



Barriers to achieving the water and sanitation-related Millennium Development Goals in Cancún, Mexico at the beginning of the twenty-first century

MAURICIO DOMÍNGUEZ AGUILAR and
ANA GARCÍA DE FUENTES

Mauricio Domínguez has a Master's degree from the Department of Human Ecology at CINVESTAV, where he coordinates the Urban Observatory of the city of Mérida.

Address: Department of Human Ecology, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional – CINVESTAV (Centre for Research and Advanced Studies of the National Polytechnic Institute), Km 6 Antigua Carretera a Progreso, CP 97310, Mérida, Yucatán, Mexico; tel: +999 124 2100, ext 2229 or 2116; fax: +999 981 4670; e-mail: mauricio@mda.cinvestav.mx

Ana García de Fuentes has a PhD in Geography from the Universidad Nacional Autónoma de México (UNAM). She works as a Researcher at CINVESTAV in the areas of tourism, development and environment.

Address: Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional – CINVESTAV (Centre for Research and Advanced Studies of the National Polytechnic Institute), Km 6 Antigua Carretera a Progreso, CP 97310, Mérida, Yucatán, Mexico; tel: +999 124 2100, ext 2229 or 2116; fax: +999 981 4670; e-mail: agarcia@mda.cinvestav.mx

ABSTRACT This paper discusses some of the barriers faced by the city of Cancún, Mexico, to making progress towards Millennium Development Goal targets on extending safe water and basic sanitation. It analyzes the socioeconomic, political, demographic, environmental and land use dimensions that surround problems of access to safe drinking water and improved sanitation services in the city. These services are central to the health and well-being of Cancún's population, urban environmental quality and the city's economy, all of which are important components of sustainable development. These issues are considered within six zones in Cancún that relate to its different historical stages of development: areas that were urbanized (or fully served) before being settled (the hotel zone and mainland city centre); informal settlements that are fully or almost fully urbanized; and newer low-income squatter settlements on the urban periphery and in the peri-urban area. The paper shows the dramatic differences in the quality of provision for water and sanitation between different zones and how this depends on four factors: the present extent of infrastructure; the current social and economic development model; various institutional considerations; and the attitudes and behaviour of the social actors involved in the urbanization process. The paper concludes with some proposals on how to address deficiencies in water and sanitation services in Cancún.

KEYWORDS Cancún / Mexico / Millennium Development Goals / urban sustainability / water and sanitation

I. INTRODUCTION

This paper differentiates between "drinking water" and "safe water". "Drinking water" is considered here as water that is suitable for human consumption, whether piped or not, but without taking into account other factors such as ease of access. It is also important to clarify that in southeast Mexico, drinking water treatment is limited to chlorination and excludes other processes such as the removal of salts. This paper adopts a narrower definition of "safe water", which is also adapted to the local context of Cancún. In contrast to the definition put forward by the United Nations Human Settlements Programme (UN-Habitat),⁽¹⁾ this paper does not consider "safe water" to include water drawn from private wells, harvested rainwater, water delivered by tankers, or water purchased from vendors because these sources not only carry a greater risk of contamination but also require time and resources to obtain. For this

reason, "safe water" is considered here as drinking water that is supplied only by the public utility through a piped network, via either household or yard connections, and at an affordable price.

Similarly, this paper adopts a narrower definition of what can be considered "improved sanitation", and also distinguishes between the different sewage (or domestic wastewater) disposal systems used in Cancún. Again, this paper is critical of the stance of UN-Habitat,⁽²⁾ namely that any system which disposes of wastewater and sewage in such a way that it prevents contact with people, animals and insects is adequate, because this does not take into account the environmental impacts of different disposal systems, in particular the contamination of groundwater. Given that groundwater is the principal source of drinking water supply in Cancún, this paper considers "improved sanitation" to be limited to effective household connections to the public sewerage network, which in turn is connected to a sewage treatment plant that meets the appropriate standards for sewage effluent.

The city of Cancún, located in Mexico's easternmost state of Quintana Roo on the Yucatán Peninsula of southwest Mexico, is known worldwide as the country's most important tourist resort. This also makes Cancún the primary national source of foreign revenue from tourism. Physically, the city comprises two distinct sites: the main city, situated on the mainland, and the hotel zone. The hotel zone was constructed by Mexico's Fondo Nacional de Fomento al Turismo (National Trust Fund for Tourism Development, FONATUR) on a coastal spit located between the Caribbean Sea and Nichupté Lagoon, to the east of mainland Cancún (Figure 1). This separate part of the city forms the main tourist resort area, comprising the majority of hotels and a number of high-income private residential condominiums. Cancún grew from a fishing village with less than 500 inhabitants in 1970 to a coastal city with a population of 458,477 inhabitants in 2000.⁽³⁾

Today, the city is characterized by a complex and diverse urban reality, with serious social and environmental problems that include extensive low-income settlements, large sections of the population with inadequate access to housing and basic urban infrastructure (especially water and sewerage), and pollution of groundwater and beaches. This is the outcome of a dramatic and inequitable process of local urban development that can be traced back to national policies of the 1970s and which created new economic growth poles. The city is now characterized by a range of problems, including large-scale in-migration, land invasions, a high proportion of the workforce relying on the informal economy for their livelihoods, a high cost of living, urban segregation and fragmentation,⁽⁴⁾ marked socioeconomic disparities, lack of environmental awareness among developers and construction companies, the privatization of urban services (in particular piped water and sewerage networks) and weak public administrations.

Groundwater is the principal source of drinking water supply in Cancún. The aquifer underlying the city falls within the Northern Quintana Roo "hydrological region",⁽⁵⁾ which is considered to be under-exploited because extractions only amount to around 10 per cent of its estimated annual flow of 764.1 million cubic metres. The aquifer is unconfined and groundwater flows in an easterly direction towards the coast and discharges into the Caribbean Sea. The aquifer is classified as "highly

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1. UN-Habitat (2004), "Urban indicators guidelines: monitoring the Habitat Agenda and the Millennium Development Goals", UN-Habitat, Nairobi, Kenya, accessible at http://www.unhabitat.org/programmes/guo/documents/urban_indicators_guidelines.pdf.

2. See reference 1.

3. Instituto Nacional de Estadística Geografía e Informática (INEGI) (2000), *XII Censo General de Población y Vivienda 2000: Principales Resultados por Localidad de los Estados Unidos Mexicanos* (Twelfth General Population and Housing Census of Mexico 2000: Principal Results by Location), Mexican National Institute of Statistics, Geography and Informatics (INEGI), Mexico.

