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The impact of climate change on health inequities in Mexico City

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The impact of climate change on health inequities in Mexico City

ABSTRACT

Mexico City has the highest living standards of the country. However, it is also among the areas with the greatest disparities. “Benito Juarez” and “Milpa Alta” are the city’s richest and poorest boroughs respectively, and an inverse relation between income per capita and health status is evident. In addition, Mexico faces a major threat: climate change. Many authors have emphasized that the impacts of climate change will vary greatly between different social groups depending on their socioeconomic status and geographic location, and that they will fall mainly on the poor, exacerbating health inequities. However, it is not clear how this occurs. Potential pathways in which climate change could increase health inequity are described.

This project looks deeper into the causes of health inequities and the potential impact of climate change on health inequities in Mexico City, by comparing these two boroughs. Each borough has strengths and weaknesses in the face of climate change. Therefore, defining if climate change could exacerbate or not current health inequities, is not as straight forward as it is normally stated. The richest borough could be more vulnerable than one might think, and a reduction of health inequities could potentially be a consequence of climate change. Policy and research implications for Mexico City are discussed.

ACKNOWLEDGEMENTS

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In addition, I would like to thank all my professors from the Masters in Global Health and Development at University College London, who provided me with an interdisciplinary view of health, essential to address this topic; my personal tutor, Mike Rowson, who constantly challenged me throughout the course; my project supervisor, Anthony Costello, for his time and comments; Carlos Grijalva, for his personal and professional support through the development of this thesis; and Antonio Sarmiento, for being the link to the academic world in Mexico, especially on the topic of climate change.

Finally, to my country (Mexico) and its people, who are the reason why I selected this Masters and the topic of my dissertation. I am looking forward to going back and return all that it has given me to me throughout my life.

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ABBREVIATIONS AND TRANSLATIONS

CEFP – Centro de Estudios de las Finanzas Públicas (Centre for the Study of Public Finance)

CIA – Central Intelligence Agency

CICC – Comisión Intersecretarial de Cambio Climático (Interministerial Commission on Climate Change)

COESPO – Consejo Estatal de Población (State Population Committee)

CONAGUA – Consejo Nacional del Agua (National Water Council)

CONAPO – Consejo Nacional de Población (National Population Committee)

CONEVAL – Consejo Nacional de Evaluación de la Política de Desarrollo Social (National Committee for Evaluation of Social Development Policy)

EVALUADF – Consejo de Evaluación de Desarrollo Social del Distrito Federal (Evaluate Mexico City. Mexico City's Committee for Evaluation of Social Development Policy)

FDI – Foreign direct investment

GDF – Gobierno del Distrito Federal (Mexico City's Government)

GHG – Greenhouse gas

ICYTDF – Instituto de Ciencia y Tecnología del Distrito Federal (Mexico City's Institute for Science and Technology)

IIED – International Institute for Environment and Development

INEGI – Instituto Nacional de Estadística y Geografía (National Institute of Statistics and Geography)

IPCC – Intergovernmental Panel on Climate Change

JSTOR – Journal Storage

NCD – Non-communicable disease

PAHO – Pan American Health Organization

Salud Pública de México – Mexico's Journal of Public Health

SEMARNAT – Secretaría de Medio Ambiente y Recursos Naturales (Ministry of Environment and Natural Resources)

PROCAMPO – Programa de Apoyos Directos al Campo (Program of Direct Support to Agriculture)

SINAIS – Sistema Nacional de Información en Salud (National Health Information System)

SMADF – Secretaría de Medio Ambiente Distrito Federal (Mexico City's Ministry of Environment)

SSDF – Secretaría de Salud del Distrito Federal (Mexico City's Ministry of Health)

UHI – Urban heat island effect

UNDP – United Nations Development Programme

UN-HABITAT – United Nations Human Settlements Programme

WMCCC – World's Mayors Council on Climate Change

WHO – World Health Organization

INTRODUCTION

Social and health inequities between and within countries are widespread and growing (WHO 2008). Mexico is no exception (Martinez 2009, UN-HABITAT 2010). Despite being among the largest economies in the world (CIA 2012) and having a high human development index (UNDP 2011a), Mexico is one of the most unequal countries (UNDP 2011b) and in 2010 more than 50% of its population was living below the national poverty line (World Bank 2012). This is having an enormous impact on people's health (Gonzalez-Perez et al 2008).

