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# Health and development: Infectious intestinal diseases in a transborder region (United States-Mexico)

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# HEALTH AND DEVELOPMENT: INFECTIOUS INTESTINAL DISEASES IN A TRANSBORDER REGION

By

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**Abstract**

Intestinal infectious diseases are considered the northern Mexican border's most obvious challenge facing children. The Mexico-US Border region is a 200-kilometer border zone that extends 100 kilometers on either side of an imaginary borderline and stretches 3,141 kilometers from the Pacific Ocean to the Gulf of Mexico. In 2000, the Pan American Health Organization (PAHO), the World Health Organization's representative for the Americas, published a study of the top causes of mortality between 1995 and 1997 to estimate the absolute burden of mortality in the primary Mexican and American border communities, collectively known as the Sister Cities. Using the PAHO (2000) study, this research identified a significant difference in diarrheal disease mortality rates between the primary Mexican border cities and their American counterparts, suggesting a potential inequity in the health situation of the populations.

The presence of a high number of cases of water-related diseases, especially infectious intestinal diseases or diarrheal disease has implications on a series of levels. Although it was first believed that contamination of the Hueco Bolson aquifer, the city's only water source, was responsible for high levels of mortality and morbidity, results from interviews and fieldwork in the City of Juarez pointed to socio-cultural behaviours, as the main determinant of diarrheal disease in this area.

This study examined the complex relationships between influences responsible for diarrheal disease in children in the City of Juarez. This study also sought to clarify misconceptions and generalizations made about the Mexico-US border region and highlight the problems associated with the health system and disease surveillance program in Mexico.

**Acknowledgments**

This project would not have been possible without the support and kindness of many people. I would like to take this opportunity to express my sincerest thanks to my advisor, Dr. Jody Decker, for her guidance, support and patience. From the Instituto National de Salud Publica, in Cuernavaca Mexico, I would like to extend my gratitude to Rene Santos for his time and extensive knowledge; Dolores, Veronica and Jaqueline for their willingness to help and their friendship; Urinda Alamo for her support and encouragement, and to Dr. Enrique Cifuentes for his generous contributions. In the City of Juarez, many offered their time, unlimited kindness and knowledge to make this research possible. I would like to extend special thanks to Dr. Sylvia Flores and Fernando Chacon for their hospitality. I would like to thank Dr. Alfredo Granados Olivas from the GIS department at the Autonomous University of the City of Juarez and his staff for their kindness and generosity. I am also thankful for the support given by the Wilfrid Laurier Department of Geography and Environmental Studies.

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working student each summer. Finally, I would like to extend my warmest thanks to Trevor for his unwavering love and support. This study is dedicated to my favorite person in the entire universe, my grandmother Soccoro Cifuentes Garcia and to the memory of my equally wonderful grandparents Angela, Enrique and Giuseppi, with all my love.

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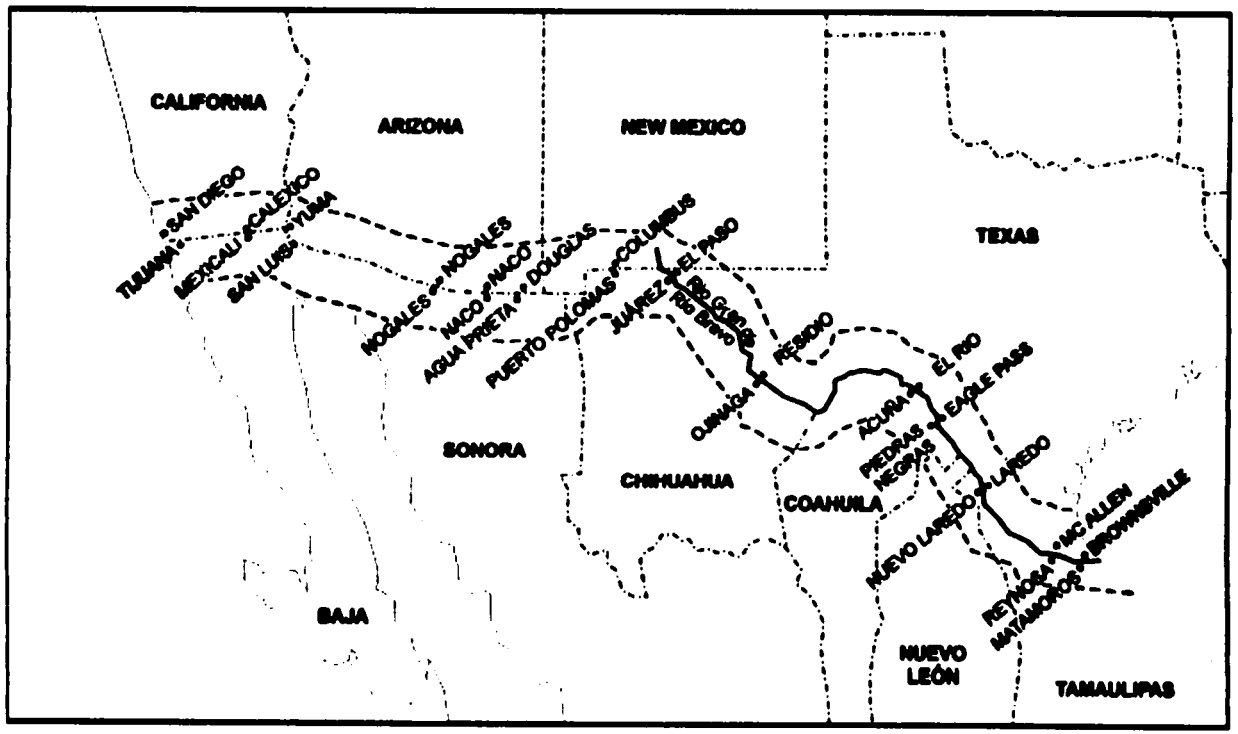
# CHAPTER ONE

## INTRODUCTION AND JUSTIFICATION

### 1.1 Research Question

Intestinal infectious diseases are considered the northern Mexican border's most obvious challenge facing residents, especially in children. The Mexico-US Border region is a 200-kilometer border zone that extends 100 kilometres on either side of an imaginary borderline and stretches 3,141 kilometres from the Pacific Ocean to the Gulf of Mexico in accordance to the La Paz Treaty signed in 1983 (Map 1.1). In 2000, the Pan American Health Organization (PAHO), the World Health Organization's representative for the Americas, published a study of the top causes of mortality between 1995 and 1997 to estimate the absolute burden of mortality in the primary Mexican and American border communities, collectively known as the Sister Cities. Using the PAHO (2000) study, this research identified a significant difference in diarrheal disease mortality rates between the primary Mexican border cities and their American counterparts, suggesting a potential inequity in the health situation of the populations.

## Map 1.1: Mexico – US Border Region




Source: EPA 2001.

What makes this inconsistency in diarrheal disease rates between both countries so important is that only a political boundary, a simple line, separates these entities. The Pan American Health Organization's (2000) publication highlights six Mexican border communities having statistically significant rates of mortality from infectious intestinal diseases: Tijuana, San Luis Colorado, Nogales, Ascencion, Juarez and Acuna. The previous PAHO study conducted between 1992 and 1994 highlights five. Because of its importance as a major economic centre with high levels of transboundary movement, migration and population growth, this study will focus on the city of Juarez in the state of Chihuahua. The City of Juarez's sister city is El Paso, Texas, which is not plagued by statistically significant mortality rates in infants from intestinal infectious diseases. The Rio Grande/Bravo is considered the political boundary that separates these two border cities. Both cities share a similar geographical landscape, many environmental challenges such as high levels of air pollution and water scarcity, as well as population and social characteristics. What is especially noteworthy is that both cities also share the same drinking water source, the Hueco Bolson aquifer. Therefore, despite their proximity and shared environmental resources, there remains a considerable difference in health between infants and children in both countries. Considering this information the research question for this study is as follows: "Why is the rate of mortality and morbidity from diarrheal diseases in children under the age of 5 greater in Juarez than in El Paso, considering the nearness of these two sites?" The geographies of inequality will be the central theme used to explain the higher rates of diarrheal diseases in children under the age of 5 in Ciudad Juarez. Environmental, cultural, economic and political influences will be considered.

## 1.2 Research Objectives and Rational

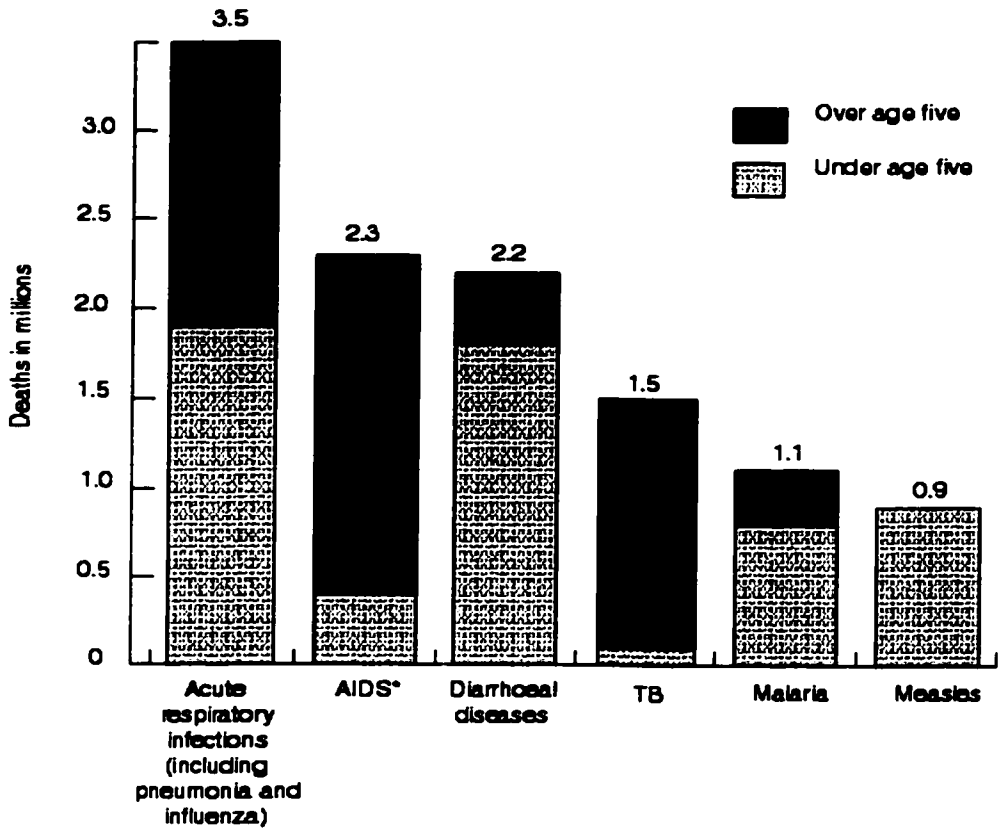
The overall objective of this research is to understand why children suffer a larger burden of disease, with regards to mortality and morbidity, in one area as opposed to another, despite a close proximity. Two important factors impinging on health will be considered: individual health behaviours and structural conditions and how these are affected by social, political, economic and even environmental inequalities. This study will attempt to fill in the gaps from previous studies on the subject of children's health in the City of Juarez, and perhaps it could contribute to a larger discussion regarding the health of children and health data quality in Mexico and on an international scale because this problem affects an entire area and cuts across international boundaries.

The presence of a high number of cases of infectious intestinal diseases or diarrheal disease in a population, has implications on a series of levels and draws attention to a basic human need and an important health indicator: clean drinking water. The occurrence of intestinal infectious diseases in the City of Juarez is strongly believed to be associated with decreasing water quality and poor water usage. Water is essential for human life, necessary in digestion, absorption, circulation, and excretion among other key functions. In addition, children and the sick are especially vulnerable to both insufficient and contaminated water. Chronic water shortages especially compromise household sanitation and personal hygiene, which in turn can lead to a variety of health problems, particularly gastrointestinal diseases and parasitic infestations (Varady and Mack 1995).

The presence of gastrointestinal diseases also suggests slow progress in regards to the epidemiological transition model[1] in the areas of water, health, sanitation and development. Infectious diseases are very devastating in terms of mortality, morbidity and health care costs. In 1995, diarrheal diseases, resulting from unsafe water and poor sanitation and food-handling techniques killed 3 million children less than 5 years of age on a worldwide basis, one every 10 seconds (WHO 1995). Worldwide there are approximately 1.8 billion episodes of childhood diarrhea annually. Figure 1.1 refers to the affect diarrheal disease has on children: out of 2.2 millions deaths from diarrheal disease, just under 2 million occurred in children under the age of five. Many of these deaths are easily preventable by using oral rehydration at a cost of US$0.07 (WHO 1995). According to the World Health Organization Guidelines for Drinking Water Quality (1993), infectious intestinal diseases, transmitted either by a pathogenic virus, bacteria, parasite or protozoa, are the most widespread health risks identified with drinking water and poor water management practices such as water distribution and storage. Esrey et al. (1990) found that improving the water supply alone was associated with a median reduction of 25% of diarrheal disease.

[1] According to Abdel R. Omran (1977), author of the *Theory of the Epidemiological Transition*, the model emphasizes the changing patterns of health and disease patterns in population groups and their relationship with numerous demographic, social, ecologic and biologic changes (Omran 1977). Although many countries have experienced a considerable transition from high to low mortality rates, as well as changes in causes of death from epidemics of infectious diseases to chronic degenerative and "man-made" diseases, some countries, mostly developing nations, battle both categories of disease, mainly because the shift is incomplete (Omran 1977). This phenomenon is known as The Delayed Model. Philips (1994) states that the transition started late for Third World countries, despite the introduction of Western technology, fertility levels remain high and living conditions do not always improve for all the people in these countries.

**Figure 1.1: Leading Infectious Killers**
Millions of deaths worldwide, all ages, 1998




Source: WHO 1999

Improvements in both water and have an even more profound affect on mortality: a median reduction of 66% in deaths from diarrheal disease (Esrey et al. 1990).

The continued presence of diarrheal diseases is often associated with unfavourable social and economic circumstances frequently found in "developing" countries where poverty level and health care costs are traditionally high, and access to quality health care

and natural resources is low and expensive (WHO 1995). Mexico is often considered a "developing" country, while the United States is considered a "developed" country. While issues of development will be discussed at a later point, these comparisons between "developing" and "developed" countries will help establish the framework for the use of geographies of inequalities throughout this study. This study will explore inequalities in various contexts, namely environmental, cultural, political and economic, which are hypothesized to be key determinants in the quality of health in the City of Juarez as well as in Mexico in general.

This process will also consider how the quality of quantitative health data in the City of Juarez and possibly in Mexico is affected by poverty and its possible consequences such as the misallocation of resources. While progress has been made in the areas of public and environmental health in Mexico, resulting in increased bi-national programs focusing on environmental cooperation, Mexico still contends with a weak disease surveillance system, an inadequate or non-existent health registry, in addition to a slow, outdated and incomplete health data processing and analysis system. Current mortality and morbidity rates are not very accurate, a problem admitted to by leading health specialists in the country. Dr. Victoriano Garza, formerly with the Pan American Health Organization and currently the head of the Environmental Health Department at the Autonomous University of the City of Juarez, revealed during an interview that in the City of Juarez for example, if a child dies of diarrhea resulting from a protozoa such as *cryptosporidium*, it would not be officially reported and reach the city's Health Secretary (*Secretaria de Salud*). It would more than likely be stored in an office in charge of death certificates and forgotten (Garza 2001). The only gastro-intestinal disease that must be

reported to health authorities is cholera. In addition, many living below poverty lines cannot afford health care or simply have no way of accessing health care, hence official numbers are not representative of the real situation (Garza 2001). The repercussion of these factors combined is increased health problems in children. Consequently, I will discuss the importance of including qualitative data in research and not relying solely on quantitative data when assessing the severity of a health problem. By discussing the factors hindering quantitative health data collection and health data quality in Mexico as well as discrepancies in foreign sources and reports on the health and environmental problems occurring in Mexico, this study will hopefully encourage other researchers to closely examine the quality of data they find and receive. This will hopefully highlight the importance of obtaining the local perspective from its source, thus encouraging Mexican authors to facilitate academic cooperation and ease the flow of information.

This research will use primary and secondary quantitative and qualitative data collected in Canada and in Mexico, as well as qualitative data from formal and informal interviews conducted in the City of Juarez.

### 1.3 The Mexico-US Border and the City of Juarez: Study Site

This section will provide important economic, social and environmental information on the Mexico-US Border and the study site, the City of Juarez. It will be divided according to the areas of investigation within the City of Juarez believed to be associated with elevated cases of diarrheal diseases in children under the age of five: geographic and environmental factors, politico- economic influences which transpire on both sides of the border, and lastly social influences. This is an introduction to these themes; they will be discussed throughout this study.

### 1.3.1 Introduction to the Study Site

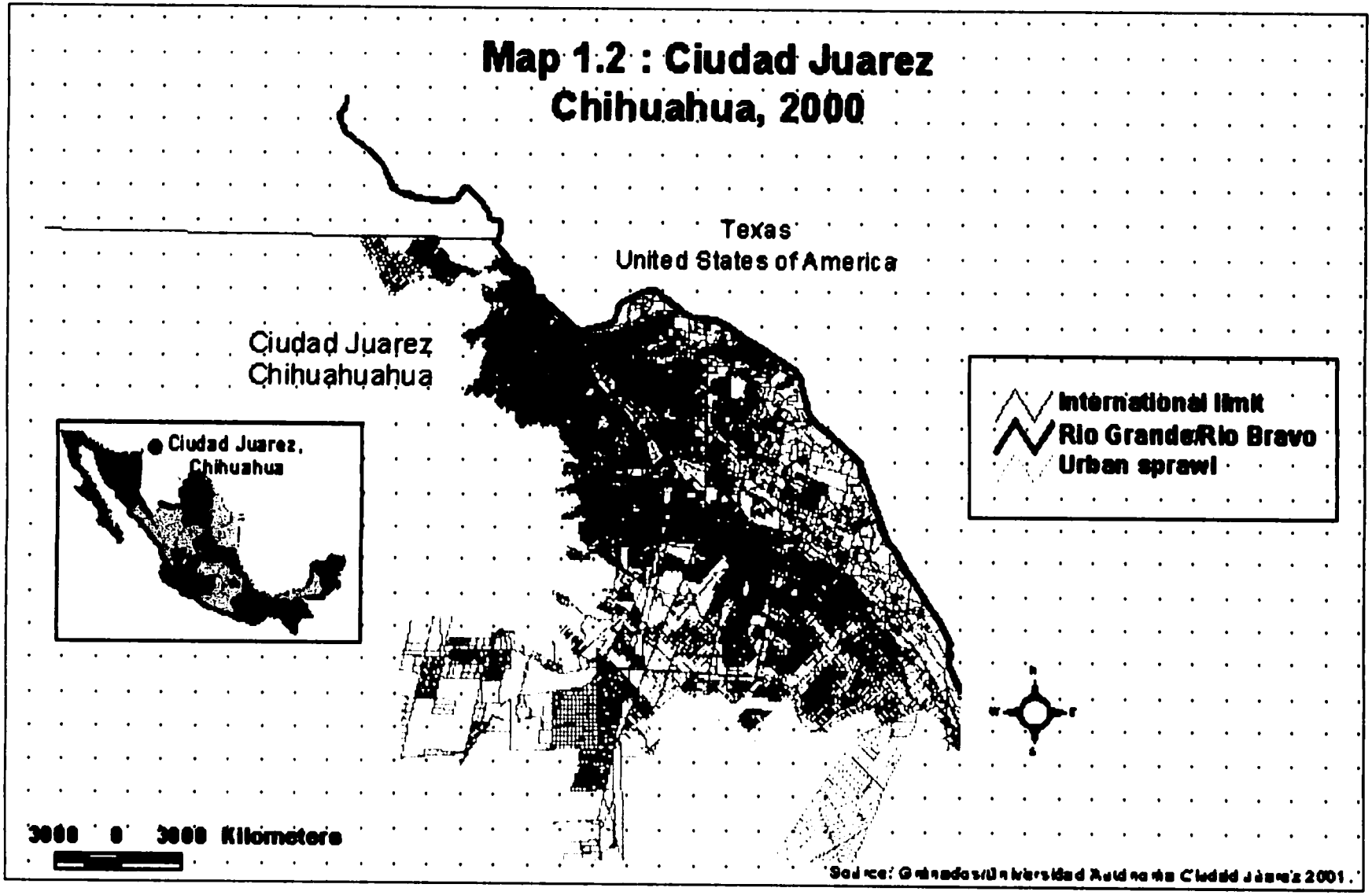
Originally founded in 1659, the *El Paso del Norte* area, now known as two different entities, El Paso and the City of Juarez, was the principle crossing ground between Mexico and the US (Gay 1986). The international border was established almost two centuries later, at the end of the War of 1846-1848; the combined population on the American side was approximately three thousand, while on the Mexican bank, numbers reached about four thousand residents (Martinez 1987). This was a time of intense population growth resulting from labour force increases. At the turn of the nineteenth century, railroads, mining, agriculture and the possibility of working in the United States were important pull-factors for Mexican workers (Camera 1979). The possibility of employment has remained the main reason for migration to the border by Mexicans.

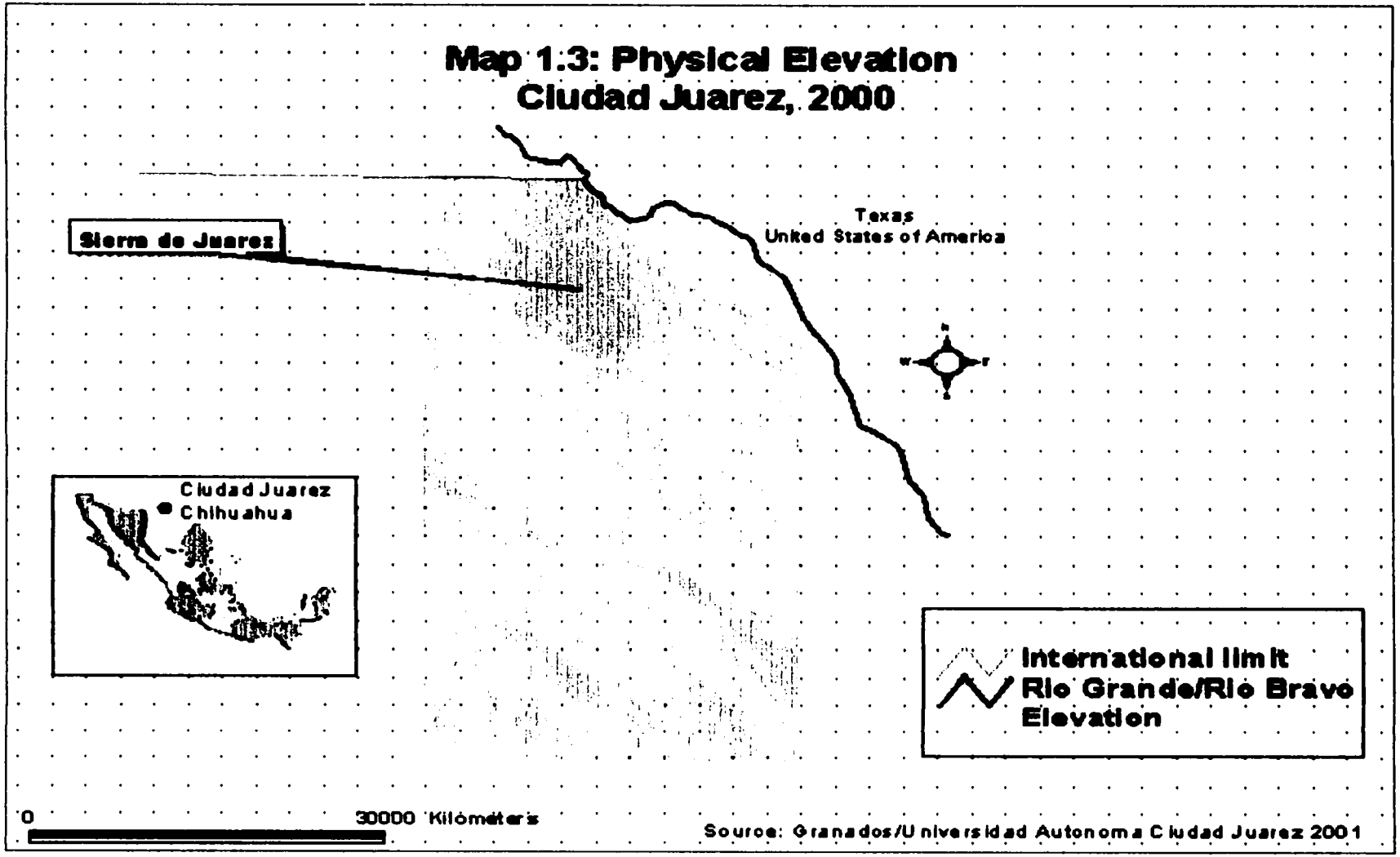
The border region is commonly defined as the area in the United States and Mexico within 100 km of the border. The region constitutes 39 Mexican municipalities from 6 states and 25 U.S. counties from 4 states. In addition there are 14 pairs of Sister Cities consisting of one American city and one Mexican city adjacent to one another, divided by the international borderline (EPA 1997). While the international border area defines the political jurisdiction of two countries with diverse social, historical and political features, the border itself emerges as a space where these differences become less obvious. This is an area of transition: in many respects, American and Mexican border communities have more in common with their Sister cities, than they do with communities within their own country outside the border region.