4. Fragmentation, also called "archipelagization", means the social disintegration accompanying the emergence of specialized zones with imbalances in infrastructure and services. See Prévot, M (2001), "Fragmentación espacial y social: conceptos y realidades", in *Perfiles Latinoamericanos, Revista Semestral de la Sede Académica de México de la Facultad Latinoamericana de Ciencias Sociales* (Semestral



MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

Journal of the Latinoamerican Faculty in Social Sciences, Academic Branch in Mexico), México, pages 33–56.

5. "Hydrological regions" are areas defined according to their geomorphological and hydrological characteristics by the Comisión Nacional del Agua – CNA (National Water Commission). The hydrological region of Northern Quintana Roo (No 32) is characterized by highly permeable limestone, dolomite bedrock and unconfined aquifers, which become thinner towards the coast and are suspended over a stratum of saline water. See CNA (2001), "Actualización geohidrológica del acuífero de la zona norte del estado de Quintana Roo" (Updated hydrogeological assessment of the aquifer of the northern zone of Quintana Roo state), CNA, Mexico.

6. UN-Habitat (2003), "Improving the lives of 100 million slum dwellers: guide to monitoring Target 11", Nairobi, Kenya, page 3.

7. See World Commission on Environment and Development (1987), *Our Common Future*, Oxford University Press.

8. See, for instance, Ojeda, Olga (1999), "La cooperación ambiental internacional en la era de la globalización" (International environmental cooperation in an era of globalization), in Ricardo Valero (editor), *Globalidad: Una Mirada Alternativa* (Globalization: an alternative view), Miguel Ángel Porrua, Mexico, pages 97–150.

9. See Guimaraes, Roberto (1997), "El desarrollo sustentable: ¿propuesta alternativa o retórica neoliberal?" (Sustainable development: the proposal of an alternative or neoliberal rhetoric?), accessed at [www.chilesustentable.net/net/textos/doc001.htm](http://chilesustentable.net/net/textos/doc001.htm), 4 October 2001; also Barcena, Iñaki, Pedro Ibarra and Mario Zubiaga (2000), *Desarrollo Sostenible: Un Concepto Polémico* (Sustainable development: a controversial concept).

vulnerable" to contamination due to the karst characteristics of the subsurface: low gradient, high porosity and permeability, and proximity to the surface.

Sustainable development promotes socially responsible alternatives to the different manifestations of current global and local environmental problems and constitutes one of the most important Millennium Development Goals (MDGs).⁽⁶⁾

However, the term sustainable development (or the more limited concept of sustainability) has been given different meanings and definitions, and each of these has different degrees of acceptance and understanding among societies, scientists and governments. The best-known definition of sustainable development is that proposed by the Brundtland Commission: "*Meeting the needs of the present without compromising the ability of future generations to meet their own needs.*"⁽⁷⁾ This has been heavily criticized⁽⁸⁾ and opposed by those who maintain that it either does not exist or cannot be achieved.⁽⁹⁾

In Latin America and the Caribbean, studies on sustainability are typically approached from two angles: first, by focusing on the environmental dimensions of economic and social development; and, second, by analyzing development over space and time. Each of these approaches emphasizes the following two aspects: first, that sustainability cannot be understood only at a macro-economic level;⁽¹⁰⁾ and second, that the capacity to sustain a development activity depends on the type and interaction of the multiple components of the system within which it is embedded.

Notwithstanding this discussion, sustainability is closely related to the challenge of addressing environmental problems in urban areas of low- and middle-income countries that impact upon the economy, public health and quality of life in general. In this regard, it is important to re-member that it is within cities that much of the high consumption of natural resources and environmental services is concentrated. Also, urban areas now contain half the world's population. Therefore, transforming cities based on the principles and objectives of sustainable development is crucial for improving the quality of life of both urban and rural dwellers.⁽¹¹⁾

For a city to achieve sustainable development, it must have in place long-term social policies and practices that adhere to the principles of intra- and inter-generational equity and cross-border responsibility,⁽¹²⁾ as well as objectives related to environmental protection, socioeconomic equity and economic growth.⁽¹³⁾

Fulfilling these objectives depends on institutional factors, the attitudes and behaviour of social actors, and also the structure and form of the urban area.⁽¹⁴⁾

The Millennium Development Goals are organized under eight objectives that relate to the most important dimensions of poverty and its implications for society and the environment.⁽¹⁵⁾ These were adopted by the United Nations member countries at the Millennium Summit in 2000, and make up a programme that spans the international, national and local levels. Despite the scale of poverty and the urgency needed in addressing it, this is not the only factor that impacts upon society and the environment. Others include: diverse perceptions of nature among different groups, companies and countries; different levels of resource consumption; conflicts over access to natural resources; the dynamic nature of

ecosystems themselves; and commitment of governments and the private sector to adopting socially and ecologically responsible development models, locally and globally.

This paper approaches the problem of sustainable development in Cancún through an assessment of the situation in the city in relation to the seventh MDG on "ensuring environmental sustainability", which proposes to:

- integrate principles of sustainable development into country policies and programmes and reverse the loss of environmental resources;
- between 1990 and 2015, halve the proportion of people without sustainable access to safe drinking water and basic sanitation; and
- achieve significant improvement in the lives of at least 100 million slum dwellers by 2020.⁽¹⁶⁾

This is undertaken by analyzing the socioeconomic, political, demographic, environmental and land use dimensions of the problem of access to safe water and improved sanitation in the city, since these have important impacts on the health and well-being of Cancún's residents, the quality of the environment and the local economy. Access to safe water and improved sanitation services, as well as land tenure and indicators of housing quality and levels of overcrowding, are powerful indicators for identifying deprived low-income zones and the problems that exist within them.⁽¹⁷⁾

Such indicators are most useful when they are adapted to specific local contexts. They are also important in identifying what are often significant disparities between coverage of basic infrastructure and technologies used in urban services within cities.