Mexico City is Mexico's capital, located within the Mexico City Metropolitan Zone, one of the largest and most densely populated areas in the world (Figure 1) (UN-HABITAT 2010). Mexico City contains 25% of the country's economic activity and is, on average, the entity with the highest living standards. However, it is also among the areas with the greatest disparities in income and opportunities (Ibarraran 2011). Benito Juarez and Milpa Alta are Mexico City's richest and poorest boroughs respectively, where an inverse relation between income per capita and health status is evident: Benito Juarez has almost four times Milpa Alta's income per capita while Milpa Alta has twice the infant mortality rate of Benito Juarez (CEFP 2009, SSDF 2010a).

Fig.1 Mexico City as part of the Mexico City Metropolitan Zone. Adapted from Policía DF (2012), COESPO (2010).

In addition Mexico, like other countries, confronts one of the major global health challenges: climate change (Costello et al 2009). Without much progress in the climate change negotiations and with an uninterrupted rise in greenhouse gas (GHG) emissions, the average global temperature will likely exceed the safe threshold of 2 degrees by 2050, placing human health and survival at high risk (Friel et al 2011a & 2011b). Some suggest that this "safe" threshold could be even lower (Turney & Jones 2010).

Mexico City, as part of a megacity, is especially vulnerable to climate change and an increase in frequency and severity of heat waves, drought and storms have been projected (Ibarraran 2011). This could lead to serious social and health impacts, including: heat related morbidity and mortality; food and water insecurity, malnutrition and communicable diseases; floods, landslides, injuries and death; exacerbation of air pollution and cardiovascular and respiratory diseases; risks to mental health; as well as

loss of livelihoods, population displacements, conflict and social unrest (IPCC 2007b, Costello et al 2009, Moser & Satterthwaite2010, SMADF 2012).

Furthermore, it has been suggested that these effects will vary greatly between different social groups depending on their socioeconomic position and/or geographic location and that they will cluster mainly among the poor further exacerbating current health inequities (IPCC 2007b, Costello et al 2009, Moser & Satterthwaite 2010, Friel et al 2011b, Vargas et al 2011, Riojas et al 2011, Bowen & Friel 2012). They argue that the worse social, economic and health status of the poor makes them less resilient to the impacts of climate change. However, it is still unclear how climate change could exacerbate health inequities (Friel et al 2011b).

Internationally, the Global Research Network on Urban Health Equity has expressed the need for more research and action on this topic in low- and middle-income countries (Friel et al 2011a). Mexico's government, through its National Health Plan 2007-2012 and the National Strategy for Climate Change, has stressed the need to evaluate the potential health effects of climate change on different social groups and to identify those most vulnerable, in order to design and implement appropriate adaptation strategies (CICC 2007, SEMARNAT 2010).

The aim of this dissertation is to describe existing health inequities in Mexico City and explore their main determinants. Additionally, I intend to analyse and discuss the potential impact of climate change on health inequities. To this aim I will provide a comparison between the richest and the poorest borough of Mexico City using an adapted

version of the social determinants of health framework. This framework includes potential pathways through which climate change could impact health inequity. In order to apply this framework I will describe projections for the impact of climate change and its potential social and health effects; and will identify, compare and discuss strengths and weaknesses of each borough in the face of climate change. Finally, I will discuss some policy and research implications that need to be considered when targeting health inequity and vulnerability to climate change in Mexico City.

METHODS

1. Search strategy

An initial exploration in databases such as PubMed, Web of Science and Salud Pública de México with the terms: Mexico City, health inequity and climate change was done without gathering sufficient information that analyses the impact of climate change on existing health inequities in Mexico City. This suggested that a simple review of the literature would not be enough to be able to critically explore the determinants of health inequities and understand their potential connections with climate change. Instead, I had to apply an adapted version of the social determinants of health framework drawing data from different sources and reviewing the literature, which enabled me to unthread some of the causes of current health inequities and think through the potential pathways by which climate change could impact health inequity in Mexico City.

