

Integrated coastal management diagnosis for the Coastal Zone Sanitation of San Francisco de Campeche, Mexico

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ABSTRACT

The contamination of the coastal zone because of the poorly planned urban development is one of the main causes for the alteration of this ecosystem with effects in the human health. The coastal waters of Campeche are contaminated, to attend this problem the state and municipal authorities had developed different initiatives that haven't been consolidated. This study establishes the diagnosis of the Campeche coastal zone problem, looking forward the creation of an integrated coastal management program for its sanitation. With this analysis it was possible to identify that the main problem of the coastal zone contamination was the lack of institutional capacity to coordinate, control, monitor and perform sanitation actions. This study conform the baseline to establish and prioritize the actions for the coastal zone sanitation.

KEY WORDS: *Integrated coastal management, diagnosis, sanitation, institutional capacity.*

INTRODUCTION

The coastal zone of the State of Campeche constitutes an area where different and numerous economic activities converge, and in which the State depends. The capital of the State is Campeche City and has a political, economic, social and cultural importance (Rivera-Arriaga and Villalobos-Zapata, 2008). Despite of its history, growth or localization the water front of the city never had been an option or likely for its development, that's why its development was made in a disordered way and without planning. This had severe consequences, both for the health of coastal and marine ecosystems, as for the city growth and image.

The discharges of municipal waters directly and without any treatment to the underground and to the coastal zone, had generated an increase in the contamination and had developed sanitary problems that limit the economic development of the water front, particularly the promotion and realization of aquatic activities in the coast.

Aligned with this necessity, various initiatives have been developed from the three levels of government. However, for various reasons they haven't been able to consolidate and coordinate with each other, having little effectiveness to address and solve the contamination of the coastal zone problem.

This study is part of the project FOMIX-CONACYT (Found: M0003, call: M0003-2007-1, application: 69537) entitled "Integrated Coastal Management Program for the Sanitation of San Francisco de Campeche Bay, Campeche", which was developed by the EPOMEX Centre of the Autonomous University of Campeche. The main objective is to develop a diagnosis of the actual situation of the San Francisco de Campeche Bay looking forward its sanitation from integrated coastal management actions.

The particular objectives are:

- 1 - Define and identify the management coastal area of the Campeche Bay.
- 2 - Diagnose the *status quo* of the coastal zone.
 - Identify and prioritize conflicts or gaps between the actors and users, sectors and activities, and processes and influences Campeche city coastal area.
- 3 - Identify the needs and opportunities for the development of an integrated coastal management program for the sanitation of the Campeche Bay.

METHODS

To create the baseline for an integrated coastal management program this study includes the different spheres that are involved in the development of the coastal zone. It includes an analysis of the environmental, socioeconomic, institutional and legal aspects.

The environmental assessment was performed in 20 sample sites distributed as follow: ten located 100 m seawards parallel and along the coast of the city and ten located parallel at 1500 m seawards, covering 15 km of coast. In each sample site physical-chemical parameters were measured and a sample of water and sediment were taken (Figure 1). The ichthyofauna samples were taken with a trawl net; organisms were identified, weighed and measured to carry out an analysis of diversity, abundance and biomass. Samples of water and sediment were analyzed for organic pollutants and bacterial colonies. This assessment was made each month during a year (from March 2008 to February 2009).

For the socioeconomic analysis the quantity of inhabitants, demographic distribution and population growth in the city of Campeche were identified. The analysis was

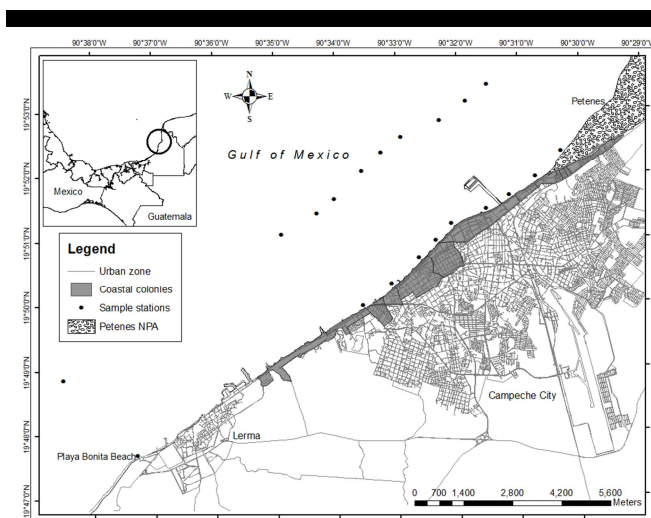


Figure 1. San Francisco de Campeche Coastal zone.

based in an official census made by the INEGI. A survey was developed calculating the minimum sample size based in the total population of the coastal colonies (Krejcie and Morgan (1970) in Bernard 1995). The survey intends was to identify perception of users and population, to coastal zone contamination, solutions and possible participation. The principal economic activities were identified as well as its distribution.