II. RESEARCH METHODOLOGY

The methodology employed in this study was designed to analyze the socioeconomic, demographic, environmental and land use dimensions of inadequate access to safe water and improved sanitation services in Cancún. The first step was to delimit and divide the city into different zones, based on socioeconomic characteristics and historical stages of urban development. Information was gathered from a review of specialized literature and in-depth interviews with key actors in Cancún. Qualitative and quantitative data collected included both historical and recent information on urban development and the use and management of drinking water supply.⁽¹⁸⁾ The data obtained were verified during field visits around the city. All data were standardized and processed through a geographical information system using census units⁽¹⁹⁾ as the basis for analyzing the following:

- population density;
- coverage of piped water supply systems;
- volume of piped water supplied;
- volume of piped water consumed and losses from unaccounted-for water;
- volume of wastewater produced;
- coverage of wastewater collection and treatment systems and problems experienced with these;

University of the Basque Country Press, Spain.

10. ECLAC (1991), "Sustainable development, changing production patterns, social equity and the environment", ECLAC, Santiago, Chile.

11. Vreeker, Ron (2003), "Intlcity: scenarios for sustainable urban development", Free University of Amsterdam, The Netherlands.

12. Haughton, Graham and Colin Hunter (1994), *Sustainable Cities: Regional Policy and Development*, Regional Studies Association Series 7, Jessica Kingsley Publishers, London.

13. Durojeannni, Axel (1997), "Management procedures for sustainable development applicable to municipalities, microregions and river basins", *Environment and Development* Series No 3, CEPAL, Santiago, Chile.

14. Finco, Adele and Peter Nijkamp (2001), "Pathways to urban sustainability", University of Ancona, Italy, and Free University of Amsterdam, The Netherlands.

15. A number of different indicators have been proposed to monitor progress towards the Millennium Development Goals. See <http://unstats.un.org/unsd/mdg/Home.aspx>.

16. See <http://www.un.org/millenniumgoals/>.

17. See reference 6, page 6.

18. The dates of the recent data used vary between 2000 and 2003 due to the periodic nature of when the sources are updated. This did not affect the analysis and interpretation because the problems discussed did not change significantly during this period.

19. For the census survey, INEGI divides the city into units of "basic geostatistical area".

MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

- production of sewage sludge;
- urban water quality; and
- social actors involved in the use and management of drinking water supply.

For the analysis, the urban area was divided into spatial units that were defined according to the historical stage of urban development as well as socioeconomic and demographic characteristics. This entailed defining certain areas as peri-urban zones⁽²⁰⁾ and deprived low-income settlements,⁽²¹⁾ in order to better contextualize the spatial form of the city and thus interpret the results of the research. The data on the use and management of drinking water supply in the different zones were analyzed, which allowed the identification of barriers to access to safe water and improved sanitation services in Cancún.

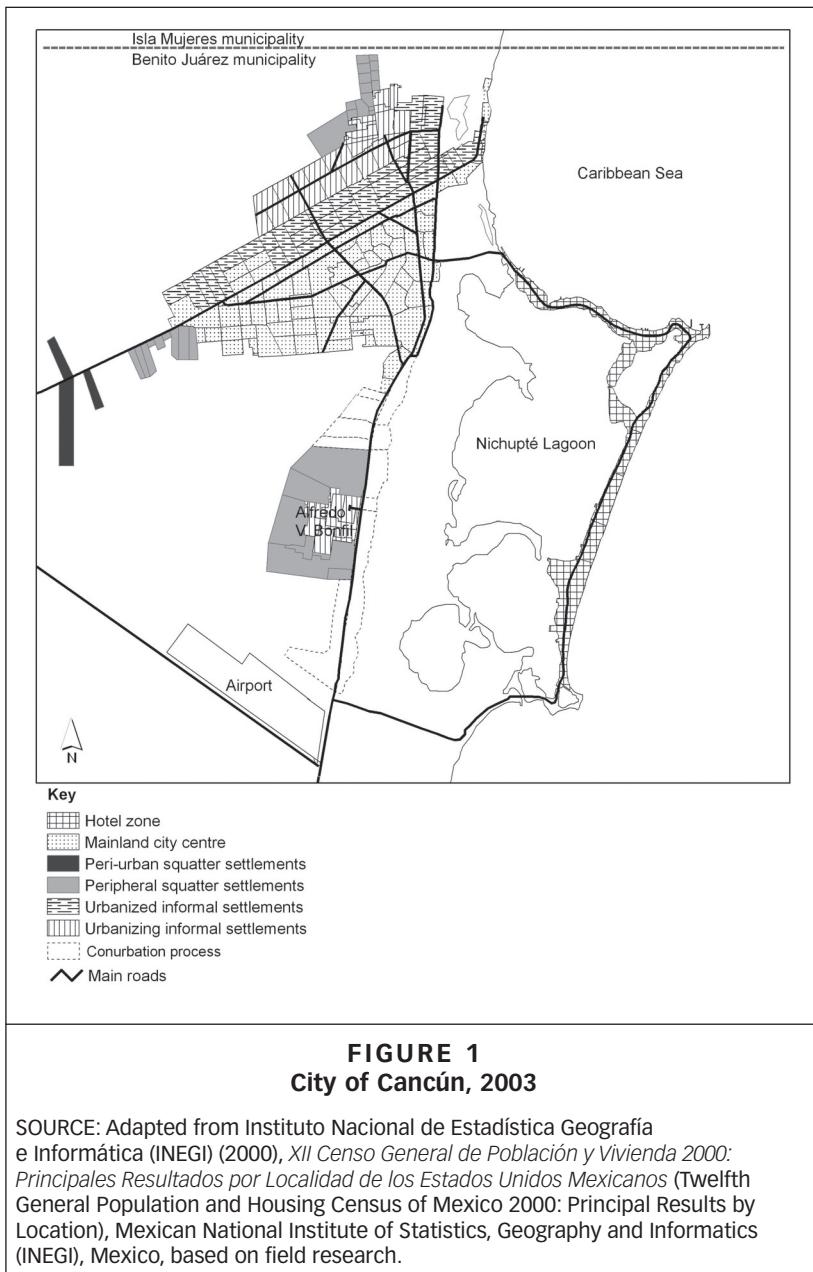
III. ACCESS TO SAFE WATER AND IMPROVED SANITATION IN DIFFERENT ZONES OF CANCÚN

With the exception of the sewerage system in Cancún's hotel zone, which is operated by the government agency FONATUR, piped water and sewerage services in the city were privatized in 1993 through a concession contract awarded to a consortium comprising international and Mexican companies.⁽²²⁾ The privatization of water and sewerage services was made possible by policy changes introduced during the six-year term of office of President Carlos Salinas (1988–1994), which allowed state and municipal governments, as well as the private sector, to operate water and sewerage networks as utilities.⁽²³⁾ Such utilities would be able to set their own tariffs although the profits were expected to be reinvested in order to finance continuous service improvements. In Cancún, the state government of Quintana Roo, which was previously responsible for operating water and sewerage networks, supported the privatization of these services due to its own lack of financial and technical capacity to maintain standards of provision. However, since privatization, there is some evidence that the construction of new water and sewerage infrastructure in the rest of Quintana Roo has decreased because network expansion had previously been financed by the surplus generated by the services in Cancún.⁽²⁴⁾