The City of Juarez or *Ciudad Juarez* as it is known in Spanish (Map 1.2) is located in the Municipality of Juarez in the State of Chihuahua, Mexico. This city was chosen as the study site because it is a reflection of all Mexican border cities as it struggles with such issues as insufficient water and service provision, an unfavourable physical landscape, inadequate water treatment and waste collection, poor health services and health threatening environmental problems. Situated in a valley and surrounded by the Sierra of Juarez a mountainous range (Map 1.3), the City of Juarez, is among the border cities that most attracts immigrants: more than 2.0% of the annual population increase (over 5.3%) of the municipality is due to migration alone. Its current population is 1.4 million people, although it is expected to double by 2020 (INEGI 2001). The population of El Paso, the City of Juarez's Sister City, is approximately 679, 622 residents (United States Census 2000).

### 1.3.2 Geographical and Environmental Context of the Study Site

The Mexico-US Border's physical landscape constitutes 66% terrestrial space and 34% fluvial space. The climate is very erratic, ranging between very dry to sub-humid template, although 96% of the border region is predominantly dry to very dry. The temperature of the border region is very extreme and the seasons are clearly defined. The winter season is known to produce temperatures well below 0°C while temperatures during the summer season reach above 40°C on a regular basis (Chavez-Alzaga and Suarez-Toriello 1999). The average annual rainfall is less than 200 millimetres, with certain very dry areas where precipitation is less than 100 millimetres annually.


Map 1.2 : Ciudad Juarez
Chihuahua, 2000
Texas
United States of America
Ciudad Juarez
Chihuahuahua
Ciudad Juarez, Chihuahua
International limit
Rio Grande/Rio Bravo
Urban sprawl
3000 0 3000 Kilometers


Map 1.3: Physical Elevation
Ciudad Juarez, 2000
Sierra de Juarez
Texas
United States of America
N
W
E
Ciudad Juarez
Chihuahua
International limit
Rio Grande/Rio Bravo
Elevation
0
30000 Kilometers
Source: Granados/Universidad Autonoma Ciudad Juarez 2001

Like many northern Mexican border cities, the climate of the City of Juarez is very dry and arid with very low soil productivity and extreme temperatures. The availability of superficial water is low and more than 50% of the area's land is unavailable for agricultural purposes, which does not make this region an ideal area for human settlement (Chavez-Alzaga and Suarez-Toriello 1999). Although air pollution is the area's most visible environmental problem, the most fundamental and urgent problems involve water quantity and quality. The area's decreasing water supply is the regions most pressing environmental challenge, especially considering the constantly increasing population. Understanding the hydrology of the city is important because although much is written about the border's poor underground water quality, the drinking water supply for the City of Juarez is good, a fact that is often not mentioned.

#### 1.3.2.1 The Hydrology of the City of Juarez

The two major watersheds in this area are the Colorado River and the Rio Grande/Rio Bravo. "The Rio Grande/Rio Bravo rises in Southern Colorado and flows across New Mexico to Texas, where for 19, 904 km it forms the international boundary; the total watershed contains 469 000 $km^2$, of which 230,500 $km^2$ are in the United States and 241 000 $km^2$ are in Mexico" (Fundacion Estados Unidos – Mexico Para la Ciencia - FUMEC 1997: 3). The Rio Grande/ Rio Bravo forms the international boundary between Texas and Chihuahua and two important treaties regulate the waters from the Rio Grande/Bravo. The 1944 treaty helped create two international dams and reservoirs along the river of which two are functioning and the third is still in planning stages, as well as the International Boundary and Water Commission (Hurlbut 2001). This treaty also "apportioned the water in the 14 major tributaries that flow from Texas and Mexico

into the Rio Grande/Bravo" (Hurlbut 2001:10). The treaty is, however, plagued with problems with respect to water sharing during droughts. The first treaty, the 1906 Convention for Equitable Distribution of the Water of the Rio Grande at El Paso and the City of Juarez, "grants Mexico 74 010 000 $m^3$ of water per year except during droughts, keeps the rest for Texas and establishes absolute U.S. sovereignty over the upper Rio Grande, before the river becomes the international boundary" (Hurlbut 2001:11). Between 1940 and 1974, however, surface water deliveries made to satisfy the United States' obligation towards Mexico failed to meet targets set by the 1906 treaty 20 of those 25 years (Day 1978). Of importance for this research is that neither refers to the management of the underground aquifer.

Both countries highly depend on the sub-surface water source, as the surface water supply is sparse and dispersed. The City of Juarez has only one water source, an underground water reservoir named El Hueco Bolson[2] shared in part with El Paso Texas, with whom it shares many geographical and environmental commonalities as well as New Mexico (Barreno 2001). The Hueco Bolson is hydrologically connected to the two other aquifers shared between Texas and New Mexico: the Mesilla Bolson and the Rio Grande/Bravo Alluvium (Rincon 1982). The Hueco Bolson "is a broad, inter-montane structural basin lying predominantly in Texas, between the Franklin Mountains to the west and the Hueco Mountains to the east, with extensions northward into New Mexico and southward into Mexico" (Rincon 1982: 940). Groundwater is found at depths ranging between 20-80 meters below the land surface (Lloyd and Marston 1985). The decreasing water supply of this source is due to a combination of high extraction rates,

[2] The term *bolson* refers to the "sediment filled basin bounded by the Franklin Mountains on the west, and lower divides and valleys on its remaining boundaries" (http://twri.tamu.edu/twripubs/WtrSavrs/v3n4/article-1.html 2002)

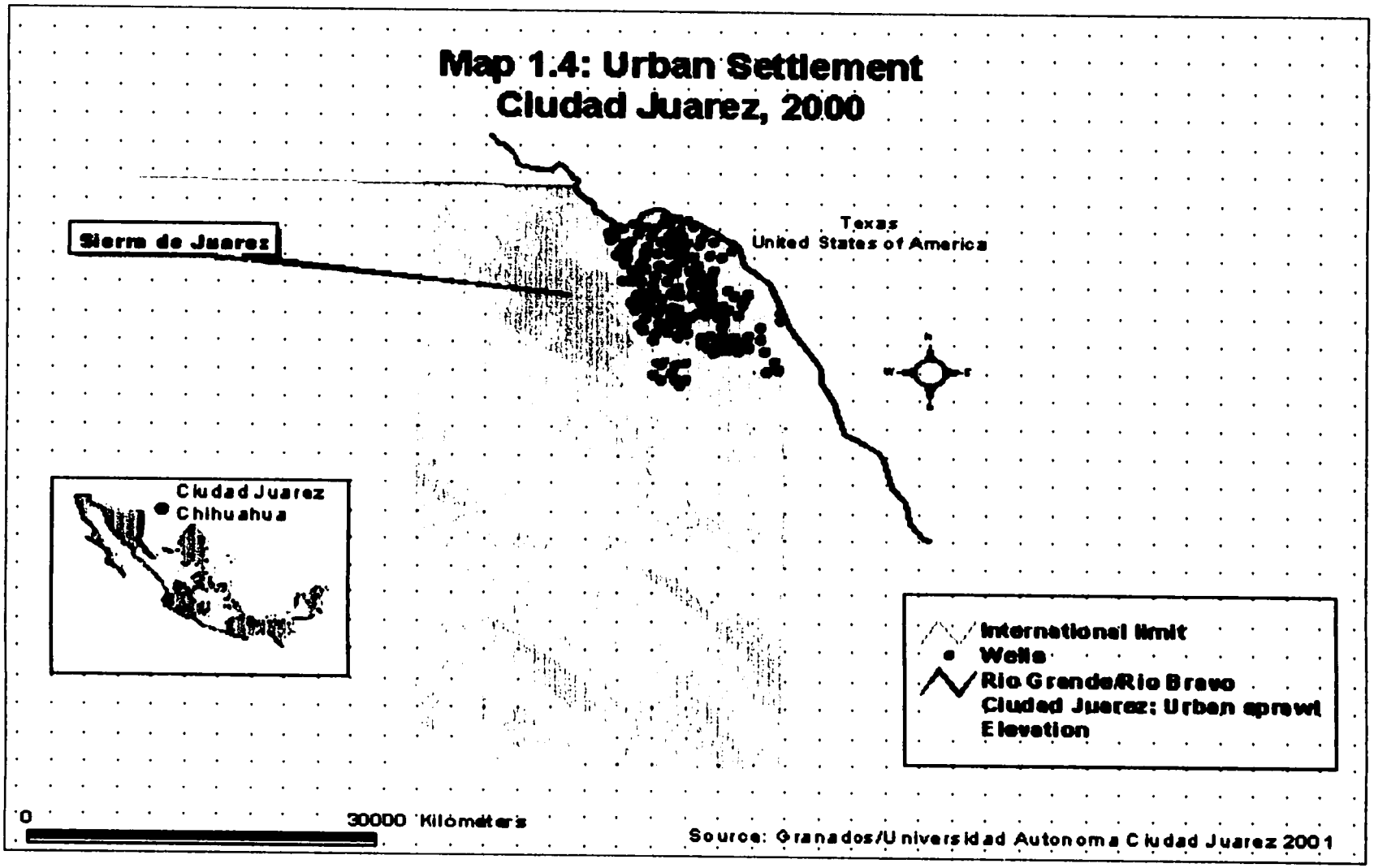
326 litters per person per day (in the City of Juarez), zero artificial re-charge and low natural re-charge, as little as 5 percent of the annual withdrawal (Day 1978). American residents are also adding pressure: El Paso and New Mexico residents both draw water from this source, and their consumption more than doubles Mexican consumption rates at almost 700 person/day/person (Suarez y Toriello 2001). Although it is beyond the scope of this paper to understand why American residents consume more water than Mexican residents, two important points should be made. First, American consumption rates decrease an already low quantity of water left in the aquifer for use in the City of Juarez by residents. Second, previous treaties do not regulate the aquifer or extraction rates, therefore, it could potentially require a complicated, lengthy and costly procedure to produce a new treaty to regulate extraction levels, especially given the problems with the previous treaties.

A dispute continues between both countries on the exact amount of water extracted by each. El Paso, however, is planning for the future by actively re-charging their section of the aquifer. Their source of water for this purpose is somewhat controversial. Some claim that the Americans are extracting water from the Rio Colorado before it reaches Mexico; a fact that is starting to become a source of conflict, especially as seasons become dryer (Suarez y Toriello 2001). Cech and Essman (1992), however, state that since 1985, El Paso has injected treated municipal sewage back into the aquifer. "This water is later pumped out by municipal wells to supply part of the drinking water needs" (Cech and Essman 1992: 1053). Some on the Mexican side believe that the process of extracting water from the Rio Grande/Bravo is breaking the international treaties, although it remains to be formally investigated. While many

speculate as to the quantity of water that remains in the aquifer, water and health specialists agree that the quality of water has become a serious threat due to increasing extraction rates and is magnified by an inefficient water treatment and reuse programs.

Water is extracted from deep wells. As Map 1.4 illustrates, there are approximately 160 of them in the municipality of Juarez, although water from the Rio Bravo is used for irrigation purposes. Map 1.4 illustrates the location of wells relative to the growth of the city and the Sierra de Juarez. The population growth in the City of Juarez is becoming increasingly problematic because new settlement is encroaching on the Sierra de Juarez, the mountainous range which surrounds the city. Drilling for wells and distributing water are difficult here because of the unfavourable landscape.

The urban sprawl, however, keeps moving on to the mountainous range, making it difficult for residents to access water. According to Lloyd and Marston (1985), evidence suggests that a layer of fresh water thick enough to support high extraction rates (at 1985 levels) occurred only in the extreme western portion of the Hueco Bolson. Unfortunately, this layer of water is relatively meagre in proportion to the much thicker underlying layers of water with high levels of sediment. Day (1978) found that the "total thickness of the bolson deposits of freshwater varied from less than 100 feet to more than 1,000 feet in Texas and to probably more than 600 feet in Chihuahua" (Day 1978: 168). Day (1978) also reminds us that between 1903 and 1976, water levels fell as much as 73 feet in the centre of El Paso and by 85 feet in the City of Juarez.


Map 1.4: Urban Settlement
Ciudad Juarez, 2000
Sierra de Juarez
Texas
United States of America
N
W
E
Ciudad Juarez
Chihuahua
International limit
Wells
Rio Grande/Rio Bravo
Ciudad Juarez: Urban sprawl
Elevation
0
30000 Kilometers
Source: Granados/Universidad Autonoma Ciudad Juarez 2001

A high level of sediment (30-50 ppm) is the most obvious problem regarding current pumping strategies and rates, and an indication of overexploitation of the source. Day (1978), states that there are certain areas of the aquifer located beneath the Rio Grande/Bravo alluvium where slightly saline water can infiltrate the freshwater source below. In addition, "the overlying aquifer of the Rio Grande/Bravo alluvium, the source of groundwater leakage into the portion of the bolson aquifer lying beneath the Rio Grande/Bravo flood plain, is generally brackish due to irrigation drainage and high rates of evaporation" (Lloyd and Marston 1985:844).

Although microbiological contamination is monitored in the City of Juarez, chemical contamination is not. Most of the chemical contamination is thought to come from industry and agriculture; health risks associated with this form of pollution are relatively unknown. Although microbiological contamination is said to be minimal, studies from the University of Texas at El Paso have confirmed the appearance of fecal coliforms in water collected from wells in the City of Juarez suggesting that the water in the Hueco Bolson is microbiologically contaminated with sewage (Cech and Essman 1992). In addition, Rio Grande/Bravo water entering Texas from New Mexico is polluted and the quality severely decreases below every border settlement (Cech and Essman 1992). This could pose a serious future threat to the quality of water.

The City of Juarez is lacking some basic infrastructure necessary to provide water and drainage services. Newcomers are often forced to establish residency in the ever-expanding periphery of the city, which is lacking water distribution and drainage because the physical geography makes it difficult to drill for wells or build the necessary water pipes and drainage canals. Currently, approximately 92% and 85% of the population

receive water and drainage services respectively, although with increasing population growth and slow data processing, some estimate that those percentages may be lower. Water is distributed through a simple water distribution line of underground pipes. These are very old, and leaks and broken pipes are not uncommon. Furthermore, because water pressure is weak through the pipes, opportunity for contamination to seep into the pipes increases. Although not all houses have a pipe directly connected to a faucet in their home, most people have access to a public faucet or well.

The city's water service is provided by the *Junta Municipal de Aguas y Saneamiento* (JMAS) an agency, which links the national, state and local levels of government (Lloyd 1982). The city's water utility mixes water from the different wells to reduce the concentration of salt, thus also increasing the potential for chemical or biological contamination. Water treatment in Juarez is very inefficient, relying on two primary treatment plants, neither of which is working at full capacity (Salas 2001). Only 34% of the wastewater is treated. Waters treated in the primary system, labelled black waters, are mixed with water from Rio Bravo and underground water, each contributing one third of the mix, and is only used for irrigation purposes in the Valley of Juarez, although some fear that the use of this water constitutes a potential source of contamination to the produce destined for consumption in the City of Juarez. Currently 345 million cubic meters of black water are produced a year (Garza 2001). Dr. Garza from the Autonomous University of the City of Juarez admits that the protozoa *Cryptosporidium* and *Gardia lamblia* have been found in humans in the Valle de Juarez due to black water irrigation. Currently scientists from the University are looking at the

feasibility of implementing secondary and tertiary treatment for wastewater as well as a better filtration system to reduce sedimentation found in the water.

Health and environmental specialists admit that the problem with regards to water quantity and quality is actually a race against time. Many disagree on the actual amount of water in the aquifer, although all concur that quality is increasingly getting worse. Although currently their biggest challenge is high levels of sediment, I speculate that chemical and microbiological contamination as a result of cross-contamination could be a very real threat in the future, further burdening current health challenges.

### 1.3.3 Politico-Economic Context

While the 1800s and the first half of the twentieth century was marked by exploration, settlement and development, the second half was marked by economic strain, expansion and redeveloping border cities (Herzog 1990). It is the strong presence of significant economic factors in the border area, namely the *maquiladora* industry[3], which is responsible for an expanding population and constant migratory movement, often termed a floating population. Created in the 1965 as a result of the Border Industrialization Program (BIP), the *maquiladora* program was aimed at motivating a faltering Mexican economy and *peso* devaluation, provoking an even higher rate of migration as well as a flow of goods and resources (EPA 1997). Between 1970 and 1985, population grew by 50% in the City of Juarez alone as a result of 70,000 new assembly jobs (Lloyd and Marsten 1985). By July 1997, there were more than 2,700 businesses employing more than 900,00 workers, with over 1,700 maquiladoras in the northern

[3] A *maquiladora* is a foreign owned factory that employs Mexican workers for cheap labour. Initiated in 1965 by the Mexican government to improve the economic situation of the border region, agreements "allowed materials to be sent duty-free from the U.S.; products assembled from these material went back to the U.S. with duty levied only on the value added by the work done in Mexico" (Kramer 1985: 731).

border" (EPA 1997: 3). The City of Juarez is currently the second most important Mexican border city in regards to maquiladoras, after Tijuana, with over 300 plants.

The *maquiladora* industry is a sensitive topic of debate, primarily because of its reputation for being another version of a "sweatshop", traditionally associated with poor human rights and environmental records. Although Mexican authorities have not strongly enforced environmental laws, especially regarding industry, there is an increasing commitment by local state governments to encourage environmental protection and conservation. Controversy also exists as to whether the *maquiladora* industry contributes to Mexico's development or endangers it (Guendelman and Silberg 1993). It is difficult to give a general description of maquiladoras because each is so different, although wages are generally kept low, and there are increasing complaints of adverse working conditions and inability to form a workers union. Although it is easily argued that low wages and poor working conditions would encourage poverty among its employees, most of whom are women, the *maquiladoras* existence is crucial to the economy of Mexico and also of the United States. They offer a source of employment for Mexicans in a country plagued with unemployment. It is the second largest source of export earning after oil, in Mexico. The Mexican government argues that it must keep wages low and prevent unions in order to entice foreign investment (Mesa-Lago 1992). Although it could be argued that the Mexican government knowingly participates in keeping its residents poor, it could also be argued that that this form of employment is better alternative to having no income at all.

Northern Mexican border states are generally more affluent relative to the rest of the country (Doyle and Bryan 2000). Having said that however, reports from health and

environmental authorities from the northern Mexican border, state that a little over 60% of the population employed in the formal sector have monthly incomes less than the monthly minimum income, meaning that these people live below the poverty line. In addition, over 40% of the border population lives in socially disadvantaged conditions (Chavez-Alzaga and Suarez-Toriello 1999). Conversely, on the US side, the border side is characterized by lower than average socio-economic levels: 5 of the 14 poorest American counties are in Texas alone (Doyle and Bryan 2000).

### 1.3.4 Social Context

The literature reveals an intense relationship between both countries, as well as highlights this border region as an increasingly problematic area, where "communities are subject to an accumulation of shortages and deficiencies in housing, employment, and utilities" (Alba 1982: 750). These issues can be common problems in "rapidly urbanizing areas with the developing countries of the arid zone" (Lloyd and Marston 1985: 841). According to Herzog (1990), the United States and Mexico border region is a zone that has been transformed by the changes in the function of the border thus influencing the dynamic relationship between economic, social and health linkages. Despite its many linkages, it remains a relationship of dependency (Alba 1982). The Mexican border is "part and parcel of a broader system relating to the Mexican development patterns and the characteristics of the international economy, especially the American economy" (Alba 1982: 749).

The border area has an average annual growth rate above 3.5%. In Mexico the growth rate averages about 4.3% per year, while in the United States the growth rate is around 1.8%. The 14 pairs of Sister Communities contain approximately 95% of the total

United States-Mexico border population (PAHO 2000). In 1997, the total border population from both countries reached 11 million (PAHO 2000). Migration is largely responsible for increasing population numbers in Mexico. Floating populations migrate to the northern states in search of employment or to cross the border into the US. Because the floating population does not intend to settle permanently, they will usually occupy or build inexpensive housing, often lacking water distribution, sewage treatment and access to basic services or infrastructure. This further contributes to a vicious cycle of poverty and an increase in environmental health problems. The population growth implicates considerable social, economic and environmental impacts.

The Mexico-US Border area is an important flashpoint over issues concerning the environment and human health, especially in regards to water related health issues. Insufficient potable water, inadequate distribution systems and wastewater treatment facilities coupled with an intense growth in population and economic development in a mostly arid environment threatens the health of over 5 million Mexican border residents while elevating and intensifying the social and economic status of water between Mexico and the United States. The net result of these demographic and geographical factors is that entire neighbourhoods or *colonias* (shantytowns) along the Mexican border remain unsupplied or undersupplied of running water, a phenomenon made worse by limited access to health care, increasing poverty and poor nutrition. It is difficult to estimate how many people do not have direct access to water in their home because the population grows so quickly. In a 1979 survey, 94% of residents from a wide area of the City of Juarez received some form of piped water to their home (Young 1986). In 1992, however, Cech and Essman reported that 35%-40% of the city's population was still

without direct access to water. By 1996, 12% or 694,151 of the total border population did not have access to potable water. Although 88% of the population had the necessary infrastructure in the home, such as faucets, they may only have running water 2 to 3 days a week, if any (Chavez Alzaga and Suarez y Toriello 1999). In 2000, the city's water utility agency, the *Junta Municipal de Agua,* reported that approximately 92% of the residents from the City of Juarez received piped water to their home in 2000 (Salas 2001). Lloyd (1982) attributes water shortages to a lack of water distribution network expansion necessary to meet growing water needs.

In the US, outside of major urban centres, a number of border residents also reside in *colonias*: an estimated 500,000 people live in over 2500 *colonias* in the US, most of them in Texas. As in Mexico, colonias on the U.S. side often lack access to indoor plumbing, adequate sewage and waste disposal systems (Doyle and Bryan 2000). In general, groundwater on both sides of the border has been shown to contain unhealthy of levels fecal coliform bacteria, although water quality varies throughout the border (Doyle and Bryan 2000).

