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Programme in Environmental Science**

**Policy and Institutional Aspects of Water
Resources Management in Nicaragua -
The case of Managua**

Master's Thesis

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Summary

All around the world, countries are facing increasing water problems. In urban areas of the south these problems are particularly critical and are likely to worsen in the near future due to increases in population, industrialisation and poor water management. Managua, the capital of Nicaragua, is not an exception to this problem. Even if this city is not as populated and industrialised as other capital cities of Latin America, it is facing numerous challenges related to water resources and land management, which threaten sustainable development in the area.

This essay deals with sustainability of water resources management in low-income cities, as exemplified by the Managua case. A systems thinking approach is taken to study the complex interrelationships between the different social, economic, institutional and environmental factors that influence water management in the study area. Concepts of sustainability of water and land management in urban areas, which are stated in Dublin/Agenda 21 and the Habitat Agenda, are used as a benchmark to evaluate the progress towards sustainable use of water resources in Managua.

The findings indicate that institutional arrangements for water management have been deficient in the area, but that in the last few years some progress has been made towards improving it. However, the efforts have focused on partial solutions, which may only address some aspects of sustainability leaving other unstressed. Among the aspects that have been poorly addressed are urban governance and economic incentives. The essay proposes to focus efforts on smaller initiatives based on partnerships between different stakeholders; and calls for a more formal commitment from the national and local governments towards integrated water resources management.

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Introduction

Background

Water is an indispensable resource for life-support. Both its quantity and quality are determinant factors in providing functions essential for environmental, economic and social needs (García, 1998; Young et al, 1994). Although water is a renewable resource, the fresh water supply is relatively fixed and vulnerable. In the last decades, population growth and processes such as urbanisation, industrialisation and intensive agriculture have put an enormous pressure on fresh water resources all over the world. Higher water demands and the degradation of water quality are increasing water scarcity everywhere (OAS, 1998). Water scarcity is expected to further aggravate in the next 25 years; especially in developing countries where population growth is the highest and people are seeking better lives (UN, 2000; McCommon et al, 1998) .

Economic and political factors have contributed to the water crisis (OAS, 1998). Water management is understood here as actions and interventions on fresh water resources, and includes policy making, planning, water rights allocation and individual use of water (Scharp et al, 1999; García, 1998). Since water is used in a wide range of economic activities, its management has responded to the demands of each sector separately. Such an approach has not considered the resource as a whole, which has led to conflicts of use. Also, the need for immediate economic growth and the undervaluing of water has promoted a short-sighted management of the resource (NFR, 1999). Mismanagement seems to be aggravated in developing countries where the financial and human resources to cope with these problems have been meagre (GWP, 2000).

The concern about water resources management has grown in the last decade. In several international meetings, nations have acknowledged the need to take concerted measures to promote the integrated management of water resources (OAS, 1998). Universal principles for a more integrated management have been stated as a guideline to overcome the water crisis and to reach sustainable use of the resource. However, the implementation of these principles at the country level has been a difficult task because of the differences in local/specific conditions and the commitment that is required from different stakeholders (Briscoe, 1994; GWP, 2000).

Problem definition

The management of water resources is quite complex as it involves diverse sectors and aspects. In many countries, the agriculture and industrial sectors are the largest users and polluters of water resources (García, 1998). In low-income countries the water supply and sanitation sector often represents the biggest challenge. This is particularly true in urban areas where water demand is high and far from being satisfied, and where pollution sources are concentrated (GWP, 2000). In these areas, a compromise between health and sustainability seems difficult to achieve. On one side, it is urgent to provide growing urban populations with the infrastructure to meet their basic water needs and to reduce water related diseases. On the other, it is important not to undermine the ecological systems, where fresh water and nutrients are essential components (Kjellén and McGranahan, 1997).

This paper deals with sustainable water resources management in low-income cities, with an emphasis on the area of Managua, the capital of Nicaragua. Although this city is not as

populated as other homologues in Latin America, it still faces difficult challenges in terms of sustainable development. Indeed, Managua concentrates about 26% of the country's population, as well as industrial and some agriculture activities (IDB, 1999b). Unsound land use practices resulting from different economic and political conditions have caused serious environmental degradation. Deforestation and erosion, as well as the discharge of untreated sewage and industrial effluents from urban and peri-urban Managua have severely affected the quality of Lake Managua and other surrounding lakes. The degradation of land and water resources has harmed local ecosystems and is hindering the possibility to use the lakes for more productive activities that could benefit the residents. This situation threatens the long-term sustainability of the area because it may affect the quality of present and future sources for water supply, which are required to satisfy the increasing development needs.

Although plans exist to build two treatment plants to reduce the point-source pollution from the city, it is unlikely that this option alone will solve the problem of water quality in Managua. This essay attempts to prove that a comprehensive water resources vision and management are needed to reverse the process of degradation of these resources, as well as to contribute to the sustainable development of the area. A comprehensive water resources management should take into account environmental, social, economic, and institutional dimensions. It should promote the use water resources to meet residents' needs for socio-economic development without jeopardising the ecological integrity of the resource.

Most of the water research that has been done about the study area has been mono-disciplinary. The comprehensive or integrated approach has seldom been considered and hence the motivation for this thesis.

Objectives

The objectives of this paper are to:

- Examine the causal relationships that influence the management and degradation of water resources in poor cities, taking Managua as an example. The emphasis is put on institutional, governance, and to a lesser extent, on economic factors.
- Evaluate some of the recent initiatives to improve management in Nicaragua and in the study area. This will be done based on sustainability principles related to institutional and socio-economic aspects.
- Propose further actions that could lead to a more sustainable use of water resources in Managua.

Methodology

As mentioned earlier, fresh water resources are an important part of different ecological, economic and social systems that are closely interrelated. The way in which water is used in one of these systems affects the other systems in either positive or negative ways. Based on these characteristics and on the objectives set for this essay, systems analysis or systems thinking has been chosen to study the problem at hand.

Systems analysis is a methodological framework whereby mental models are constructed to examine and understand the interdependent relationships between components and processes of a given system (Anderson and Johnson, 1997). The dynamics generated by the relationships can be represented in the form of a Causal Loop Diagram (CLD). In the case of this essay, a CLD is developed to understand the underlying driving forces that are leading to the degradation of water resources in low-income urban centres. This is crucial to identify possible strategies to counteract and reverse this problem. The CLD, which is based on a literature review of the topic, is applied to the information collected from Nicaragua, and more specifically from the Managua area. The advantage of using systems analysis in this case is that it allows approaching the problem in a multidisciplinary way, favouring a holistic rather than a detailed perspective of the system under study.

Scope and limitations

The topic of sustainable water resources development and management is quite broad and complex. This work is not intended to cover all aspects pertaining to integrated management of these resources. Although the essay examines more closely institutional, political and economic aspects of water management, it is not meant to be a deep discussion of either pure political or economic theory. It is rather aimed at providing a multidisciplinary view of the problem of water resources degradation and mismanagement in the area of Managua.

It is acknowledged that the watershed or catchment basin has a particular importance as a planning and management unit for land and water resources (NFR, 1999; GWP, 2000). However, the discussion of this essay is restrained to the urban and peri-urban area of Managua. Further, the accent is put on water quality problems, rather than on quantity, because of the relative abundance of water in the study area. Besides, it is recognised that protecting the quality of water is crucial for sustainable development and the promotion of human health (UN, 2000).

One of the main limitations of this work is the data sources. Due to time constraints it was difficult to obtain primary data. Thus the essay relies on secondary data, which may not be abundant and updated, and whose reliability can be questionable. Moreover, this limits the possibility to evaluate accurately the progress towards sustainable water resources management in the study area.

Structure of the thesis

The thesis consists of three main parts. The first part provides the theoretical framework for Integrated Water Resources Management (IWRM). First, the concept of sustainability is defined and discussed. A mental model is then presented in the form of a CLD to illustrate the interactions between different driving forces of unsustainable water management in developing countries. In a following section guiding principles for the implementation of IWRM are

discussed. The discussion focuses on institutional, governance and economic aspects that can contribute to a more sustainable use of water resources in urban areas in developing countries.

In the second part of the thesis, the theory is applied to the study area. This part starts with a brief introduction to Nicaragua and Managua. Then follows a short description of the environmental situation of the Managua watershed, as well as the current approaches to water management at the national and local level. Next, some efforts aimed at changing the current situation are presented. In Part three these efforts are evaluated against the Dublin-Rio principles. In a final section, a strategy for further actions leading to sustainable WRM in Managua is proposed.

Part I Overview of concepts related to sustainable water resources management

Generalities about Sustainability

As we enter the 21st century, sustainable development is the ultimate goal for most nations in the developing world because it links the simultaneous achievement of development with environmental needs. The concept, which has been much debated, tries to conciliate three broad fields that are mutually interconnected, namely economics, social, and environment (Pugh, 1996). Everyone agrees on the importance of the concept but it is its interpretation and how to operationalize it that remains difficult to reconcile (Connelly and Smith, 1999). Indeed, the criteria for sustainability may differ strongly according to different interests. While some stress the need for resource conservation, others are primarily concerned with meeting human needs (Mitlin and Satterthwaite, 1995).

Water resources are an essential premise for sustainable development. However, more and more countries are being faced with water related challenges that are a constraint to reaching such goal. The water resources sector is referred to by the Inter-American Bank as "the portion of the hydrological cycle that provides overall socio-economic and life-support functions to all possible needs for water, including economic, social and environmental needs" (García, 1998). What needs to be sustained in this sector can be sometimes unclear and surrounded by contradicting ideas, especially because of the number and diversity of stakeholders involved. A stakeholder can be defined as an individual or group of individuals that has a strong interest in something (Scharp et al, 1999). Water stakeholders include regulators and policy makers, suppliers of water services, municipalities, industrial organisations, consumer organisations, and other NGO's. Therefore, some of these stakeholders may give more attention to ecological sustainability, others to economic sustainability, or to social-community sustainability, or even to institutional or managerial sustainability. Due to the variety in interests and means available, the operationalization of sustainability in this sector can prove to be extremely difficult.

Causal Loop Diagram

While defining sustainability in the water sector seems difficult, it is perhaps easier to outline what is clearly not sustainable and to identify the causal relationships that are leading to unsustainability. The following Causal Loop Diagram illustrates some of the driving forces that are conducive to unsustainable use of water resources in low-income cities.