For the purposes of this analysis, Cancún was divided into the following zones, as shown in Figure 1:

- hotel zone;
- mainland city centre;
- informal settlements undergoing urbanization;
- informal settlements that are fully or almost fully urbanized;
- recent low-income squatter settlements on the urban periphery; and
- recent low-income squatter settlements in outlying peri-urban areas.

The first two zones, the hotel zone and the mainland city centre, present a varied situation in terms of different land uses, socioeconomic strata and urban characteristics. Some parts of the city centre were originally urbanized by FONATUR to house the medium- and high-income populations who would work in the hotel zone. It also includes adjacent areas that were later either released by FONATUR or regularized after they were invaded or bought by the people, or expropriated by the state



government to be sold to construction companies that later urbanized and sold them on the housing market. This zone covers 45.9 per cent of the total area of the city and is inhabited by 36 per cent of the population (Table 1). The average population density of this zone is 4,412 inhabitants per square kilometre.

The mainland city centre has full coverage of piped water, but the service is intermittent and only operates for a few hours per day. In

centralization and subsidies to municipal management, self-sufficiency and privatization), in *Región y Sociedad* Vol 14, No 24, pages 41–69.

24. Interview with a staff member of the Quintana Roo State Drinking Water and Sanitation Commission, March 2004.

MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

TABLE 1
Population of the different zones of Cancún, 2003

Zone	Area		Population		Households	
	km ²	%	Inhabitants	%	Units	%
Hotel zone	8.8	10.7	37,018	8	760	0.7
City centre	37.4	45.9	164,999	36	43,814	41.1
Urbanizing informal settlements	10.8	13.3	97,043	21	22,795	21.4
Urbanized informal settlements	10.3	12.7	146,112	32	35,995	33.8
Peripheral squatter settlements	11.7	14.3	3,174	1	727	0.7
Peri-urban squatter settlements	2.5	3.1	10,000	2	2,500	2.3
Total	81.5	100.0	458,346	100	106,591	100.0

SOURCE: Adapted from Instituto Nacional de Estadística Geografía e Informática (INEGI) (2000), *XII Censo General de Población y Vivienda 2000: Principales Resultados por Localidad de los Estados Unidos Mexicanos* (Twelfth General Population and Housing Census of Mexico 2000: Principal Results by Location), Mexican National Institute of Statistics, Geography and Informatics (INEGI), Mexico; Municipality of Benito Juárez (2002), "Actualización de la carta urbana de la ciudad de Cancún" (Updated urban plan of Cancún); FONATUR (2000), "Principales indicadores turísticos para Cancún en 2000" (Principal tourism indicators for Cancún); Secretaría de Turismo (1994), "Guía oficial de hospedaje de México, 1994–1995" (official accommodation guide for Mexico, 1994–1995), National Department of Tourism (SECTUR).

response, residents have adopted two strategies. First, many have constructed water storage tanks connected to the household water supply, which are either filled during the hours in which piped water is available or filled by tankers, known locally as *pipas*, with water for which households pay. Second, residents keep down their water consumption. This part of the city also has a networked sewerage system to which the majority of households are connected. The system is linked to three sewage treatment plants, two located in the north and one in the south of the city, which are operated by the private concessionaire. However, the level of sewage treatment falls below the standard needed to qualify as an improved sanitation service, as shown in Table 2.

In contrast, the hotel zone was fully urbanized by FONATUR, and is served by a complete range of urban services. The hotel zone is the most developed part of the city and resembles wealthy tourist resorts in high-income nations. This zone covers 10.7 per cent of the city and has an average population of 37,018 (including tourists) at any one time (Table 1). The population density in this zone varies greatly, from up to 5,000 people per square kilometre in the more established residential areas, to just 1,500 people per square kilometre in other parts. Unlike the mainland city, the hotel zone enjoys an uninterrupted piped water service.

TABLE 2
Sewage treatment in Cancún

Treatment plant	Location	Date sample taken	Indicators		
			Total suspended solids* (milligrams per litre)	Biochemical oxygen demand* (milligrammes per litre)	Quality of treated effluent
Corales	City centre	January 2002	150	150.0	Poor
Norte	City centre	January 2002	150	150.0	Poor
Caribe 2000	City centre	January 2002	150	150.0	Poor
El Rey	Hotel zone	November 2003	< 5	2.2	Good
Gucumatz	Hotel zone	November 2003	< 5	23.2	Good
Poc-Ta-Pok	Hotel zone	November 2003	< 5	15.4	Good

* Total suspended solids and biochemical oxygen demand were evaluated using the parameters for "natural and artificial reservoirs – urban public use" from the 1996 Mexican standards that establish the maximum permissible limits for contaminants in wastewater effluent from public urban water use. These standards were used for two reasons. First, because they are those used by the Comisión de Agua Potable y Alcantarillado del Estado de Quintana Roo, CAPA (State Commission for Water and Sewerage of Quintana Roo) to assess the public operator (concession company) in Cancún; and second, because they are stricter than the other standards that are regularly used, that is "rivers – urban public use", especially because no specific studies exist on the ability of the local aquifer to withstand contamination.

SOURCE: Adapted from CNA (2002), "Normas Oficiales Mexicanas" NOM-001-ECOL-1996, NOM-002-ECOL-1996 and NOM-003-ECOL-1997 (Official standards for Mexico), Comisión Nacional del Agua – CNA (National Commission of Water), Mexico; also CNA (2004), "Datos sobre calidad del agua del acuífero de Cancún", Oficio BOO.00.R13.04.1 (Water quality data for the aquifer in Cancún), Comisión Nacional del Agua – CNA (National Commission of Water), Mexico.