**1.4 Population at Risk: Children's Environmental Health and Disease**

This target population was chosen based on the discrepancy in health between infants in the City of Juarez and infants in El Paso found in the Pan American Health Organization's most recent study. For this study, the population at risk are children less than 5 years of age because the effects of diarrheal disease are especially devastating in this age group. In addition, health problems suffered during this age period can contribute to chronic challenges throughout adulthood. Therefore, this research will

examine the prevalence of gastro-intestinal diseases in children less than 5 years who reside in the City of Juarez, Chihuahua.

Children today live in a very different environment than did the previous generations and are increasingly dealing with environmentally-related health problems and diseases. In fact, almost "one third of the global burden of disease can be attributed to environmental factors; over 40% of this burden falls on children under 5 years of age, who make up less than 12% of the world's population" (WHO 2001). Children are more susceptible to exposure to environmental contaminants and are more sensitive[4] to their affect (Goldman 1995). Sensitivity varies among different populations and age related differences have significant effects on metabolism, physiology, development, behaviour and diet (Goldman 1995). Lubin and Lewis (1995) remind us, that children have "unique metabolic and physiologic pathways that are distinct from those described in an adult. Many of these are the result of developmental changes that are initiated during foetal life and continue through adolescence" (Lubin and Lewis 1995:100). At birth, children's nervous, respiratory and immune systems are not fully developed, although their development is dynamic (Children's Environmental Health Network 2001). Young children breathe more rapidly and take in more air in proportion to their body than do adults. They also have a higher metabolic rate and a higher proportionate intake of food and liquid than adults do (National Research Council 1993). Children are not little adults; damage caused early on in a child's life may be devastating and permanent, manifesting itself throughout their life and developing into chronic health problems.

All children are affected by environmental contamination, although children living in poverty are at a disproportionate risk for exposure to environmental hazards.

[4] In this context, sensitivity is the capacity to be harmed.

Increased risk to environmental pollution and related health problems is associated with poor nutrition, inadequate housing, limited access to health care, and inadequate water supply (Children's Environmental Health Network 2001); all of these factors are current influences on the health of children in the study site. On a worldwide level, according to the World Health Organization (2001), more than 10 million children in low and middle-income countries die before they reach their fifth birthday each year. "Seven in ten of these deaths are due to five preventable and treatable conditions: pneumonia, diarrhea, malaria, measles and malnutrition, and often a combination of these" (WHO 2001:1). In regards to drinking water contamination, "children are at particular risk not only because they consume two and half times more water than adults relative to their weight, but also because most standards for pollutants are based on anticipated effects on *adults*" (Journal of Environmental Health 1998: 46).

Because of these damaging effects, there is a growing urgency to study the effects of environmental contamination on the health of children and make appropriate adjustments in standards, laws and policy. As Goldman (1995) clearly states "the health care community and those responsible for children need to be alerted to possible environmental factors in identifying and responding to health problems confronting children (Goldman 1995:13). Unfortunately data on children's health relative to environmental health is scarce. Considering the expected population increases forecasted in the near future in Ciudad Juarez, information of this type is important and urgent.

### 1.5 Health Outcome

The health outcome studied in this paper is intestinal infectious diseases, more commonly known as diarrheal disease, the most common gastrointestinal infection in children. A uniform definition of [acute] diarrhea does not exist (Burkhart 1999). An infectious gastroenteritis is an infection of the digestive tract and is caused by viruses, bacteria and protozoa, with symptoms including vomiting, diarrhea (very frequent, watery bowel movement) and dehydration (Your Family Doctor 1999) although these have a relatively low predictive value and should not be depended upon solely for treatment decisions (Gianakos et al. 2001). Dehydration occurs when fluid loss exceeds fluid consumption; it occurs quickly in infants and small children and is often the cause of death with children suffering gastrointestinal diseases. The specific pathogen that causes diarrhea in a particular geographic area often depends on the area's sanitation, level of economic development, access to water, nutrition and local hygiene practices. The most common type of water related infectious diseases are those caused by faecal contaminated water; they are known as faecal-oral water borne (which are ingested) or water-washed diseases (which are preventable by hand/hair/clothes/food washing and other measures) (Meade and Earickson 2000).

This study considers both acute and chronic infections, in which a case needs to be diagnosed by a health specialist, although in this study the exact aetiology of the disease may be inaccurate because of a deficient health monitoring system currently in place in the City of Juarez. Diarrheal disease is endemic in Mexico as in most developing nations, and results from many factors. Most people infected contract the pathogen through contaminated food and water, although some cases of diarrheal disease

can be spread from person to person. For this study, contamination through water will be explored, although contamination via food will also be considered. Many pathogens can cause diarrhea, among them: *E. coli*, salmonella, and shingella. Of particular interest is diarrheal disease causing pathogens *Gardia lamblia* and *Cryptosporidium parvum* because they spread easily through the water system and they can survive chlorination (Meade and Earickson 2001).

In regards to diarrheal diseases as a priority in the state of Chihuahua, it is low, due in part to problems in reporting diarrheal disease as a cause of death. In 1995, for example, infant mortality in the border area was 22.4 for every 1000 live births and for diarrheal disease it was 8.7 for 1000 live births. In 1998, in Chihuahua, there were 335.9 infant deaths for every 100,000 live births: 141.9 due to respiratory illness and 67.9 resulting from diarrheal disease. Poor or insufficient nutrition as a cause of death also ranked in at 14.12 for 100,000 live births, as did septicemia[5] at 13 deaths for every 100,000 live births (Suarez y Toriello 2001). Malnutrition and diarrhea are very closely connected, one influencing the other, therefore Dr. Suarez y Toriello, a leading health expert in Mexico, director of the FEMAP, the Mexican Federation of Private Health and Community Development Association in the City of Juarez, and co-editor of the *National Report of Border Environmental Health* (2000) states that he would add mortality rates of these causes together. In addition, he questions how many diarrheal cases ended in septicemia. The answer is unknown. Due to its relevance to diarrheal disease and the probability of misdiagnosis, Dr. Suarez y Toriello would also group these deaths to the total amount of diarrheal deaths and deaths to malnutrition: this would equal 95 deaths

[5] Septicemia: spread of sepsis by carriage of bacteria in the blood; Sepsis: destructive infection of tissues by bacteria such as *streptococci* or *staphylococci* (Wingate and Wingate 1996: 546)

for every 100, 000 live births not 67.8 deaths. Health authorities will see 141.9/100, 000 deaths due to respiratory illness, placing higher health priority on these than on diarrheal disease. Interviews with health authorities in the study site confirmed that diarrheal disease was at one point the principle health priority, but because of decreasing mortality rates, it no longer is. Diarrhea, however, remains a leading killer here and around the world of children and scientific technology has not eliminated this diseases.

Diseases are classified and chosen according to the International Classification of Disease (ICD) published by the World Health Organization. This classification system assigns a three character alphanumeric code to every major condition or cause of death. The system is used internationally for coding death certificates (Coggon, Rose and Barker 1997). Currently, the 10th Edition, published in 1998, is the most updated source. With regards to the ICD, 10th revision, diseases within the Diarrhea and Gastroenteritis from Infectious Disease (code A09) rubric were chosen. With regards to the ICD, 9th revision, diseases within the Infectious Intestinal Diseases rubric (code 001-009) were selected.

**1.6 Definitions and Important Concepts**

Before proceeding, it is necessary to define important concepts included in this study. Although the definitions for the clinical components of this study are scientific in nature, the explanation for these factors will include yet move beyond the scientific particulars in favour of other possibilities (i.e. traditional as opposed to modern medical definitions). It is beyond the scope of this study to provide a complete pathology of health outcomes and threats described here or to provide a clinical assessment as to the cause(s).

The central theme of this study is the concept of *health* and this study acknowledges that there exist several interpretations of the term. In 1947, the World Health Organization defined positive health as "the state of complete physical, mental and social well-being and not just the absence of disease" (WHO 1949: x). The concept of health slowly evolved to incorporate a more holistic approach, moving away from the traditional linear allopathic medical approach, which revolves around the notion that a particular germ will cause a particular disease, credited to Louis Pasteur and Robert Koch during the 19th century. The cornerstone of holism is the concept that the whole is made up of interdependent parts. A more holistic definition of health incorporates such factors as environmental characteristics, both physical and human-made, as potential influences on the quality of health of a person. The incorporation of holism into health can be traced back to the time of Hippocrates (460-377 BC) who believed that where one lived, and consequently the climate and weather they were exposed to, as well as the life style common in that area, would influence that persons state of health (Adams 1849).

Jacques May, a leader in disease ecology, argued that health and diseases are not clear cut notions, because it is difficult to measure when and where disease begins and ends (May 1958). Health, according to Pearse and Williamson (1931), is a continued condition between an organism and an ever-changing environment. René Dubos (1965) concurs, defining the state of health or disease as being "the expression of the success or failure experienced by the organisms in their effort to respond adaptively to environmental changes" (Dubos 1965: xvii). Gerald F. Pyle (1979), a medical geographer, defined positive health as a balance between several systems necessary to reach a state of "healthiness". Therefore, the state of being healthy depends on influence,

both internal and external, which can jeopardize the survival of an organism in their environment. While the author agrees with a more holistic approach to defining health as well as with May's (1958) remark that good health is not a clear-cut notion, I would also add that health also depends on scale and location or geography. In terms of scale, one must define a unit of study: an organism can be within the body, the human itself or a population. In regards to geography or location, health or the perception of healthiness in one place may not be the same as health in another place. Furthermore, the geographical and environmental characteristics of one location may influence health differently from those in another location. Defining health and judging what is healthy and what is not, depends on a definition of normal and abnormal; it is culturally constructed and perceptions on health vary from place to place. According to Jones and Moon (1987) "what is normal and abnormal is a social and moral judgment and this will vary according to society's norms, expectations and culturally shared rules of interpretation" (Jones and Moon 1987: 4-5). Because the perception of health changes from person to person, and from setting to setting, it would be difficult to focus in on a general perception of health common in the City of Juarez, or in Mexico. If we consider diarrheal diseases, interviews with health and environmental specialists in the City of Juarez revealed that while there are many people who associate diseases with pathogens or germs, others still believe that diarrhea is a common, if not normal occurrence in infants and children and could simple be the result of a type of fruit the child ate that did not sit well in the baby's stomach. These beliefs will in turn determine whether or not a child will be taken to see a doctor, as well as treatment.

Good health is often equated with lower *mortality* (death) and *morbidity* (illness) rates (Meade and Earickson 2000) and disease is best understood and almost always described within the context of health. According to the *Taber's Cyclopedic Medical Dictionary* (1973) *disease* is described as "literally the lack of ease; a pathological condition of the body that presents a group of symptoms peculiar to it and which sets the condition apart as abnormal" (Taber 1973: D-47). From a biomedical or Western perspective, diseases are abnormal biological entities existing independently from their hosts, and even prior to their discovery and classification (Lederberg 2000). *Infections* occur when a *pathogenic* or disease causing microbe enters the body through five main gateways: respiration, blood, skin, ingestion and sexual contact (DeSalle 1999). The microbes will infect the tissues, multiply and cause harm. It is not in the parasites best interest to affect the host fatally, because it will die and prevent further multiplication and spread, therefore, the parasite and host need to co-exist in a biological balance until the life cycle of the disease comes to an end (Burton and Smith 1975). Infectious diseases, often associated with poverty and inadequate public health and education, remain the major cause of death in developing countries according to the comparison of proportional mortality between developed and developing countries in the *World Health Organization Infectious Disease Report* (1999). Mexico itself remains, despite efforts, a developing country, although it must increasingly contend with both chronic and infectious diseases.

If we examine disease within a holistic or traditional context as explained above, disease would occur when there is an imbalance in the system(s) and the survival of an organism is jeopardized because of this (Pyle 1979). Howe (1977) adds the geographical component and describes disease as the result of "a combination of geographical

circumstances which bring together, disease agent, vector, intermediate host, reservoir and man at the most auspicious time" (Howe 1977: 8).

The causes of illness can be internal and/or genetic in origin or external in nature such as a virus and bacteria among others, and are considered components of the biological environment. A *pathogen* is any disease-producing agent, such as a virus, bacterium or any micro-organism (DeSalle 1999). It is the technical term used to replace *germ* (Learmonth 1978). Infectious diseases caused by pathogenic bacteria, viruses and protozoa or by parasite are the most common and widespread health risk associated with drinking water (WHO 1995). A *bacterium* is defined as a living single cell creature too small to be seen without a microscope, prevalent in nature and abundant in the human body (Wingate and Wingate 1996). While some bacteria may be harmless, others do cause disease. Examples of pathogenic bacteria are cholera or shingella, both water related. Bacteria, unlike a virus, are not immune to antibiotics and can be cultivated on laboratory media. A *virus* is the smallest known pathogen, which exhibits the highest form of parasitism (May 1958). When a virus invades a host, it will attach to a living cell, multiply, cause and spread disease (Wingate and Wingate 1996). Enteroviruses and rotavirus are an example of water related viruses. A *protozoon*, with its simple unicellular structure, is the smallest living entity comprising some 50,000 organisms (Wingate and Wingate 1996). In this study the protozoa of importance are *Gardia intestinalis* and *Cryptosporidium prevum.*

Measuring the effect of illness in a population is achieved by calculating rates, prevalence and incidence. A *rate* is simply the probability of a disease occurring in a population at risk during a specified time frame (Pyle 1979). *Incidence* is defined as the

number of new cases of a disease diagnosed for a specific period of time in relation to the total population at risk. *Prevalence*, however, is the total number of cases in a population over a specific period of time in relation to the entire population at risk. When a disease is constantly present in an area it is said to be *endemic*. When the incidence of a disease occurs at a level above normal, it is said to be *epidemic*.

The concepts of sanitation and hygiene are relevant to this study as the level of these have a proportional relationship to the state of health in an area. Sanitation refers to actions taken for the purpose of sanitary reform, promotion of health and prevention of disease: use of flush toilets or septic tanks, sewage collection, water treatment and waste collection (Dornete 1976). Hygiene refers to the science of health, or relating to hygiene: it is the study of the methods and means of preserving health (Taber 1973).

The *environment* is an essential component to the study of health and to the discipline of medical geography. The term *environment* has many different components: the physical environment, the built environment and the human environment. The physical environment is simply the natural environment in which humans live and can "exert slightly more influence, particularly through his or her mobility" (Foster 1992:2). Variables of the natural environment include the air, water, solar radiation, moisture, vegetation and soil. The variations of these components produce different geographical settings, which in turn influence the ecological niche of pathogens. The built environment is the human-made environment. Meade and Earickson (2000) note that humans spend most of their lives inside a building, whether a house or their workplace; the alteration of the natural environment for the purpose of construction will inevitably

affect the ecology of health. Finally the social environment "consists of the groups, relations and societies within which people live" (Meade and Earickson 2000: 28)

### 1.6.1 Development and Poverty

Poverty, a socially constructed phenomenon can be defined in several ways. The first is based on the term *absolute poverty* and is done by defining a *poverty line* (Gwatkin 2000). Absolute poverty considers a universal perspective and defines poverty in terms of a given level of income or consumption, which is equally relevant to all people despite location (Gwatkin 2000). The poverty line is the lowest amount of money needed to purchase the amount of food for a minimally adequate diet (Gwatkin 2000). A second approach to defining poverty is referred to as *relative poverty*. This practice defines poverty in terms of relevance for a specific society or group (Gwatkin 2000). Poverty in both cases is defined solely in economic terms. Poverty can be used to categorize members of a population or society in order to examine the inequalities among them and determining their needs, such as health care. Development and poverty are linked together because economic development was supposed to be the tool to alleviate poverty and inequalities. The provision of inexpensive or free health care was supposed to be a benefit according to many initiatives developed in the 1970s, but development proved to be elusive for too many countries (Gwatkin 2000).

Adjectives such as "Developed", "Developing", "Third World" and "Underdeveloped" used to describe or classify countries around the world are part of this discussion and need explaining. Underdevelopment "refers to a measurable, numerically comparative backwardness" (Ramirez-Faria 1991:79). These terms are used to divide people and countries into opposing categories, which is fostered by power relationships. Although

these definitions are not adequate, they are sometimes necessary to differentiate the level of wealth and power between countries or groups (Shakow and Irwin 2000). While such terms are used throughout this research, they are used with a critical consciousness of the limitations these terms represent as well as awareness of the political history and potentially distorted view of the world they symbolize.

Underdevelopment is the result in large part of past and continuing uneven economic and political relationships between satellite underdeveloped countries and their developed metropolitan counterparts. According to Andre Gundar Frank (1966), architect of the Dependency Theory, these relationships are the essence of the structure and evolution of the capitalist system on a world scale. There is an unfortunate and historic tendency to separate the world into opposing, conceptually manageable, albeit inadequate categories (Shakow and Irwin 2000). Prior to the 19th century, the world was separated mainly into different yet comparable cultures and civilizations. The "combination of western ethnocentricity and Western material advantages over other cultures expressed in economic, military and political terms engendered the cultural attitude that is known as Eurocentrism" (Ramirez-Faria 1991: 4-5). These relationships, based heavily on racism and social Darwinism, differentiated peoples based on cultural superiority (Ramirez-Faria 1991). Although current divisions rely heavily on politics and economics, hints of cultural superiority and racism are continuous and still very damaging. This is especially evident in current terminology used to describe these differences such as "development" and underdevelopment" or "First World" and "Third World". During the 19th century, and especially after the Second World War, the world was formally divided into "capitalist nations and the politically and culturally backwards

rest of the world, which was made up mostly of former colonies, a handful of African and Asian independent states and the remaining Latin American republics" (Ramirez-Faria 1991:78). Hence, post war terms such as "developed" and "underdeveloped", became the newest terms used to differentiate countries which had achieved a certain level of growth from those who had not, and where underdevelopment "referred to a measurable, numerically comparative backwardness" (Ramirez-Faria 1991: 79)

The underlying power, which forces an incorrect dichotomized view of the world, is capitalism, a market economy and system of production for profit that relies on problematic assumptions. The first is that the entire world adheres to one homogeneous mode of production. Rather, different economies co-exist (Frank 1966). It is imperative to understand the historical evolution of a country's economy, as well as its place in a larger world system. The second assumption is that capitalism will foster growth, a linear process, which is equated with development (Frank 1966). Neo-liberals advance a capitalist market based on the conviction that intensified economic growth will automatically lead to prosperity or at the very least a better life for all. This phenomenon, known as the trickle-down-effect, seems comforting at best, but can in fact be considered a treacherous tool used by politicians to appease the conscience of voters and sceptics. What is most significant argues Ramirez-Faria (1991), is not the invention of terms such as "underdeveloped" or the association of growth with development, but the widespread general acceptance of these notions. Wilber and Jameson (1992), as do many others, argue that development is not the same as growth, nor does it entail progress, depending of course on the definition of progress, while those who adhere to the dependency theory argue that development is not a linear process (Ruccio and Simon 1992). In addition,

once must question the lifestyle one hope to achieve once development has occurred; what are the standards for development? Do all countries need to develop into the United States or Great Britain?

Underdevelopment is a condition, which groups an entire area of the world as one, despite their obvious economic, social, historical, political and other internal differences. One external factor, however, that is common among these nations is their dependence on a developed country (Ruccio and Simon 1992). According to the Dependency Model, dependency causes underdevelopment because dependency is a relationship based on exploitation. The primary economic relationship between developed and underdeveloped countries depends on the dependence of the satellite city on the metropolis; the relationship between the City of Juarez with Mexico City and the United States and also with Mexico as a whole with the United States is a prime example of this type satellite-metropolis dichotomy. Satellite entities are not in control of their own development and at times even economy, nor does it materially benefit from the relationship (Frank 1966).

**1.7 Thesis Layout**

This thesis comprises five chapters. Chapter two provides a literature review of previous studies and their conclusions that will contribute to the understanding of children's health in the City of Juarez.

Chapter three will begin with a discussion on children's health and vulnerabilities. It will then introduce the theoretical framework and methods applied in this study.

Chapter four will discuss qualitative and quantitative findings and link these to the geographies of inequality. Finally, the last chapter will provide concluding remarks,

explore future research possibilities and offer recommendations for future work in this field.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter provides a literature review involving past studies highlighting key concepts, research methodologies, influences and stakeholders pertinent to the subject of environmental and human health along the border area, believed to be useful for this study. The purpose of this process is to gain insight in to the issues of health and environment in the City of Juarez as well as highlight gaps in previous studies concerning the environment and health of residents in the Mexican-US Border region in general and in the City of Juarez specifically. The literature review has been divided into three principle themes in accordance to the triangle of health ecology: population or host, habitat or environment and behaviour as presented by medical geographers Melinda Meade and Robert Earickson (2000). Population is "concerned with humans as biological organisms and as potential hosts of disease" (Meade and Earickson 2000: 25). The discussion on the population at risk as been determined to be children under the age of 5 in the City of Juarez, and will focus on mortality and morbidity trends in the Mexico-US Border region as well as the characteristics of children which increase their susceptibility to health risks. Habitat or environment refers to the parts of the environment within which people live, built or natural (Meade and Earickson). Finally behaviour is "the observable aspect of culture; it springs from cultural precepts, economic constraints, social norms, and individual psychology" (Meade and Earickson 2000: 26).

It should be noted that often articles discuss all three themes, and that at time it is difficult to distinguish where one theme ends and another begins. For example, when discussing environmental pollution, two themes arise, both environment and behaviour, because we are discussing how human behaviour modifies the built and natural environment, as well as the end result. However, given the nature of this study, I believe that this will only enforce the importance of the holistic approach to the study of the environment and human health.

This literature review will include books, journal articles, academic studies, information from the Internet and books. Relevant information from interviews will be included to add depth to the various discussions.

**2.2 Population**

Mortality data found in the Pan American Health Organization's (2000) *Mortality Profiles of the Sister Communities on the United States – Mexico Border* established the foundation for this research. This source presents an overview of the US-Mexico border's population and mortality trends for the years 1995-1997 and is an update of the previous profile from 1992-1994. The counties and the municipalities of the 14 Sister Communities form the basic unit of analysis. "Mortality information corresponding to each Sister Community was aggregated to form the border total reflecting overall morality" (PAHO 2000: 3).

The development of mortality profiles for this region required data analysis for leading causes of death and patterns of mortality in six broad causal groups and then categorizing them by age and sex. Maps provide a complimentary visual aid of the spatial distribution and magnitude of the leading causes of death. According to the data

presented by PAHO (2000), intestinal infectious diseases rank 5th overall as a cause of death for children under the age of one in Mexico. Trends varied according to city and sex. Intestinal infectious diseases were not considered a cause of death for infants in the American counties. Intestinal infections were also not considered a cause of mortality in children over the age of one.

This source highlights the health differences between Sister Communities, bringing attention to a vulnerable population. It was an important first source in this research. Unfortunately, the publication does not state how the data was collected although it does state its sources. This is very important to consider because Mexico has a very incomplete health and disease vigilance system, and their data collection methods differ from American standards and methods. One key source for mortality data from Mexico in PAHO's publication is the *Secretaria de Salud* (the Secretary of Health). This is also of importance because noted health experts in the City of Juarez and in Mexico City have commented on the many data collection and processing problems associated with the Secretary of Health. Therefore, accuracy of data could be questionable even in a PAHO publication. Future publications would benefit from including data collection methods from both countries in order to assess how collection methods and discrepancies in data could influence the statistical information provided. Nonetheless, the information included in this publication can be used to estimate the importance of mortality from different causes according to age-standardized death rates between both sexes, and begin the necessary research and remedial process.