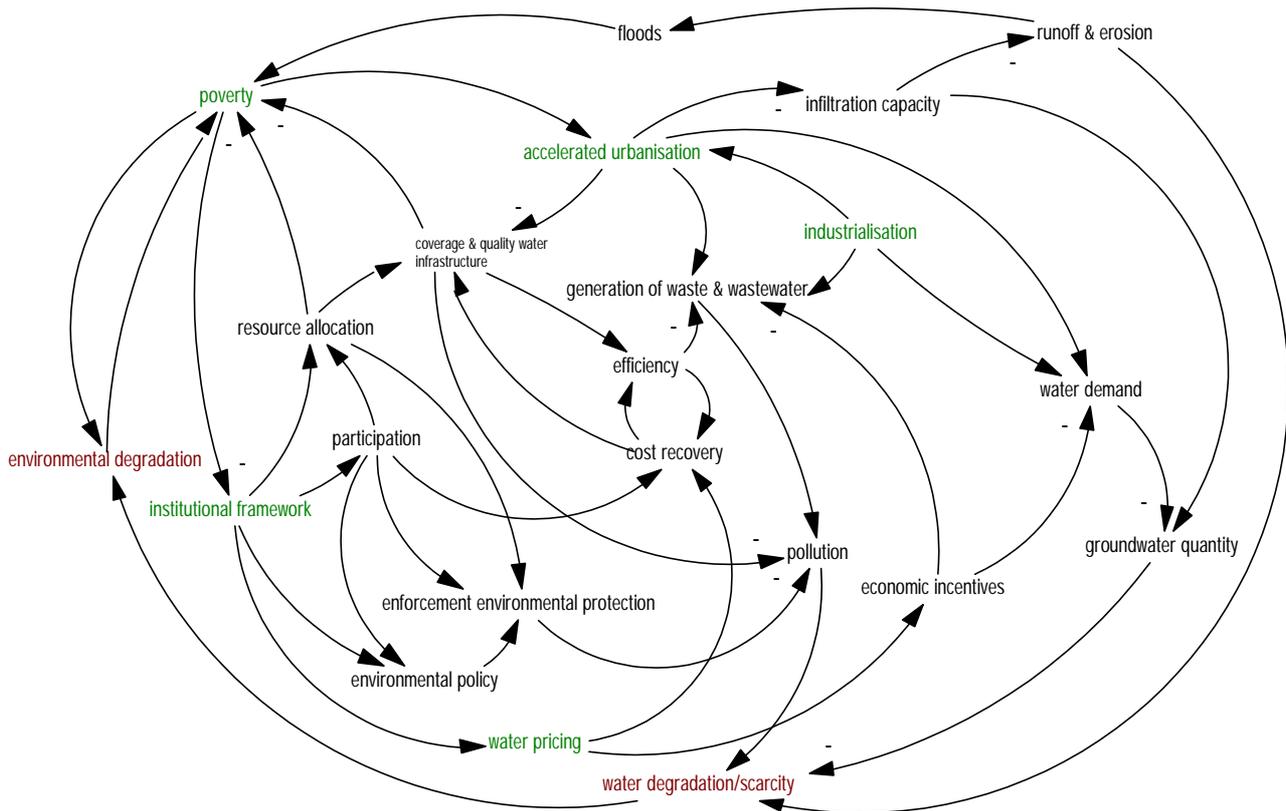


Figure 1. Causal loop diagram representing the links between water degradation and other environmental, social, economic and institutional systems. The arrows with no signs indicate that a change in variable A causes a change in the same direction in variable B.

The arrows in the CLD not only link two variables. They also convey information about the type of relationship between the variables (Anderson and Johnson, 1997). This information is shown with negative and positive signs. A positive sign means that when variable A changes, variable B changes in the same direction. The negative sign indicates that a change in variable A causes a change in B in the opposite direction. In order to simplify the CLD, only negative signs are shown. In the following section, the discussion focuses on the concepts upon which these links are built.

Driving forces for unsustainable water resources management in developing countries

Human activities alter environmental systems in many ways. The water system is directly affected by using water as input for development activities and as a sink for domestic, industrial and agricultural waste. Interventions on soil and vegetation systems also affect the availability and quality of water resources (NFR, 1999). A reduction in these parameters causes a deterioration of this valuable resource and disturbs other environmental systems that are closely interrelated (García, 1998; NFR, 1999). Although these problems can be localised, the effects can extend to a regional scale and prevail over a long period of time.

Human disturbances on environmental systems are generated by different sectors in society, which are influenced by specific economical, political, institutional conditions of a given country (NFR, 1999). In developing countries, the deterioration of water resources is caused by the action of several factors. Pervasive poverty, population growth, land use practices, market failures, power and institutional structures are some of the factors that contribute to land and water resources degradation in these countries (NFR, 1999; GWP, 2000).

Poverty and environmental degradation

Poverty and environmental degradation are reciprocally interrelated (Ekbom and Bojö, 1999). Poverty limits people's options and forces them to overexploit natural resources or to perform land use practices that have a negative impact on water resources. Poor people are often pushed to settle in areas that are not suitable for living or cultivating. Such areas include hillsides, flood plains, etc (McCommon et al, 1998). In order to survive, people clear the vegetation cover for cultivation or energy-supply purposes. The soil is exposed to erosion, which eventually results in land degradation, reduced infiltration capacity and sedimentation of watercourses. The depletion and degradation of natural resources namely soil and water, affects ecosystems and human beings. It also hinders land productivity and economic development, and increases poverty. This furthers the cycle of environmental degradation. Factors such as social and economic inequity exacerbate this cycle (GWP, 2000; Ekbom and Bojö, 1999).

Urbanisation and industrialisation

Poverty also pushes people to migrate to urban areas in search of better opportunities. Cities are usually poles of industrial development; therefore, rural poverty and industrialisation tend to attract migrants towards cities. In low-income countries, cities are expanding at an accelerating pace, due to migration and to already high rates of population growth (McCommon et al, 1998; Pugh, 1996).

Accelerated urbanisation and industrialisation are two of the main processes responsible for increased pressure and deterioration of water resources (NFR, 1999; Hjorth and Nguyen, 1994). The impermeabilization of large surfaces alter the flow regimes within surface and underground water systems by reducing water infiltration into the ground and producing large volumes of runoff during storm events (Gilbert et al, 2000). As a result, groundwater recharge may be affected, and the quality of runoff water may be degraded as this water carries along waste, sediments and chemical pollutants in its way towards rivers and lakes. Also, the risk of floods in lower lands and the consequent damage of infrastructure and human lives is a result of large

volumes of runoff. Soil erosion and sedimentation of watercourses is another negative impact associated with increased runoff.

Urbanisation and industrialisation also affect the carrying capacity of the water system due to the overexploitation and pollution of water resources (GWP, 2000). In effect, with industrialisation and urbanisation comes a rise in water demand. Many cities in developing countries rely on groundwater (Bethune et al, 1998); therefore, the amount of groundwater is reduced as extraction increases and less water infiltrates into the ground. A lower amount of groundwater may also affect the quality and availability of superficial water.

But just as water demand increases, so does the generation of solid waste and wastewater. This puts a considerable stress on wastewater and solid waste treatment facilities, which are already quite inefficient (UN, 2000). Indeed, in rapidly growing urban areas, authorities have been unable to provide and manage adequate urban services. High public debts result in almost no resources to extend infrastructure, especially sewerage. Where sanitation infrastructure exists it is rather obsolete and inefficient. Poor sectors of society, which represent the majority of the population in developing countries, are the most affected by this situation. The allocation of resources gives low priority to squatter settlements because of their illegal situation, their lower income and the difficulty to recover investments (Biswas, 2000). The lack of resources to maintain and to extend the infrastructure to cover all sectors of society has resulted in large environmental burdens that causes losses in productivity and quality of life.

Limited finances and the increasing demand on services also handicap solid waste management (Van Beukering et al, 1999). Although organic waste may be prevalent over non-biodegradable waste, not everybody has access to waste collection services. Very often, waste is illegally disposed of in drainage canals or on vacant land. When collected, waste is deposited in landfills that do not meet minimal technical requirements. Hazardous waste may also be disposed of in the same landfills (Ibid.).

Superficial and groundwater contamination can be increased by runoff and leaching from poorly managed landfills, pit latrines and septic tanks. Even the existence of a sewerage networks does not guarantee that water resources will not be contaminated. In low-income cities it is common that raw sewage and industrial effluents are directly discharged into neighbouring watercourses without recycling or previous treatment (NFR, 1999). With such an approach, valuable resources such as limited clean water and nutrients are depleted. The lack of efficient pollution control measures further aggravates the degradation of the quality of water resources. This situation adds to the overall environmental degradation that affects human and ecosystems health, and incurs into externalities that reinforce poverty (Ibid.; GWP, 2000).

Market failures

According to environmental economics, those goods and services for which there is a market get allocated to their highest valued use (Turner et al, 1994). In the case of unpriced goods, the market fails to allocate the resource efficiently, creating external costs to society.

Water has traditionally been treated as a free and unlimited good. As a result, its full value, which consists of its use and intrinsic value, has not been recognised. The use value is the economic value and is divided into direct use value, indirect use value, and the option value.

The indirect use value is the net benefits obtained from the ecological functions of a watershed; and the option value, includes the potential uses for the achievement of social objectives. The intrinsic value includes non-use values such as well being or existence values (GWP, 2000).

Fully valuating water is a difficult task (Ibid.). But the more environmental and social values are neglected, the lesser market prices reflect the real cost of the resource. This leads to a misallocation of water resources and provides no incentives to use it as a limited and vulnerable asset (Ibid.). As a result water is overexploited, wasted and contaminated, creating both environmental and economic externalities that affect public health, ecosystem maintenance, and economic opportunities (Rogers et al, 1998).

In urban areas the provision of water supply and sanitation services tends to be heavily subsidised (Wegelin-Schuringa, 2000). Tariffs, if existent, do not reflect the real cost of water. This cost consists of "the full supply cost due to resource management, operating and maintenance expenditures and capital charges; the opportunity costs from alternative water uses, and the economic externalities arising from changes in economic activities of indirectly affected sectors; and the environmental externalities" (GWP, 2000). Therefore, the charged rate may at best cover only the supply cost, which is not enough for sustainable management of the resource. But often tariffs are so low that people do not use water efficiently, leading to a wasteful use of the resource for some while many do not even have access at all.

Low cost recovery becomes economically unsustainable and limits the expansion, maintenance and renewal of infrastructure, as well as proper wastewater treatment. As mentioned earlier, the people who suffer the most from this situation are poor urban dwellers. In developing countries, their legal situation is not clear and their income is so low that it takes a long time before authorities decide to build infrastructure to fulfil the needs of these residents. Therefore, they are often compelled to buy water from informal vendors or to connect illegally to the network in order to gain access to the resource. Illegal connections and leakage from poorly maintained and old pipes can represent as high as 40 to 60% of the total water produced (Wegelin-Schuringa, 2000). A low efficiency results in water wastage and economic loss that further limits cost recovery. This vicious circle is further reinforced by the fact that users do not want to pay for a service that is not efficient and of good quality. The limited participation of the private sector in providing water supply and sanitation services is claimed to be another factor constraining the efficiency in water resources management (Strottman, 2000).