The institutional legal framework was reviewed and the institutions of municipal, state and federal level with jurisdiction and attribution in the water and coastal zone were selected for a personal interview. The interview was divided in four parts that include: a) jurisdiction and programs focused in the contamination of the coastal zone; b) institutional problems and deficiencies; c) water quality problem (main problems identified); and d) institutional capacity to carry out the programs and to solve the water quality problem.

Three workshops were made, authorities of the federal, state and municipal level; institutions with jurisdiction and attributions in the water sector and coastal zone management participate. The aim of each workshop was to: a) identify the limitations in the administrative processes; b) recognize the legal framework loopholes and needs and c) the needs for a policy development and identify the actions to improve the inter-institutional and intersectorial coordination.

RESULTS

Environmental

The temperature recorded their maximum in August and the minimum in December (23.85 ° C and 35.48 ° C respectively) salinity values ranged between 26.17 and 42.17 UPS (with minimum values in October and maximum in May) for dissolved oxygen thresholds were 3.24 mg / L and maximum of 12.87 mg / L (in June and May, respectively), and finally the pH showed values between 7.61 in September and 8.55 in July. The spatial representation of the physicochemical parameters showed variations between stations close and far from the coast (Ayala-Pérez and Can-González, 2009).

Biodiversity

It was determined the presence of four major groups: 1) Fishes, with 27 families, 35 genera and 47 species, with the presence of 11 dominant species: *A. quadricornis*, *A. rhomboidalis*, *C. Penna*, *E. gluttony*, *H. plumieri*, *L. rhomboids*, *M. ciliatus*, *S. testudineus*, *O. chrysoptera*, *S. hispidus* and *S. foetens*, from which 5 species have commercial importance; 2) Crustaceans, represented mainly by blue crabs, crabs and shrimps; 3) Molluscs like sea snails and octopus, both with commercial importance and 4) Echinoderms such as sea urchins, starfish and sea cucumbers.

Related to the abundance (density and biomass) it was found that the stations near the coast and near the municipal discharges are those with a greater abundance of species (Ramos Miranda et al., 2009).

Pollutants in sediments

There were detected the presence of three major groups: aliphatic hydrocarbons (16 long chain linear compounds, and compounds of Phytane and Pristane), aromatic hydrocarbons (15 aromatic hydrocarbon compounds being Anthracene and 9.10 Dihydrotraceno the most abundant) and organochlorine pesticides (majority groups, the PCBs and DDT derivatives compounds) (Alpuche Gual, 2009).

Microbiological analysis

It was found the presence of *Salmonella spp.*, *Escherichia coli*, total and faecal coli forms. The values of the colonies of the three species increased in the rainy season (Lara, 2009).

Histopathology

In the analysis of the *Archosargus romboldales* tissues, 13 anomalies were observed. The trematode infestation in their larval stage was the most frequent. Encysted larvae were found in vital organs such as heart, kidney and digestive sub mucous. These are diseases which have zoonotic significance (disease transmitted to humans by animals) (Del Río-Rodríguez, 2008).

Social

In the study area was estimated a population of 5.684 inhabitants (SINCE, 2000) and the minimum sample size established for this population was 357 surveys, which corresponds to the 6% of the total population.

It was found that the highest percentage of respondents recognize that the bay is polluted, while a smaller percentage didn't recognize it (mainly by fishermen, because catches are good and fishes "would not live in a contaminated site"). The main indicators of contamination are the garbage floating on the shore, the smell, the health alert and sewage. Also, the main sources of pollution recognized by users: boardwalk drains and littering.

It is known that pollution mainly affects the environment and is an impediment for the development of recreation activities on the coast, reducing the tourist attraction. The effects of pollution are health problems, which is a discouragement to visit the place. For 40% of the population land-based activities have no effect on the pollution of the coastal zone.