The R*eporte del Estado Ambiental y de Los Recursos Naturales en la Frontera Norte de Mexico* (Environment and Natural Resource Report for the Northern Mexican

Border) (2000) was commissioned and published by the National Institute of Ecology (*Instituto Nacional de Ecologia* - INE) and was coordinated and contributed to by Enrique Suarez y Toriello and Octavio E. Chavez Alzaga, leading health and environmental specialists in Mexico. The authors believe in a holistic approach to health for this publication. Expanding on WHO's 1947[1] definition, the book refers to an ecosystematic approach to health by acknowledging the strategic collaboration between humans and their different environments: built, natural and social. The conceptual framework is based heavily on a systems approach referring often to the delicate balance that exists between humans and their environment. This book is the most up-to-date and comprehensive Mexican source of information on environmental and socio-economic data on the Northern Mexican border. It compliments the PAHO publication as a Mexican source of information and has helped establish the foundation for this research. The publication provides, in as much detail as possible, information on hydrology, air pollution, pedology and geology, waste management in addition to general information on social, economic and health topics regarding border residents. This book also provides a strong background analysis of general causes of mortality in the different border cities in comparison to Mexico as a whole.

In regards to infant health, which is relevant to this study, the average infant mortality rate for Mexico was 17.5 deaths per every 1000 live births in 1999; for the border region, the average was 14.4 deaths per 1000 live births. The municipality of Juarez ranked second highest out of all the sister cities, with 22.48 deaths per 1000 live births, well above the national and border average. The top eight causes for infant

[1] "Health is a state of complete physical, mental, and social well being and not merely the absence of disease or infirmity" (WHO 1947: x).

mortality were listed; intestinal infections ranked third. Problems with nutrition and septicemia ranked fifth and eight respectively. The municipality of Juarez ranked fifth with regards to the 14 sister cities in terms of child mortality (ages between 1 and 4), although causes are not listed. The publication does refer to a 1992 publication stating that intestinal infectious diseases are the second cause of death in children between the ages of 1 and 4 on a national scale. With respect to morbidity, only the top seven causes were identified using hospital, clinic and doctor visits data. Infectious intestinal diseases were first, responsible for 69% of all health care visits (INE 2000). Despite their importance, intestinal diseases are receiving less attention with regards to research and funding than they previously had and are slipping as a health priority (Suarez y Toriello 2001).

Dr. Suarez y Toriello and Dr. Octavio E. Chavez-Alzaga make many important contributions to the study of health of border children. First, they state that the high incidence of intestinal infectious diseases along the border area is a combined result of poverty, decreasing water quality, lack of education, deficient drainage systems, poor access to drinking water, food contamination and poor hygiene, thus remedies should focus on each of these. They believe that intestinal infectious diseases should be considered as an environmental health problem for their eradication. The authors also acknowledge that despite the importance of the subject, the briefness of the chapter on environmental health is due in large part to limited information for such reasons as lack of information on a geographical area, no established cause and effect relationship, inadequate diseases/health vigilance system and insufficient registry system for environmental problems affecting health. Finally, the authors repeatedly state the

importance of applying a holistic perspective to the study of health due to the complexity of many health challenges. They advocate a multi-disciplinary approach to studying environmental health and when proposing remedial actions.

While this source provides a strong, in-depth of the Mexican border, it is weakened by the lack of information on environmental health. Future updated publications will benefit from continued research with more emphasis on city level challenges, rather than a broad state-level perspective and generalizations.

In the article *Infectious disease morbidity in the US Region bordering Mexico 1990-1998*, Doyle and Bryan (2000) assess morbidity due to infectious diseases in the US region bordering Mexico, which compliments the previous source by highlighting the top causes of illness in the Southern American border region. Case report data for 1990-1998 were obtained via the National Notifiable Disease Surveillance System (NNDSS) for 22 infectious diseases reportable to public health authorities in the United States. The authors concluded that when comparing the border region with non-border regions, they found a significant excess morbidity due to certain infections disease in regions bordering with Mexico.

Diarrheal disease was not mentioned as an important cause of morbidity probably because it is not reportable, or simply because the number of cases were not statistically significant. This article was important because it brought attention to several important challenges on the American side of the border, which mirror Mexican challenges. First, the authors highlight that shantytowns, or *colonias*, are also part of the rural American border landscape. The American border is characterized by a higher incidence of poverty than in the rest of the country. Residents in these neighbourhoods often lack access to

indoor plumbing or adequate sewage and waste disposal services. The authors also mention that groundwater on both sides of the border has been shown to contain unhealthy concentrations of fecal coliform bacteria, which is a potential risk for waterborne infectious diseases. Although several municipalities along the border are plagued with microbiologically contaminated water, future discussions in this study will show that not all border cities have this problem and the consequences of making these kinds of generalizations.

Secondly, Doyle and Bryan also discuss problems with health data collection and public health surveillance methods in the United States. The authors discuss how American border states monitor the health of residents through standard, usually passive, public health surveillance methods. Although the authors do not explain what "passive" surveillance methods are, they recognize that these methods fail to treat the population living in the border region as a "single geographic or epidemiologic group, one that share many of the same health and demographic features among states on both sides of the international boundary" (Doyle and Bryan 2000: 1503). Doyle and Bryan also admit that the NNDSS database used for this study is derived from a passive surveillance system of disease reporting among states, therefore it likely underestimates the real burden of disease and reported incidence rates should be reported with caution. These challenges regarding monitoring and data collection are also present in Mexico, therefore the health burden of the entire border area is clouded with uncertainty.

This study highlights the importance of not limiting health studies to the use of quantitative data, however, the authors do not mention the potential usefulness of qualitative data. Although this study provides an important general overview of causes of

morbidity, it cannot offer more in-depth information such as potential sources of disease or remedial actions. Although by highlighting problems with data quality in the United States, it states that data quality challenges are international and not limited to the "developing" countries, where resources and funding have been traditionally low.

### 2.2.1 Children's Health and Susceptibility to Disease

According to the World Health Organization's Task Force for the Protection of Children's Environmental Health (2001), a growing number of diseases in children are increasingly linked to an unsafe environment, one in which they live, play, learn and grow. Consequently, "almost one third of the global burden of disease can be attributed to environmental factors, over 40% of this burden falls on children under the age of 5 years, who make up no more than 12% of the world's population" (WHO 2001:1). Their physical, social and intellectual development from conception to adolescence requires an interaction with an environment, which will be protective of their health (WHO 2001).

A child's exposure to the environment is expected to be different, and at times much higher than adults (Bearer 1995). According to Cohen Hubal et. al. (2000), the differences in exposure[2] are due to different physiological functions and surface-to-volume ratio, physical activities and behaviour, diet and eating habits, sex, and socio-economic status and race/ethnicity. (Cohen Hubal et al. 2000). Sensitivity to risk is therefore influenced by both exposure and susceptibility (Charnley and Putzrah 2001). This section will briefly review different influential characteristics, which increase a child's susceptibility to disease. Using data gathered from secondary and primary sources, I will relate each characteristic to Mexican children living in the northern

[2] Exposure is defined as "the contact of an individual with a pollutant for a specific duration of time" (Cohen Hubal et al. 2000: 475).

Mexican border. When possible I will make reference to children living in the City of Juarez.

1) *Physiologic characteristics*: physiologic characteristics influence a child's exposure by "affecting its rate of contact with exposure media or by altering the exposure-uptake relationship that governs internal dose resulting from an exposure" (Cohen Hubal et al. 2000: 476). A child's very first environment is its mother's womb, where it can be permanently damaged if the child's mother is exposed to any number of chemicals that can cross into its bloodline. At birth their nervous, respiratory, reproductive and immune system are still developing and are very fragile. Young children have a much larger surface area relative to body weight than adults do, therefore children provide a larger area for dermal absorption and also require higher consumption of food and oxygen to provide the necessary metabolic fuel to promote growth and development, which at this stage is very dynamic (Cohen Hubal et. al 2000).

Women working in *maquiladoras* often work in adverse working conditions and the potential for exposure to toxic chemicals and carcinogens exists. Adverse pregnancies have been identified among electronic assembly workers (Guendelman and Silberg 1993). Women make up 60% of the *maquiladora* work force in Mexico, most of them are from low-income families and with little education. Should they become pregnant, women may expose their fetus to dangerous substances, thus affecting its development *in utero*. This exposure can manifest itself in different ways, such as birth defects or chronic health problems.

2) *Behavioural characteristics and physical activities*: A child's behaviour and interaction with their environment may have a great effect on the magnitude of their

exposure to contaminants (Charnley and Putzrah 2001) and depending on the activities a child is engaged, the location of the activity and the activity level (Cohen Hubal 2000). In their first year of life, a child spends endless hours close the ground, where it can come in contact with soil, dust, chemicals, carpets and low-lying pesticide vapours. Behaviour during this time is very important. A child's early development includes a lot of hand-to-mouth behaviour and playing outdoors which often includes vigorous play, providing additional pathways for exposure to dangerous substances such as lead in paint dust or chips and to pesticide residues (CEHN 2001). Because children breath more air in proportion to their bodies and because their respiratory system is still developing they are very vulnerable to air-borne contaminants such as environmental tobacco smoke.

Interviews with health and environmental experts in the City of Juarez revealed that high prevalence of diarrheal disease in children in the study site was highly associated with behavioural practices. Although most were related to the primary caretaker of children, children's own behaviour was also important. For example, the simple act of washing their hands after the use of the lavatory or prior to eating was considered an important measure to reducing potential pathways for diarrheal-causing pathogens in children. If the family depends on outdoor facilities, children are less likely to wash their hands when they are cold or in a hurry, in order to return to their activity or to a warm shelter. Children will simply wipe their hands on their clothing and be on their way. Behavioural habits associated with adults will be discussed in more depth in chapter four.

3) *Diet and eating habits*: Their diet is equally crucial and also very different from that of an adult. One of the principle routes of exposure to potential environmental risk

for children is through their diet (Goldman 1995). An infants diet primarily consist of breast milk or formula, both of which can expose infants to significant environmental contamination (Chance and Harmsen 1998). Children eat more fruits and vegetables and drink more liquids in proportion to their body weight hence their potential exposure to toxic substances such as lead, pesticides, and nitrates is increased (Goldman 1995). In addition, there could be tremendous variability in the foods children will eat and how they will eat. Children will go through phases where they will only eat a certain type of food, will prefer to eat the food with their hands, or will eat foods that have fallen off the ground (Cohen Hubal et a. 2000).

According to interviews with health and environmental experts in the City of Juarez, eating habits also heavily influence a child's risk of diarrheal disease in the study site. In neighbourhoods lacking access to water and electricity, such as the neighbourhood of Anapra, homes often lack a cooling unit, such as a refrigerator, thus increasing the potential for food to decompose before consumption. Food must be consumed quickly to avoid disease or food poisoning. Also, these homes may also lack direct access to water, therefore water may be collected once a day depending on how far one must travel to obtain it, and then stored and used throughout the day according to necessity. If the water is not stored properly in a clean container, the water may become contaminated. This water may then be used to wash food for consumption thus posing a risk to consumers, such as children. Water used for consumption may also pose a health risk if it does not receive proper treatment, such as boiling. These behavioural practices associated with a child's diet are mostly associated with a caretakers activities and perceptions, which will be discussed further in chapter four.

4) *Gender roles*: According to Cohen Hubal et al. (2000), the sex of a child will play an important part in determining their activities, frequency of play and activity level. Boys are more likely to play outside and engage in vigorous activities, although these differences are more noticeable in older children. There is a lack of information on how sex would influence risk of exposure of infants and toddlers (Cohen et al. 2000).

Discussions with health experts in the City of Juarez did not reveal any increased risk associated with one sex as opposed to another with regards to mortality or morbidity from diarrheal disease.

5) *Social-economic status*: Children's exposure to environmental contaminants can be influenced by the family's social and economic status. All children are adversely affected by environmental hazards; pollution and environmental degradation is borderless. Evidence suggests that low-income groups tend to be more exposed to environmental contamination, than the general population. Source of exposure may include inexpensive housing closer to toxic sites, housing type, activity patterns, diet and drinking water supply (Sexton and Adgate 1999). Race has also been shown to influence increased rates of exposure to some environmental hazards. Several studies in the United States highlight increased risk among African-American, Hispanic-American and Native-American children as opposed to Caucasian children. A 1987 study by the United Church of Christ, for example, showed that the racial composition of neighbourhoods was an important influence in the location of hazardous waste facilities.

Often time, all these characteristics will act together, to some degree, to influence a child's risk of contracting a disease. Therefore it is important to consider a holistic perspective supported by the human ecology, discussed at a later point.

## 2.3 Environment

Gay Young (1986) presents one of the first comprehensive English studies on the economic and social development of the City of Juarez. He provides important information on settlement patterns and housing styles, still relevant today. At the time of his studies, Young reported that there were relatively few spontaneous squatter settlements, but many non-invasion poor settlements. The City of Juarez consisted of two very different residential sectors: homes built on private land and those built on public land. Homes built on public land are located west and southwest of the city's nucleus and have very little government planning regulations thus resulting in very many small and oddly shaped properties (Young 1986). Housing in this area was, and still is, defined as self-help housing as opposed to contractor-built housing; homes are smaller in size and it is suggested that the family's income usually decreases with increased distance from the centre (Young 1986). These zones characterized by the lack of pavement, basic services such as water, public spaces such as parks and community facilities such as schools. Unplanned settlement is still mostly limited to the western part of the City, with the new population increasing infringing upon the Sierra de Juarez. While the author credits poverty and the city's inability to accommodate the new migrants as key influences on inadequate living conditions, he does not discuss the consequences on health that this type of housing may bring, nor does he mention how residents of unplanned neighbourhoods obtain their water. Because this research took place during an important growth period in the history of the City of Juarez, it would be beneficial to know how past residents coped with the lack of water, how they obtained water and if they experienced any health challenges associated with water quality and quantity.

Following the evolution of these challenges could potentially benefit current remedial activities.

Charles Schmidt (2000) presents a general overview of environmental challenges occurring along the US-Mexico border in "*Bordering on environmental disaster*". His focus is primarily on the health consequences from the contamination of water, air and soil by pesticides, raw sewage and untreated wastewater. Schmidt recognizes that the bulk of environmental health problems in this area are the result of the region's explosive population growth coupled with the lack of basic services. Schmidt also highlights the importance of water relative to health and issues of quality and quantity, mentioning the City of Juarez as a prime example. Although the author links poor health to adverse environmental conditions along the border, he makes several conclusions, which are misleading. Schmidt cites gastro-intestinal disease from exposure to water-borne viruses and bacteria as the most conspicuous health problem in this area. To justify this statement, he refers to the PAHO publication *Mortality Profiles of the Sister Communities on the United States-Mexico Border 1992-1994*, to highlight gastro-intestinal disease linked to water-contaminated with sewage as the leading cause of infant death in six Mexican states. Upon examination of the original PAHO publication, one could observe that although infectious intestinal diseases was one of the leading causes of mortality in Mexican states, it was significant in five of the states, as opposed to six, and even then their severity varied across the states. The author also considers sewage-contaminated water as the main cause of these infections, yet does not explain how sewage contaminates drinking water, an important consideration for remedial actions. Indeed, sewage contaminated water is not solely responsible for diarrheal diseases; in the

City of Juarez it is not a cause of disease at all. Schmidt does not explore other potential pathways, omitting important behavioural processes considered important in the transmission of water-related gastro-intestinal disease.

Schmidt does, however, highlight the many challenges associated with data quality, collection and disease surveillance along the border region, although seems to focus on Mexican challenges. He distinguishes between American active surveillance, where field workers conduct field work, and Mexican passive surveillance, where data is processed and sent back to state and federal agencies in Mexico City. These descriptions lack sufficient detail to assess their effectiveness. He does, however, explain that Mexican researchers tend to base their diagnosis on clinical symptoms, while their US colleagues rely on laboratory results. This could lead to under-reporting or over-reporting of diseases in a population or in an area.

While Schmidt (2000) highlights important challenges in the border area, his conclusions do not provide sufficient information to make sound conclusions. It should also be noted that Schmidt provides an American perspective to border health and environmental challenges, with little reference to Mexican sources or activities, which are aimed at remedying the many problems he discusses. He does give general insight using secondary data to the various problems and challenges faced by residents on both sides of the border.

In "*Life along the Rio Grande defined by lack of water*" (2000), Kevin Sullivan describes the severity of water shortages along the Texas-Chihuahua border. Access to a clean, cheap and sufficient water supply is the leading topic of discussion and conflict in this area. Sullivan predicts that this battle will only get worse, especially since water in

the Hueco Bolson aquifer is limited. Although the author estimates that the aquifer could be exhausted within 25 years, he does not discuss or compare consumption patterns. The author discusses how many environmental problems such as air and water pollution are in fact borderless, requiring joint effort by both countries to solve many problems. If cooperation is not achieved political confrontation could arise, threatening diplomatic relations. One should question, if political tension where to result in legal battles between both countries, who would have the political and economic advantage? There are many issues of dependence and inequalities surrounding the topic of environmental pollution, resource scarcity and health in the border, and although the authors hint at the political nature of water scarcity problem, he limits his discussion to comparing the consequences of water scarcity between American and Mexican farmers.

David Hurlbut (2001) also discusses water shortages in the border area in "*The good, the bad and the arid*". He provides a detailed account of the two agreements that govern the Grande River, or Rio Bravo as it is known in Mexico. Both the City of Juarez and El Paso face the bulk of the river; two treaties govern water distribution: the 1906 Treaty and the 1944 Treaty. The author discusses in detail the benefits and drawbacks of each treaty and the resulting consequences. Perhaps the most important point the author makes is that neither of these treaties regulates the water supply of the Hueco Bolson aquifer. The 1906 "Convention for the Equitable Distribution of the Waters of the Rio Grande at El Paso and Ciudad Juarez" grants Mexico a certain amount of water a year, and the rest belongs to Texas; the aquifer, the main source of water for both cities, is not mentioned. According to the author, El Paso extracts less water than the Mexican side, a figure easily debatable in Mexico. Dr. Suarez y Toriello, co-editor of the R*eporte del*

*Estado Ambiental y de Los Recursos Naturales en la Frontera Norte de Mexico* (Environment and Natural Resource Report for the Northern Mexican Border) (2000), believes that the American site extracts more water than the Mexican site. Obviously this topic requires more research. Hurlbut also discusses the recharge of the aquifer by the Rio Grande, although he does not mention more controversial methods such as extracting water from the River Grande before it reaches the Texas-Chihuahua border and injecting that water into the aquifer. Mexicans are accusing the Americans of this tactic. It is believed that Americans are injecting this water into their side of the aquifer. Other authors, such as Cech and Essman (1992), believe that the Americans are injecting treated wastewater back into the aquifer. In his conclusion, Hurlbut (2001) provides important suggestions to be considered by both countries.

Prior to Hurlbut (2001), J.C. Day (1978, 1975) discussed water management of both the Hueco Bolson aquifer. In his discussions of urban water management of an international river, the case of El Paso-Juarez, Day reviews the systems of institutions and laws that govern urban water distribution between both countries. He also discusses how water needs were considered in dividing the flow of the Rio Grande between Mexico and the U.S., and how allocating surface waters affects competing users among each nation. Although it is dated information, Day also compares water uses, sources, and pricing. He notes that in the 1960s, municipal water consumption was approximately four times higher in El Paso than in Juarez, and in the 1970s, it was three times higher. Higher water use in El Paso at the time was attributed to the higher number of areas with laws, gardens and parks in El Paso as opposed to Juarez. Also at the time Juarez had many fewer pools and evaporative coolers. Day mentions that despite increasing

population growth in Juarez, water per capita consumption remained low because the city could not provide or deliver water for a large part of the city. An enlarged transmission network was designed to serve 400,000 people but had not been extended to dwellings in the rugged terrain of the Sierra de Juarez, where migrants were beginning to establish. By revisiting older data on the City of Juarez, we can deduct that current water distribution problems have a long history, dating at least 27 years, and it continues to affect the same area: the western part of the city.

In his concluding remarks, Day states that the characteristics of the international aquifer between El Paso and Juarez had not yet deterred development. He encourages a coordinated groundwater management system to create and enforce a mutually acceptable set of developmental standards and policies to permit maximum aquifer productivity and extractions. Unfortunately, a management system of the aquifer has yet to occur. I suggest that this has not occurred because of the potential political, legal and financial complexities of establishing guidelines for extractions of the shared aquifer. In addition, it would involve the distribution of the Rio Grande, which could further complicate the division process. Day also makes several valuable predictions, which have been realized. He warned that continued population growth would place added pressure to an already delicate water supply from the Hueco Bolson (Day 1978). Day (1978) concluded that prior ecologically and economically unsound water management practices would be a major source of strife in the future. He also warned that long-term expansion would make water more expensive, scarce, and possibly decrease the quality (Day 1978). Although this article is dated, it allows readers to revisit the origin of certain water distribution and consumption challenges, which have given way to current issues.

**2.4 Behaviour**

In *"Maternal and child mortality along the US-Mexico border"*, Chan and Portnoy (1986) examine mortality rates for residents from six border regions on the US side under the age of 25, and compare them with Mexican regions. Their research arose from the concern among health professionals over the differences in health among residents between the Mexico-US border regions. Their research found that on the U.S. side of the border, the improvements in the general mortality status of maternal and child health from 1970 to 1980, was equal to or better than that of the entire country. On the Mexican side, the authors found that maternal and child mortality where lower in the border region than in Mexico on whole, although they remained much higher than those in the United States. The 1-4 year old in Mexico had the highest mortality rates amount the three age groups over the age of one. The authors found that the border region has unique health problems, requiring different approaches in coping with specific problems, although they do not provide any suggestions. Chan and Portnoy warned that should the immigration to the northern Mexican border continue as it has, maternal and child health programs will need to be strengthened. They also comment on the research challenges associated with the limited availability and comparability of data broken down by state and county. The comparison between each country's data was hampered at the time by the absence of a uniform reporting system and the fragmentation of information. The complaints regarding data challenges are relevant for current studies, as is the warning of potential consequences of high population growth.

In their article *Environmental health and hazardous waste issues related to the US-Mexico Border*, Carter et al. (1996) also discuss data quality problems hampering

environmental and health research, by highlighting the lack of baseline data, especially environmental health data. An increase in trade and residents in the US-Mexico border region has resulted in a growing concern for environmental health and hazardous waste problems in the two countries. Although problems of environmental quality in general are not new in the U.S-Mexico border region, preventive and remedial activities are inadequate and uneven. According to the authors, this is the result of several factors: a mutual distrust between both countries, societal indifference to environmental concerns, focus on economic development and lack of environmental health data. Carter et al. discuss in depth the problems associated with data quality, providing insight into the challenges that lay ahead for both countries. Accurate and thorough environmental health and environmental quality data are conspicuously absent. The border region does not have an inventory for data, and existing studies are not epidemiological studies published in peer-reviewed publications. The authors discuss the consequences of the lack of trustworthy data. Revelations like these are very important for researchers attempting to acquire data on the subject of health along the border. Researchers are warned of this problem, and can seek alternative routes or reduce their dependency on quantitative data. One of the most important challenges is perhaps the difficulty in linking illness to hazardous chemicals because of the lack of baseline data. The authors claim that the majority of the data and registry problems exist in Mexico because the country's health statistics do not distinguish the border states from the rest of Mexico. Mexico does, in fact, provide information at a state-level and does distinguish between border states. This research has found that health information in Mexico is not always available at a smaller scale, for example, at a city or municipality-level. Therefore,

information is available for the entire state of Chihuahua, but not readily available for the City of Juarez, for example. Obtaining this information requires qualitative inquiry because quantitative data is not yet available. Also, this article demonstrates how important it is to rely on information from the country or area of study, rather than on information from foreign sources.