Political institutions have enhanced these trends, since their actions prevent or distort the operation of water markets. It is now recognised that economic valuation and trading water rights could correct the market failures that surround water use and management (GWP, 2000).

Institutional and Governance aspects

Institutions are more than organisational structures. They are made of three interactive components, law, policy and administration, which create norms, rules and legal systems that affect the governance and management of natural resources (Saleth and Dinar, 1999; Lo and Tang, 1994). Institutional frameworks are influenced by the socio-economic, political and resources-related conditions in which they operate. But depending on how they are established, institutional frameworks can have significant effects on incentive and disincentive structures. If appropriate, such structures can operate for environmental protection and achievement of social

needs (Pugh, 1996). The institutional context consists not only of policy formulation and its enforcement. It includes how decision-making is distributed among authority levels, both vertically and horizontally, and the quality and the commitment to their implementation.

The management of water resources has been characterised by simplistic and short-sighted models. In such models a sectoral approach and fragmented administration have prevailed. The resulting institutional structures are inadequate for integrated water resources management (NFR, 1999; OAS, 1998; GWP, 2000). Generally speaking, development policies have not been co-ordinated and have overlooked the links between land use and water resources. Each sector dealing with water has managed the resource according to its own policy objectives, without considering the implications for other water users. The interdependence between superficial water and groundwater has also been mishandled in the institutional frameworks (GWP, 2000).

Where extreme poverty is present, governments seldom have enough resources to ensure environmental protection. In low-income countries institutions suffer a series of limitations that not only prevent the access to adequate water supply and sanitation services to all sectors of society, but also reinforce the mechanisms that lead to degradation of water resources. Such limitations include unclear and conflicting responsibilities at different government levels, lack of human resources and capacity, unattractive salaries, political influence, centralisation of decision making (Wegelin-Schuringa, 2000; OAS, 1998; Biswas, 2000).

Municipal authorities may have responsibility for providing water goods and services. However, municipal governments often rely on assistance from central government. On the other hand, water protection may in some cases be the responsibility of central governments, which creates an overlapping of functions with municipal governments. This is counterproductive because central governments end up with too many responsibilities, which they are unable to meet. But municipal authorities are unable to take over because they might not have that mandate, and because they lack the resources to effectively protect water quality. Top-down approaches and the exclusion of important stakeholders in water management are common. The effectiveness of such approaches has been questioned in the literature (GWP, 2000).

It is clear that a shortage of well trained professionals, and limitations in financial and technical resources are a major constraint to sound planning, use and monitoring of water resources. But also a shortage in human and financial resources affects how legislation to protect water resources is formulated and enforced. In some contexts, legislation may not be coherent and realistic, and it may lack the mechanisms to facilitate its implementation (Burchi, 1991). Where standards for water quality exist, there might not be enough incentives to enforce them and comply with them. Economic incentives can promote water conservation and waste reduction at source, but they can also affect how regulations are enforced by the environmental protection agency (Lo and Tang, 1994). Aspects such as the existence of a "law culture" and effective sanctions for polluters are also important factors necessary for ensuring compliance with regulations (Chacón and Pratt, 1996).

Towards sustainable urban WRM in developing countries

Principles for sustainable WRM: The Dublin-Rio Principles

Most nations have recognised that there has to be a change in the management of water resources, so that water contributes to sustainable development instead of being a major constraint to it (OAS, 1998). In essence, there has to be a paradigm shift from development of water resources, which relies on technical solutions, to a better management. Likewise, there has to be a shift from a sectoral to an integrated approach, which includes the integration of the social aspects of water management with the technical aspects.

In 1992, a set of principles stated in the Dublin Declaration was universally adopted as a guide for taking actions to achieve sustainable use of water resources (García, 1998; Young et al, 1994). Chapter 18 of Agenda 21, which addresses fresh water resources, was based on these principles. That is why they are also referred to as the Dublin-Rio principles. These have subsequently been restated in other meetings in Harare and Paris in 1998, and in the VI session of the UN Commission for Sustainable Development in 1998 (García, 1998; GWP, 2000; Aguilar et al, 1999). There have been regional meetings where the principles have been adapted to local goals. The Declarations of Buenos Aires and San Jose, both signed in 1996, are examples of such initiatives in Latin America (García, 1998).

But the sustainability of water resources management has not only been the priority of the water sector. Other UN Conferences have also included this topic in their agenda. For instance, in 1995 the Social Summit held in Copenhagen addressed aspects of social development and poverty reduction, which are closely related to water supply and sanitation (WSSD, 1995). The City Summit or Habitat II, held in Istanbul in 1996, was also concerned with aspects of water resources management in urban areas (Pugh, 1996). The implications of the Habitat Agenda on water issues will be discussed later.

Some of the recurrent concerns in these meetings are that water should be conceptualised as a finite resource essential for life-support and socio-economic development and that its development and management should be integrated, involving all stakeholders' participation. Furthermore, it has been agreed that water should be recognised as a social and economic good. By this it is meant that its use should benefit people, especially the poor, without compromising the environment (García, 1998; Aguilar et al, 1999; GWP, 2000).

The concept of Integrated Water Resources Management (IWRM) is regarded as a process intended to translate the agreed principles into concrete action. According to the Global Water Partnership, IWRM "promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000).

Of course these ideas can be very difficult to implement in practice (Briscoe, 1994). According to the literature, cost recovery, capacity building and stakeholder participation need to be stressed in order to have a successful IWRM (García, 1998). Cost recovery is essential for financial sustainability in the sector, and a precondition for the good implementation of IWRM is the capacity of institutions. It is certainly a big challenge to develop an institutional framework that would be able to integrate economic, social, and political aspects necessary to the implementation of IWRM. In this section, three of the four Dublin principles are presented and discussed:

Principle 1 Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment. This principle calls for a holistic approach to manage water. The resource has to be considered as a complex system with multiple interrelations within itself and with other natural systems. Therefore, the holistic approach should integrate the management of land and water resources, the quantity and quality of water resources, and surface and groundwater. The adverse effects of unsound water management on ecosystem integrity and on other natural resources have to be kept in mind.

Due to the multifunctional character of the resource, the demands of different users have to be taken into account. This implies the co-ordination of policies and institutions that have impacts on the resource

Principle 2 Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels. According to this principle decisions about water management should be taken at the lowest appropriate level, which is the level at which significant impacts or potential conflicts may arise (Young et al, 1998). The principle calls for decentralisation of decision making, where more space is given to local actors. It also implies that decision-making has to be co-ordinated in both vertical and horizontal levels.

The implementation of this principle may prove quite difficult due to the diversity and number of stakeholders involved in water resources management. Also the existence of a truly democratic system is a premise for its implementation. This is not always granted in developing countries, where democracy may be quite incipient. Real participation requires that all stakeholders are not only consulted but that their concern has an impact on decisions about the planning, developing and managing water resources. Participation is not real when is used to legitimise decisions that are already made.

But even where spaces for real participation exist, people may not be willing to participate because they think that their voice will not change anything (Connelly and Smith, 1999). This is because traditionally, the interests of particular groups have tended to dominate the political scene. In this way, large portions of society have been excluded from decision making. Governments have overlooked their concerns and experiences. Therefore people have become uninterested in public affairs, and there is a general apathy towards political institutions and politicians. It would take a serious commitment from governments and other actors to improve communication and create a partnership with those stakeholders that have traditionally been kept apart from the decision-making scene.

Principle 3 Water should be recognised as an economic and social good. This principle recognises that everybody should have access to clean water at an affordable price, but that the resource should not be unnecessarily wasted nor damaged. By treating water as a social and economic good, conservation and protection of water resources will be encouraged so that they are used more efficiently and in an equitable way.

This can be achieved through the use of economic instruments, which will favour demand management over the extension of supply, an option that is no longer feasible nor economically viable in many parts of the world. The recovery of the costs involved in supplying water good and services is very important in order to ensure the sustainability of the investments. This is crucial for the extension and maintenance of centralised water infrastructure intended to improve the quality of life of its users.

A concern exists regarding the fact that the poor will be affected by such decisions. According to some authors, current subsidies to the water sector largely benefit wealthy segments of society, while the big majority has to pay enormous prices for low quality water provided by informal vendors (GWP, 2000). Some have suggested that targeted subsidies for specific poor groups could be put into place, provided that these are transparent (Ibid.). This could be difficult to achieve especially in countries where mechanisms for revenue collection are not transparent, and where corruption of government agencies is a common problem.

In the case of protection against pollution, the use of economic mechanisms may provide incentives that would encourage polluters to limit or to reduce their wastewater discharges. Some authors have claimed that this approach may prove more efficient than *command-and-control* approaches (Briscoe, 1994). The collection of taxes from pollution discharges could be put into a fund to provide means to improve pollution reduction technologies for polluters and it could also increase the budget of regulating agencies which usually have limited resources to carry out their jobs. This can be an important incentive for the agency to do a better job and be less dependent on governmental investments (Lo and Tang, 1994). However, as in the case of subsidies, it is important that a country has an effective and transparent system for tax/fees/fines collection, and this might not be always guaranteed in developing countries.

The Habitat Agenda and sustainable water resources management

Unlike Agenda 21, the Habitat II Agenda puts a greater emphasis on the "brown agenda". This agenda is concerned with poor sanitation, water quality, air pollution, and housing problems, which are prevalent in low-income cities (Pugh, 1996). The Habitat Agenda recognised the need for a paradigm shift in aspects such as empowerment, decentralisation and urban governance, which are very relevant to sustainable management of water resources and sustainable development in general (Toepfer, 2000). Therefore, important concepts in this Agenda are urban governance and the "enabling" approach. These two concepts imply "accountable, transparent and participatory approaches where governments — both at the national and local levels — work in partnership with all urban actors, including local authorities and civil society" (Toepfer, 1999)

Basically, the habitat agenda calls for optimising the relative strengths of the different actors in order to avoid redundancies that result in inefficiency. Governments for instance, have a comparative advantage providing the legal, fiscal and regulatory framework to enable and ensure coherence of water supply and sanitation policies. The private sector is recognised as an important player to bringing investment capital and to improve efficiency in water management (Strottman, 2000; Toepfer, 2000). Finally, community participation in the design and the implementation of water services systems is crucial to satisfy local needs. It is also an important instrument to facilitate transparency, equity, and to provide a sense of ownership that will increase the willingness to pay for those water services (Toepfer, 2000).

Part II Water resources management in Nicaragua: the case of Managua

Brief introduction to Nicaragua and Managua

Nicaragua is the largest of the Central American states, but it is also the second poorest in Latin America. During the 70's and 80's the country was immersed in political turmoil and suffered economic decline. Since 1994 macroeconomic indicators have improved as a result of adjustment structural programs (Escoto, 1997). However, social and environmental indicators have worsened and the index of human development is very low, ranking 117th out of 174 countries (IDH, 2000; CCAD, 1998). Data indicates that in 1998, 50% of the population lived below the poverty line, and 24% lived under extreme poverty conditions (IDH, 2000). The rate of unemployment in the urban population for the last years has been of more than 20%, and underemployment over 50% (Escoto, 1997). This situation, coupled to other social and political problems, has led to mismanagement of natural resources and increased environmental degradation.