Furthermore, interviewed considered the necessity to take immediate action to solve the problem of water quality, they consider that the actions of urban sanitation, construction of sanitary sewers and treatment plants and education are needed to improve the situation. There is a lack of sanitation infrastructure and less than 10% of the population is

connected to the sanitary sewer, more than a half said having adsorption well.

Infrastructure

Water and sewer

The Commission on Water and Wastewater reported that in 2008, the City of Campeche had 95.4% coverage of water service, which was extracted from 47 deep wells, 41 located in the City and in the town of Lerma, and 5 in the town of Chiná. Water is pumped through 11 lift stations and one infiltration gallery. The only treatment that is given to water is the chlorination, held in 30 regularization tanks.

In 2005 the INEGI reported that 77% of housing uses septic tanks, while only 6% are connected to the public network, 16% doesn't have sewer service, 1% drains directly to the sea and 1% drains directly to the underground.

The City has a combined sewer this is that both rainwater and sanitary water are carried by the same network. In the city there are 21 drains and canals that discharge directly in the coast. It is estimated that approximately 452,496 gpd of wastewater and rainwater are discharged.

Treatment Plants

According to the Department of Public Services in the municipality of Campeche in 2009 were working six treatment plants. Five of these plants were working below their installed capacity and all these plants discharge in the aquifer.

Municipal Trail

The Municipal Trail is located north of the city, behind the Biosphere Reserve of Petenes. The trail has no treatment system so the wastewater goes directly to the mangrove area by drain tubes (Public Services Department, 2008).

Municipal Landfill

The municipal landfill is located northwest of the City. It is an 8 hectares area, owned by the municipality which has been running since 1985. Its initial projection was for 15 years, but at these days the authorities haven't attend its situation exceeding its capacity.

Institutional framework

To design adequate strategies in an Integrated Management Plan and for its implementation, it is necessary to identify the institutions involved in the regulation and management of sanitation issues and the coastal zone, at the three government levels. It is also important to identify those institutions that could support the management and development of the management plan.

After reviewing the Public Administration Organic Law at the three levels it was found:

Federal - there are four institutions involved, nevertheless one focuses only in the terrestrial wildlife and has no attribution in the coastal zone. The other three institutions, after the interview, declare that have programs orientated in the construction of sanitary infrastructure, regulation and surveillance of the environmental impacts, and observation of the quality of the coastal waters.

Main problems identified:

- Lack of economic and human resources
- Lack of capacity for the vigilance

- Lack of projects with technical, social and environmental viability.
- Authorization of resources out of time.
- Labelled money.
- Poor coordination (due time and scopes)
- Personnel changes

State – In the Public Administration Organic Law there were identified six institutions with jurisdiction in the problem but only three were really involved in the management and regulation of the activities in the coastal zone. The programs and projects in these institutions were the projection of the new municipal land fill, the monitoring of hazardous red tides in the coastal zone (in cooperation with federal institutions) and projects that involve the construction of sanitary infrastructure, such as a waste water treatment plant for the septic tanks cleaners.

Main problems identified:

- Lack of economic and human resources
- Lack of capacity for the vigilance
- There is no continuity in the projects
- Lack of jurisdiction into the coastal zone

Municipality – The municipal authorities have the obligation to provide the public services of drinking water, sewage, drinking and waste water treatment, and final waste disposal. There were six institutions involved but only four have programs that address the issue focused in the construction of a waste water treatment plants.

Main problems identified:

- Lack of economic and human resources
- No money for executive projects
- Untrained personnel
- Time gaps between projects
- Deficient regulation (law gaps)
- Communication between institutions at the three levels

Legal framework

The legal framework that supports the regulation, management and control of sanitation in the coastal area, is given by 13 federal laws, one regulation and three Mexican Official Standards; in the state level is given by 11 laws and in the municipal level is given by four internal regulations.

The main problem identified was the insufficient legal framework for the regulation of wastewater discharges. It is pertinent to update and reform the Mexican Official Standards on maximum permissible discharges in national goods, waters and aquifers. Also include the generation of technical standards that incorporate the region's aquifers.