The authors rightfully conclude that to identify environmental health problems in the border region, the baseline incidence of disease must be determined. This must begin with health registries on both sides of the border. The authors also encourage more study on the effect of chemical toxicity on health. This is very relevant in the City of Juarez, where microbiological contamination of water is studied but not the health effects of chemical contamination of water. Overall, the authors state that more research is needed, and this can only be accomplished with the establishment of a strong health and environmental surveillance program.

In their article, *Transboundary water resources and public health in the US-Mexico border region*, Varady and Mack (1995) research the effects of water quality, quantity and sewage on public health of border residents from the twin sister cities of Nogales, Arizona (US) and Nogales, Sonora (Mexico), as well as tackle the data quality issue. This project applied a multi-disciplinary approach by involving experts from several fields, including health and epidemiology and recognizes the importance of maintaining human and ecosystem health in the border region. With regard to health, the authors affirm that there "can probably be no improvement in general health unless the more basic problems of the environment, sanitation and safe drinking water are resolved" (Varady and Mack 1995: 9). The authors make the important connection between

sanitation and disease throughout the paper with examples concerning a decreasing water supply, the effects of neighbourhoods lacking water and sewage systems and increasing water contamination issues. Varady and Mack argue for new opportunities to improve and sustain human and ecosystem health in the region. They also argue that incomplete scientific data, few studies on water related health problems and problems with data accuracy should be considered catalysts for future research of the nature and magnitude of water-related health problems along the border.

During the "US-Mexico Border Science, Technology and Policy Issues Workshop on Water and Health", organized by the Mexico-USA Foundation for Science (FUMEC) in Tijuana in 1997, discussions focused around the incomplete development and use of water resources and their effects on public health along the border region. The resulting publication, by the same title as the workshop, revealed that it was difficult to estimate the benefits from improvements in water and sanitation in terms of costs, because so little information and hard data exists on the prevalence and incidence of diseases associated with water in Mexico (FUMEC 1997). The authors discuss the challenges facing water quality as an issue of access, another common theme among public health specialists, and the unfortunate result of a mixture of poverty and geography. Closely associated with access to water, are issues surrounding sanitation and disposal of waste.

Like previous publications, this document highlights once again the problems with data quality, an important theme throughout this research. What is most important is that this meeting and resulting publication was organized and written by the Mexican counterpart of this organization, therefore Mexican environmental and health specialists

are openly admitting to data quality problems. This will hopefully push the federal government to take a closer look at the problem.

## 2.5 Conclusions

This chapter has brought together a collection of the main sources and studies to better understand the current health and environmental situation and challenges faced by residents in the Mexico-US border area, including in the City of Juarez. Through this literature review the severity of the health and environmental problems within the Mexico-US border region is revealed. Most sources discussed the relationship between poverty and increased susceptibility to health problems, however, few expand on the behavioural or cultural activities related to poverty or other social characteristics, which would affect the quality of children's health and increase the possibility of illness or death. Instead many sources focused on water pollution as the main cause of disease, especially in children. There is also a definite gap in the literature on children's health and diarrheal disease, particularly on Mexican children living on the Mexico-US border. The Mexican-US border is an area where intense economic development and population growth are negatively affecting the natural environment. This is an area where children are especially at an increased risk for environmentally related health problems. As a result, there is a need for increased research on children's health by both Mexican and foreign health and environmental specialists.

It should be noted that literature from American sources is more readily available than from Mexican sources. Also, Mexican literature is usually in Spanish, a major disadvantage to non-Spanish speaking researchers. Access to Mexican sources is difficult and accessing documents can be lengthy, especially since there remains a

shortage of in-depth information on health issues in Mexico available outside of the country. Overall, these sources offered crucial insights into a complex series of problems associated with environmental health and doing research along the Mexico-US border.

# CHAPTER THREE

# METHODOLOGIES

## 3.1 Theoretical Framework

This section will define and assess the theoretical framework employed for this study. The theoretical framework is composed of principles from medical geography and the ecological or holistic approach.

### 3.1.1 Medical Geography

There are many ways to explain why health or disease differs from place to place. According to Akhtar and Hunter (1991) "the scope of geographic contributions to health and disease is immense" (Akhtar and Hunter 1991: 14). The geographic distribution of disease and ill health has long been studied under different disciplinary rubrics such as geographic pathology, geographical epidemiology, and geomedicine (Meade and Earickson 2000).

Foster (1992) describes the essential relationship between geography and disease,

> *Since biological characteristics, environment, lifestyles and the nature of medical treatment vary from place to place, it follows that so, too must the probability of developing, or dying from ,a particular disease. Indeed, the incidence of disease, or the likelihood of a particular cause of death, varies geographically, at scales from international to local.*
>
> (Foster 1992: 10)

According to Pyle (1979), the relationship between the study of health and geography is implicit,

> *The study of spatial aspects of disease as well a health care are logical extensions of trends in geographical analysis that have developed during this century. Health problems require the use of spatial research techniques to assist in understanding and in some instances explanations.*
>
> (Pyle 1979: 10)

The relationship between geography and disease patterns has a long history, although medical geography as a sub-discipline within the discipline of geography is relatively new (Meade and Earickson 2000). An in-depth, historical account of the evolution of medical geography as a sub-discipline and geography as a discipline, and their respective epistemologies, is beyond the scope of this paper; the challenge is to accurately define the term and key influence, and relate its importance to this research[6].

McGlashan (1972) broadly describes the sub-discipline of medical geography as the effect local variations of environmental conditions have on human health or ill-health. Furthermore, he states that in the West, medical geography is a research tool used to reduce humankind's load of suffering from disease and ill-health (McGlashan 1972). Pyle (1979), a leader in medical geography, defines the discipline as a multi-dimensional body of knowledge, as well as a multifaceted approach geared toward understanding spatial aspects of human health challenges. According Armstrong (1983), geography is the study of place and medical geography is the study of health and medical characteristics of place. Therefore, the objective of medical geography is to study and understand the geographical differences in conditions of health and illness, and how these differences are influenced by geographical similarities and differences between places.

[6] For future reading on the conceptualization of medical geography please refer to Barrett (1986).

(Armstrong 1983). Barrett (1986) states that medical geographers do not directly study health, but rather the lack of health, the consequence of disease and the attempts to create a health care system to restore lost health. Barrett (1986) also asserts based on evidence from his own literature reviews, that a high percentage of medical geographers study facilities rather than people. Meade and Earickson (2000) summarize medical geography as the application of a holistic approach, uses concepts and techniques of the discipline of geography to study health–related topics[7].

Medical geography is not without challenges. While geographers have the potential to contribute to the reduction of human suffering and increase lifespan, their reliance on causal links between a specific disease and the environment can be problematic (Foster 1992). This can be attributed to what Thomas (1990) terms as a one-sided partnership, where historically medical geographers "have managed to gain a secure research interest only when a disease at the forefront of epidemiological investigation has had a strong environmental component postulated for its aetiology" (Thomas 1990: 1). Thomas (1990) also argues that the partnership between geography and health has not always been productive, and that geographers have on occasion made few contributions to the understanding of disease causation. Despite these potential challenges, the principles of medical geography are an essential component of this research.

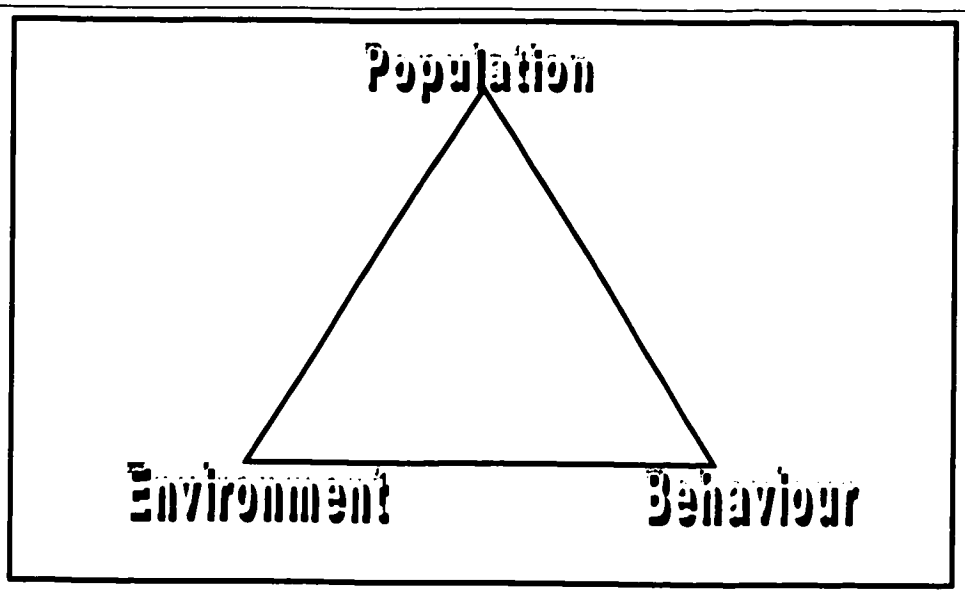
This study considers several concepts and theories from medical geography. First, this study considers infectious diseases, which is a major sub-field of medical geography (Akhtar and Hunter 1991). The subject of this study, diarrheal disease in

[7] For further reading on the differences and similarities between medical geography and epidemiology, please refer to Akhtar and Hunter (1991)

children from the City of Juarez, was chosen because of differences in the occurrence of diarrheal disease between two places separated by a political boundary. Diarrheal disease was a substantial health burden in the City of Juarez but not in El Paso, its sister city. Therefore this study is based on geographic variations in conditions of health between places. In addition, it was hypothesized that the water source of the City of Juarez, the Hueco Bolson aquifer, was an important contributor to the high levels of diarrheal disease in this area. The Hueco Bolson is shared with El Paso therefore both cities share the same water source; this fact encouraged the use of medical geography in this study.

Geography is an important tool used to study health in different places as well the influence of the natural and built environment and environmental contamination on health and behaviour. Figure 3.1 shows the Triangle of Human Ecology as explained by Meade and Earickson (2000). Introduced in chapter one, the triangle of human ecology is composed of three facets: habitat, population and behaviour that enclose the state of human health.

**Figure 3.1: Triangle of Human Ecology**



### 3.1.2 Ecological Analysis

An ecological study examines the association between the occurrences of disease and exposure to known or suspected causes (Coggon et al. 1997). Its unit of analysis is a group or a population, rather than an individual, common in more clinical studies. "Typically, the group is in a geographically defined area, such as a state, county or census tract" (Morgenstern 1982: 1336). One of the many benefits of an ecological study is that often information about the target population or unit of analysis, disease and exposure can be retrieved from published data, therefore decreasing expensive and time consuming research related activities, such as surveys (Morgenstern 1982). While ecological studies can achieve certain objectives not met with non-ecological studies, it does have its limitations. For example, a major requirement of ecological studies is that all relevant health information or events are accurately and completely recorded. This may vary according to the health events in question, whether mortality or morbidity related (Walter 1992). In addition, data from many variables, such as medical history or health perspectives are not easily available at a group level (Morgenstern 1982). Meade and Earickson (2000) also refer to the ecological fallacy, which is associated when measuring accuracy at different scales. For example, group-level studies cannot be applied to individuals, nor can individual responses in an interview summarize national opinions (Meade and Earickson 2000). While there remain other challenges when using an ecological analysis, of importance to this study is the ecological fallacy. Solutions based on ecological analysis can be based on generalizations and may not work for everybody.

An ecological analysis is useful for health studies. Within this context, ecological studies have two major objectives: to generate or test the occurrence of disease and to

evaluate the effectiveness of a population's response and intervention methods (Morgenstern 1982). While an ecological study can have many designs, the general purpose is to observe the association between average exposure level (x) and the disease rate (y) among several groups.

This study employs several principles of an ecological study. First, it studies a group, in this case children under the age of five, rather than individuals. This study also recognizes, as suggested by Walter (1992), that the quality of data many not be accurate. In the case of this study, I believe that underreporting of diarrheal disease and poor recording methods could be responsible for devaluing the importance of diarrheal disease as a cause of mortality and morbidity in Mexico. This could be problematic when assessing the severity of this disease, which could decrease remedial actions. Overall, the ideologies of an ecological analysis are appropriate for this study because it considers the health of a group in a particular geographic area, while considering a small budget and a short time period for research.

### 3.2.3 Ecology of Disease: A Holistic Approach

According to Meade and Earickson (2000), the human ecology of disease considers the way "human behaviour, in its cultural and socio-economic, interacts with environmental conditions to produce or prevent disease among susceptible people" (Meade and Earickson 2000: 21). This study in particular, considers the triangle of human ecology to explain the interactions between different elements, which influence the health and the occurrence of disease. In this context, a holistic approach considers the characteristics and influences of the population, behaviour and the habitat on the

occurrence of health and suggests that these characteristics are linked, and influenced by proximity, temporal and intergenerational effects (Rose 1992).

In regards to human health, it is generally accepted and understood that "the concept of microbes as the cause of an infection is inadequate and incomplete because it ignores the influence of the host, the milieu and the social and physical environment" (Wilson 1995: 1682). Spencer (1999) acknowledges the deceptive deductions generated by the pursuit of a linear cause of disease and the simplification of the complexities, which are responsible for human health and sickness. As he explains, causal agents such as bacteria or smoking both, which exert a direct pathological effect on human health, are themselves influenced by other factors.

Grzywacs and Fugua (2000) define the holistic perspective as an interdependent, multidimensional, multilevel perspective or point of view, useful for analyzing the etiology of individual or community health. A key factor of the ecological model is a joint, equal focus on both the subject and the environment, although the concept of environment is changing rapidly and its definition is at times ambiguous (Grzywacs and Fugua 2000). With the ecological perspective we acknowledge and understand the interrelatedness of the physical and social environment, and describe how change in one part of the system can bring about changes in other parts. Locker (1997) considers the socio-environmental approach, which identifies the social and physical environments as powerful influences on health; any risk to these environments can pose a threat to health directly. "The quality of health depends on the improvement of these environments through political action" (Locker 1997:19). These influences are described by May

(1958) as stimuli, which vary according to every cultural and geographic environment. Three types of stimuli exist: organic, inorganic and socio-cultural.

Given its holistic quality, an ecological model or study is usually very complex, a possible limitation to both theory and practice (Mitchell 1997, Kay and Schneider 1994). In a study of health, it is impossible to consider all influences on the state of health of an individual or a community. Grzywach and Fugua (2000) suggest that focusing on the factors that wield a disproportionate amount of influence on health, and labeling them leverage points simplify such models. Grzywach and Fugua suggest four factors: socio-economic status and health; family and health; employment and health, and school and health.

In *Health of Children*, Spencer (1999) discusses the influence of micro and macro-environmental influences on health of children, stating, "a child's health is determined by a complex interplay of factors" (Spencer 1999: 75). Spencer refutes the notion that macro and micro-environmental influences are separate from one another and applies ecological terms to explain these terms. Micro-environmental influences consist of the immediate environment of the child, influenced mostly by the parent's own state of health and mind. Macro-environmental influences are concerned with the "structural and material influences, which are mainly centred outside the child's immediate environment and are without parental control" (Spencer 1999: 75). This study recognizes that there are many leverage points important to the integrity of this study such as poverty levels and socio-cultural beliefs and perceptions.

This study encourages holism in the study of health and in remedial actions by examining causes within their contexts to better understand their roles as deterrents to

health. This promotes preventive health care rather than simply curative remedies; remedies that stop problems at the source are essential to an efficient and cost-effective health system, which is trivial in developing countries.

### 3.2 Methods

The rest of this chapter will explore the methods used to conduct this research. This section will examine the secondary collection and the proposal based on this information. It should be noted that the goals and methods of this research changed upon arrival to Mexico. This important fact will be discussed here. It will also discuss the field work, the collection of primary data and examine the participation of health and environmental experts in the City of Juarez. Additional methods for this research include data analysis, the creation of maps and statistical analysis. This chapter will end with a discussions on the challenges encountered during this research.

#### 3.2.1 Secondary Data

Secondary data collection involved the compilation and assessment of information related to the subject of infant and child health in the Mexico-US border region, as well as information on environmental and geographic characteristics of this region, migration and settlement patterns, health attitudes, hygiene behaviours and economic development. This process began in September 2000, and continued throughout the research and writing process of this thesis. The study site, health outcome and study population were chosen based on the Pan American Health Organization's 1995-1997 *Mortality Profiles of the Sister Communities on the United States – Mexico Border* (PAHO 2000). Furthermore, discussion with representatives of the National Institute of Public Health (INSP) and the Mexico-US Foundation for Science (FUMEC)

in Mexico also educated the author on intestinal diseases as an important cause of both morbidity and mortality in children under the age of 5 in Mexico as a whole as well as in the border region. Statistics from the INSP and the National Institute of Statistics and Information[8] (INEGI) on causes of mortality and morbidity in Mexico supported this information. Based on this information, morbidity and mortality from intestinal infectious diseases in children under the age of five was chosen as the health outcome to be studied for this research. The City of Juarez was identified as an environmental and health sensitive area based on both health patterns and concerns featured in the PAHO mortality profile (2000) maps, in addition to secondary data on water quality and quantity problems specific to this area as well as geographic characteristics, considered possible influences on the state of health of children.

Secondary sources included journal, books, Internet sources, conference papers, and maps from both Mexican and American authors, although American authors were more readily available resulting in a lack of Mexican-based information. Sources were both in Spanish and in English. Throughout the secondary data collection, important associations were discovered and contacted. These were able to provide more information and literature necessary for this research, although this occurred while visiting the study area.

### 3.2.2 Original Study

This research is not the result of the original study plan, which changed upon my arrival to Mexico. The original plan of study was also based on the PAHO (2000) literature and focused on four different Mexican Sister Communities along the border:

[8] INEGI "provides the geographic, demographic and economic information of Mexico. It also coordinated the Informatic Development Program and provides the public service of statistical and geographic information" (http://www.inegi.gob.mx/difusion/ingles/portadai.html 2002)

Tijuana and Mexicali in the state of Baja California, and Nogales and Aguas Prietas in the neighbouring states of Sonora. Like the City of Juarez, these cities were also plagued with high rates of intestinal infectious in infants resulting in death, compared to their American Sister Communities. The study population was to be children under the age of one, and the health outcome was diarrheal disease. The original methods included interviewing the primary caretaker of approximately 50 children living in lower socio-economic areas, to be defined upon arrival to the study site and upon discussion with key environmental and health experts from the area. Interview questions focused upon behavioural practices and perceptions on health, disease, and the environment. The goal of these questions was to understand if behavioural practices were increasing the risk of diarrheal disease in infants. I was also going to identify and interview key environmental and health experts in each study site. Interviews would consider geographical characteristics of study site, environmental challenges, health priorities, water quality issues etc. The goal of these interviews was to include expert information to understanding the high levels of infant mortality from diarrheal disease in each study site. Ethics approval had been granted.

Upon arrival to the National Public Institute of Health in Mexico new information on border health, increasing costs of living in Mexico, security concerns and issues of positionality challenged my original study plan. First, traveling and living in the Mexican border area had become increasingly expensive. A travel budget had been set and it was believed that funds would be sufficient. Upon arrival to Mexico, I discovered that the accommodation arrangements I had made were inexpensive but not safe. I had made arrangements to stay at inexpensive motels in each site during my field work. I

was informed by other researchers at the National Institute of Public Health, that as a foreigner, these border cities would be very dangerous and that the location of my accommodations were in very unsafe areas, and far from the downtown area, hence the low price. If I wanted safe and central accommodations I would have to more than double the price I had anticipated. I knew prior to the research that conducting research in the border area would merit caution and I believed that I had taken the correct precautionary measures: traveling only during the day, traveling by monitored taxi as much as possible, returning to my accommodations early etc. In addition, I had never considered myself a foreigner in Mexico.

Despite my Mexican nationality, Latin American appearance (dark hair, dark eyes and dark skin) and my fluency in Spanish, I was still considered an outsider, a foreigner, because I did not live in Mexico. Also, I am not fluent in Mexican slang, an important asset to have to be considered truly "Mexican". I was also warned that being a young, foreign female was an additional risk, because it made me a weak and easy target for thieves. Based on these revelations I was forced to reconsider my position in this country. Although I believed that my Mexican background would facilitate my research process, it in fact challenged it, creating issues of exclusion I had never expected. Prior to my research trip I had never felt like an "other" in a country I consider my own. I never believed that this was a cross-cultural study, because I am Mexican; I believed myself to be an "insider". As a result I believed that my research and my investigating abilities would be void of any sentiments that "real" foreign researchers might feel, such as these feelings of exclusion. But in Mexico, there are elements of my identity that are in fact those of an outsider. This influenced the outcome of my research.

Upon reassessment, I calculated that financially, I should travel to one, possibly two study sites, and stay longer, rather than choosing more than one city and staying for a very short time. After much investigation I decided to focus on one study area, the City of Juarez, an area I truly believe is worthy of research, for the reasons mentioned in previous chapters. I also decided to focus on the key environmental and health informants and decided against interviewing the caretakers of children primarily because this was no longer a comparative study of Mexican cities. I decided to expand the age of my study group to children under the age of five, because this age group is most vulnerable to diarrheal diseases.

Once at the border, I had originally planned to cross the border into the United States, where I had made some important contacts with health and environmental authorities who agreed to meet with me for interviews. This portion of the original plan had remained unaltered despite the changes. However, during the month of September 2001, terrorist attacks occurred in the United States. As a result, the crossing areas between Mexico and the United States was shut down or severely restricted. When I arrived to the City of Juarez, a restriction was placed on crossing hours, and crossing the international border by foot, my method of travel, would take between two to three hours. Crossing by automobile could take as long as six hours. Prior to September 2001, crossing the border by food would take approximately 30 minutes. Therefore I decided to forgo the opportunity to travel to El Paso, and rely on secondary information.

Therefore, this current research is in actuality, a variation from another plan of study. Despite the changes, I believe that the purpose of the studies is similar, and that

the modified study is equally as important. I believe that it will make important contributions to the subject of children's health along the Mexico-US border region.

### 3.2.3 Proposal Creation

Due to the involvement of human participants, the proposal required approval by the Research Ethics Board. Of importance to this component were the issues of confidentiality and risk. To protect the identity of the participant, the participant had to be assured that all material displaying their name, information and interview would be safe and protected at all times and would only be viewed and handled by the principle investigator and the thesis advisor. Participants also had to authorize the use of both their name and the company or institution that they represent. Without this consent, the principle investigator agreed not to identify them. Questions were aimed at a variety of different participants with diverse backgrounds on the subject of environment, public health and water in the study area. Questions could not be intrusive or politically biased in nature. Although most sought the general knowledge of the participants, some questions did require an opinion. An interview guide featuring key points and questions was created for the purpose of directing an interview limited in time (please refer to Appendix C). All forms were created in English first and translated into Spanish, requiring formal interpretation. Barbara Cifuentes Garcia (MA) from the National Autonomous University of Mexico, Faculty of Linguistics, supervised this interpretation.

### 3.2.4 Exploratory Assessment

Exploratory interviews with key stakeholders were conducted in the study area, the City of Juarez. Participants included environmental and health specialists, medical doctors, academics specializing in hydrology and engineering from the Autonomous

University of Ciudad Juarez, geographers and cartographers (please refer to Appendix B). Participants were from both government and non-governmental agencies in Mexico. All interviews were conducted in Spanish and in the City of Juarez.