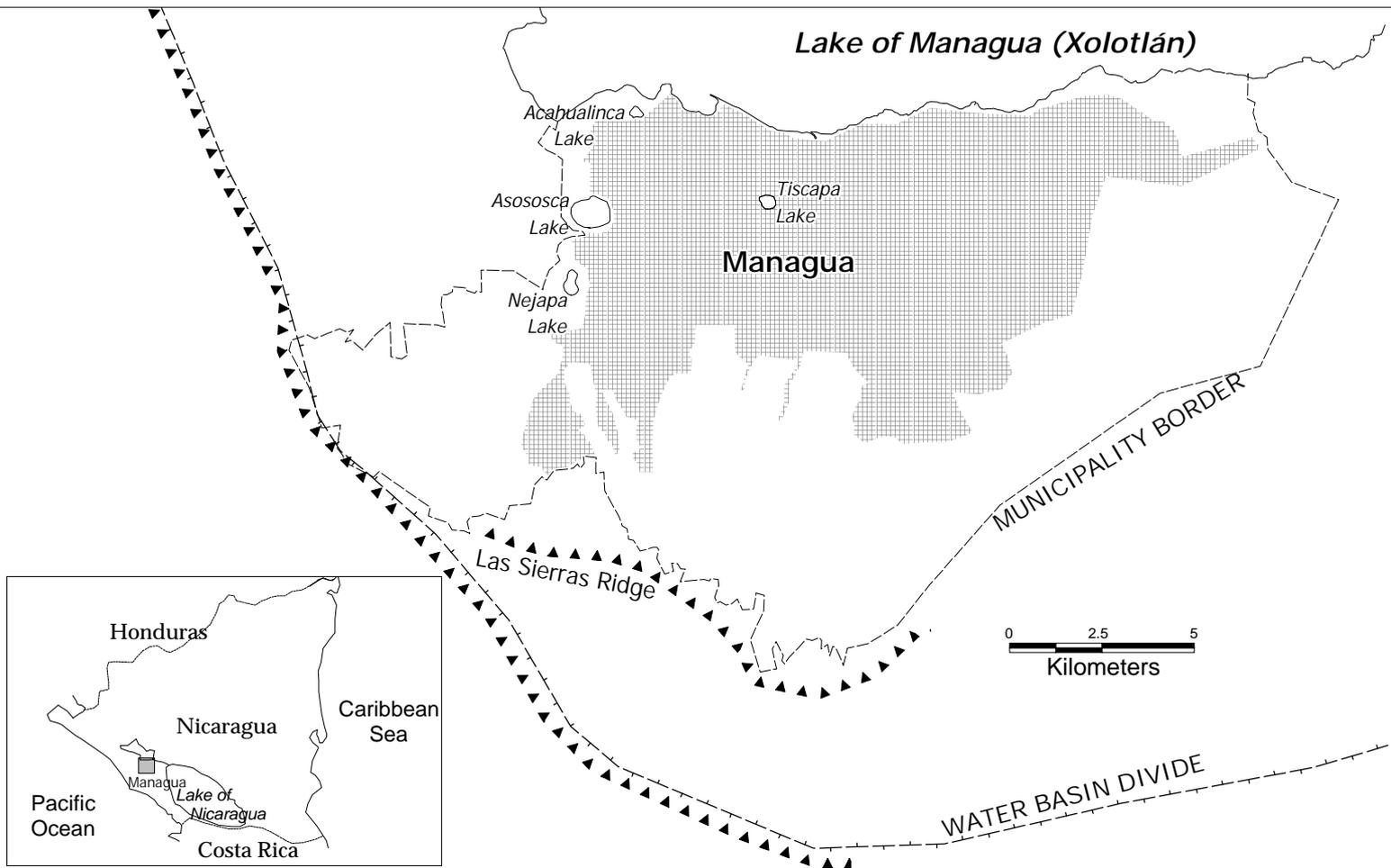


Figure 2 Location and map of the study area.

Economic development and population pressure may not be yet of the same magnitude of other countries in the region. However, these processes have been increasing in such a way that they have been putting a lot of pressure on Nicaragua's water resources. Estimates indicate that the country has an average water availability of around 309,284 million cubic meters, which is enough to supply all sectors (CONADES, 1998). Nonetheless, in the pacific region, which is the most economically active and populated area, water is relatively scarce and its quality is deteriorating. The area of Managua is a critical case, where the state of water resources is likely to worsen in the future.

Managua lies on the southern shore of Lake Managua (Figure 2). It extends over 540 km², in the lower part of the southern basin of the Lake, which is of 825 km² (ALMA, 2000). A hilly terrain surrounds the urban and peri-urban area to the west and south. The municipality's total population is about 1.4 million people, 90% of which lives in the urban zone and represents around 40% of the total urban population in the country (ALMA, 2000; IDB, 1999b). The rate of population growth is about 5% per year, which is due to a high natural growth and to an increased rural-to-urban migration (IDB, 1999b).

A rapid and chaotic urbanisation has taken place in the last two decades (Wall, 1996). The shortage of housing has stimulated the proliferation of spontaneous settlements not only in the periphery but also within the city (Ibid.). It is estimated that about 255, 838 inhabitants live in 260 spontaneous settlements, most of which are located in highly risky and vulnerable areas, such as on seismic fault zones or along the lake coast (ALMA, 2000). These settlements have a deficit in basic public infrastructure and services such as water supply, sanitation, drainage and waste collection (IDB, 1999b; UNCHS/UNDP, no date; Uilemberg, 1998; PAHO/WHO, 1997). Many of the houses have illegal access to water supply and electricity networks, and about 95% of them rely on latrines or lack any sanitation (ALMA, 2000; ENACAL, 2000a; ENACAL, 2000b). Environmental and health risks, as well as increased unemployment and poverty are serious problems in these areas.

Water resources are relatively copious in Managua. A vast aquifer, which is the main source of water supply, feeds four small crater lakes scattered through the city (Johansson et al, 1999; Scharp et al, 1997; Scharp, 1994). However, only one of these lakes is suitable for potable water. The other three suffer from natural and anthropogenic contamination (PARH, 1998b). Unsound land use, pollution and inefficient water use are thus a threat, and in the absence of an integrated water resources management plan, socio-economic development will be limited.

Environmental conditions in Managua and trends

Drainage and erosion problems

In the last 25 years, Managua has rapidly expanded towards the south. The increase in urbanisation and deforestation of the southern hills has reduced infiltration rates. As a consequence, high runoff rates have caused serious soil erosion in the hills. It is estimated that every year 1.2 million tons of sediments are washed away and discharged into Lake Managua (END, 2000). Downhill, the existing drainage infrastructure is overburdened by the amounts of water and sediments that are carried towards the lake after a major storm event. Flooding of the lower land is common in the rainy season, creating damage to the infrastructure and human lives (ALMA, 2000).

Pollution due to solid waste and wastewater management

Managua is not as populated and industrialised as other homologues in the continent, yet the management of solid waste and wastewater produced is a significant challenge. An assessment of solid waste management in urban Managua stated that about 90% of the city's solid waste is collected by the municipality and a private company (PAHO/WHO, 1997). Nevertheless, the same assessment indicated that 60% of the waste generated in marginal settlements was not collected due to difficulties in accessing these areas. This waste and the one generated in peri-urban Managua, which is non-served by the municipality services, are buried or deposited on vacant land or in drainage canals (Uilemberg, 1998; PAHO/WHO, 1997).

The municipal landfill is located at about 100 metres from the lakeshore. It is an open landfill, which contains waste from hospitals, industries and households. No strict technical criterion has been considered for its location and operation (PAHO/WHO, 1997). Leachates from the pile are not collected and they infiltrate the ground producing local groundwater contamination. A tiny crater lake, located nearby, is also badly contaminated by the landfill (Abt, 1995; PAHO/WHO, 1997; PAHO, 1997b).

The sewerage network collects both industrial and municipal waters, with a coverage of about 55% of dwellings (Proctor & Redfern, 1996). The rest of the population relies on septic tanks and pit latrines for sanitation, which together with leaking sewerage pipes constitute a potential risk for groundwater contamination. In some areas, local contamination has already been reported (IDB, 1999a; SUWAR, 1996).

Piped wastewater is collected and discharged into Lake Managua without previous treatment. Some industries discharge their effluents directly into the lake (SUWAR, 1996). Estimates indicate than more than 32 millions of gallons of municipal wastewater and an unknown amount of industrial effluents are discharged every day (Proctor & Redfern, 1996). High concentrations of mercury, released from a former chlor-akali plant, are found in the lake sediments and in the food web (Lacayo et al, 1991; Proctor & Redfern, 1996).

Wastage of water

The rise in population and industrialisation has increased the water demand in Managua. Relative to sanitation, water supply has a wider coverage with about 90%, which includes house connections and public posts (ENACAL, 2000a). However, the percentage of unaccounted for water, that is the water that is not charged for, is still high. In September 2000, this was 46% of the total water produced in Managua (Somoza, Pers. Comm.). It is suspected that most of this water is lost due to old leaking pipes, illegal connections, and non-paid services (ENACAL, 2000a).

Water resources management

Nicaragua in general

The management of water resources in Nicaragua has been quite similar to other developing countries. The lack of integration in water and land management policies has resulted in situations like the Managua example. Indeed, until very recently the country lacked a well-defined water policy and coherent legislation. Although a comprehensive water law was prepared in 1998, it is still not enacted. Thus the existing legislation is dispersed and water rights are not clearly defined, which makes the administration of the resource quite difficult. Also the different laws have focussed on specific uses rather than on planning. (PARH, 1998c). According to the national constitution of 1995 water resources are public property, which should be preserved and administered by the State. However in the older civil code, which is still in force, water resources are public property but their use is subject to property rights over the land. The law on Exploitation of Natural Resources of 1958 establishes that water resources may belong to the state and that a special law should regulate them. The General Law on the Environment and Natural Resources, enacted in 1996, recognises the public nature of water and establishes general provisions requiring previous authorisation for its use. This law opens the way to a more sustainable use of water resources but it calls for the preparation of a specific water law. Other norms require holding a permit for the perforation of private water wells, but the issuing agency no longer exists and no one enforces this regulation. On the other hand, the ownership rights for groundwater are not clearly defined, which can lead to conflicts between private well owners and water companies (Walker and Velasquez, 1999).