Conflict identification

The problem of the Bay pollution is addressed by each government level with a different vision and mission from each other, which had led to isolated actions with no significant impact on the quality of coastal waters. The conflicts lie in two main areas (legal and institutional framework) that are reflected in five common results. These correspond to three basic elements of public administration: a) institutional design b) the legal and regulatory framework, and c) the operationalization intra and inter-institutional of the water resources.

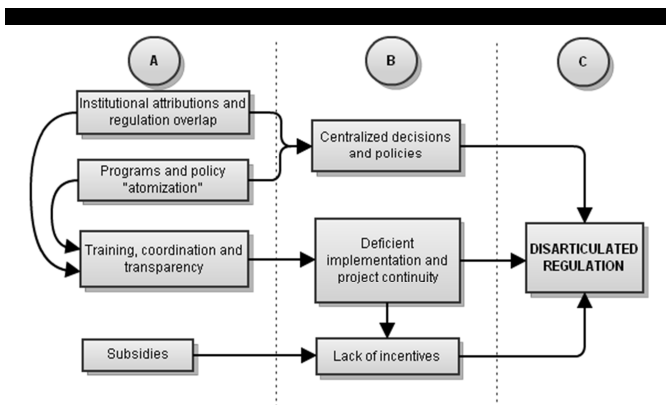


Figure 2. Conflict tree of the water resource management in Campeche (Alday, 2009).

The conflicts that the water resource management faces were identified (Figure 2). These are outlined in three levels of problems: a) in the processes, b) in the decision making and c) in the disjointed action regulation.

Diagnosis of the Campeche coastal zone

After identifying the problems there were determined the order of importance into the integrated management to establish the appropriate strategies for cleaning up the bay (Table IV). It was recognized that the problems identified in the environment were impacts of both: the socioeconomic activities and the institutional and legal deficiencies, so its evaluation over the management program should be an indicator of progress. Below is the problem hierarchization (Table 1).

With the problem tree it was possible to identify and confirm the priority of the problems that the management plan must address.

The localization of problems within the administrative process helped to identify that they were found mainly at the municipal level, where the greatest lack of financial and personnel resources are; lack of regulation and surveillance; and poor coordination and cooperation between different

Table 1. Problem hierarchization.

Level	No.	Problems
High	15	1) Lack of financial resources to operate 2) Insufficient municipal water infrastructure 3) Lack of qualified personnel 4) Administrative and integrate management inefficiency
Medium	10	1) Disjointed management of water resources 2) Impact of coastal water quality on users
Low	12	1) User perceptions on the Bay contamination (causes/consequences) 2) Users/impacts increase, related to tourism 3) Necessity to improve the regulatory framework of water resource 4) Accelerated change in land use in coastal colonies

institutions at the same level and upper levels. At the state and federal levels the main problems are in the lack of sufficient regulation and coordination between institutions (Figure 3).

Needs and opportunity identification

It was established three themes that were identified as priorities:

Administrative Processes

- Programs and operations congruence, lack of communication between government institutions and lack of a suitable institutions profile for regulation and management of the resources → procedures manuals conducting internal assessments for improvement.
- Discretionarily → Internal evaluations
- Population Growth, quality and quantity of the discharged water and no payment for the water service → Monitoring and law enforcement
- Lack of social environmental awareness → education programs

Legal framework

- Upgrade and reform the official Mexican standards of permissible limits on national water discharges.
- Include regulations for the use and exploitation of aquifers and groundwater.
- Update the legal framework for the marine pollution mitigation.
- Implement regional agreements to mitigate marine pollution from land-based sources.

Policy development

- Increased coverage of drinking water and sanitation infrastructure
- Ensure the protection and aquifer recharge
- Design environmental education programs focused on water culture.
- Upgrade rates commensurate to the cost operation
- Capacity building in the decision making process
- Strengthen watershed councils and apply the principle of subsidiary.
- Cut-out subsidies

CONCLUSION

The environmental study reveals the presence of ecosystem changes due to the water contamination by municipal discharges. It was determined that the stress caused by the contamination may influence the presence and abundance of diseases in fish, which at some point may be transmitted to humans.

It was found that the main problems are the poor sensibility and awareness from users to the pollution of the coastal area, and the lack of knowledge of their activities impacts in the zone; to identify the real effects of pollution on the health of users; and a reduced coverage of sanitary infrastructure.