Nevertheless, some hotels have installed private desalination plants to produce their own drinking water. This is the only zone of the city with improved sanitation services as defined by this paper because it possesses a sewerage network and three wastewater treatment plants (Table 2), which all function properly. Operation of the sewerage network is subsidized by the federal government⁽²⁵⁾ through FONATUR.

The urbanizing and urbanized informal settlements were occupied between 1975 and 1995 through spontaneous land invasions and without any initial infrastructure. These areas were settled by lower-income workers in the city, who were not considered within FONATUR's housing plans for Cancún. These two zones have been gradually regularized and urbanized, mostly directly by the state government or indirectly in conjunction with other actors. The development of these neighbourhoods included a number of social housing projects, some of which were extensive. The urbanized settlements cover 12.7 per cent of the total area of the city, and contain 32 per cent of the population (Table 1), with a very high average population density at over 10,000 people per square kilometre. The urbanizing settlements cover a slightly larger area of the city (13.3 per cent) and contain 21 per cent of the population (Table 1), with an average density of 8,985 people per square kilometre. This zone includes the locality of Alfredo V Bonfil, which is in the process of conurbation with Cancún.

According to the 2000 census, the majority of households in the urbanized and urbanizing informal settlements reported a household

25. The Mexican federal government has subsidized wastewater treatment in Cancún's hotel zone since the 1970s.

MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

26. They reported salaries equivalent to two to five "minimum salaries".

27. Mexico has adopted three different poverty lines: food poverty (*pobreza alimentaria*), for households with incomes of up to two minimum monthly salaries, who cannot afford adequate food; inability to meet basic needs (*pobreza de desarrollo de capacidades*), for households with incomes of three minimum salaries or less, and unable to afford adequate food, health care and education; and asset poverty (*pobreza de patrimonio*), which applies to households with incomes of less than five minimum salaries, who cannot afford additional necessities such as clothing, transport and housing.

28. The Cancún Urban Development Programme of the municipal government of Benito Juárez (the municipality where Cancún is located) regulates the construction of new infrastructure in the city. Aside from the hotel zone, the original downtown and the original locality of Alfredo V Bonfil (to the south, and currently in process of conurbation), the rest of Cancún grew through different mechanisms including illegal settlements, small or large private land acquisitions and government expropriations of ejido land. The Cancún Urban Development Programme of 1992 recognized all of this area as part of the legal city (even though it is not yet all fully developed) and put a limit (at least on paper) on urban sprawl until urban infrastructure and services could be managed or supervised by the municipality. Despite this, different squatter settlements have continued to grow up around the periphery of Cancún, taking advantage of the lower cost of land and/or proximity to urban infrastructure and services.

income that is low when compared with the high cost of living in Cancún⁽²⁶⁾ – and below what is characterized by Mexico's Department of Social Development (SEDESOL) as the poverty line, which includes both those who are "asset poor" and those too poor to have their basic needs met.⁽²⁷⁾ It is important to emphasize that these informal settlements have undergone improvements in land tenure legalization, housing standards and provision of most urban services. However, the main difference between these zones lies in the provision of sewerage infrastructure. The urbanizing settlements have no public sewerage system at all and instead, dispose of human waste into septic tanks (the majority of which are self-built and do not function adequately) or empty it directly into unlined pits dug in the ground, which generally contaminate groundwater resources (as groundwater is shallow and close to the coast in Cancún). In most of the urbanized settlements, a sewerage network was constructed and a wastewater treatment plant installed in the late 1990s; however, the majority of households have still not yet been connected to the network. Given the higher population densities in the urbanized informal settlements, this implies even greater potential environmental impacts.

The peripheral and outlying peri-urban squatter settlements have undergone spontaneous occupation over the last 10 years and are the poorest and most deprived areas of Cancún. This is reflected in the 2000 census, in which the majority of households in these settlements reported incomes of up to two minimum salaries (US\$ 210 per month). Thus, according to the SEDESOL classification, they are characterized as experiencing the most extreme level of poverty, namely food poverty. The peripheral settlements cover 14.3 per cent of the area of the city but contain only 1 per cent of the population; thus the population densities are low, at less than 500 people per square kilometre in most of these areas. The peri-urban settlements cover 3.1 per cent of the city and contain 2 per cent of the population (10,000 inhabitants).

These squatter settlements have no provision for piped water or sewerage because they are located outside the official city boundaries as established by the Cancún Urban Development Programme of 1992.⁽²⁸⁾ For this reason, the residents meet their water needs (estimated at 60 litres per person per day) through the following means:

- shallow wells dug by the residents themselves;
- free "lifeline" water supplies of approximately 1,680 litres, delivered by tanker once a week and funded by the municipal government (by sub-contracting the tankers); and/or
- purchasing additional water from the tankers (often the same ones that deliver the lifeline supply).

The water that is sold by the tankers to the peripheral and peri-urban squatter settlements is sourced from the water treatment plant that supplies the public system (operated by the concessionaire). The tankers buy water at the same price as residential customers – approximately US\$ 0.40 per cubic metre, to later re-sell this water at a rate of around US\$ 4 per cubic metre, that is, ten times its original cost. In other words, the poorest residents of the city pay the highest price for their water. In relation to sanitation provision, the most common sanitation arrangements are open-air defecation or, at best, latrines from which untreated waste empties directly onto the ground or into unlined pits.

In addition, the quality of housing in the peripheral and peri-urban squatter settlements is also poor, and in most areas land tenure is illegal.

Table 3 illustrates the previous discussions regarding the presence or absence of safe water and improved sanitation across the different zones of the city.

TABLE 3
Access to safe water and improved sanitation in Cancún, 2003

Zone	Access to:	
	Safe drinking water	Improved sanitation
Hotel zone	Yes	Yes
City centre	Yes	Yes
Urbanizing informal settlements	Yes	No
Urbanized informal settlements	Yes	No
Peripheral squatter settlements	No	No
Peri-urban squatter settlements	No	No

SOURCE: Based on field research and from Instituto Nacional de Estadística Geografía e Informática (INEGI) (2000), *XII Censo General de Población y Vivienda 2000: Principales Resultados por Localidad de los Estados Unidos Mexicanos* (Twelfth General Population and Housing Census of Mexico 2000: Principal Results by Location), Mexican National Institute of Statistics, Geography and Informatics (INEGI), Mexico.