In the case of the institutional environment, there is no unique authority to regulate water in both quantity and quality. Seven main institutions are concerned with water resources use and management. These are:

- Ministry of the Environment and Natural Resources (MARENA), which is in charge of preparing protection plans for natural resources. It also controls water quality.
- Ministry of agriculture and forestry (MAG-FOR), which is responsible for the development of agriculture activities, including industries, forestry, irrigation, and control of agrochemicals. It also establishes protection plans for soil and water resources.
- Ministry of Health (MINSAL), which controls aspects of water supply and sanitation, water quality, and agrochemicals.
- Institute for Territorial Studies (INETER), which is in charge of the physical land use planning, inventories and characterisation of water resources.
- Institute for Water Supply and Sanitation (INAA), which regulates the provision of these services to the population.
- Institute for Energy (INE), which regulates the use of water for hydropower and geothermal activities.
- Ministry of Industry, Production and Commerce (MIFIC), which is in charge of the administration of natural resources for economic development.

As it can be observed, some of these institutions have overlapping mandates regarding the protection of water resources quality and quantity. Also, these institutions have maintained a sectoral vision in planning and administration, seldom considering the effects on other users and on the environment (PARH, 1998c). This has hindered institutional co-ordination and has resulted in contradictions that affect water resources. A clear example is the case of Ministry of the Environment and the Ministry of Industry, where each institution has prepared contradictory action plans for the same areas. Indeed, MIFIC granted long-term mining concessions to foreign investors in the buffer zones of several protected areas (Elizondo, 1997). It did not consult previously with MARENA as to whether such activities were recommended or not in those specific zones. In the BOSAWAS reserve, which is one of the most important protected areas of Nicaragua and Central America, mining activities were not allowed in a portion of its buffer zone. Nonetheless, some exploration concessions were granted, which not only resulted in strong institutional conflicts but also in conflicts with the investors (Espinoza, Pers. Comm.).

Traditionally, Nicaraguan institutions and decision-making have been quite centralised, with local governments having limited authority and resources to manage and decide over their natural resources, including water. For instance fiscal policies have focussed in increasing the income of the central government in order to face the external debt and the internal fiscal deficit (Chacón and Pratt, 1996). The industrial complexes in Managua have benefited mainly the central government, whereas the resulting environmental problems and costs are borne by the local government and society in particular. Indeed, during the 60's the central government authorised the opening of polluter industries without any environmental concern (Lapidus, 1999). These industries were located in vulnerable areas such as along the lakeshore and close to Lake Asososca, which is the only crater lake in Managua suitable for water supply. Some researchers of Nicaraguan politics claim that these decisions were driven by greed of the ruling political regime rather than by interest in the economic development of the city (Lapidus, 1999; Wall, 1996).

As a result of the structural adjustment programs of the last decade, Nicaragua has been required to modernise its government. This includes a decentralisation of its institutions and the increased participation of non-government actors in decision making. Decentralisation is defined as "the transfer of functions, resources and power from a central government agency to another agency, which can be regional or municipal, or directly to the civil society" (CSD, 1999). There is also a term known as *deconcentration*, which is defined as "a type of administrative organisation, whereby the superior level of an agency transfers functions or technical autonomy to a subordinate level, so this can have limited competency over some managerial and decision aspects or over a territory" (Ibid.).

A reform to the Municipalities Act requires that local governments become more involved in providing basic services and in the environmental management of their jurisdiction. A process of decentralisation and deconcentration has initiated in most governmental institutions and important structural changes have happened in environmental protection and in water supply and sanitation. Yet, municipalities run only 20 of the 177 urban systems, which amounts to about 10% of the connections in the whole country (ENACAL, 2000a; Walker and Velasquez, 1999). Several critics have stated that the decentralisation process has not been accompanied by a real transfer of resources, skills and opportunities from the central level to the municipalities. In a recent paper, Perez and Barten (1999) claim that in 1998 municipal taxes were lowered from 2% to 1%.

The participation of non-governmental actors in decision-making is also incipient in Nicaragua. Despite the discourse about participation being an important instrument for natural resource management, the government has maintained an excluding attitude towards non-governmental groups. It is claimed that a lack of information, and maybe organisation and capacity may restrain people from participating in decision-making. However, it seems rather that a lack of communication and willingness for co-operation prevails. As a matter of fact, these stakeholders and sometimes even local governments have had limited space to participate in the formulation of regulations or projects that will affect them. The so-called participation has been rather a consultation to legitimise a decision that is already made. This can be illustrated by the process that led to the formulation of the proposal for the new water law. The process was part of the water action plan, which was financed by the Danish Agency for International Development (DANIDA) and which will be discussed later. An evaluation of the water action plan made by DANIDA reported that only members of the National Commission for Water Resources (CNRH) participated in the preparation of the draft. The CNRH included members of the National Assembly and the heads of the six main government agencies involved in various aspects of water resources use and management. Only when the final draft was finished, did the CNRH allow submitting it for consultation of local governments and non-government actors. Despite the participatory character of the water action plan, the very same CNRH was reluctant to include within its membership representatives of local governments, private sector and public in general (Milton and Knudsen, 1998).

Environmental protection is rather a recent concern in Nicaragua and therefore the experience in this field is quite limited. The Ministry of the Environment was established in 1994, and most of the regulations related to the protection of water resources came to force after 1995. The approaches have relied on *command-and-control* mechanisms, which consists of quality standards for effluents, environmental permits for new investment projects, and the regulation of the use of pesticides and other toxic substances (Nuñez-Ferrera, 1998). However, these instruments have not been very efficient to reduce pollution because of the difficulty to implement them (Chacón and Pratt, 1996). These difficulties arise from the fact that MARENA does not have enough trained staff and the financial resources to monitor and enforce the regulations; neither has it the capacity to penalise those who do not comply with the norms. For the year 1999 for example, the projected budget for the whole MARENA was of US \$ 1,424,000, which was less than 1% of the national budget (BCN, 2000). Of this amount, about 70% constitute the salaries of 540 persons, and 30% represent operative expenditures. For that same year the personnel allocated to environmental protection were 22 persons in the central level and 31 in the rest of the country, which is clearly not enough to address pollution problems in the whole territory (Nuñez-Ferrera, 1998)

Compliance with water quality standards has also been limited because the industrial sector and other actors affected by these norms were not included in the formulation process (Chacón and Pratt, 1996). On the other hand, the *command-and-control* strategy has not been accompanied by economic incentives, which has further restrained compliance (Espinoza, Pers. Comm.). In Nicaragua, 60% of the industries are concentrated in Managua and most are characterised by using obsolete and extremely polluting technologies, which makes them the least competitive in Central America (Nuñez-Ferrera, 1998; Röhrer, 1999). A few companies have started cleaner production initiatives but there is still a long way to go before this concept can be applied in most companies because of financial reasons (Röhrer, 1999). The need for economic incentives to promote the reduction of waste and wastewater at source was discussed in the General Law on the Environment and National Resources of 1996. But concrete mechanisms have not been established yet, and it seems unlikely that they will be so in the near future (Chacón and Pratt,

1996). Indeed, in several occasions the MARENA tried to co-ordinate meetings with the Ministry of Taxes and Finances and the Ministry of Industry, Development and Commerce in order to define the procedure to regulate the incentives indicated in the Law. However, the Ministry of Taxes and Finances showed no interest to attend the meetings. As a matter of fact this Ministry is interested in increasing income, therefore the approval of incentives for environmental protection appears to be counterproductive to its interests (Ibid.).

Managua

The management of water resources in Managua has not differed much from the rest of the country. The miscoordination between different institutions and levels of government has resulted in the serious contamination mentioned earlier. In the case of water supply and sanitation, Managua has been given more attention due to its population and its status as capital of the country. Similarly, financial resources to solve such problems have been mobilised faster. For example, during the 80's and beginning of 90's the city experienced severe water shortages as the water demand increased relative to supply. By the mid 90's international funds were mobilised to finance a new water project to increase supply and to extend the network. Despite the improvement in supply and the increased access to water in progressive settlements, there is a lot of water that is not used efficiently. As mentioned earlier, the percentage of unaccounted for water is about 50% (ENACAL, 2000a; Walker and Velasquez, 1999). On the other hand, increasing water supply has not necessarily been accompanied by a rise in local participation because the approach tends to consider the beneficiaries as passive rather than active actors. At best, the local community may be required to participate during the execution of a project by providing the labour force to dig trenches.

The case of drainage and sanitation is more critical especially in poorer neighbourhoods, where residents lack land tenure rights, have very low capacity to pay for the service and have almost no representation in political spheres. Thus, the extension of the sewerage network has been very slow in progressive settlements, where the legality of their situation has been resolved, and totally absent in spontaneous settlements. Other services like solid waste collection are affected by the same reasons and by the difficulty to access most of these areas (Uilemberg, 1998).

The critical state of the Managua watershed has been recognised since three decades ago (Proctor & Redfern, 1996). Several projects have been formulated in order to address the problem of contamination of Lake Managua, and more recently Lake Tiscapa. However, very little has been achieved so far, despite the fact that international co-operation agencies have approved funds to tackle these problems. In fact, both central and local governments have shown little interest to address these problems. The reasons are merely political, since any project geared towards decontaminating these lakes would require a long time before results can be seen. Unfortunately, governments, whose terms of office are of 5 years, are more interested in benefits that can be achieved in the short term. Therefore, instead of undertaking long term projects, the local government has focussed its efforts on building roundabouts around the city to ease traffic congestion.

Efforts to improve the management of water resources

Given the increasing deterioration of water resources and deficiencies in its management, a few initiatives have been taken in order to address the problem. Some of these initiatives respond to an increased international pressure and some respond to a greater awareness about the importance of sound water management for sustainable development. Indeed, following the UNCED conference of 1992, Nicaragua started to introduce sustainability criteria in the management of its natural resources. In 1994, the country signed an alliance with the rest of the Central American states for sustainable development in the region (ALIDES). One of the commitments of ALIDES was to prioritise the formulation of policies and legislation for integrated water resources management.

National Water Action Plan

In 1995 the government of Nicaragua initiated a National Water Action Plan (WAP) with the assistance of DANIDA. The plan was prepared in an attempt to translate the guiding principles of the Dublin-Rio process discussed before to the reality of the Nicaraguan context. During the duration of the plan, the National Commission for Water Resources (CNRH) was reactivated. This is an inter-institutional body, which was created in 1968 and it is formed by the heads of six state agencies concerned with water management, and by members of the National Assembly. The water action plan contributed to increase awareness and understanding among state agencies and stakeholders about what is required for integrated water resources use and management. The principal outcomes were the recognition of the need for a unique water authority to regulate and administer water resources in quantity and quality; a coherent water policy; a proposal for a comprehensive water law; and an action program to implement the required changes (PARH, 1998a).

Reforms in the water supply and sanitation sector

Structural adjustment programs have required the Nicaraguan government to reorganise its structure. Among the reforms that have taken place is the separation of the normative role from the operative role that many government agencies had in the 80's. Prior to 1998, planning, regulation and provision of water services were the responsibility of a single government agency (INAA). Under this modality, INAA's performance was low because there was no pressure to correct inefficiencies in coverage and service quality (ENACAL, 2000a). On the other hand, costs were not recovered due to a high number of employees per connection, very low tariffs, non-payment, etc, which lead to financial deficits. All this affected severely the quality of the infrastructure and services (Walker and Velasquez, 1999).