Also it was determined that there is a low legal and institutional capacity to address the sanitation problem. This is mainly due to the lack of financial resources, the low number of trained personnel in the institutions in charge to regulate, monitor and control the water discharges; in addition to a poor inter-and intra-institutional coordination and cooperation that drives into lags of projects time execution and attribution and jurisdiction overlap.

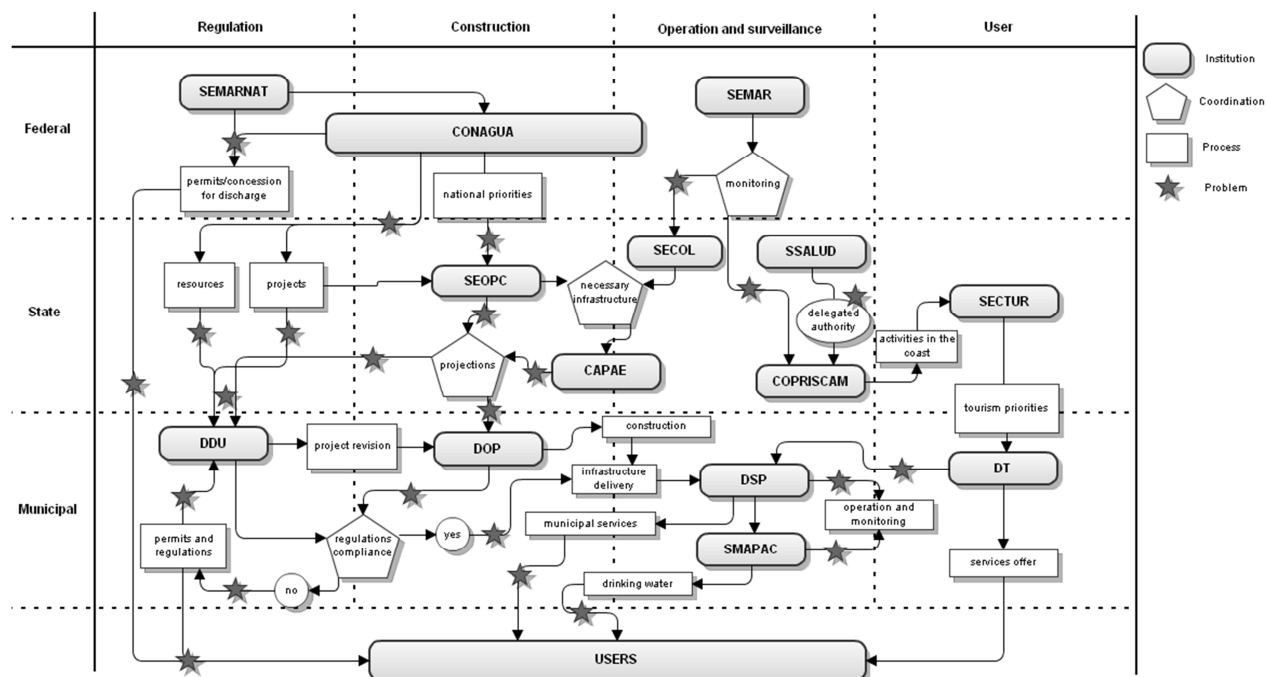


Figure 3. Problems identified in the water and sanitation management process.

This is why it is highly recommended that the coastal management program should include strategies for institutional strengthening of the authorities in charge of the inspection, monitoring and management. For this, it is necessary to develop a resource evaluation (human, material and financial) of institutions involved and to identify mechanisms to access to internal or external financing.

It must be establish cooperation and coordination mechanisms between the different government institutions involved to improve the lack of communication and efficiency. It is also necessary to create and implement annual training programs for the personnel and evaluate their impact.

The opportunities identified include the growing international concern for incorporating actions at national and local levels to reduce land-based pollution in the coastal. This represents a strong political commitment by the three government levels, especially the municipal, to increase the coverage of basic sanitation.

That is why, to address the lack of economic resources is important to encourage the payment of water and sanitation services on the premise "water pays the water". At the same time, there must be find new sources of funding either national or international, to provide wastewater treatment infrastructure, technology transfer and capacity building.

Finally it is important to address the problems of users perception on the Bay pollution, its causes and consequences. For this is necessary to create environmental education programs for different target groups of the civil society that promote population appropriation of water resources, as well as actions aimed to empowering society.

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