Contact with participants was established while still in Canada and continued throughout the field study. Most participants were found using journal articles, Internet sources and professional environmental, health and government directories. Word of mouth also helped identify potential contacts. Participants were contacted via electronic mail first, and then via a phone call. It was often necessary to make repeated phone calls because in several instances contact information was not updated or correct. Appointments were set up with participants who agreed to be interviewed. It should be noted that all participants contacted were very eager to partake in this study, many volunteered contact information on other potential participants and eased the process of making an appointment with new participants. Interviews were conducted according to the outlined procedures found in the consent forms, although on occasion the topic of conversation was allowed to stray from the original questions and outline, if the subject was considered to be in the best interest of the research and would not compromise the confidentiality clause or involve any risk. Thus the interview format had to be flexible enough to allow for any unforeseen changes and to include topics of discussion previously not considered. The objective was to let the participants outline their health, water and environmental concerns as well as voice their opinion on relevant subjects. Upon completion of the interview, all participants were asked whether continued contact via electronic mail was possible, should a question arise.

All interviews were tape recorded with permission of the participant. The duration of the interview depended on the availability of the participant. The tapes were transcribed in Canada.

During my travels to the City of Juarez, I took all the precautions necessary to ensure a safe trip. I was fortunate to be accompanied by another researcher from the National Institute of Health who is Mexican. We coordinated our field work in order to travel together for safety measures. Also, while in the City of Juarez many participants kindly offered their personal chauffeur service to take me to my next appointment.

### 3.2.5 Data Analysis

A comparison and analysis of secondary and primary data will be included in this study. The data analysis will examine quantitative and qualitative data. Issues of development and inequalities will be included in this discussion in order to help explain the results. This process will also examine and compare health statistics from several important sources including the Pan American Health Organization, the health department in Ciudad Juarez, and INEGI. Health statistics from the City of Juarez were obtained from the Health Department and from the Autonomous University of the City of Juarez. The INSP and INEGI in Mexico City provided health statistics used to compare with those from the health department in Juarez.

### 3.2.6 Maps and Statistics

Maps for chapter one were constructed using a geographic information system (GIS) software called ArcView. Data for the construction of these maps was obtained from Dr. Alfredo Granados Olivas, coordinator of the Geographic Information Centre at the Autonomous University of the City of Juarez. Dr. Granados Olivas provided the most

up-to-date maps available. Maps were constructed based on the characteristics to be features, such as population growth.

Statistical data was gathered from a variety of sources including the Autonomous University of Ciudad Juarez, the National Institute of Public Health (INSP), FEMAP in Ciudad Juarez, JMAS and INEGI. Health statistics compiled at the INSP are based on information collected by the INEGI and is based on the International Classification of Disease ($9^{th}$ Revision). This INSP is currently converting to the International Classification of Disease ($10^{th}$ Revision), causing issues of compatibility among different sources. All maps and statistics published prior to 1998 needed to be compared and standardized with those published after 1998. Causes of mortality were compiled for the years 1995 through to 1999, and when possible 2000. Queries within health statistics on a variety of computer programs from the INSP were performed to isolate three principle factors for this study: the study site, the City of Juarez, all children under the age of 5 established as the target population and finally all cases of mortality and morbidity from infectious intestinal diseases.

### 3.2.7 Conclusions on Research in the City of Juarez

Although the literature proved to be very valuable prior to the fieldwork, the real learning process began as soon as the fieldwork began. Several conclusions were formed prior to my arrival to the study area, which were based on the secondary data collected prior to the fieldwork. I had understood, as mentioned earlier, that water pollution was the principle culprit in the high levels of child mortality and morbidity rates from diarrheal disease in the City of Juarez. As a result, this may have affected the direction of my data research prior to the field work; that is to say that I have may placed more

emphasis on environmental links to health than on other potential pathways. It was in fact a combination of factors that contribute to the high rates of this disease. This disclosure greatly affected the direction of the research and as a result I explored social pathologies I had never considered.

There were several challenges encountered during this research. For example, I had never expected to encounter such major problems or gaps with the quality of data I was working with. The quality of data was further complicated by its availability; health data was not always available at a city or local level; it was more often available at a state level. Because of a lack of technology, most notably the absence of computers in one of the Ministry of Health offices, requesting and receiving information was very time consuming. It should be noted that several important institutions, such as the Autonomous University of the City of Juarez and the City Planning Department, were outfitted with the very latest equipment, especially mapping technology and were also very eager to help and provide information. Also, because updating information is a challenge, contact information was often outdated, which required additional time and effort to locate potential participants. Despite these challenges, residents and health and environmental experts were willing to contribute to this research, often recommending contacts, consenting to interviews and providing any written documents.

Almost all participants, especially those not associated with any government organization, complained freely of the surveillance system and data quality. During my interview with the Ministry of Health in the City of Juarez, I made a request for data concerning the addresses of all mortality cases for children under the age of five for mapping purposes. I assured the director of the department that this was strictly for

academic purposes and that the privacy of the families would be respected and protected at all times. The head of the department agreed to send me the information, which ultimately never arrived. It is to be noted that this verbal request was followed by several phone calls and faxes. During the last call, members of the office ended the phone call abruptly once they found out who was calling. This leads me to make two conclusions. First, the information simply does not exist despite affirmation from the department that it did. My second postulation is that, if indeed it does exist, the information is not updated. The ministry may be worried about exposing these or other facts and are as a result not complying with my request. This also proved to be challenging because it is difficult to conduct research or business so far away from the study site. There were as a result added costs, which were never figured into the original budget. Also, when I sent out requests to several international organizations, as well as local contacts made during the fieldwork in the City of Juarez on information regarding the disease surveillance program in the municipality, I never received replies.

These challenges occurred despite a warm reception on behalf of all participants. The participants were very eager to provide us with important information and contacts; in fact their kindness was a welcomed surprise. I expected to encounter some gender bias with the participants, but it was not a concern in this situation. In a traditionally patriarchal country like Mexico discrimination against women is a fact, although it is diminishing. The only concerns I faced as a female researcher were associated with my safety in certain neighbourhoods of the City of Juarez. While originally, I considered visiting the neighbourhoods which were lacking water services and basic infrastructure to see first hand living conditions and possible health risks, in order to gain an important

first hand perspective of the "real" situation in the study are, it was deemed too dangerous for a foreign female to venture into those areas without at least one male travel companion using a secure and large vehicle. Going out to these neighbourhoods would have proved very beneficial to this research but these are areas with high murder rates among young women. This warning was appropriate considering the high levels of crimes against women in the border, but would have been equally necessary for a male researcher. Certain areas are unsafe to strangers.

If participants showed any hesitation, it is believed to be the result of having to answer questions of a foreign student. Having dealt with so much negative publicity from foreign authors and publications, it is no surprise that Mexicans would be hesitant to comply with interviews. This occurred rarely and most participants were eager to participate. All participants were informed of the strictly academic nature of this study and of their right to stop the interview whenever they were uncomfortable with the questionnaire.

One last weakness of the research in the City of Juarez was length of time I was there. The majority of my time was spent in Mexico City doing secondary data collection. I believed that with sufficient secondary data I would be well prepared for my interviews and did not believe my time in the City of Juarez should be more than one week. In actuality, given the shifts in direction my research took once I was in the City of Juarez, due to the new information, an additional week would have been beneficial. Perhaps more investigative work on the disease surveillance subject would have been preformed with more time.

# CHAPTER FOUR

## FINDINGS

### 4.1 Introduction

This chapter will assemble the data necessary to answer the research question established in chapter one: "why is the rate of mortality and morbidity of diarrheal disease in children under the age of 5 greater in the City of Juarez than in El Paso, considering the close proximity of the two sites?" This chapter will include an assessment of primary and secondary sources. For this study, information was retrieved through secondary data and through information from interviews with experts in the fields of environment and health in Mexico. Although the interviews proved to be both informative and insightful, evidence for many conclusions proved to be elusive. Secondary data obtained prior to the field trip to the study site offered an incomplete assessment of the actual health and environmental situation in Juarez; unfortunately I only realized this upon discussion with experts in the City of Juarez. The data analysis, proved to be a dynamic and sometimes difficult process, which required the author to make important decisions about the credibility of the sources of information to be included in this portion of the study, especially when considering the causal web presented in this chapter.

A review of the findings from secondary and primary sources will identify the factors that increase the risk for diarrheal disease in children in the City of Juarez. These factors were identified according to the triangle of ecology discussed in Chapter Two. This chapter will also highlight important deficits in the disease surveillance systems of

Mexico, which ultimately contributed to statistical data problems. This examination will benefit from a discussion on the merits of qualitative research. Finally, discussions on inequalities in health and development will conclude this chapter.

**4.2 Assessment of Primary and Secondary Sources**

Several unforeseen data challenges presented themselves throughout the research process; these will inevitably affect the outcome of this study. One particular concern must be introduced at this point. The quality of data in any research is critical, as is the accountability and reliability of its source. It was discovered during the interviews with several noted health and environmental experts in the City of Juarez, both at the governmental and non-governmental levels that several government agencies believed to be reliable and trustworthy are in fact not. Of importance at this point is the reliability of three government agencies: the Secretary of Health, both at the federal and at the local level; INEGI, the government agency in charge of collecting and providing the geographic and socio-economic information of the country; and the municipal water agency of the City of Juarez (*Junata Municiapl de Agua y Saneamiento* – JMAS). The Secretary of Health and INEGI collaborate together to produce the statistical health information, such as mortality and morbidity rates. Within the City of Juarez, it is the Junta Municipal de Agua y Saneamiento (JMAS), a central agency with offices throughout the country that controls the testing, extraction, distribution and use of water. Their output is considered official and representative of the state of the country.

Many health and environmental authorities in the City of Juarez and in Mexico City have voiced complaints about the quality and flow of available information, especially from these sources. As discussed earlier, an inadequate disease surveillance

program combined with poor access to health care, especially by the underprivileged, means that official numbers do not represent the real health situation. Therefore, the Secretary of Health and INEGI are not as informed as believed to be. A major problem exists with the standardization of information between government agencies and non-government agencies, in addition to data sharing. While many persons interviewed blamed a lack of funding, other believed that the ever-changing personnel that results from changing political parties and political pressure thwart any progress made in improving health data produced in Mexico. Therefore, due to poor disease vigilance it is impossible to really know how many children are dying of gastro-intestinal diseases. It should also be noted that when discussing this phenomenon with the head of the Health Secretary of the City of Juarez, Dr Elisa Aguilar Jimenez, I was assured that when a child dies a representative of the health department goes to the home of the deceased and performs a verbal autopsy[11]: they evaluate the home and potential risks of disease and death, and register the death. She did admit that the secretary of health was lacking both funding and infrastructure and she hoped that by increasing the number of health care centres and units that perhaps the cases of diarrhea as a form of morbidity would decrease. Dr. Aguilar Jimenez pointed out on several occasions that intestinal diseases as a cause of mortality are not a health priority, because of low mortality rates. It is only a concern for morbidity.

[11] "Very little scientifically based information is available on cause-specific mortality rates in developing countries. A verbal autopsy is a method of finding out the cause of death based on an interview with the next of kin or other caregivers. In recent years, verbal autopsies have been used more widely to provide information on the causes of death in areas where civil registration and death certification systems are weak, and where most people die at home without having had contact with the health system" (WHO 1994).

These are all symptoms of a larger problem associated with economics and inequalities. Funding needed for health is either unavailable or directed elsewhere. Non-governmental agencies and academic institutions are weary of information provided by the Ministry of Health and INEGI and prefer to conduct their own information or find alternate sources of information if possible (Suarez y Toriello 2001).

Although valiant efforts are made by the municipal water agency to provide clean water to the residents of Juarez, the city remains under-serviced and environmental specialists are sceptical about water quality reports and its relationship with industry. Interviews with JMAS employees discussed the monitoring and control systems in place, especially regarding industrial use and discharge. The JMAS does its own water quality testing, and monitors discharges from *maquiladoras*, often working together to promote a "clean and green" industry. When asked about problems with bribery of JMAS employees by industry, a phenomenon often reported in environmental publications, Rosamanuelas Salas, an environmental engineer with JMAS, stated that in Juarez it was not a problem, especially since the implementation of a surveillance team with strict procedures to minimize illegal activities (Salas 2001). The subject of the *maquiladora* is an important topic of discussion, because while the JMAS and others such as independent environmental consultant Dr. Franco Barreno maintain that the residents are a bigger source of water usage and pollution than industry, others such as leading health and environmental expert Dr. Suarez y Toriello believe that there is still too much secrecy surrounding industry and industrial related water contamination. Dr. Suarez y Toriello (2001) explains that water pollution is not always the most obvious form of pollution such as air pollution for example. He warns that this is a type of industry that uses a lot

of chemicals during production and that there are many clandestine dumps, despite American laws, which state that American industries have to return any chemical by-products or dangerous residue to the U.S.A. This potential source of water contamination is further aggravated by the lack of testing for chemical contamination of water, therefore chemical related health risks are not necessarily considered (Garza 2001). As for microbiological contamination, most, including JMAS agreed that it is not a severe threat. Records at the JMAS head office, offered to this researcher by the president of the organization, show pristine results, perhaps as a result of intense chlorination efforts on behalf of JMAS.

With regards to water quality of the Hueco Bolson, it is high and is monitored daily by the municipal water agency. Studies show that the possibility or risk of cross-contamination from microbiogical contaminants looms near. Studies at the University of Texas at El Paso have found the *Cryptosporidium* protozoa in wells in El Paso, which also draws its water from the El Hueco Bolson aquifer (Cech and Essman 1992). While *Cryptosporidium* does not currently pose a serious health threat to the City of Juarez, it has been found with frequency in human subjects in the Valley of Juarez due to the use of black water for irrigation purposes. Although biological contamination of the water is monitored, chemical contamination is not (Garza 2001). Dr. Garza, from the Autonomous University of the City of Juarez warns that chemical contamination of water is already a health threat.

Overall, a common struggle within all three important government-reporting agencies is the lack of and perhaps the improper use of funds combined with structural problems, dynamic politics and a stagnant flow of information. Furthermore, a common

problem related to lack of funding with all three agencies, especially with the health department, is the availability of current information: the newest publications are dated from the year 2000 and in some cases high speed technology is lacking and information is still stored manually. As a result, statistical data were at times incomplete or unavailable. Statistical data used for this study may not be representative of the real health situation in the City of Juarez, and numbers from one institution may differ from another's even regarding the same topic and year.

## 4.3 Identifying Misconception about the Influences on Health: Environmental and Behavioural Characteristics Contributing to Increased Risk of Diarrheal Disease in the City of Juarez

The purpose of this process is to gather the information collected through secondary and primary sources in order to highlight, according the triangle of health ecology, environmental and behavioural characteristics, which increase the risk of diarrheal disease in children in the City of Juarez. Characteristics pertaining to the population were considered earlier. We know that children under five are susceptible to diarrheal diseases because their vulnerable physiology and behavioural activities.

This discussion will consider water quality and quantity issues, clarify some important misconceptions about border environment and water sources, examine the role of the *maquiladora* industry as a water user and potential polluter, and discuss soc-cultural behaviours. Finally, this section will discuss remedial actions taken by the government, academic and non-governmental agencies, which are often not revealed

### 4.3.1 The Mexico-US Border: A Heterogeneous Landscape

Many articles have discussed the environmental problems associated with the Mexican-US border, often making reference to the water pollution plaguing this area.

Unfortunately, many articles clump the entire border region as one homogeneous area, without distinguishing each individual state and its diverse cities. It is believed that this occurs mostly due to a lack of information available from Mexico. Therefore upon reading these sources, one would be lead to believe that each city suffers from similar environmental problems. The Environmental Protection Agency (1997) was correct in stating for example, that insufficient potable water and water pollution resulting from inadequate wastewater treatment and infrastructure are the principle water related and public health problems facing this area. In addition, the limited supply of water is insufficient to meet the growing population and wildlife needs (EPA 1997). However, each city or area is different. For example, water problems in Nogales, located in the neighbouring Sonora, differ greatly from those in the City of Juarez (Varady and Mack 1995).

A major conclusion drawn from the secondary data collection was that a common problem associated with the Northern Mexican border was sub-surface water sources, which exist throughout the border, which were severely contaminated mostly as a result of cross-contamination of the aquifer from excessive dumping by industry, especially the maquiladora industry, and lack of sewage treatment. The well water extracted from the aquifer was then thought to contain dangerous levels of microbiological contamination. It was believed that there could be a relationship between the occurrence of diarrheal disease and the contamination of the aquifer. Articles and even a workshop on the subject of water pollution and public health conducted by both Mexican and American partners seemed to validate this conclusion (www.fumec.org.mx 1997, Kelly and Reed 1998, Schmidt 2000, Streiker 2000, Sullivan 2000). Charles Schmidt (2000), for

example, presented one conclusion in his discussion on the negative influence of industry on water quality. He states that the border region industries, especially the maquiladoras and agriculture are placing severe demands on the area's aquifer and are a major polluter in this area. Many authors agreed that the lack of proper sewage and waste disposal and treatment are to blame for the high incidence of water-borne disease (EPA 1997, Sullivan 2000).

During the interviews in the City of Juarez it was discovered that the public health problem related to water is much more complex, and is not in fact directly related to the quality of sub-surface drinking water. In addition, if Mexican water sources where polluted and the main contributor to the high levels of diarrheal disease in children, then any shared water source with neighbouring American cities, such as is the case between the City of Juarez and El Paso with the Hueco Bolson, would present a threat to America residents. Yet in the US, diarrheal disease is not a health risk in children. Therefore, there had to be other reasons responsible for the occurrence of diarrheal disease in the City of Juarez that was not being fully explored.

When during interviews the information provided in secondary sources was discussed, local Mexican experts explained that the lack of available data or flow of data explained the misinterpretation of information or the incomplete nature of these articles. It should be noted once again, that although Mexican specialists would clarify important questions and issues, such as the possible influence of the maquiladora on water consumption and pollution patters, the experts did not always agree with each other. There was, however, uniformity in the opinions as to the cause of mortality and morbidity from gastro-intestinal diseases and their pathogenic pathways.

### 4.3.2 The Roles of Industry

It is generally assumed that *maquiladora* industries are the main source of pollution and consumption of resources along the Mexican border (Schmidt 2000, Simon 1997, Carter et al. 1996). Once again, it is a matter of specifying where along the border these problems exist, and of course different sources will respond differently. According to Patricia Juarez (2001), president of Aqua 21, a non-profit educational organization in Juarez, the type of *maquiladora* in the City of Juarez is not heavy industry, and water is not often used for their processes. Industry in Juarez revolves primarily around clothing and electronics. She does admit that they do use some chemicals for processing, and that it is most likely dumped in the drainage system. Industry is obligated by law to process used water through a purification system to clean the water before discharge and this water is supposed to be tested. Salas (2001) from JMAS, confirmed this statement, and added that employees from the JMAS can go to any industry prior to the discharge and conduct tests; the samples are tested in JMAS laboratories. Although the JMAS has the power to sanction any illegal activity, Salas (2001) admits that it is usually not done because of lack of money and staff. Even though industry initially resisted testing regulations because of additional costs, both the industry and JMAS need to test the water and discharge, industry agreed after it was considered a public relations "plus" and they were considered a "clean and green industry".

Barreno (2001) tried to clarify some misconception regarding the import, production and lack of export of dangerous materials and by-products. To this, Barreno (2001) states that Mexico on a whole produces more dangerous by-products than all the border industries combined. These by-products are all dumped within the country or

surrounding oceans. Unfortunately there is not enough infrastructure to dispose of any dangerous material such as specialized incinerators.

Juarez (2001) adds that industries in the City of Juarez have the funds to perform the water testing. *Maquiladoras* in Juarez are big, clean, well lit, unlike the deplorable conditions of *maquiladoras* in Toluca, located in central Mexico. In Juarez, it is not to the convenience of the maquiladora to treat their employees badly or to pollute. The problem with regards to water pollution in the City of Juarez is related more to intense population growth and to hospitals, car shops, chemical companies and even large government organizations known to simply dump their debris wherever they can. Dr. Franco Barreno (2001), through his own studies, made an important observation. Dr. Barreno recognizes the misconception surrounding industry in this area, that it is a major contributor to environmental pollution.

With regards to water supply, industry is not a major user. Barreno (2001) states that the city loses more water because of leaks in the old underground pipes. If the city installs more distribution lines, as it is currently trying to do, the city would have the capacity to double the number of maquiladoras in Juarez, although he does not recommend it. There is not enough information regarding *maquiladoras*, and there is a misuse of information that is available. Barreno (2001) explains that news reporters or authors use only part of the information, charts or graphs to promote their cause. It should be noted that Dr. Suarez y Toriello, a leading health and environmental expert, believes that industry is in fact an important contributor to the contamination of water. He states that industry in Juarez uses a lot of chemicals, and that chemical by-products or dangerous residues are not exported back to the U.S.A. Furthermore, Dr. Garza (2001),

formerly from the Pan American Health Organization and currently at the Autonomous University of Ciudad Juarez, adds that both industry and agriculture contribute largely to the chemical pollution of water in this city, which goes unmonitored, posing increased health risks.

### 4.3.3 Water Services

Increasing any threat posed by high levels of contamination in water is the inadequate wastewater and sewage treatment facilities currently in use in Juarez. Interviews with water and health specialists from the City of Juarez during the fieldwork confirmed that both plants are not operating to their full capacity and they have many technical problems (Diaz and Kretzschmar Steinle 2001). Up until two years ago, there was no treatment of residual waters. There currently exists two primary treatment plants, one in the north of the city capable of treating 2.5 cubic meters per second and one in the southern region of the city, capable of treating 1 cubic meter per second. The northern plant is treating approximately 1.7 –1.9 cubic meters per second and it has never worked at full capacity. As for the southern plant, it is running at full capacity. Unfortunately, secondary and tertiary treatment plants are currently beyond the financial capability of the city. Academics at the Autonomous University of the City of Juarez are actively involved in improving current water treatment systems and investigating options such as injecting water into the city's own section of the aquifer, de-salinization techniques, and secondary and tertiary water treatment. They admit that the lack of funding is a major obstacle and the cheaper alternative is not always effective or even efficient. While eliminating water shortages is handicapped by the lack of funding, university academics

also admit that the residents are using more water than necessary, prompting the academics to use and encourage a more integrative solution to water shortage problems.

Although different sources give different percentages, it is estimated that approximately 85% of the population is somehow connected to a drainage system, usually a common collector; for those who do not, it is very common for residents to simply throw their garbage or residues on the street (Amador and Acosta del Val 2001). In less developed areas of the city, latrines are also very common, although they are rarely built well, and pose an additional threat to health and can contaminate water distribution lines. Currently, engineers from JMAS are exploring the option of installing dry septic tanks to ease the burden of a poor drainage system. Cultural beliefs, however, seem to impede the successful use of these. There is a stigma attached to the use of dry latrines that discourages their use. Approximately 70% of the water is treated and from this amount 30% is mixed with water extracted from aquifer and water from the Rio Grande/Bravo for irrigation purposes in the Valley of Juarez. Ramon Alfonso Grijalca (2001) from the National Commission of Water, Irrigation Department reports that the water is often mixed in open canals, spread along the Valle. During the summer time, health risks increase and surrounding areas are flooded with an intense, almost unbearable stench.

A major hurdle faced by the city's planning department and government agencies is the intense population growth in this city, which results mostly from employment opportunities. Although the JMAS and others estimate the number of people who have access to water and drainage systems, it is impossible to calculate with certainty, as new, unplanned neighbourhoods are sprouting at a rapid rate. Once a *colonia* is created, it

becomes very dense as new family members arrive in search of a better life. Those *colonias* located right up against the border or those that are located on the Sierra de Juarez are especially vulnerable, because drilling in these areas is difficult and there is no real capacity to build. Hence, the physical geography of the area does influence access to water and drainage. The city is expanding beyond the capacity of JMAS. JMAS estimates that, with regards to services, 85% of the city's population have drainage connections, while 94% have access to drinking water. Patricia Juarez from Aqua 21, estimates that 85% of the population has access to potable water, while 86% have access to drainage. It is important to remember that not all homes that have access to water have water directly within their home. This percentage includes residents who count on a common faucet located outside of their home and shared by many homes in the neighbourhood. Dr. Suarez and Toriello (2001) believes that approximately 12.9% of the population in Juarez, approximately 147 500 people are without water. These people must travel to a location to receive water, usually distributed on a weekly basis, to collect water distributed from a truck, which is then stored, at times in contaminated containers.