In sum, in 2003 Cancún had a public sewerage network that potentially could serve 77 per cent of its population, yet only 44 per cent of its inhabitants had effective connections to the system. More importantly, only the residents of the hotel zone and the majority of those living in the city centre had access to the system, and only the hotel zone had what this paper defines as an improved sanitation service. When comparing the level of access to sewerage in Cancún (44 per cent) with the average for urban areas in Mexico for 2000 (75 per cent), the extent of provision in the city is clearly very poor. However, if the coverage of infrastructure is considered instead (77 per cent), then Cancún comes slightly above the national average. These potentially misleading statistics have impeded the municipal government's recognition of the true extent of deficiencies in sewerage provision in the city. The coverage of piped water in the city as a whole is good (97 per cent)⁽²⁹⁾ and is above the average for urban areas in Mexico in 2000 (93 per cent). However, the capacity of the water supply infrastructure is inadequate and water services throughout the city are intermittent, with the exception of the hotel zone.

29. The 3 per cent who do not have access to piped water correspond to all the residents of the peri-urban squatter settlements, which are the poorest areas of the city (Table 1).

IV. UNDERLYING CAUSES OF DIFFERENTIAL ACCESS TO WATER AND SANITATION IN CANCÚN

The analysis of access to, and quality of, water and sanitation services in Cancún reveals similar problems in the different zones of the city, but also uncovers complex processes and outcomes that affect sustainable

MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

development, in particular quality of life and the natural environment, especially the aquifer.

a. Hotel zone

The hotel zone has a high demand for piped water and also produces a large volume of wastewater, accounting for 21 per cent of both in the city (Table 4). As previously mentioned, this zone is the only one with adequate wastewater treatment (Table 2). However, the regular increases in the price of piped water in this zone have affected residents in terms of quality of life and have had a commercial impact on businesses.

The installation by some hotels of their own desalination plants, which extract and purify saline groundwater to produce drinking water, works out to be more economical in the medium term. This option could prove attractive to other hotels in the zone that are also high consumers of water. This is illustrated by the following information from one hotel, which has 201 holiday villas and a capacity for 1,206 guests: the installation cost of the desalination plant was US\$ 2.15 million, excluding the cost of the civil works, while the water services bill for January–March 2003 was US\$ 536,000. By the same period in 2004, following the installation of the desalination plant, the hotel had already saved US\$ 321,000. The hotel chain that owns this hotel also plans to install desalination plants in four other hotels in Cancún.⁽³⁰⁾ It is also worth highlighting that hotels

30. Interview with a managing engineer of this hotel group, Cancún, 28 April 2004.

TABLE 4
Consumption of water and production of wastewater in Cancún, 2003

Zone	Consumption of water		Production of wastewater		Volume of sewage treated		Production of sewage sludge	
	Cubic metres per year	%	Cubic metres per year	%	Cubic metres per year	%	Kilogrammes per year	%
Hotel zone	7,129,994*	21.0	5,710,076	21.0	10,089,954	50	12,774,821	29.7
City centre	12,994,049*	38.3	10,395,241	38.3	10,091,874	50	11,833,760	27.5
Urbanizing informal settlements	5,404,385*	15.9	4,323,506	15.9	0	0	6,959,925	16.2
Urbanized informal settlements	8,140,427*	24.0	6,512,342	24.0	0	0	10,479,151	24.4
Peripheral squatter settlements	74,787**	0.2	59,831	0.2	0	0	227,640	0.5
Peri-urban squatter settlements	219,000**	0.6	175,200	0.6	0	0	717,200	1.7
Total	33,962,642	100.0	27,176,196	100.0	20,181,828	100	42,992,497	100.0

*Piped water **Other sources

SOURCE: Adapted from AGUAKAN (2004), "Planos de los sistemas de agua entubada y alcantarillado en Cancún, Quintana Roo" (Plans for piped water and sewerage systems in Cancún), AGUAKAN SA de CV, Mexico; also CNA (2003), "Ficha técnica 2003 de la ciudad de Cancún" (Technical brief for Cancún), Comisión Nacional del Agua – CNA (National Commission of Water, Mexico); FONATUR (2004), "Tabla con la capacidad instalada de tratamiento de las plantas administradas por BMO–FONATUR" (Table showing the capacity of treatment plants operated by FONATUR), FONAPUR, Mexico; and Municipality of Benito Juárez (2004), "Caracterización ambiental del municipio Benito Juárez: programa de ordenamiento ecológico territorial del municipio de Benito Juárez" (Environmental assessment of the municipality of Benito Juárez: programme of ecological zoning), Municipality of Benito Juárez.

only pay an administration fee to obtain a permit to extract saline groundwater⁽³¹⁾ but no fee for continued extraction. In this way, hotels with desalination plants get a good deal for the raw water for their water supply, besides the subsidy they receive by way of the treatment of their wastewater by FONATUR.

b. Mainland city centre

The city centre zone has the highest demand for water and thus discharges the largest volume of wastewater in Cancún (38.3 per cent of water consumed and wastewater produced, as shown in Table 4). Its residents have also been affected by increases in water tariffs over the last few years despite the intermittent nature of the service. Depending on their socioeconomic status and level of water consumption, residents have responded by adjusting their water use to the times when the supply is available and/or by installing water storage tanks and purchasing additional water from tankers. In addition, in this zone the concessionaire handles the collection and treatment of wastewater in treatment plants. The performance of city centre treatment plants has been poor (Table 2), since they frequently fail to comply with the maximum permissible limits for contaminants discharged into water bodies.⁽³²⁾

c. Urbanizing informal settlements

Since adequate water infrastructure was installed, demand from the population of the informal settlements undergoing urbanization has increased and the zone now consumes 15.9 per cent of the city's water supply (Table 4). This has meant that on the one hand, the risk of contracting water-related diseases has decreased; but on the other, residents have also found themselves worse off from water price rises following privatization, again despite the intermittency of water supply. As shown in Table 4, in 2003 the urbanizing settlements produced 15.9 per cent of Cancún's wastewater and 16.2 per cent of its sewage sludge, neither of which received any form of treatment. This lack of adequate sanitation has led to serious groundwater contamination. Throughout the gradual urban development process of these informal settlements, various government bodies have regularized land tenure and constructed new infrastructure, with the exception of sewerage, which does not appear to have been considered a priority.

d. Urbanized informal settlements

Although the informal settlements that are fully, or almost fully, urbanized have piped water provision, residents have also faced frequent price increases since privatization, again despite the intermittent supply. Due to the size of the population living in these areas, demand for water is high, and represents 24 per cent of the city's total water consumption (Table 4).