A literature search was performed through the following databases:

- **MetaLib**: a University College London resource that cross-searches multidisciplinary databases including PubMed, Scopus, JSTOR, Web of Science and the University College London library catalogue. This was the database from where I retrieved most of my articles because of the interdisciplinary nature of the topic of my thesis.
- **Redalyc**: a resource that searches scientific Latin American, Spanish and Portuguese journals. It was effective especially for the topics on inequity, poverty and climate change related to Mexico.

Grey literature including governments', national public institutions', and international agencies' reports and conference proceedings were obtained through access to national and international official websites (Appendix 1) and Google. The documents obtained were essential for this work, especially because not much academic research has been currently done.

Table 1 lists the search terms used.

Table.1 Search terms

Location	Health inequity	Climate change
- Urban - Cities	- Health inequ* - Health equ* - Inequity in health - Equity in health	- Climate change - Climate
- Mexico - Mexico City - Federal District	- Socioeconomic disparities - Socioeconomic inequ* - Socioeconomic status - Inequ*	
- Benito Juarez	- Social determinants of health	
- Milpa Alta		

These terms were truncated and combined in different ways using AND/OR to retrieve a narrower search except for Milpa Alta and Benito Juarez which were searched on their own to gather as much information as possible about them.

Table 2 lists the criteria used to select the documents in which this dissertation is based.

Table.2 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
• Academic and grey literature • Documents in English and Spanish • Documents from 1997 to retrieve as much academic literature as possible	• Full text not available • Documents before 1997 • Documents not in English or Spanish • Redundancy

A hand search of references in relevant articles and reports was performed.

To be able to apply the framework, national, entity and borough level data was needed. The main websites accessed to obtain indicators on population, health, education, housing, among others are shown on Appendix 2. Socio-economic indicators were easy to find, however, the National Centre of Epidemiological Surveillance and Disease Control had to be contacted to obtain health indicators disaggregated by borough, but still limited information was provided.

In addition, key researchers from different disciplines and nationalities were contacted to get feedback on the topic and path of the dissertation.

2. Framework for analysis – The adapted social determinants of health framework

I adapted Friel et al's (2011b) social determinants of health framework (Appendix 3) by making use of information from the Intergovernmental Panel's on Climate Change (IPCC) Fourth Assessment Report (IPCC 2007a & 2007b). I also included aspects of Martinez's

(2009) analysis of the distribution of power and how this distribution shapes public policies (See Figure 2).