At the very least, water in the City of Juarez is cheap, costing approximately 3.60[12]$ Mexican pesos per cubic meter; this is equal to about 2000 bottles of one half litres of water which would cost 6$ pesos each (Amador and Acasto del Val 2001). In addition, water is subsidized in Mexico; those who cannot afford it do not pay and those who are able to afford it, such as large industries, will cover the bill for those who cannot (Monarrez 2001). Financing bigger and better water services becomes problematic when residents are unable to pay for improvements, thus increasing the price of water would

[12] 5.72 Mexican Pesos = 1 Canadian dollar on Friday April 5th, 2002.

not achieve the desired effect. Barreno (2001) believes, however, that cheap price of water is an instigator to current environmental and health challenges.

The water is usually distributed through underground distribution lines, which are increasingly posing an important health threat. Houses located in the periphery of the city are serviced with above ground water pipes. Upon extraction, drinking water does undergo chlorination and a norm has been established to sample a prescribed number of wells on a daily basis. With regards to chlorination, Mexico adheres to the world standard of at least 0.2 p.p.m. of chlorine, regardless of location so as not to allow the production of bacteria (Barreno 2001). Testing standards are international standards and not specific to Mexico. Water quality is actually very high in this area because its source is a deep underground aquifer. Excess sedimentation of iron and potassium is the only major problem that originates within the aquifer; any chemical or microbiological contamination is from outside sources. Hence, as is, the water from the aquifer does not pose a health threat to the consumer, at this point. When water comes up from the ground through tubes and pipes, contamination could occur at this point, which is why the city applies chlorine. Past studies have shown water contaminated with *E. coli* and coliforms in the water distribution lines. This is the result of old lines, which are prone to fissures and easily contaminated. Hence, when one asks if diarrheal disease related to water pollution in this area, the answer is yes, but this answer requires close investigation. A researcher must ask, at what point or stage does drinking water become a threat to health.

Current evidence shows that the water within the aquifer does not pose a chemical or bacteriological threat to health. High levels of sediments are the result of high

extraction rates and it does affect water quality, requiring additional filtration methods. It is not, however, a cause of diarrheal disease or a health risk. Potential health risks for diarrheal disease start to emerge as soon as the water enters the water distribution lines. The pipes, both above and below ground, are old with fissures. When water pressure through the pipes is low, such as during peak water use hours, there is the potential for contamination to percolate into the pipes, although no one interviewed was able to specify what type of contamination. Also, when one is forced to carry water home, because they lack access to water in their home, as is the case in many communities on the periphery of the city, the possibility of water contamination rises once again depending on the container. Schmidt (2000) reports that residents may store their water in 55-gallon barrels obtained from maquiladoras, although Salas (2001) reports that storing water is less common now then before. Although water shortages are common, especially during the summer months in elevated areas, it usually for a short period of time, unlike in the capital City of Chihuahua, where residents can go without water for 24 hours and are forced to buy special storage containers placed on the roof of their residence. In addition to potential harmful transportation of the water, Salas (2001) also states that water management once in the home is linked to higher levels of diarrheal disease. These risks are associated with socio-cultural behaviour.

### 4.3.4 Socio-Cultural Behaviour

The importance of socio-cultural behaviour is hardly mentioned or discussed in secondary data, and yet in the case of diarrheal disease rates in the City of Juarez specifically, it appears to be the most important influence on rates of diarrheal disease among children, a bigger influence than even poverty, although poverty does influence

behaviour. High levels of morbidity from diarrheal disease seem to be related more to socio-cultural behaviour, while mortality from this cause is related to both socio-cultural behaviour and poverty, usually extreme poverty. When asked what would influence incidence of diarrheal disease among children, Patricia Juarez (2001) listed hygiene as an important stimulus. During the harsh winters common to this area, people will wash their hands less, shower less often, clean their latrines less often, prompting the spread of diarrheal disease causing germs. Over-crowding also seems to be a problem, and it is the result of both poverty and socio-cultural ideologies. When new residents settle into a community, a home, it is usually members of the immediate family first. The family, however, expands to include extended family also in search of employment in order to maintain the family together, an important phenomenon in a Latin American family. Before long there is a small community living in a one family plot, making the handling of excreta, garbage disposal and consumption of water more problematic and at times costly.

Cultural ideas about sickness and health combined with a lack of education or knowledge on basic health also increases the risk of disease. Women in this area and perhaps in many parts of Mexico and the developing world believe that it is normal for their babies to become ill from diarrhea, and these women associate disease with other agents besides germs or lack of hygiene. Often they believe that food, but not the germ, management or storage of food is associated with their sick child. With regards to hygiene, most people know that they should wash their hands after using the bathroom, but when there is no water or the water is already contaminated, risk increases once again. If a child has a bucket of water to wash their hands in (if the water must be stored)

or they must run outside to use the bathroom when it is cold, they will most likely prefer to quickly wipe their hands on their shirt or pants. Juarez (2001) explains that certain customs, perhaps more than a lack of education is to blame. It is difficult to change habits and admit that our actions are wrong. In poorer areas, where there is no water, people need to learn to use more soap and to wash their hands and food for consumption, but not re-use dirty water.

In the middle and upper classes, pathways for disease are different. Salas (2001) described a study conducted in Juarez, which compared the three economic levels and the incidence of diarrheal disease. Investigators hypothesized that there would be a higher incidence of gastro-intestinal disease among those living in the lowest economic level, but it was not so. Results indicated equal or less new cases of diarrheal disease in the lowest economic level. The poor are more likely to eat in and eat foods that are simple, such as beans, whereas people with a higher income will have their main meal of the day, lunch, at a restaurant or usually at a food stand on the street. Vendors on the street are very common throughout Mexico and often an important place for social gathering. Unfortunately, street vendors usually do not have access to water and must store water in a bucket or container. They are simple stands set up on the streets. This water is often used to clean food and dishes, as well as hands. More water is brought in when it becomes necessary, which depends on the owner's description of necessity. These stands may not all rely on a refrigeration system, meaning that food, especially in the summer time can spoil very quickly. This problem is also common in poor households who do not have a refrigerator and do not consume food quickly enough before it starts to decay.

Combined with these influences is the general mentality of Juarez residents about water and health, and also about the environment. Although residents are becoming more aware, all experts agreed there is a need for a major change of mentality; it is perhaps one of the biggest challenges facing health of children. Slowly people are beginning to realize that water is an important and increasingly precious resource. This interest is expanding to include other cities, both Mexican and American. The message of conservation is targeted at children of all levels, from kindergarten to university, and is supported by the maquiladora industry as well as the local government and JMAS in hopes of keeping water costs down. According to academics from the Autonomous University of the City of Juarez, however, people do not really assimilate the severity of this problem; they do not really believe that water could possibly run out. Educational messages are often short lived, although they can be intense. Due to the high turnover of employees at JMAS because of political changes, many promotional programs are often discontinued and information lost, while new employees have to be trained in environmental conservation and promotion.

There are remedial actions, such as information sessions, advertising, and plenty of research. Educational facilities are in place; there are several excellent research institutions although there is a need for scientists trained in the social sciences that understand real human needs. It is still not enough considering the intense development and population growth and the persisting general mentality on water and the environment.

### 4.4 Diarrheal Disease in the City of Juarez and the Disease Surveillance System

Diarrheal disease in Mexico remains an important cause of morbidity and mortality. As previously mentioned the exact number of morbidity and mortality cases in the City of Juarez remains elusive. The Health Department of the City of Juarez and the National Institute of Public Health of Mexico provided age-specific and general data on mortality and morbidity cases from diarrheal disease. The following tables provide information on mortality and morbidity rates. A rate is simply frequency of on thing relative to another. In health studies, "the numerator is the event happening to the population and the denominator is the population at risk for the event (Meade and Earickson 2000: 404). A rate is usually "multiplied by a constant *k* (usually 100, 1000 or 100,000) to ease the comparisons among places and time periods" (Meade and Earickson 2000: 404).

Unfortunately, there are several problems with the following tables that prevent comparisons between them, a further data challenge. Some tables use a constant (*k*) of 1000, while others use 100,000. Some tables consider the entire Municipality of Juarez, while others consider only the City of Juarez. The sources do not specify of the data was gathered from public, private or both types of health care systems. This is important because many people can not afford even public health care. Also, the tables do not indicate whether they are measuring incidence or prevalence. It is also not clear if tables, which describe data, produced after 1998 adhere to the International Classification of Disease, $10^{th}$ Revision or if they are still using the $9^{th}$ Revision. According to Meade and Earickson (2000) case mortality rates say nothing about how common a disease is in a population. Finally, there is a host of other problems with reported rates, which vary over

time and space (Meade and Earickson 2000). The purpose of including these tables is to highlight additional data challenges; they cannot be compared, they will only be described.

Table 4.1, *Infant mortality according to cause in the Municipality of Juarez*, lists the top ten causes of mortality in the municipality of Juarez for infants. According to this table, there were 614 infant deaths in the Municipality in 2000. The causes of mortality are listed according to a general rubric, such as intestinal infectious diseases for example. In 2000, there were 26 infant mortality cases from Intestinal Infectious Diseases, which represents 0.90/1000 live births. This table does adhere to the International Classification of Diseases - 10$^{th}$ Revision.

Table 4.2, *Child (1-5) mortality according to causes in the Municipality of Juarez*, examines the top ten causes of mortality for children in 2000 in the Municipality of Juarez. It also abides by the ICD-10. Intestinal infectious disease (A09) is the fourth cause of mortality, although there were only 2 deaths. In 2000, there were 62 deaths within this age group. Categories are divided differently from the table listing the causes of deaths for infants in table 4.1; causes are divided into more categories rather than using main rubric or general titles. Table 4.3 ranks general morbidity causes for all ages in the Municipality of Juarez between 1992 until 2000[13], although the source does not specify whether it is measuring prevalence or incidence. Intestinal infections rank second overall out of the top fifteen causes. This table also considers the ICD-10. Although intestinal infections dropped to third place between 1994 and 1995, it remains

[13] It is not know whether the change in the International Classification of Disease and the change in rubrics for Intestinal Infectious diseases was accounted for. A discussion on the comparability of causes of deaths between ICD-9 and ICD-10 will be included.

**Table 4.1: Infant Mortality According to Cause**
**Municipality of Juarez, 2000**

| *Ranking* | *ICD 10th Revision* | *Cause of Death* | *Cases* | *Per 1000 Live Births* | *%* |
|---|---|---|---|---|---|
| 1 | P01-P96 | Certain infections originating in the perinatal period | 321 | 11.16 | 52.28 |
| | P22-P28 | Difficulties in breathing in newborns and other respiratory problems | 204 | 7.09 | 33.22 |
| 2 | Q00-Q91 | Congenital malformation, and deformation and anomalies | 116 | 4.03 | 18.89 |
| | | Congenital malformation of the circulatory system | 32 | 1.11 | 5.21 |
| 3 | J00-J06 | Acute respiratory infections | 39 | 1.36 | 6.35 |
| 4 | A09 | Intestinal infectious diseases | 26 | 0.90 | 4.23 |
| 5 | J11-J18 | Pneumonia and influenza | 26 | 0.90 | 4.23 |
| 6 | V03-Y34 | Accidents | 17 | 0.59 | 2.77 |
| | V03-V89 | Traffic accidents and motor vehicle accidents | 3 | 0.10 | 0.49 |
| | X47.0 | Accidental poisoning via exposure to other gazes and vapors | 3 | 0.10 | 0.49 |
| 7 | A41 | Septicemia | 8 | 0.28 | 1.30 |
| 8 | E43-E46 | Nutritional deficiencies | 6 | 0.21 | 0.98 |
| 9 | G049 | Viral meningitis | 2 | 0.07 | 0.98 |
| 10 | D61 | Anemia | 1 | 0.03 | 0.33 |
| | | Other Causes | 40 | 1.39 | 0.16 |
| | | TOTAL | 614 | 21.34 | 100.00 |

Source :Municipio de Juarez (2001) *Sistema Epidemiologio y Estadistico de Defunciones*. SSCH: Municipio de Juarez

**Table 4.2: Child (Ages 1-5) Mortality According to Causes**
**Municipality of Juarez, 2000**

*Per 100,000 residents, except the total which is calculated for per 10,000 residents

| *Ranking* | *ICD 10th Revision* | *Cause of Death* | *Deaths* | *Per 100,000* Residents* | *%* |
|---|---|---|---|---|---|
| 1 | V03-Y34 | Accidents | 23 | 20.57 | 37.10 |
| | X47.0 | Accidental poisoning via exposure to other gazes and vapours | 5 | 4.47 | 8.06 |
| | W67 | Accidental drowning and submersion | 4 | 3.58 | 6.45 |
| | V03-V89 | Traffic accidents and motor vehicle accidents | 1 | 0.89 | 1.61 |
| 2 | Q00-Q91 | Congenital malformation, and deformation and anomalies | 5 | 4.47 | 8.06 |
| | Q20-Q25 | Congenital anomalies of the heart and the respiratory system | 2 | 1.79 | 3.23 |
| 3 | C06-D48 | Malignant tumors | 4 | 3.58 | 6.45 |
| | C95.9 | Leukemia | 2 | 1.79 | 3.23 |
| | G049 | Meningitis | 2 | 1.79 | 3.23 |
| | Y09 | Homicides | 3 | 2.68 | 4.84 |
| 4 | A09 | Intestinal infectious disease | 2 | 1.79 | 3.23 |
| 5 | E43-E46 | Nutritional deficiencies | 2 | 1.79 | 3.23 |
| 6 | J11-J18 | Pneumonia and influenza | 3 | 2.68 | 4.84 |
| 7 | G40.9 | Epilepsy | 1 | 0.89 | 1.61 |
| 8 | J00-J06 | Acute Respiratory Infections | 2 | 1.79 | 3.23 |
| 9 | I01-199 | Cerebral paralysis and other paralyzing syndroms | 3 | 2.68 | 4.84 |
| | | Other Causes | 12 | 10.73 | 19.35 |
| | | **TOTAL** | **62** | **5.55** | **100.00** |

Source :Municipio de Juarez (2001) *Sistema Epidemiologio y Estadistico de Defunciones*. SSCH: Municipio de Juarez.

**Table 4.3: Ranking of General Morbidity According to Causes (All Ages)**
**Municipality of Juarez, 2000**

| *Ranking* | *ICD 10th Revision* | *Cause of Death* | *1992* | *1993* | *1994* | *1995* | *1996* | *1997* | *1998* | *1999* | *00* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | J00-J002, J02.8 | Acute respiratory infections | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | A04, A08-A09 | Intestinal infections | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| 3 | T00-T14, V01-V09 | Accidents and traumatism | 3 | 3 | 2 | 2 | 27 | | 6 | 8 | 11 |
| 4 | B01 | Varicela | 4 | 4 | 4 | 5 | 5 | 3 | 4 | 3 | 5 |
| 5 | I10-I15 | Arterial hypertension | 5 | 5 | 6 | 6 | 6 | 4 | 3 | 4 | 6 |
| 6 | J12-J18 | Pneumonia and bronchial pneumonia | 6 | 6 | 8 | 7 | 8 | 8 | 9 | 9 | 13 |
| 7 | A06.0-A06.3 | Intestinal amibiasis | 7 | 7 | 9 | 9 | 10 | 11 | 11 | 15 | 15 |
| 8 | E10-E14 | Diabetis mellitus | 8 | 8 | 7 | 8 | 9 | 7 | 7 | 6 | 10 |
| 9 | B26 | Parotidis | 9 | 9 | 5 | 17 | 11 | 5 | 27 | 32 | 30 |
| 10 | B86 | Escabiasis | 10 | 11 | 15 | 18 | 19 | 18 | 25 | 27 | 22 |
| 11 | X20,X21,X23 | Intoxicacion por ponzona de animal | 11 | 21 | 24 | 38 | 26 | 22 | 18 | 22 | 20 |
| 12 | A01.1-A02 | Paratifoides y otros salmonellas | 12 | 13 | 16 | 21 | 13 | 17 | 21 | 26 | 19 |
| 13 | J02.0, J03.0 | Angina estreptococcia | 13 | 17 | 17 | 14 | 15 | 13 | 24 | 25 | 20 |
| 14 | A05.7 | Giardiasis | 14 | 16 | 19 | 23 | 22 | 23 | 30 | 33 | 28 |
| 15 | A54.0-A54.2 | Infeccion gonococcica genitourina | 15 | 15 | 23 | 31 | 23 | 26 | 48 | 57 | 50 |

Source: Municipio de Juarez (2001) *Informe de Casos Nuevos de Enfermedades*. Direccion General de Epidemiologia SSCH: Municipio de Juarez.

steady as the second most common cause of morbidity. Acute respiratory infections have been the top cause in terms of morbidity in Ciudad Juarez throughout.

Table 4.4 examines the number of new cases of intestinal infections, as a cause of morbidity, in the Municipality of Juarez over a ten-year period, from 1990 until 2000. The source does not state whether they consider both revisions of the International Classification of Disease, nor does it specify if they are considering prevalence or incidence. Overall, the number of cases increased over the decade. Unfortunately, the total population for each year is not listed. This makes assessing the severity of the diseases within a population difficult, because cases in themselves do not reveal much information. INEGI, the agency responsible for collection demographic data in Mexico was consulted, both at the federal level and at the state level for Chihuahua. Neither provided information on population at a municipal scale[14].

[14] Please refer to http://chih.inegi.gob.mx/ for more information.

**Table 4.4: Morbidity from Intestinal Infections**
**Municipality of Juarez, 1990-2000**

| *Year* | *Number of Cases* | *Per 100,000 Residents* |
|---|---|---|
| 1990 | 39,260 | 4,732.31 |
| 1991 | 35,756 | 4,233.07 |
| 1992 | 36,287 | 4,188.00 |
| 1993 | 38,031 | 4,112.93 |
| 1994 | 41,491 | 4,350.77 |
| 1995 | 48,421 | 5,283.08 |
| 1996 | 52,281 | 5,167.20 |
| 1997 | 33,441 | 3,152.27 |
| 1998 | 50,639 | 4,453.06 |
| 1999 | 47,396 | 3,996.36 |
| 2000 | 52,665 | 4,320.66 |

Source: Municipio de Juarez (2001) *Diagnostico de Salud del Municipio de Juarez.*
Departamento de Information y Evaluacion de SSCH: Muncipio de Juarez.

Statistical data was also retrieved from the National Institute of Public Health (INSP) in Mexico, their primary source of information is INEGI. Table 4.5 *Infant and Child Mortality in the Municipality of Juarez 1994-1999* provides mortality information in children under 5 years of age between 1994 and 1999. Death is from intestinal infectious disease. Information is only available until 1999 because the INSP is still in the process of computing and standardizing data according to the International Classification of Disease ($10^{th}$ Revision). Prior to 1998, the INSP used the ICD ($9^{th}$ Revision). Mortality was divided according to infants (0-11 months) and children (12 months–5 years).

**Table 4.5: Infant and Child Mortality from Infectious Intestinal Diseases in the Municipality of Juarez 1994-1999**

| Year | Infant Deaths | Child Deaths |
|---|---|---|
| 1994 | 6 | N/A |
| 1995 | 25 | 5 |
| 1996 | 14 | 1 |
| 1997 | 30 | 3 |
| 1998 | 15 | 3 |
| 1999 | 25 | 4 |

Source: Instituto Nacional de Salud Publica 2001.

According to the Texas Child Fatality Annual Statistical Review for 2000, there were 119 child deaths and 63 infant deaths from all causes in the county of El Paso. Because cause of death for infants and children were difficult to locate according to counties, Table 4.6 highlights the leading causes of death for infants and children under the age of 5 in the state of Texas, while Table 4.7 highlights infant mortality rates for the state of Texas for 2000 (Texas Department of Health 2000). While I realize that it is problematic to compare statistics from different scales, problems with scale can occur, of importance for this research is the fact that diarrheal diseases was not a cause of death among infants in El Paso, because diarrheal disease was not listed as a cause of death in Texas in 2000. As for children, diarrheal disease is not considered a statistically significant cause of death (Texas Department of Health 2000).

**Table 4.6: Leading Causes of Death Among Infants and Children Residents of Texas, 2000**

| INFANT DEATHS | | AGE 1-4 YEARS | |
|---|---|---|---|
| 1. Perinatal Conditions | 860 | 1. Accidents | 207 |
| 2. Congenital Malformations | 493 | 2. Congenital Malformations | 52 |
| 3. S.I.D.S. | 233 | 3. Malignant Neoplasms (Cancer) | 44 |
| 4. Accidents | 76 | 4. Assault (Homicide) | 40 |
| 5. Diseases of Hearts | 37 | 5. Diseases of Hearts | 17 |
| 6. Septicemia | 34 | 6. Influenza and Pneumonia | 11 |
| 7. Assult (Homicide) | 24 | 7. Septicemia | 8 |
| 8. Influenza and Pneumonia | 23 | 8. Conditions Arising in Perinatal Period | 4 |
| 9. Cerebrovascular Diseases (Stroke) | 3 | 9. Nephritis, Nephrotic Syndrome, Nephrosis | 16 |
| 10. Medical and Surgical Care Complications | 3 | 10. Malignant Neoplasms (Cancer) | 11 |

Source: Texas Child Fatality Annual Statistical Review 2000.

## Table 4.7: Infant Mortality from Selected Causes, Residents of Texas, 2000 by Race/ Ethnicity and Sex

| | TOTAL | M | F | WHITE | M | F | BLACK | M | F | HISPANIC | M | F | OTHER | M | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALL CAUSES OF DEATH | 2,064 | 1155 | 909 | 690 | 387 | 303 | 468 | 266 | 202 | 876 | 484 | 392 | 30 | 18 | 12 |
| | | | | | | | | | | | | | | | |
| CERTAIN INFECTIOUS AND PARASITIC DISEASES | 52 | 30 | 22 | 11 | 7 | 4 | 15 | 8 | 7 | 26 | 15 | 11 | 0 | 0 | 0 |
| Certain intestinal infectious diseases | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diarrhea and gastroenteritis of presumed infectious origin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tuberculosis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tetanus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diphtheria | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Whooping cough | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 |
| Meningococcal infection | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| Septicemia | 34 | 21 | 13 | 8 | 4 | 4 | 8 | 5 | 3 | 18 | 12 | 6 | 0 | 0 | 0 |
| Congenital Syphilis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source: TEXAS DEPARTMENT OF HEALTH - BUREAU OF VITAL STATISTICS 2000 (http://www.tdh.state.tx.us/bvs/stats00/ANNR_HTM/00t31.HTM)

### 4.5 Underreporting and the Accuracy of Data

There are several factors, which can impede the accuracy of the data. First, with regard to diarrheal problems, it is unsure whether the numbers representing mortality are correct since only cholera water-related intestinal diseases must be officially reported to the ministry of health (Garza 2001). Causes of diarrheal disease such as *cryptosporidium* do not have to be reported as a cause of death. According to Dr. Garza, it will not reach the Ministry of Health. Second, several participants believe that one of the reasons why they do not trust health reports from major agencies such as the ministry of health or INEGI is that they think that often doctors will write diarrheal disease simply to write a cause down. That is to say that doctors are too busy or lacking the funds, or even the patients are lacking the funds to pay for the doctors time, to fully assess a patients condition and give a proper prognosis. Morbidity and mortality numbers may also be affected by underreporting. Many residents do not have access to health care, even the services offered by the ministry of health, therefore numbers in official reports may not represent the severity of the problem.