In 1998 a commercial but state-owned company (ENACAL) took over the operative role of INAA, opening the way for future private sector participation. INAA retained its regulative role to make sure that ENACAL and other service providers meet previously agreed goals of service quality and scope (Ibid.). Also sectoral reforms have included a new tariff legislation to ensure full cost-recovery. Furthermore, the decentralisation of service provision has been initiated, but regionalisation rather than municipalisation has prevailed. Only in two departments, Jinotega and Matagalpa, is service run by the local authorities (Walker and Velasquez, 1999; ENACAL, 2000a).

Management Program for the southern watershed of Lake Managua

Despite its name this program covers only the portion of the watershed that belongs to the municipality of Managua. It is the most recent project to address the problem of contamination of Lake Managua. Its aim is to improve both the environmental conditions of the lake and the health condition of Managua's population by a better management of the southern sub-watershed. It is a very ambitious project that will be financed by the Inter-American Bank, the government of Germany and the Nordic Development Fund (IDB, 1999a). The main component of this project is the improvement of the infrastructure that collects and conveys municipal wastewater in the area of Managua, and the construction of two treatment plants on the lakeshore. Other actions include:

- Improvement of the pluvial drainage infrastructure and promotion of soil conservation practices and reforestation upstream Managua.
- A program to ensure the treatment of industrial effluents from 116 industries before they are discharged into the sewerage system or the lake.
- Works to eliminate stagnant ponds on the lakeshore, and the implementation of a comprehensive program to combat malaria.
- Improvement of solid waste management.
- Environmental monitoring of the lake and lakeshore

Due to its multisectoral nature the program will require the participation and co-ordination between ENACAL, several government agencies and the local government. Among the government agencies are the Ministries of the Environment, Health, Industry and Commerce, Social Affairs, and INETER (Abt, 1995). The program calls for the participation of other stakeholders, although to a lesser extent.

Part III General discussion

Evaluation of the initiatives and changes that have taken place

The water action plan is an important step towards sustainability in the water sector in Nicaragua. However, there are still many political, institutional and economic obstacles that can hinder its good intentions. Some of these constraints were already identified in the plan itself. For instance, it was recognised that creating a unique authority to regulate water resources in quality and quantity could result in conflicts with the existing environmental protection agency. Other constraints were not considered, for example, the fact that the government does not really have a national strategy for development, with a clear vision of the future and with fully integrated social, economic and environmental objectives (Navarro and Gandarias, no date). Independently of its political affinity, the government's tendency has been to react to emergencies instead of being proactive. Also social and environmental issues have been given lower priority than economic recovery. This has affected the full implementation in time and form of any plan related to the protection the environment and natural resources, and it is likely to affect the implementation of the water action plan as well.

Therefore, even if the water action plan is a long-term strategy that, although flexible, should not be affected by governmental periods, its implementation will depend on the political will of the government in turn. As a matter of fact, the current government has shown little interest to start the implementation phase of the plan, which questions its level of commitment towards sustainable water management. The water action plan process finished in 1998; however, some of the outcomes that were supposed to be operational by the year 2000 are not achieved yet. These include the enactment of the new water law, and the establishment of the water authority. The legal proposal is still waiting for discussion and approval by the legislature (López and Vammen, Pers. Comm.). In the case of the water authority, in 1998 the Law on Organisation, Competencies and Procedures of the Executive Power created an office that would have the responsibilities of a water authority, but it is not physically existent yet (Ibid.).

Furthermore, one of the most important aspects to support the implementation of a water action plan is the human resource capacity, especially in the government institutions. Institutional efforts can be dissipated due to the constant changing of human resources. Every new government changes not only the Ministers, but also other key functionaries and experienced officials. Others leave because they find better employment opportunities elsewhere. The instability of human resources can disrupt the line of work and affect the effective formulation and implementation of the existing policies.

In the case of water supply and sanitation, the Nicaraguan reforms are claimed to be the most coherent in the Central American context (Rosensweig and Perez, 1999; Walker and Velasquez, 1999). Also this type of reform points towards improving sector performance, which fits within the principles of sustainability in water resources management. However, as mentioned earlier, the process of decentralisation in this sector has not been accompanied by full participation of local authorities and users in all the aspects of project development. On the other hand, a further privatisation of water services may not necessarily imply that coverage for all will increase. As a matter of fact there is always a risk that water services become monopolised, which reduces the chances for the company to become more competitive and consumer oriented.

The intentions of the Management Program for the Lake Managua Watershed are good. It is also the first proposal to include a more integral vision of the problem, because it addresses also relevant issues such as solid waste management, drainage and soil management in the upper watershed. But it represents a partial solution in case it is actually implemented. One of the reasons is because the program is very technology-driven, with the sanitation component not only being the most stressed but also the most resource-demanding one. It can not be denied that technology is required to improve the collection and treatment of municipal wastewater and to considerably reduce health risks and the organic contamination of the lake. But the price to pay may be quite high, and perhaps not affordable to everyone. In addition, this type of system usually depends on centralised decisions and management, which does not leave room for community participation and is not receptive to the needs of the least represented in society (Kjellén & McGranahan, 1997). Thus it is likely that only part of the population will benefit from this alternative. Indeed, according to the Plan for the Rehabilitation of the Sewerage System in Managua, which is part of the Management Program for Lake Managua Watershed, in 2020 the sanitation coverage will have risen from the current 55% to only 72% (Proctor & Redfern, 1996). In the meantime, a considerable part of the population, especially the poorest, will not have proper access to sanitation unless complementary programs are established.

The social and institutional sustainability of the whole program can therefore be questioned. If the program is to succeed in all its different components it is important that a solid institutional

framework is present, where all institutions are not only capable but also willing to cooperate. To date, both institutional co-ordination and co-operation in environmental matters have been difficult at times. This does not mean that co-ordination will not happen, but that it is a potential constraint to bear in mind. Another aspect that may be counterproductive to a solid co-operation is the human resource instability that surrounds governmental institutions and that was mentioned earlier for the implementation of the water action plan.

In order to keep a decentralisation perspective the role of the municipal government should be more emphasised, as well as that of the community. The program addresses social as well as environmental objectives, but it keeps a top-down approach where, again, users are perceived as passive rather than active actors. In the formulation phase, the participation process was limited to the governmental institutions and donors. The participation of other stakeholders in the execution and management phases has been mentioned as important but the emphasis is put on government actors. Only the private sector might be more actively involved in the program, especially in the operation of the sewage system, as these services may be privatised in the near future in Managua.

Strategic measures for sustainable water resources management in urban and peri-urban Managua

The interactions between the different aspects of water management (legal, institutional, political, social, technical, economic and environmental) in Managua are rather complex. It is clear that in order to improve water management several changes are required, which range from modifications in legislation to physical modifications of the built environment. The government has already considered some of these changes, which were discussed in the previous section. It is important to mention though, that these changes should not be isolated or be seen from one single perspective. They should be put within a context of sustainable development, bearing in mind the needs of all sectors of society. Therefore, salient problems like poverty, unemployment, housing and access to basic services have to be addressed. Water management should therefore be integrated with poverty alleviation measures in a municipal development plan. However, due to the complexity of the issue all this can take a long time and require significant financial resources to happen.

In the meantime, smaller initiatives may be helpful in the effort to improve water resources management and to address urgent needs of an important portion of the population in Managua. Such initiatives should be geared towards improving the communication between different government agencies, between these and the local government, and between them and other stakeholders like the industrial sector and civic society. Information and communication are important in order to approach people, sit them together and initiate a dialogue and co-operation for a better use and management of water resources. In the difficult conditions of Nicaragua, and specifically of Managua with its heterogeneous population, only concerted action will help to find solutions to improve water resources management. A real two-way communication is needed to rebuild trust in authorities, and to work together for the common well being. Therefore, platforms should be promoted where different stakeholders participate, communicate and negotiate with each other about common concerns on water resources.

In this section a series of recommendations are suggested, which could help to improve water resources management in Managua in the short term.

Water services and user's organisations

Whether it gets privatised or not, ENACAL's service should become more consumer oriented. The company should view its users as clients and partners, and not only as passive beneficiaries of a project. Thus, it should do all its best to improve service delivery. In order to achieve this, there has to be an office for consumer attention that truly listens to all users concerns, regardless of their political and economic standing. A special emphasis should be put on poor neighbourhoods because of the difficulties they experience. Officials at ENACAL should be trained in how to give attention to this sector. In this way, the needs of the poorer can be better addressed and it is likely that both development and environmental objectives will be successfully met.

Users need to be empowered as well. The government should promote the creation of consumer organisations that represent different sectors of society and not only privileged groups. These groups can exert pressure on the municipality and ENACAL to make the latter more accountable for service delivery, and they can also participate in decision-making in issues related to water management or local development. Also these users organisations can be multipliers of information to create awareness about water problems and to promote a better use of the resource by the consumers. This is likely to improve if efficient communication between consumers and service providers is established and if fair but realistic water pricing is introduced.

The city of Matagalpa constitutes a nice example of improved communication. In this city, where the municipality runs the local water utility, the promotion of greater communication between municipal officials and the water users resulted in greater civic involvement at the local level (Dorsey, 1995).

Water and waste projects in settlements

Since most of the Managua's spontaneous settlements are located in areas that are not suitable for living and/or on private land, it is likely that they will remain illegal. However, this does not justify inaction towards provision of water services in these areas. More serious efforts should be made to resettle the squatters to more suitable areas, where people can have legal land titles and access to adequate water supply and sanitation services. In this process, the municipality, ENACAL, NGO's and the affected communities need to work together.

Community participation in the planning of a housing project is important. In the case of water services, participation ensures that the chosen system and the level of service will not only suit the community's needs but also their ability to pay. This is important for cost-recovery and the financial sustainability of a project. A lower priced service though, should not imply a lower quality standard. On the other hand, water management is likely to improve in the long-term if communities are involved in all aspects of planning, development and management of water projects. The community will feel responsible for the fate of a project if it responds to their needs and if they feel that they own it.

Some participatory experiences in local development of poor urban communities in Nicaragua, have shown positive results if people are given the space to participate in decision-making processes and if resources are made available and managed under transparent conditions (Stein, 1996; UNCHS/UNDP, no date). These development initiatives include an important component of water supply and sanitation and housing improvement. The impact has been greater when income-generating activities are associated with these development projects. In Managua for instance, one of these projects facilitated micro-loans to encourage poor families to develop

different productive activities in their homes. Future local development projects could include the organisation of income-generating activities related to the reuse and recycling of waste. For example, local micro-enterprises can provide the service of separation and collection of waste. Organic waste can be composted and sold as biofertilisers. Non-organic waste that can be reused or recycled may be sold in the emerging markets or brought to recycling facilities. The rest of the waste can be brought to previously selected sites where it can be easily collected by the municipal trucks. This type of local initiatives may be a key to survival by improving sanitary conditions while creating some extra income and environmental awareness. They could also pave the way towards turning problems, like waste, into resources that can sustain local economies and improve living conditions.