In addition, this zone presents the highest risk of aquifer contamination due to inadequate sanitation provision. As shown in Table 4, in 2003 this zone discharged 24 per cent of Cancún's wastewater and 24.4 per cent

31. In Mexico, saline water is defined as water that contains 2,500 (or more) milligrammes of total dissolved salts per litre. Authorities do not charge a fee for the extraction of saline water.

32. Mexican standards (NOM-001-ECOL-1996) rule that contaminants in wastewater from public urban uses that is discharged into natural or artificial water bodies should comply with the following maximum limits: the monthly average should be less than 40 milligrammes per litre for total suspended solids and less than 30 milligrammes per litre for biochemical oxygen demand.

MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

33. Article 36, chapter 3,
Quintana Roo State Drinking
Water and Sanitation Law.

of its sewage sludge, again without any form of treatment. Moreover, the wastewater in this zone could have been adequately treated if the majority of households were connected to the sewerage network. The reasons why so many households have not connected are complex and are related to the gradual urbanization process over the last 30 years. While land tenure has been regularized and urban infrastructure provided, sewerage was not constructed until the late 1990s, when water and sanitation services in Cancún were privatized. However, the main reason for households' failure to connect is the unaffordable economic cost. The exact cost, which can reach several hundred dollars, depends on two factors: first, the modifications required to the dwelling, because septic tanks and other on-site wastewater facilities are usually situated at the rear of the house; and second, the level of the sewer, which in some areas is positioned higher than the septic tank. Technical solutions exist for this problem, but at a cost. The problem arose because the municipality was never involved in reviewing or approving urban development works in this zone as most of it was simply built unofficially. Furthermore, it is worth mentioning that the State Drinking Water and Sanitation Law⁽³³⁾ states that all households should be connected to the sewer system if the infrastructure exists. However, in practice, no level of government enforces this because to do so would mean having to take concrete actions to connect households to the sewerage network, with political and economic repercussions. Either the connections would have to be subsidized by government or people would have to be required by law to pay for the connection – with electoral consequences for the political party enforcing this requirement.

Untreated sewage from the urbanized informal settlements is not only contaminating groundwater but also the sea and lagoons along the coastline between the municipalities of Benito Juárez and Isla Mujeres, and thus jeopardizing the tourism potential of this region. Other environmental problems in this zone include poor wastewater treatment and frequent accidental sewage spillages from the plant in the north of the city, and leachates from the landfill site that until recently was shared by the two municipalities. In conjunction, these problems have the potential to create conflict between the two municipalities, especially since Isla Mujeres has plans to develop tourism projects and a new resort on its mainland coast.

e. Peripheral squatter settlements

34. UN-Habitat (2001), "Global urban indicator database", Version 2, UN-Habitat, Nairobi, Kenya.

The peripheral squatter settlements, along with the squatter settlements in the peri-urban areas, are where economic inequalities are most pronounced because the residents of these zones pay the highest prices for drinking water in the entire city. While the residents of these areas do receive a limited amount of water from the municipality via the tankers once a week free of charge, this is always insufficient. This means that families in these zones are forced to buy additional water from the same tankers at a much higher cost, which is not only ten times the price of the public water supply but also five times more than the average price paid in informal settlements in Latin America and the Caribbean, which is estimated at just US\$ 0.78 per cubic metre.⁽³⁴⁾ Furthermore, the residents of the peripheral settlements are at constant risk of contracting infectious diseases and parasites due to the lack of sufficient drinking water, poor

hygiene practices of the tankers, inadequate sanitation provision, and use of water from shallow wells that are contaminated by their own human waste. The peripheral settlements consume the least drinking water in the city, only 0.2 per cent. They produce only 0.2 per cent of the city's wastewater and 0.5 per cent of sewage sludge⁽³⁵⁾ (Table 4), and therefore contribute least to the problem of aquifer contamination. The residents of the peripheral settlements do not have the financial means to move to the other zones of the city that have full coverage of infrastructure and services, because land prices are much higher.

f. Peri-urban squatter settlements

The residents of the peri-urban squatter settlements on the outer edge of the city experience the same economic and health inequalities as those living in the peripheral settlements. Their consumption of drinking water is very low, accounting for only 0.6 per cent of the total consumed in Cancún (Table 4). Similarly, these zones produce just 0.6 per cent of the city's wastewater and 1.7 per cent of the sewage sludge, neither of which receive any form of treatment. However, despite the small quantity of untreated sewage produced by these settlements, the potential for groundwater contamination is particularly acute because the peri-urban settlements are located in the same area as the well field from which the drinking water that supplies the city is extracted. If these settlements continue to expand from the estimated 10,000 inhabitants in 2003, the lack of an adequate sanitation system, as well as land use changes uncontrolled by the municipal government,⁽³⁶⁾ could result in groundwater contamination, similar to other Latin American cities.⁽³⁷⁾ If this were to happen, it would affect the whole population of Cancún because the city would either have to find new areas from which to extract its groundwater supply – which is not easy for technical, economic, political or legal reasons – or otherwise bear the increased costs of treating drinking water.

The complex dynamics of urbanization in the peri-urban squatter settlements are also revealed through the different, and sometimes antagonistic, perspectives of the private water operator, the *ejido* landowners,⁽³⁸⁾ the municipal governments of Benito Juárez and Isla Mujeres, and the state and federal governments. While the concessionaire considers the peri-urban settlements to be a threat to the city's source of water supply, and thus favours their removal, the *ejido* landowners see them as a commercial opportunity because they can sell them undeveloped plots of land. The municipal, state and federal governments have adopted different positions because on some occasions, they have regarded the settlers as potential voters and have not contemplated removing them in order to avoid conflict, while at other times they have supported the idea that they should be removed. However, to date this has not been carried out.

V. CONCLUSIONS

Although diverse, the barriers to sustainable development in Cancún in terms of inadequate access to safe water and improved sanitation services do present some similarities between different zones of the city, also with regard to the social actors involved and the dynamics of urban development.

35. The wastewater produced by a household is estimated to represent 80 per cent of the water consumed. See Bazant, J (2000), *Manual de Diseño Urbano*, Editorial Tillas, México. The production of sludge is considered to be 71.72 kilogrammes/inhabitant/year.