Green (1999) explains that most data is always incomplete. "Information provides a means of presenting a view about the real world; such views can differ not only in terms of distortion or "inaccuracies" but more fundamentally, as a result of genuinely different perceptions" (Green 1999: 118). In addition, Green (1999) confirms that medical information is even harder to obtain "accurately" because a diagnosis is an art and not always a science, especially where diagnostic aid and resources are scarce. Additional inaccuracies can occur as a result of lack of knowledge, multiple causes of death and when a single diagnosis is required, and when confusing diagnosis on

admissions as opposed to on discharge (Green 1999). Overall, the accuracy of the disease surveillance system and resulting data are very questionable as stated by many of the participants. This study examines the effects of poverty and economic and political relationships on health and access to health care.

### 4.6 Economic Development in Mexico

As a result of a major devaluation of the Mexican Peso in the mid-1960s the government established the Border Industrialization Program (BIP) and Mexico's border became an Exporting Processing Zone (EPZ's) (Brenner et al., 2000). The liberalization of Mexico's economy during the 1980's and 1990's, which ultimately led to its inclusion in the General Agreement on Tariffs and Trade in 1986 and its participation in the North American Free Trade Agreement (NAFTA) in 1994, was encouraged by decades of neo-liberal policies from the ruling political party, a major debt crisis, and structural adjustment programs implemented by the International Monetary Fund to repay loans (Lustig 1998; Brenner at al., 2000). As a result Mexico has become very dependent on foreign investment, especially American investment. Currently, the *maquiladora* sector, perhaps the most important end-result of NAFTA, is the second largest contributor to the Mexican economy, after oil exports and certainly the fastest growing. Since 1994, the industry has more than doubled in size and accounts for more than 40% of Mexican jobs (Brenner et al, 2000). Although there are *maquiladoras* located throughout the country, the majority are concentrated in the border zone. Its success is due to many factors. Mexico's unlimited supply for cheap labour, especially after the crash of the *peso* in 1995 made business very profitable for foreign manufacturers. Companies will not assemble or manufacture in Mexico if it is more profitable to do so elsewhere. In addition, the

Mexican government has kept wages low in order to make Mexican labour competitive on the international marker by making wage "pacts" with government affiliated unions and employers and by simply not raising wages (Brenner et al., 2000). Therefore, despite a growth in productivity and investment, wages are purposely kept down, propagating poverty for the sake of economic growth which benefits very few, at the expense of workers health, social welfare and the environment. This is a clear example for the dependency model as explained by Frank (1966). The City of Juarez is a satellite to Mexico City, home to the central federal government. Its dependence on foreign investment is obvious, simply by the amount of internal displacement the possibility of employment in any of the maquiladoras encourages. Mexico City, or Mexico as a whole is therefore a satellite to the United States metropolis.

A second major contributing factor to the increase in foreign investment is the lax enforcement of already deficient environmental laws. A 1992 study by the Government Accounting Office (GOA) from the United States, found that 100% of all U.S. factory were in violation of Mexico's environmental laws (Brenner et. al., 2000). Health and environmental problems associated with industry pollution is widespread and increasingly documented, although this does not automatically lead to remedial action, nor are industries quick to assume responsibility. The border area has become one of the most polluted areas in the Americas (Brenner et al., 2000). Environmental law in Mexico as a whole is still very much in its infancy, therefore it is appropriate to consider Mexican environmental law weak if not unsuccessful for two principle reasons: Mexico's policies have traditionally focused on economic growth because of its staggering poverty and debt, and as a result, has not had much experience nor support for this type of

enforcement. Also, environmental law has evolved very slowly, and the consequences are obvious throughout the country. Water and air pollution related diseases are rampant, but these are due to more than poor environmental law or enforcement of laws.

Poverty remains in Mexico and on an international scale a major deterrent of health, and poverty is the result of many factors and events. Unfortunately, when faced with so much scarcity, prioritizing and funding allocation becomes a difficult and complicated task. Because poor health in Mexico is so tied to poverty, and poverty itself is so complex, the quality and access to health care will be an important challenge for years to come.

**4.7 Inequalities and Health**

Poverty, inequalities and patterns of economic change are a major culprit on a series of levels with regards to the quality of life of a person, their vulnerability in the face of disease and illness, and their access to quality health care (Gersham and Irwin 2000). According to Adam Wagstaff (2002) "poor countries tend to have worse health outcome than better-off countries. Within countries, poor people have worse health outcomes than better-of people" (Wagstaff 2002: 97). In addition, "poor countries and poor people within countries, suffer from a multiplicity of deprivations that translate into high levels of ill- health" (Wagstaff 2002: 97). Disease breeds in areas or communities lacking adequate housing, food, sewage, waste disposal, drainage and clean water for drinking, cooking and cleaning, putting millions of people at risk for air and water borne diseases, thought to be a problem of the past. Although by most accounts, health on a worldwide scale is getting better as a result of dramatic improvements in science and technology. In the understanding of illness and the human body, a closer examination

reveals that health improvements are unevenly distributed. Perhaps the biggest problem is the unequal distribution or restricted access to health care. Although developing countries account for 90% of the world's disease burden, these countries have access to only 10% of the resource that go to health (Millen, Irwin and Kim 2000). The decline in some health indicators highlights an important paradox: despite the promise from neo-liberal proponents of capitalism, free trade and the trickle down theory that increased wealth and technology would relieve poverty, vulnerability and suffering, the quest for economic growth and profit has in fact worsened the lives of millions of people worldwide.

This chapter has presented the data necessary to answer the objectives formulated in Chapter One. The research question will be revisited in the following chapter. The goal of this chapter was to highlight the complexity of possible disease pathways of diarrheal disease in children under the age of five from the City of Juarez.

# CHAPTER FIVE

# CONCLUSION

## 5.1 Introduction

Chapter five will revisit the original research question and discuss the limitations of this study. I will summarize and discuss the main findings from this research. Finally, this last chapter will incorporate suggestions and future research possibilities in this field. This thesis has shown that the causes of diarrheal disease are numerous and that the relationship between causes is very complex. The presence of disease in the City of Juarez is primarily due to socio-cultural behaviours and poverty and indirectly due to the physical geographical structure of the city and human-made environmental contamination, which have been explored throughout this study. Given the vulnerability of the city's only water source, the Hueco Bolson aquifer, the dynamics between primary and secondary disease pathways are likely to shift in the future requiring continued research.

## 5.2 Revisiting the Research Question and Considering the Limitations of this Study

The original research question established chapter one was: "Why is the rate of mortality and morbidity from diarrheal disease in children under the age of 5 greater in Juarez than in El Paso, considering the proximity of these two sites?" This study acquired the necessary information to explain why diarrheal disease is so prominent in the City of Juarez. It also explored the factors, which impede knowing the full extent of this health burden in children in the City of Juarez, and possible along the Mexico-US Border region. However, more research on the perception and socio-cultural behaviour,

and access to health of residents from El Paso must be considered to full answer this research question. This is especially relevant as the population of El Paso is so ethnically diverse. Approximately 80% of the population from El Paso is of Hispanic descent, while only 17% is Anglo (US Census 2000). It would be important to study if and how perceptions of health and behaviour varied among the ethnic groups, and how that influences the health of children. The influence of migration must also be further explored. Since this is an area of high migration, both in the City of Juarez and in El Paso (PAHO 2000), do perceptions of health, behaviour, access to health care and resources differ between migrants and long time residents of each city?

This study provides the Mexican information on the influences, which lead to the occurrence of diarrheal disease in the City of Juarez. Interviews with the caretakers of children in the City of Juarez would have been beneficial to confirm or challenge the information provided by the participants on socio-cultural behaviour and perception. An additional, more in-depth study on the factors, which prevent or minimize the occurrence of diarrheal disease in the City of El Paso would be necessary to provide a complete answer to the research question and understand the differences between place.

**5.3 Discussion of Findings**

This section will provide an overview of the four main conclusions drawn from this study. Section 5.4 on the value of qualitative data in the study of health will compliment this current section.

This first important finding drawn from this research is that in the City of Juarez, mortality and morbidity from diarrheal disease in children are not directly related to water quality, but rather to a combination of factors, with socio-cultural activities having

the largest influence on outcome. The literature review revealed few studies on socio-cultural behaviour and perception on health, and their relationship with levels of morbidity and mortality from diarrheal diseases in the City of Juarez, and along the Mexico-US Border. Understanding the importance of these influences is essential to reducing morbidity and mortality rates from diarrheal disease. More research on socio-cultural behaviour in both the cities of Juarez and El Paso is needed.

Current literature also has a tendency to make generalizations about the border area and I would also add that authors do not dig deep enough to uncover the real source of these problems or explain the complex relationships between these. There are many people working together to solve water and health problems in Juarez, but this fact is largely unknown. Foreign publications do not always discuss what locals from Juarez are doing or the research that takes place by local Mexican institutions. Combined, these factors will have a negative influence on foreign opinion, which could potentially encourage the North-South dichotomous relationship by casting Mexico as a poor, helpless country in need of rescue.

The relationship between socio-cultural practices and behaviour exerts a noteworthy influence on the health of children, a fact Mexicans understand and consider during the implementation of educational programs in Ciudad Juarez. Water conservation also figures prominently in promotions. These are important steps in solving both health and environmental challenges in Juarez.

A second conclusion drawn from this study is that inadequate access to health care, especially among the poor, and a deficient health care system are contributing factors to many health burdens in the City of Juarez. According to Oscar Altimir (1982),

the welfare of the poor depends largely on their access to free or highly subsidized social services, most notably health care. "In practice, inequalities in the access to these services among the population aggravate the incidence of poverty" (Mesa-Lago 1992: 12). In Latin America, health services are administered by a number of providers, which can be grouped into three categories: public, social insurance and private (Mesa-Lago 1992). Of these three providers, the public sector, which includes the ministry of health, is the most important because "the poorest segment of the population usually only has access to the services by the ministry of health" (Mesa-Lago 1992: 15). The poor rely heavily on the Ministry of Health because they do not qualify for social insurance and cannot afford private health care.

The health care system in Mexico is very problematic and exclusive. In Mexico, as in many Latin American countries, there is a great need for more physicians and hospital beds. The Mexican Institute of Social Security (IMSS), the main social security agency covers all employees, with some exceptions. In practice it "excludes the poor because the group must have economic resources and an administrative organization" (Mesa-Lago 1992: 105). Residents not covered by the IMSS depend on the Ministry of Health whose services are at times of very poor quality and not always easily accessed. If poverty levels increase, more people will be forced to rely solely on the Ministry of Health.

Simply stating that the federal government should spend more money on health care is naïve. Prioritizing pressing concerns is difficult in even in the richest of nations; there is no simple solution. Green (1992) discusses grassroots remedial action to ease the burden of an inadequate health care system in Mexico. He considers different

community development projects as potential self-help schemes because improvements in health require the participation of active partners rather than passive recipients. Green proposes community health workers, for example, as a relative economical way of providing basic health services in areas where the government has a limited budget. This shift in emphasis from high-technology medicine to more cost-effective health care methods could also pave the way for a wider acceptance of traditional medicine, which has very strong roots in Mexico.

A combination of both traditional and modern medicine, favoured by *Tlahuili*, the Mexican Institute of Traditional Medicine, is an inexpensive alternative for the rural and urban poor (Mesa-Lago 1992). One of the biggest challenges faced by the Mexican health system is that it provides little health care alternatives to the poor. Although this institute serves primarily the central state of Morelos, it is an excellent example of low-cost health care, which could do very well throughout Mexico. Clinics are run by *Tlahuili* trained health promoters who provide curative services mostly for respiratory and intestinal disease, parasites, typhoid, nutrition and dehydration (Mesa-Lago 1992). It is not free of problems and it must receive foreign aid for its maintenance; however, this type of health care alternative appears to be a sound investment. There are a number of non-profit health centres operating in the City of Juarez although their focus is on modern medicine and they too depend on foreign aid. Perhaps they would benefit from adopting certain traditional remedies or traveling "foot" doctors. These could in turn contribute to a more accurate health status report. Many participants interviewed complained of underreporting of diseases because so many people go undiagnosed. Future research

could investigate the benefits of increased use of traditional medicine combined with modern health care on the health of residents.

The third conclusion drawn from this study is that the City of Juarez has a very inadequate disease reporting system and statistical health information is not trustworthy. This too is the result of many important factors. The Ministry of Health, the agency servicing those most in need, is plagued with problems, and many health and environmental experts believe that it is not reliable. The quality of data is highly disputed. Therefore the overall foundation of the health care system is very unstable. In order to allocate the appropriate time and resources to the most pressing causes and priorities, a functioning and dependable disease surveillance system is a requisite.

Prior to visiting Mexico, it was unknown to me how troubled the surveillance system was or indeed the overall health system was. It is a subject one can safely assume a country would not want to advertise. There are several questions that arise given the poor disease surveillance system: what are the alternatives to the Mexican system? How is data passed around and how does it reach central offices in Mexico City? How does El Paso, home of the Pan American Health Organization offices obtain Mexican data? How do different sources of data, for example the university and non-government organizations, compare with the Ministry of Health data? These questions could be considered a source for future research.

The Ministry of Health is not the only government agency to provide unreliable data. Many agencies are plagued with difficulties such as low funding, however, political pressures and relationships exert a negative influence on government programs and agencies. When the main political party of the federal government of Mexico changes, so

do the top-level jobs within government offices. This is done so that the philosophy and mentality of top-level employees matches those of the new government in office. This process wreaks havoc within government agencies because programs are changed or cancelled, funding can be redirected or cancelled and new staff entering the agency may require training. This process is very time-consuming. Senior-level positions should be independent of political preferences in order to avoid such disruptive changes in government offices, otherwise initiatives to improve the disease surveillance system for example, will never materialize because of political interruptions.

Communication between government agencies and non-governmental agencies and the educational institutions is also limited. There needs to be an increase in data sharing between agencies and groups to facilitate the flow of information and to peer-review the data.

The final conclusion drawn from this research is that it is difficult to make any conclusions on the exact contributions of *maquiladoras* and industry to the area's environmental problems and how in turn this might affect the health of the residents of Juarez. While some experts contend that it is not a major consumer or polluter of water in the City of Juarez, others argue that there is still too much secrecy surrounding their operations to make any formal conclusion on their roles. It was confirmed by government and non-government agencies, as well as from members from the Autonomous University of Ciudad Juarez that industry is making an effort to participate in environmental workshops and meetings and are concerned about water conservation. Participants also confirmed that residents and smaller businesses such as restaurants and auto shops are equally responsible for water pollution and poor water conservation

methods. Future research could investigate the possibility of cross-contamination between different types of above ground pollution stemming from industry and the aquifer, and study its potential discharge into the water system.

### 5.4 Conclusions on Qualitative Research in the Study of Health in the City of Juarez

New primary evidence revealed important information not available in qualitative data and highlighted important contradictions and misconceptions. I realized upon arriving to the study site that the secondary data was not representative of reality. Thus field work proved to be essential to the outcome of this study. While the quantitative data used in this research highlighted an important health burden experienced in the City of Juarez, as opposed to the City of El Paso, qualitative methodologies allowed me to acquire the necessary information to explain the health burden.

According to Winchester (2000), qualitative research in geography contends with two fundamental questions concerned with social context and the individual experience. The social structures examined here were social and cultural, environmental, political and economic. It was important to evaluate how these structures affect the issue at hand, but it was equally important to study how these factors are influenced by a large socio-political system, thus resulting in the discussion on development and inequalities in the previous chapter. Interviews with key environmental and health experts gave insight into personal experiences, opinions, ideas and behaviours, which were missing from the literature. I also felt it was important to be a participant in the study, as well, in order to gain the trust and understanding of those I was researching, as well as get local "expert" opinion on the subject of my study. Experts encouraged my participation by asking questions and wanting to know about health and environmental relationships in Canada.

I feared that being viewed, as a detached outsider would provoke participants to feel that I was judging them, thus cutting short their participation and omitting important details. Even though this may appear to be a selfish tactic, it was in fact not. I considered it a way to balance the relationship between interviewer and the participant.

Although I did have certain preconceived notions about poverty in Mexico, I did not let my existing knowledge of Mexico's poverty influence my opinion of Mexicans as a people. Any research carried out in this area would have to be sensitive to the unfortunate consequences of poverty. Researchers in any poverty stricken area should not judge a person or their community based on their living and working conditions. It is those in the direst of situations who are willing to work the hardest for their survival. It is also these people who have a difficult time considering long-term goals when their immediate future is threatened; researchers must take this fact into consideration in any educational program or study. Researchers must leave any speculations about the poor behind.

**5.5 Conclusions and Recommendations for Future Research**

This research has shown that there are many obstacles regarding the health of residents in the City of Juarez. There is a definite relationship between cultural-social behaviour, environmental contamination, poverty, and the city's infrastructure. I put forth several recommendations that can be drawn from this research. These include:

1. a need to improve the disease surveillance system,
2. a need to facilitate the flow of information nationally and internationally;
3. a need to standardize and update health care records;
4. a need to update the technology used in the health care system;

5. a need to promote the use of dry latrines;
6. a need for continued investigation of the effects of black waters on food;
7. a need to monitor and regulate chemical contamination;
8. a need to investigate the possibility of cross-contamination in the aquifer;
9. a need for continued education, which is not affected by political changes.

Given these recommendations there are many possibilities for future research, some of which have already been recommended. It would be interesting, given the poverty, to see how residents manage to pay for health care, in other words, what must they forfeit for the sake of treatment. What do residents not go see the doctor for, even though they know or believe they should seek treatment? Does it differ among men, women and children? What do residents consider an important health threat, and what services are they willing to pay more for? If residents cannot afford a doctor's fee or treatment costs, what are their alternatives?

While Mexican health, educational and environmental authorities are dealing with an insufficient budget, they are at the same time trying to prioritize pressing health concerns enveloped in political pressure, while also contending with foreign misconceptions about their commitment to environmental and health betterment as well as their academic competence and capacity for progress. Mexico is struggling to make the transition from a "developing" country to a "developed" nation, and is caught in a tangled web where it produces academics with the knowledge and the will to tackle its many environmental and health challenges, yet the responsible institutions and organizations are lacking the funding and support necessary to implement the changes which would improve the environmental and living conditions, affording preventive

rather than curative measures. This is the result of complex core-periphery relationships within Mexico and between Mexico and other countries, as well as multi-faceted internal social, political and economic relationships. While there is a current lack of academics capable of handling both the social and scientific aspects of the environmental and health problems, the academic facilities are in place to produce future generations of these specialists. Mexico's academic strengths may not be evident because of the lack of Mexican information flowing to foreign countries as well as unfavourable and uninformed foreign studies which are quick to assign blame over decreasing resources, increasing environmental pollution and related health and social problems.

Those most affected by all these challenges are the children, future adult residents of the border, who must cope with a lifetime of environmental and health uncertainties due to early exposure. The situation has progressively worsened since the appearance of the first *maquiladora* back in the 1960s, which initiated a mass movement of people, forever changing the social and physical landscape of the northern Mexican border.

Informed and effective policies and regulations are dependent upon the knowledge and understanding of the effects of environmental hazards on children's health. Therefore, in order to assure children's protection, a major priority of future environmental research will have to include children as a susceptible, high-risk population (Weaver 1998). Any future study should contribute to the development of the health care system in the border region in general and improving access to quality health care because ultimately research should be about enhancing the quality of life. It is a shame that despite so many advancements in technology and health science, there are people still dying of very preventable diseases, such as diarrheal disease.

**Appendix A: Sample of Research Questions for Health and Environmental Specialists:**

**PART ONE: THE ENVIRONMENT OF CIUDAD JUAREZ**

1. WHAT IS THE INFLUENCE OF THE GEOGRAPHY OF CIUDAD JUAREZ ON ENVIRONMENTAL CONTAMINATION?
2. WHAT IS THE INFLUENCE OF INDUSTRIAL GROWTH OF CIUDAD JUAREZ ON ENVIRONMENTAL CONTAMINATION?
3. WHAT IS THE INFLUENCE OF POPULATION GROWTH OF CIUDAD JUAREZ ON ENVIRONMENTAL CONTAMINATION?
4. OVERALL, WHAT ARE IN YOUR OPINION, THE BIGGEST CHALLENGES FACING THE PRESERVATION AND WELL-BEING OF THE ENVIRONMENT OF CIUDAD JUAREZ?

**PART TWO: WATER**
**GENERAL**

1. WHAT IS THE INFLUENCE OF THE GEOGRAPHY OF CIUDAD JUAREZ ON WATER QUALITY AND QUANTITY? PLEASE INCLUDE THE INFLUENCE OF TOPOGRAPHY, CLIMATE AND PRECIPITATION.
2. WHAT IS THE INFLUENCE OF INDUSTRIAL GROWTH ON WATER QUALITY AND QUANTITY?
3. WHAT IS THE INFLUENCE OF POPULATION GROWTH ON WATER QUALITY AND QUANTITY?

**TECHNICAL**

1. WHERE DOES CIUDAD JUAREZ DRAW ITS WATER FROM?
2. WHAT IS THE DISTRIBUTION METHOD FOR WATER FOR CIUDAD JUAREZ? (HOW DOES THE WATER REACH THE RESIDENTIAL AREAS)
3. ARE THERE WATER SHORTAGES?
4. IF SO, WHY DO THEY OCCUR?
5. HOW DOES RESIDENTS DEAL WITH WATER SHORTAGES?
6. PLEASE EXPLAIN 'TANDEOS'.
7. HOW IS THE WATER OF CIUDAD JUAREZ TREATED FOR CONTAMINANTS?
8. WHAT CONTAMINANTS DOES CIUDAD JUAREZ TREATMENT FACILITIES TEST FOR?
9. HOW ARE THE SAFETY STANDARDS SET FOR WATER CONTAMINATION AND DRINING WATER?
10. DO WATER SOURCES, SUCH AS WELLS AND WATER TANKS, TEST POSITIVE FOR UNSAFE LEVELS OF CONTAMINANTS CONTAMINENTS?
11. IF SO, HOW OFTEN?
12. HOW MUCH DOES WATER COST?

13. WHAT HAPPENS OF SOMEONE DOES NOT PAY THEIR WATER BILL?
14. WHAT DOES THE MEXICAN CONSTITUTION SAY ABOUT WATER AND WATER CONSUMPTION FOR RESIDENTS (PERSONAL USE)?

**PART THREE: HUMAN HEALTH**

1. WHAT IS THE BIGGEST CHALLENGE IN REGARDS TO THE HEALTH OF CHILDREN IN THIS AREA?
2. DO YOU BELIEVE THAT ENVIRONMENTAL CONTAMITION HAS AN AFFECT ON HUMAN HEALTH? PLEASE EXPLAIN.
3. IS THERE A RELATIONSHIP BETWEEN WATER CONTAMINATION AND RATES OF DISRRHEAL DISEASE IN CHILDREN? PLEASE EXPLAIN
4. WHAT ARE THE CHALLENGES FACED BY THE PUBLIC HEALTH CARE SYSTEM IN CIUDAD JUAREZ?
5. IS BREAST-FEEDING ENCOURAGED IN HOSPITALS AND HEALTH CARE EDUCATION?

**Appendix B: List of Participants, Ciudad Juarez 2001**

| | |
|---|---|
| **Dr. Victoria Garza** | **Autonomous University of the City of Juarez, Head of the Environmental Health Department** |
| **Maria de Rosiaro Diaz** | **Autonomous University of the City of Juarez, Department of Engineering** |
| **Dr. Thomas Kretzschmar Steinle** | **Autonomous University of the City of Juarez, Department of Engineering** |
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