It is important to bear in mind that better sanitation does not necessarily imply water-borne sanitation. The latter is expensive and difficult to provide in many of the settlements due to land property issues or because of the physical characteristics of the site. This should not be a constraint to implement sanitation projects featuring alternative technologies that are cheaper and faster to build.

Industrial sector

In the case of the industrial sector, it is important to start a dialogue between the most polluting industries in Managua and the government to seek alternatives that will help reduce industrial pollution. Industries need to be convinced that environmental protection is not against business but it is a requirement for future development. Again for this to happen, effective communication and willingness to cooperate are required from all groups.

Another aspect that is important is the issue of incentives. More efforts should be done to get government agencies like MARENA, the Ministry of Taxes and Finances, the MIFIC and the municipality to establish fiscal mechanisms that could incentivise cleaner production initiatives. A municipal fund can be set up to provide concessionary loans to those businesses that have difficulties to obtain funding in private banks. Non-economic incentives can be also promoted to reduce industrial pollution. For example, the municipality, together with MARENA and MIFIC, could organise annual contests where different industries that have made important efforts and improvements in reducing pollution are publicly recognised. Similar contests are organised at the national level both in environmental protection and in industrial security. Both contests have shown very good results both in increasing awareness and reducing accidents (La Prensa, 2000; MARENA, 1998).

Conclusions

This essay presents a multidisciplinary conceptual framework to understand the *problematique* of water resources in cities of the south as illustrated by the case of Managua. The case study shows that weak institutional frameworks, poor governance and the lack of incentive mechanisms are the main causes of mismanagement and escalating water resources degradation. A problem that if not tackled will continue to affect the quality of life of many residents, especially in the poorer settlements. Water mismanagement also represents a risk that could undermine sustainable development in the area.

Institutional deficiencies are not only illustrated by the overlapping and often unclear mandates of several government agencies related to water resources management. Also striking is the fact that the legislation assigns competencies to institutions that are no longer in place or that have been created but are not physically existent yet. There are also situations where the legislation calls for actions that are subsequently blocked by certain government agencies like the case of the fiscal incentives for pollution reduction. The analysis suggests that as in other developing countries, the deficiencies regarding institutional arrangements and the legislation framework can be attributed to the lack of capacity, financial resources and political will. In the area of institutional capacity, there is evidence that the human resource base in the water sector is weak, and that more efforts should be made on building a local critical mass in order to be less dependant on expatriate consultants for better management. In the case of urban governance, the paper suggests that more work has to be done to strengthen democracy and to allow the effective participation of the different stakeholders in decision-making and water resources development and management.

The examination of the efforts made to solve water problems indicate that there is now a greater understanding of what is required for sustainable use of water resources, and that water management practices are being slowly redirected towards reaching that goal. Some of these projects address important issues like soil erosion management, sanitation, water quality, and efficiency and coverage of water services. Nevertheless, technical and managerial aspects still prevail over social aspects, which questions the overall compatibility of these projects and reforms with the sustainability principles discussed in the paper.

The analysis yields to the conclusion that water resources management in Managua is confronted with numerous challenges, which will not be an easy task to overcome as they require plenty of resources and time. The paper proposes to focus efforts on smaller initiatives based on better communication between different stakeholders. Other key recommendations that can have big impacts on making water management more sustainable in Managua and in the rest of the country are:

- Make government agencies and water utilities more transparent and accountable. For that it will be necessary to make them independent of politics.
- Implement the national water action plan as soon as possible. Otherwise, the momentum and knowledge base gained during that process would be dissipated.
- Emphasise capacity building at all levels and set up incentive mechanisms to prevent losing trained staff in government institutions.

References

- Abt Associates Inc., CISCONCO Ingenieros Consultores, Camp Dresser & McKee Inc. 1995.** *Feasibility Study of the Management Program for the Managua Watershed*. Executive Summary. October 1995.
- Aguilar, E., López, F., Flores, N. and Morgan, L. 1999.** *Apoyo para Políticas y Estrategias de Manejo Integrado de Recursos Hídricos en América Central*. Technical Report. Working Paper, Sustainable Development Department, Interamerican Development Bank. Washington, D.C.
- Anderson, V. and Johnson, L. 1997.** *Systems Thinking Basis, From Concepts to Causal Loops*. Waltham: Pegasus Communications, Inc.
- Bethune, D., Ryan, C. and Losilla, M. 1998.** "Contaminant Hydrogeology in Developing Countries: Benefiting from Experience in Developed Countries". *Groundwater*, 36(3): 385-386.
- Biswas, A. 2000.** "Water for urban areas of the developing world in the 21st century". In Uitto, J. and Biswas, A. (eds.) *Water for Urban Areas*. Tokyo: UN University Press.
- Briscoe, J. 1994.** "Implementing the New Water Resources Policy Consensus: Lessons from Good and Bad Practices". In Lundquist, J. and Jønch-Clausen, T. (eds.), *Putting Dublin/Agenda 21 into practice: lessons and new approaches in water and land management*, Special session at 8th IWRA World Congress, Cairo.
- Burchi, S. 1991.** "The need for Effective Legal and Regulatory Frameworks". In Alaerts, G.J., Blair T.L. and Hartvelt, F.J.A. (Eds.) *A Strategy for Water Sector Capacity Building*. New York.
- CCAD. 1998.** *Estado del Ambiente y los Recursos Naturales en Centroamerica 1998*. Comisión Centroamericana de Ambiente y Desarrollo. Guatemala.
- CONADES. 1998.** *Aplicación del Programa 21: Examen de los adelantos realizados desde la Conferencia de las Naciones Unidas sobre el Medio Ambiente y Desarrollo. Reseña de Nicaragua*. Prepared by the Nicaraguan Commission for Sustainable Development to the UN Commission for Sustainable Development.
- Connelly, J. and Smith, G. 1999.** *Politics and the Environment – from Theory to Practice*. 1st Edition. London: Routledge.
- Ekbom, A. and Bojö, J. 1999.** *Poverty and the Environment. Evidence of Links and Integration into the Country Assistance Strategy Process*. Discussion paper No. 4, Environment Group, Africa Group. World Bank.
- Elizondo, D. 1997.** "The Environment". In Walker, T. (ed.) *Nicaragua without Illusions. Regime Transition and Structural Adjustment in the 1990s*. Wilmington: SR Books.
- ENACAL. 2000a.** *El sector de agua y saneamiento en Nicaragua: Una evolución permanente*. Planning Unit, Nicaraguan Water Supply and Sanitation Company. Internal Document.
- García, L. 1998.** *Strategy for Integrated Water Resources Management*. ENV-125 Sustainable Development Department, Interamerican Development Bank. Washington, D.C.
- GWP. 2000.** *Integrated Water Resources Management*. TAC Background Papers No. 4. Technical Advisory Committee, Global Water Partnership. Stockholm.
- Hjorth, P. and Nguyen, T. D. 1994.** "Water management options for urban areas in Asia". *Cities* 11(2): 125-130.
- Johansson, P.O., Scharp, C., Alveteg, T. and Choza, A. 1999.** "Framework for Ground Water Protection - the Managua Ground Water System as an Example". *Ground Water* 37 (2): 204-213.
- Kjellén, M. and McGranahan, G. 1997.** "Urban Water - Towards Health and Sustainability". *Comprehensive Assessment of the Freshwater Resources of the World*. Swedish Environmental Institute. Stockholm.
- Lacayo, M., Cruz, A., Lacayo, J. and Fomsgaard, I. 1991.** "Mercury contamination in Lake Xolotlán (Managua)". *Hydrobiological Bulletin* 25(2): 173-176.
- Lo, C.W. and Tang, S. 1994.** "Institutional contexts of environmental management: water pollution control in Guangzhou, China". *Public Administration and Development* 14: 53-64.

- MARENA. 1998.** "Preservemos a Nicaragua Siempre Verde. Premios Ambientales Semper Virens". *Naturaleza*, Bulletin from the Ministry of the Environment and Natural Resources, Nov-Dic. 1998. Managua.
- McCommon, C., Perez, E. and Rosensweig, F. 1998.** *Providing Urban Environmental Services for the Poor: Lessons Learned from Three Pilot Projects*. EHP Applied Study No. 7. Environmental Health Project, Arlington, Virginia
- Mitlin, D. and Satterthwaite, D. 1996.** "Sustainable Development and Cities". In Pugh, C. (ed.) *Sustainability, the Environment and Urbanization*. London: Earthscan.
- Navarro, K. and Gandarias, J. No date.** *Identidad, conflicto y violencia en Nicaragua*. Fondo Editorial CIRA.
- NFR. 1999.** *Water a reflection of land use. Options for counteracting land and water mismanagement*. Swedish Natural Science Research Council, UNESCO-IHP. Stockholm.
- Nuñez-Ferrara, M. 1998.** *Estrategia Institucional para la Prevención y control de la contaminación*. General Directorate of Environmental Quality. Ministry of the Environment and Natural Resources. Managua.
- OAS. 1998.** "Integrated Water Resources Management in Mesoamerica". Final Report of the *Workshop on Assessment and Implementation of Water Resources and Coastal Areas Initiatives in the Region*, Panama City, October 20-22, 1997. Unit of Sustainable Development and Environment General Secretariat of the Organisation of American States Washington, D.C.
- PARH. 1998a.** *El Plan de Acción de los Recursos Hídricos (Borrador). Informe Principal*. Plan de Accion de los Recursos Hídricos en Nicaragua. Managua.
- PARH. 1998b.** *Evaluación Rápida de los Recursos Hídricos. Resumen ejecutivo*. Plan de Accion de los Recursos Hídricos en Nicaragua. Managua.
- PARH. 1998c.** *Aspectos Institucionales. Informe Final*. Plan de Accion de los Recursos Hídricos en Nicaragua. Managua.
- Perez, R. and Barten, F. 1999.** "Urban Governance and Health Development in León, Nicaragua". *Environment and Urbanization*, 11(1): 11-23.
- Proctor & Redfern Intl. Ltd. 1996.** *Proyecto para la Actualización del Plan Maestro de Alcantarillado Sanitario para la Ciudad de Managua. Informe Final Vol. No.1*. Commissioned by the Nicaraguan Institute of Water Supply and Sanitation.
- Pugh, C. 1996.** "Sustainability and Sustainable Cities". In Pugh, C. (ed.) *Sustainability, the Environment and Urbanization*. London: Earthscan.
- Rogers, P., Bhatia, R. and Huber, A. 1998.** *Water as a Social and Economic Good: How to Put the Principle into Practice*. TAC Background Papers No. 2. Technical Advisory Committee, Global Water Partnership. Stockholm.
- Rosensweig, F. and Perez, E. 1999.** *Decentralisation of Water Supply and Sanitation Systems in Central America and the Dominican Republic*. EHP Activity Report No. 76. Environmental Health Project, Arlington, Virginia.
- Saleth, R. and Dinar, A. 1999.** *Evaluating Water Institutions and Water Sector Performance*. World Bank Technical Paper No. 447. Washington, D. C.
- Scharp, C., Alveteg, T. and Johansson, P. O. 1999.** "Participatory protection of groundwater - experiences from methods developed for the Managua groundwater system". In C. Scharp Ph.D. Dissertation *Strategic Groundwater Protection - a systematic approach*. Division of Land and Water Resources, KTH. Stockholm.
- Scharp, C., Alveteg, T. and Johansson, P.O. 1997.** "Assigning a groundwater protection value: Methodology development". In Chilton et al. (eds.) *Groundwater in the Urban Environment: Problems, Processes and Management*. Balkema, Rotterdam.
- Scharp, C. 1994.** "Groundwater protection plan for the Managua aquifer - development of a planning tool". In Soveri, J. and Suokko, T. (eds.) *Future Groundwater Resources at Risk*. IAHS/AISH publication No. 222.
- Strottman, W. 2000.** "The role of the private sector in the provision of water and wastewater services in urban areas". In Uitto, J. and Biswas, A. (eds.) *Water for Urban Areas*. Tokyo: UN University Press.