36. Some of the existing land uses in the zone that are incompatible with the well fields include a petrol station, warehouses and human settlement.

37. The contamination of sources of drinking water extraction with urban wastewater is considered the primary problem faced by human settlements in Latin America and the Caribbean in terms of access to drinking water. See Galvão, Luís Eduardo (2003), "A water pollution crisis in the Americas", in *Habitat Debate* Vol 9, No 3, page 10.

38. Ejidatarios are the collective owners of areas of land known as *ejidos*, which are Mexican farms communally owned and operated by the inhabitants of a village on an individual or cooperative basis.

MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

39. The private concessionaire has already implemented initiatives to improve the efficiency of its three wastewater treatment plants.

In the hotel zone and mainland city centre the barriers are technical, and thus fairly straightforward to resolve through measures such as effluent control monitoring in wastewater treatment plants.⁽³⁹⁾ However, more complex barriers relate to institutional factors and the attitudes and behaviour of social actors. The introduction of the market system to the urban water supply in Cancún opened up the possibility for heavy water consumers in the hotel zone to opt out of the public system by installing private desalination plants. The implications of this in terms of uncertainty of revenue for the main public supply could affect the price of water in the whole city. This situation is to a certain extent reinforced by institutional factors such as the law regulating water extraction, which does not include saline water at all. The dichotomy between the wealthy high-volume consumers who can afford their own private supplies on the one hand, and the lack of access and high cost of water borne by the residents of the peripheral and peri-urban squatter settlements on the other, is probably the most representative manifestation of socioeconomic inequity in the city. Indeed, it constitutes another barrier to achieving sustainable development locally.

Furthermore, inadequate wastewater disposal in the urbanizing and urbanized settlements, which can potentially cause serious groundwater contamination, is a significant barrier to sustainable development in both the municipality of Benito Juárez (where Cancún is located) as well as the neighbouring municipality of Isla Mujeres. Groundwater contamination could affect the current sources of drinking water supply of both municipalities, pose risks to public health, and also pollute tourist attractions (beaches, lagoons and sea), which form the basis of economic development in the area. Furthermore, the lack of clearly defined responsibilities for cross-border problems could also lead to conflicts between the two municipalities.

The gradual urban development that these densely populated zones have undergone over the last three decades explains the scale and nature of the barriers to sustainable development. This process involves complex underlying factors that are the root causes of the extent of groundwater contamination from these settlements. Some of these are institutional factors, while others relate to the attitudes and behaviour of social actors. In terms of institutional factors, the current social and economic development model has limited the ability of the population of these settlements to address contamination, while the local authorities have also showed little concern in protecting the aquifer, largely demonstrated by the long delay in installing a sewerage network. In the urbanized settlements, the different levels of government have neither enforced the State Drinking Water and Sanitation Law nor implemented programmes to connect households to the sewerage network through public campaigns, grants or loans. In relation to attitudes and behaviour, the most important underlying causes are the lack of environmental awareness among residents and the low level of social organization that could otherwise encourage people to connect to the sewerage network, which is, after all, already present. As sewerage in Cancún is privately operated, the concessionaire is also implicated in this problem. The analysis shows that the private operator has demonstrated no commitment either to aquifer protection or to the residents whom it serves. If it had, it would have sought to collaborate with the local government to address these issues and would have offered alternatives to enable residents to connect to the sewerage

network. Instead, it has limited itself to installing the infrastructure in line with its contract, while ignoring the commitment that this entails, that is, wastewater collection and treatment in order to prevent the contamination of water and other natural resources in Cancún.

The barriers to sustainable development posed by the peripheral and peri-urban squatter settlements arise from both institutional factors and the physical development of the city; this is reflected in the incompatibility of land uses with the protection of the area from which groundwater (to supply urban drinking water) is drawn. These two factors are undoubtedly linked because institutional factors determine how the city develops. The institutional factor that most affects sustainable development in these zones is the current social and economic development model, which is extremely inequitable in terms of distributing the benefits from Cancún's tourism industry. Another institutional factor is the lack of coordination and the often-conflicting objectives and goals of the different social actors in these settlements, namely *ejido* landowners, local settlers, the two municipal governments, the state and federal governments, the private water company and the state government regulator, the Comisión de Agua Potable y Alcantarillado del estado de Quintana Roo – CAPA (State Commission for Water and Sewerage of Quintana Roo). The challenge for these settlements, particularly in the peri-urban areas, is to improve residents' quality of life while simultaneously reducing the risks from inadequate sanitation, in terms of both public health and aquifer protection. In this regard, creative and innovative policy formulation from the bottom up, in order to address these problems, is paramount for achieving consensus and commitment among all parties involved; for example, relocating residents from the groundwater extraction area, installing sanitation infrastructure in undeveloped *ejido* land, and stronger regulation of water and sanitation providers and users, even when this implies reducing or conceding some of the prerogatives currently enjoyed.

In sum, the following barriers to sustainable development in Cancún that relate to safe water and improved sanitation services continue to have a negative impact on social and economic development in the city and its region:

- the socioeconomic disparity and inequity produced by market forces, which is reinforced by government policies. In this way, the tourists and the richest areas of the city are provided with subsidized services and have free access to resources, while the poorest have either inadequate, improvised or disproportionately expensive basic services, or no access to services whatsoever;
- the failure, for political and economic reasons, to enforce the State Drinking Water and Sanitation Law; and
- the lack of concern shown by social actors to aquifer contamination. However, there are some non-government organizations that strive for natural resources conservation in the city despite the low level of social organization that is characteristic of most parts of Mexico.

Given the multi-faceted nature of its urban problems, Cancún will require complex responses in order to get on track towards the MDG goals related to water and sanitation. Some of the main responses to be developed include the following:

MILLENNIUM DEVELOPMENT GOALS IN CANCÚN, MEXICO

- redefining the role and responsibilities of both the state and the private sectors in the provision of urban public services in order to devise policies that are both socially and environmentally responsible;
- enforcing the State Drinking Water and Sanitation Law in the urbanized informal settlements;
- investing in the improvement and expansion of water supply and sewerage infrastructure and developing effective alternatives for those areas that do not yet possess such infrastructure, irrespective of their land tenure status;
- fostering environmental awareness and encouraging local social actors to participate in addressing water and sanitation problems in the city; and
- improving urban planning, and fostering the definition, coordination and monitoring of shared objectives among the different public and private actors involved in the provision and use of urban services in Cancún.

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