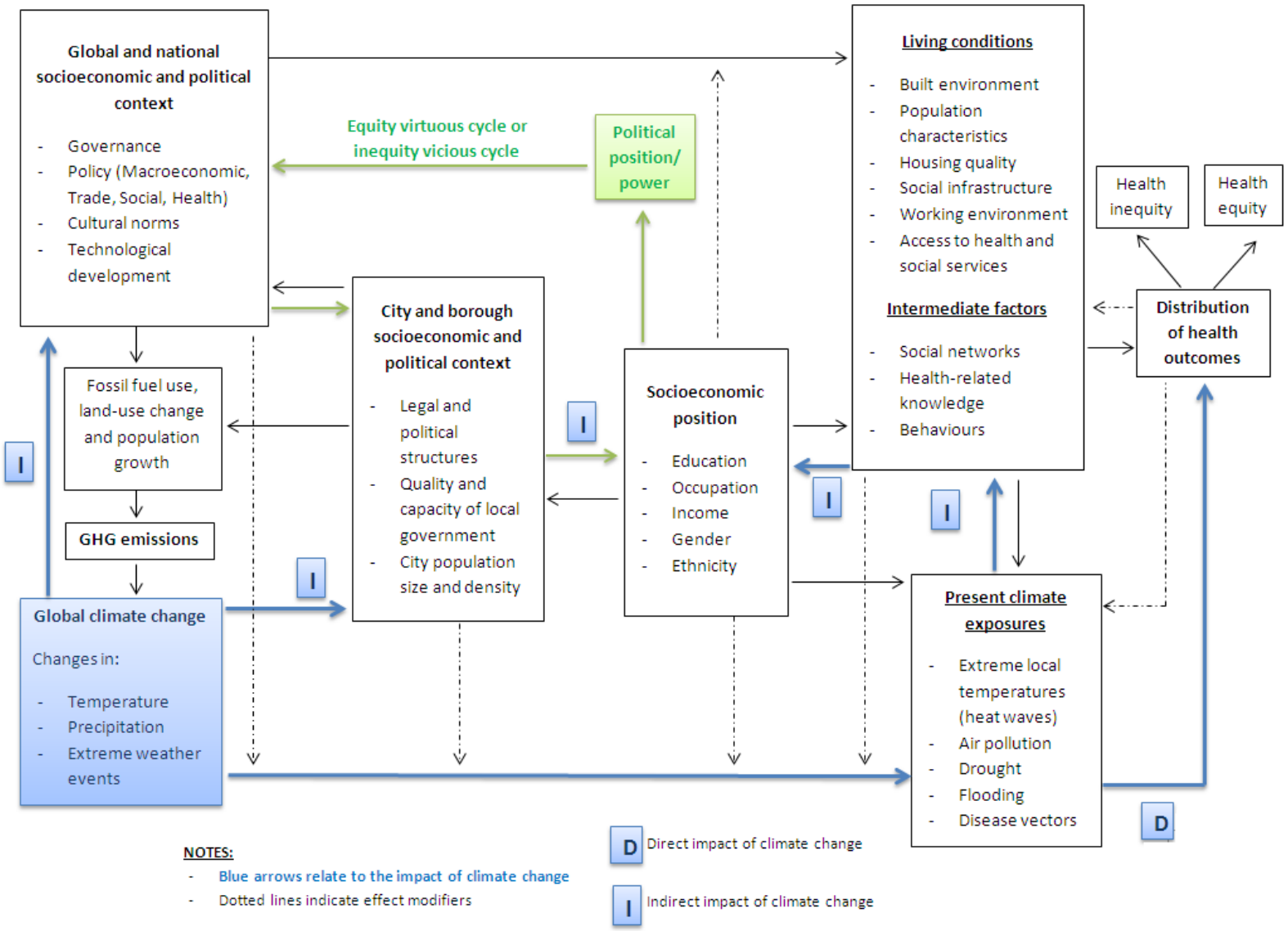

Fig.2 The adapted social determinants of health framework. Adapted from Friel et al (2011b)

This adapted version of the social determinants of health framework enables us to consider how specific determinants could influence the distribution of health in a population and their interaction with other determinants. These determinants are grouped according to the proximity with which they influence health outcomes, that is: from the local and individual level to the global and structural level.

People's health and its distribution across the population is determined by their living conditions such as their housing and working conditions, access to services, urban infrastructure, and the environment (Marmot et al 2008). Differences in these conditions are a consequence of the social and political position people/communities have in society (Friel et al 2011a). Depending on their education, occupation and income, people/communities are virtually sorted into different socioeconomic positions. Those who have a higher educational attainment, and an occupation that provides job security, employment benefits and a sufficient income for healthy living, have greater freedom to live the lives they have reason to value, and most importantly they have greater political power to intervene in decisions that affect their lives (Friel et al 2011a). In this sense, they are more able to further improve their living conditions and health outcomes by influencing policies.

Therefore, when there is a concentration of power and resources in a few, and consequently greater constraints for the poor to articulate their demands and defend their interests, policies such as those that reduce tax payments and funding of public services may be supported (Martinez 2009). This could augment social inequity and

further increase the political power of the few (Martinez 2009), leading to a potential inequity vicious cycle.

The equal/unequal distribution of education, occupation and income across the population is defined by the socioeconomic and political context at the global, national, entity and borough levels (Marmot et al 2008, Friel et al 2011a). This includes aspects such as the government's ideology and, as a result the type of social, economic and health policies implemented. While neoliberal governments are less likely to implement egalitarian policies, governments from political parties committed to egalitarian goals are more likely to act on health inequity (Muntaner et al 2012).

In addition, this framework shows potential pathways through which climate change could impact health inequity. The projected increase in the frequency and severity of heat waves, droughts, storms and floods could impact health directly or indirectly (IPCC 2007a, Friel et al 2007b). The former, by increasing heat strokes, injuries and deaths (IPCC 2007b, Friel et al 2011a); and the latter, by damaging households, public infrastructure, businesses and crops which may lead to unemployment and loss of income, and reduced access to food and water (IPCC 2007b). Furthermore, current health outcomes, living conditions, socioeconomic position and institutional capacity, may act as effect modifiers. That is: the impact of climate change on different populations will vary depending on the state of these factors making some populations more vulnerable than others (IPCC 2007b, Bowen & Friel 2012). Therefore, those in a worse social, economic and health status could be more affected, increasing health inequities (Bowen & Friel 2012).