- SUWAR. 1996.** *Carga Contaminante en la Sub-cuenca Oriental del Acuífero de Managua (Tomo I)*. Project Sustainable Use of Water Resources, Directorate of Water Resources, Ministry of the Environment and Natural Resources. Managua.
- Turner, R. K., Pearce, D. and Bateman, I. 1994.** *Environmental Economics. An Elementary Introduction*. Hemel Hempstead, Hertfordshire: Harvester Wheatsheaf.
- Uilemberg, J. W. 1998.** "Barramos con la basura. Proyecto de Micro-empresas de Gestión Ambiental". Paper presented at the First International Congress of Technology and Environment. Managua, 23-27 March 1998.
- Young, G. J., Dooge, J.C.I. and Rodda, J.C. 1994.** *Global Water Resources Issues*. Cambridge University Press.
- Van Beukering, P., Sehker, M., Gerlagh, R. and Kumar, V. 1999.** *Analysing Urban Solid Waste in Developing Countries: A perspective on Bangalore, India*. CREED Working Paper Series No. 24. IIED, London and Institute for Environmental Studies, Amsterdam.
- Walker, I. and Velasquez, M. 1999.** Regional Analysis of Decentralisation of Water Supply and Sanitation Services in Central America and the Dominican Republic. EHP Activity Report No. 65. Environmental Health Project, Arlington, Virginia.
- Wall, D. L. 1996.** "City profile: Managua". *Cities* 13 (1): 45-52.

Internet material

- ALMA. 2000.** *Principales Problemáticas*. Available at <http://www.managua.gob.ni/alcaldia/pprob.html> Sourced 2000-11-08
- Asentamientos Humanos Espontáneos*. Available at <http://www.managua.gob.ni/proyectos/ah.html> Sourced 2000-11-08
- BCN. 2000.** *Informe Annual 1999. Finanzas públicas*. Banco Central de Nicaragua. Available at <http://www.bcn.gob.ni/economia/informe/99/default.htm> Sourced 2000-11-11
- CCAD. 1996.** *Perfil Preliminar Comparativo de Riesgo de la Republica de Nicaragua. Evaluación de los Problemas*. Central American Commission on Environment and Development. Available at <http://www.sicanet.org.sv/ccad/Contaminacion/Nacional/acrindni.htm> Sourced 2000-11-07
- Chacón, C. M. and Pratt, L. 1996.** *Desarrollo Sostenible en Centroamérica: Políticas Públicas, Marco Legal e Institucional*. CLACDS-INCAE, CEN 700. Programa Nacional de Competitividad Nicaragua. Available at <http://www.agenda21.org.ni/doc/amvu237.pdf> Sourced 2000-11-08
- CSD. 1999.** "Conceptos y Definiciones". *Boletín Informativo. Comisión Sectorial para la Decentralización*. 1(2): 8. Sectorial Commission for Decentralisation. Managua. Available at <http://www.csd.gob.ni/otros/boletin02.pdf> Sourced 2000-11-11
- Dorsey, S. 1995.** "Promoting community participation in municipal services. Potable water project in Matagalpa, Nicaragua". *USAID Participatory Practices #5: Learning from Experience*. Synopsis of a USAID funded study published in July 1995 by the Regional Information Clearinghouse (RIC) at USAID/Guatemala-Central American Programs, authored by Sharon Van Pelt, RIC Consultant. Available at http://www.usaid.gov/about/part_devel/docs/prtpract5.htm Sourced 2000-11-10
- ENACAL. 2000b.** "Gestión entre 1996/1998". Nicaraguan Water Supply and Sanitation Company. Available at <http://www.enacal.com.ni/p0.htm> Sourced 2000-11-07
- END. 2000.** "Contaminación de agua es más grave" *El Nuevo Diario*, edition 2000-08-04. Available at <http://www.elnuevodiario.com.ni/archivo/2000/agosto/04-agosto-2000/nacional/nacional2.html>. Sourced 2000-11-07
- Escoto, R. 1997.** *Diagnóstico de la Situación Económica Actual: Un Arranque Insostenible*. Red de Desarrollo Sostenible Nicaragua. Available at <http://www.sdnnic.org.ni/documentos.htm> Sourced 2000-11-07
- Gilbert, R., Wood, H. and Brugmann, J. 2000.** *Urban Land Management and Global Sustainability*. Prepared by the International Council for Local Environmental Initiatives (ICLEI) for the 8th session of the UN Commission on Sustainable Development April 24 – May 5, 2000. Available at <http://www.iclei.org/csd/csdfinal.pdf> Sourced 2000-11-08

- IDB. 1999a.** *Project profile I. Apoyo Ejecución Programa de Saneamiento Lago de Managua* - NI-0027. Inter-American Development Bank Project NI-0142. Oct. 1999. Available at <http://www.iadb.org/EXR/doc98/pro/pni0142.pdf>. Sourced 2000-11-07
- IDB. 1999b.** *Project profile II. Programa de Modernización del Municipio de Managua*. Inter-American Development Bank Project NI-0111. Nov. 1999. Available at <http://www.iadb.org/EXR/doc98/pro/uni0111.pdf>. Sourced 2000-11-07
- IDH. 2000.** *Informe Mundial sobre Desarrollo Humano. Resumen Ejecutivo. Nicaragua*. Available at <http://www.pnud.org/ni/idhnicaragua/index.htm> Sourced 2000-11-08
- Lapidus, J. 1999.** *The Ecology of National Liberation: Nature and Environmentalism in Revolutionary Nicaragua*. Master Thesis Department of Geology and Geography Hunter College of CUNY, New York. Available at <http://everest.hunter.cuny.edu/~jlapidus/research/thesis.htm> Sourced 2000-11-07
- La Prensa. 2000.** "MITRAB premia a empresas seguras". La Prensa, edition 2000-08-16. Available at <http://www-ni.laprensa.com.ni/archivo/2000/agosto/19/nacionales/nacionales-20000819-19.html> Sourced 2000-11-10
- Milton, D. and Knudsen, J. 1998.** "Case Study: Nicaragua". Workshop on Water Action Plans - Experience with Alternative Implementation Strategies. Danish Agency for International Development (DANIDA) and Danish Hydraulic Institute (VKI). September 1998. Available at <http://www.vandressource.dk/water-plans-98.pdf> Sourced 2000-11-08
- PAHO-Nicaragua 1997b.** "Programa Salud y ambiente. Situación Sanitaria". Panamerican Health Organisation-Nicaragua. Available at http://www.ops.org.ni/opsnic/s-ambiente/sal_amb/prog_sal_Amb/sit-sanitaria.htm. Sourced 2000-11-07
- PAHO/WHO. 1997.** *Análisis Sectorial de Desechos Sólidos en Nicaragua*. Plan Regional de Inversiones en ambiente y Salud. Panamerican Health Organisation/World Health Organisation. Studies Series No. 12. Available at <http://www.cepis.org.pe/eswww/fulltext/analisis/nicarag/nicara.html>. Sourced 2000-11-07
- Röhrer, C. 1999.** *How to bridge gaps in terms of knowledge and consciousness quickly - The Nicaraguan Experience*. Nicaraguan Cleaner Production Center. Paper presented at National Pollution Prevention Roundtable NPPR Conference, Washington DC, April 6-9, 1999. Available at <http://www.tu-berlin.de/abz/netz/deutsch/unternehmen/artikel/roehrer/text.htm>. Sourced 2000-11-07
- Stein, A. 1996.** *Decentralisation and Urban Poverty Reduction in Nicaragua: The Experience of the Local Development Programme (PRODEL)*. Available at http://www.globenet.org/preceup/angl/docs_angl/stein.rtf Sourced 2000-11-07
- Toepfer, K. 2000.** "Water crisis linked to human governance". *Habitat Debate*, Vol. 6, No.3. Available at http://www.unchs.org/unchs/english/hdv6n3/water_pgovrn.htm Sourced 2000-11-09
- Toepfer, K. 1999.** "Editorial". *Habitat Debate*, Vol. 5, No. 4. Available at <http://www.unchs.org/unchs/english/hdv5n4/index.htm> Sourced 2000-11-09
- UN. 2000.** *Progress made in providing safe water supply and sanitation for all during the 1990s*. Report of the Secretary-General of the United Nations Economic and Social Council for the Commission on Sustainable Development 8th session. 24 April-5 May 2000. Available at <http://www.un.org/documents/ecosoc/cn17/2000/ecn172000-13.htm> Sourced 2000-11-07
- UNCHS/UNDP. 1995.** *Productive Home-Communities and Local Development in Managua, Nicaragua*. ACUP René Cisneros. Initiative sponsored by the UNCHS and UNDP Available at <http://firewall.unesco.org/most/centram6.htm> Sourced 2000-11-07
- Wegelin-Schuringa, M. 2000.** "Strategic elements in water supply and sanitation services in urban low-income areas". *Waterfront, Issue 14, April 2000*: 3-6. UNICEF publication. Available at <http://www.unicef.org/programme/wes/pubs/watfrnt/wf14e.pdf> Sourced 2000-11-07
- WSSD.** *Report of the World Summit for Social Development, Copenhagen 6-12 March, 1995*. Available at gopher://gopher.undp.org/00/unconfs/wssd/summit/off/a--9.en Sourced 2000-11-08

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