- Preparation of new feasibility studies in nine Latin American countries
- Preparation of new feasibility studies in Jamaica, Belize, and Haiti
- Technical assistance for the formulation of the 12 previous feasibility studies
- Organization of a workshop for the feasibility study leaders
- Editing and publication of the 12 case studies
- Technical assistance for the implementation of five projects formulated in the first stage
- Workshop for those responsible for the operating systems
- Evaluation of the operation of the projects implemented in the locality
- Organization of a Second Regional Round Table on Integrated Systems
- Organization of 12 national seminars to disseminate the results.

Training and dissemination of information

- Preparation of a mathematical model for the design of stabilization ponds
- Preparation of a manual for the design of stabilization ponds
- Preparation of a manual for the operation and maintenance of stabilization ponds
- Preparation of a manual for the evaluation of stabilization ponds
- Preparation of a manual for the control and monitoring of integrated systems
- Preparation of a practical guide on simplified methods for microbiological and parasitological analyses of domestic wastewater
- Preparation of a self-instruction course on integrated systems
- Preparation of a self-instruction course on stabilization ponds
- Preparation of a wastewater glossary
- Preparation of a virtual library on wastewater issues
- Two regional course-workshops on stabilization ponds
- Two regional course-workshops for treatment plant operators
- One regional course-workshop on assessment of treatment plants
- One regional course-workshop on control and monitoring of integrated systems
- One regional course-workshop on simplified analyses of wastewater

For further information on the Integrated Systems Project visit the following website:

http://www.cepis.ops-oms.org/bvsaar/and/project/proyecto.html