An advantage of applying this framework is that it could show at which level health inequities and vulnerability to climate change could be more effectively tackled. This may encourage the development of policies and actions that address the root causes of these inequities and at the same time increase resilience to climate change.

3. Potential limitations and biases while carrying out the analysis

Analysing the determinants of health inequities and the potential pathways through which climate change could impact health inequity has a high level of complexity**.** Many factors which influence each other must be included; therefore, significant amounts of knowledge are needed from various disciplines. However, there is a lack of academic literature, most of the information is grey literature or comes from the government, and health data at the borough level is not easy to gather (Riojas et al 2006, Vargas et al 2011). In addition, there is a huge uncertainty when taking climate change into account (Maslin & Austin 2012).

Due to the limitations of length for this work and the lack of empirical data, I was unable to include as many factors as required to achieve a deeper analysis. I focused in comparing the richest and poorest boroughs; however, I should have analysed and compared all boroughs in Mexico City to better understand the social gradient in health within this context.

Researchers that were consulted helped clarify and deepen my understanding, and guided me towards unfamiliar factors for consideration; however there is the potential that this biased my argument.

All of these factors make the analysis less robust, imposing limits on our understanding which could lead to wrong conclusions. However, it could help identify and unravel new causal pathways and important links which could form the basis of new research and interventions and give insights into where research is needed.

DETERMINANTS OF HEALTH INEQUITIES IN MEXICO CITY

To gradually untangle the determinants of health inequities between both boroughs I will start by describing the current distribution of health outcomes, and then work my way up from the most immediate determinants of health inequities such as living conditions, to the structural determinants, which are defined by the socioeconomic and political context. I will not discuss the impact of climate change immediately but I will set the ground for it.

1. Distribution of health outcomes

Health inequities in Mexico City exist across and within the 16 boroughs of Mexico City (Caudillo et al 2010). For this case study, health inequity becomes evident when comparing infant mortality rates (Medina 2011): the poorest borough (Milpa Alta) of Mexico City has almost twice that of the richest (Benito Juarez) (20.3 vs. 11.6 per 1000 live births respectively) (SSDF 2010a). In relation to the leading causes of death in the general population, non-communicable diseases (NCDs) and injuries predominate in both boroughs, however, maternal and perinatal conditions and malnutrition are still in the top 15 causes of death in the poorest borough, consequently suffering the double burden of disease (Table 3) (SSDF 2007a & 2007b).

Table.3 Comparison of leading causes of death. Adapted from SSDF 2007a & 2007b.

	MILPA ALTA 2007 The poorest borough	BENITO JUAREZ 2007 The richest borough
1	Type 2 diabetes	Cardiovascular diseases
2	Cardiovascular diseases	Malignant tumours
3	Malignant tumours	Type 2 diabetes
4	Cerebrovascular diseases	Cerebrovascular diseases
5	Liver diseases	Influenza and pneumonia
6	Injuries	Chronic obstructive pulmonary diseases
7	Influenza and pneumonia	Liver diseases
8	Certain conditions originating during the perinatal period	Injuries
9	Suicides	Renal failure
10	Congenital malformations and chromosomal anomalies	Chronic bronchitis, emphysema and asthma
11	Malnutrition and other nutritional deficiencies	Septicaemia
12	Chronic obstructive pulmonary diseases	Gastric and duodenal ulcer
13	Renal failure	HIV
14	Chronic bronchitis, emphysema and asthma	Suicides
15	Septicaemia	Homicides

When looking at the causes of morbidity from 2006 to 2011 in the general population from data provided by Dr. Ricardo Cortés on 21 June 2012 from the National Centre of Epidemiological Surveillance and Disease Control (Appendix 4), although infectious diseases were the most common cause in both boroughs, a greater predominance was seen in the poorest. NCDs and injuries were present in both but were higher up in the list

of the richest borough. While pneumonia and asthma were important causes in the richest; malnutrition was important in the poorest. In relation to vector-borne diseases a few cases of dengue fever were found in both boroughs, however, due to the number of cases it is highly unlikely that they originated in the area.

Furthermore, in Mexico City mortality and fertility rates are decreasing, life expectancy is increasing and the population is getting older (Caudillo et al 2010). However, Benito Juarez has a greater percentage of elderly population (Figure 3) and a lower fertility rate than Milpa Alta, and is already experiencing a negative population growth (Table 4) (INEGI 2011a).

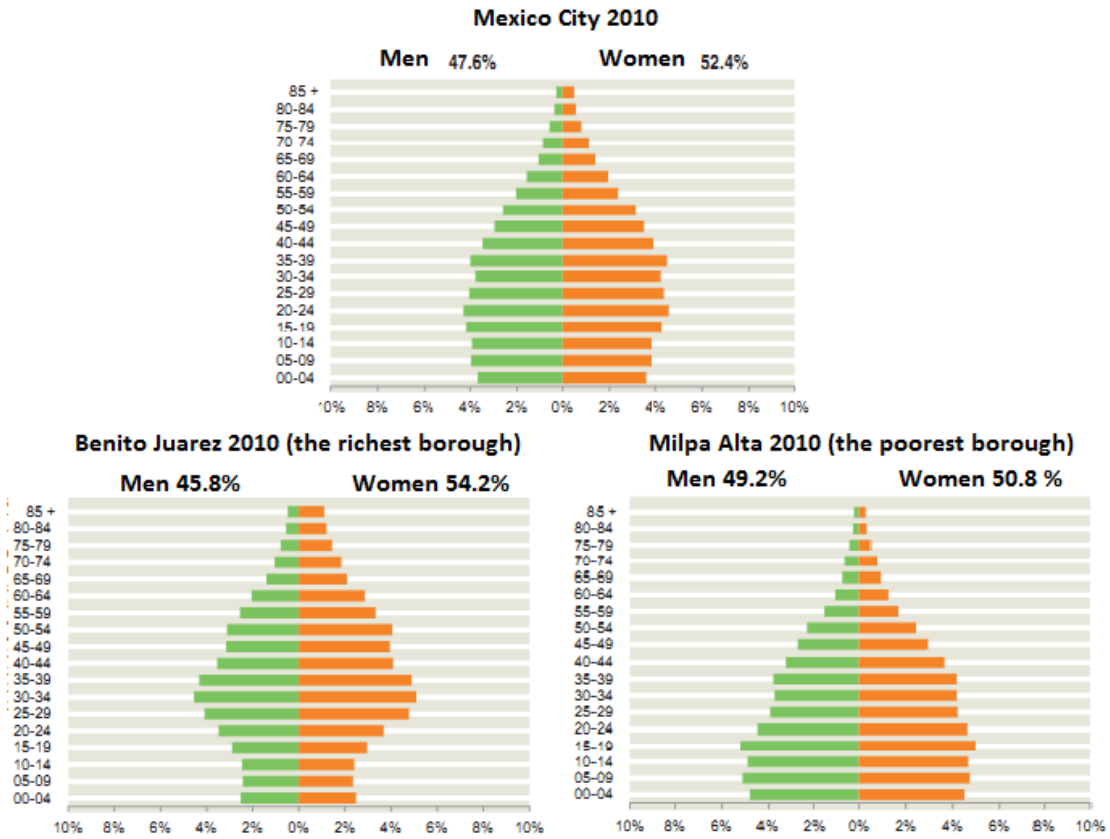

Fig.3 Population pyramids 2010. Adapted from INEGI (2011a)

Table.4 Population indicators

Indicator	Mexico City	Benito Juarez (The richest borough)	Milpa Alta (The poorest borough)
Total population (2010) (INEGI 2011a)	8,851,080	385,439	130,582
Population density (per sq. km) (2010) (SSDF 2010b)	5,904	14,666	486
Annual population growth rate (2000-2005) (INEGI 2009)	0.24 %	-0.27%	3.23%
Median Age (2010) (INEGI 2011a)	31	36	26
Fertility rate (average number of children per woman) (2005) (INEGI 2009)	1.39	0.88	1.76
Life expectancy (2012) (INEGI 2012d)	76.5	No data available	No data available
Standardized mortality rate (2008) (per 1,000 inhabitants) (SINAIS 2012)	6.2	No data available	No data available

With these data we could conclude that Benito Juarez is in an advanced stage of the epidemiologic and demographic transition compared to Milpa Alta. That is: NCDs take over the majority of the disease burden (Stevens et al 2008), and it has an older population and a negative population growth. The immediate causes of these differences in health are the conditions in which people are born, grow, live, work and age (WHO 2008).

2. Living conditions

Mexico City is "located in a closed basin on the flat bed of what was once a series of lakes" surrounded by mountains and volcanoes (Figure 4) (Connolly 2003 p.4). It has no natural drainage outlet and has a relatively high annual rainfall. This and the overexploitation of

aquifers under the city, makes it vulnerable to flooding, subsidence and earthquakes (UN-HABITAT 2010, ICYTDF 2011). Furthermore, Mexico City is one of the most densely populated cities (CEFP 2009, Ibarraran 2011) and is already a water-stressed region having to import a third of the water it consumes (IIED 2007, Ibarraran 2011). In addition, it has one of the highest levels of air pollution in the world and is a major GHG emitter (UN-HABITAT 2011).

Fig.4 Sketched map of Mexico City at the time of the Spanish Conquest (Libre en el sur 2010).

When looking at the borough level, Benito Juarez is one of the smallest and the most densely populated borough in Mexico City, having almost 30 times Milpa Alta's population density (SSDF 2010b, INEGI 2012b). As part of the city centre and being totally urbanized it has greater access to services and public transport than the poorest borough, however

only 4.5% of its land is covered by green spaces (SMADF 2010, INEGI 2012b). Due to its location, where the lakes once existed, it is at high risk of flooding, subsidence and earthquakes (Figure 5) (Benito Juarez 1997).

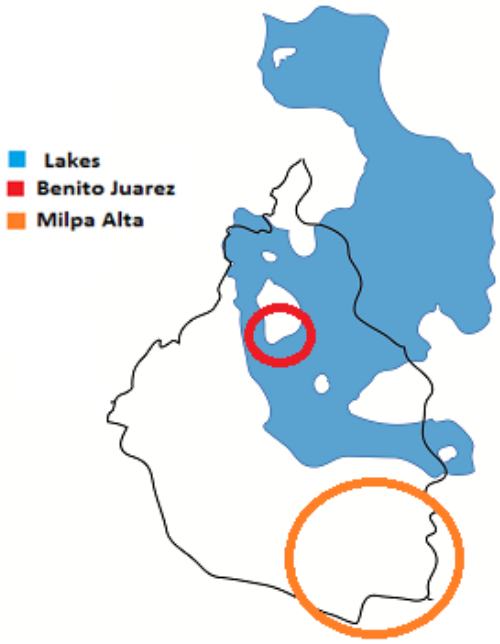

Fig.5 Approximate location of lakes at the time of the Spanish Conquest. Adapted from Conolly (2003).

In contrast, Milpa Alta is one of the largest boroughs (INEGI 2012c), it is located on the outskirts of the city and 100% of its surface is considered conservation land (INEGI 2012c). Only 10% of its land is urban; 40% is cultivated- and pasture-land; and 50% is covered by forest**.** It is situated at a higher altitude than the richest borough and has a high risk of landslides (Milpa Alta 2008). Due to the lack of roads and public transport it has a low mobility capacity consequently having fewer opportunities to access jobs and services, and possibly encountering higher prices of goods such as food (Villarreal 2006).

In terms of climate, both boroughs are temperate regions, however, Milpa Alta has a lower temperature and a higher precipitation especially in the forest area (Table 5) (INEGI 2012b & 2012c).

Table.5 Climate indicators (INEGI 2012b & 2012c).

Indicator	Benito Juarez (The richest borough)	Milpa Alta (The poorest borough)
Altitude (meters above sea level)	2200-2300	2200-3600
Temperature range	12-18°C	6-16°C
Precipitation range	600-899 mm	700-1600 mm
Climate	Temperate sub-humid with summer rains	Temperate sub-humid with summer rains and medium cold with rain ranging from average to abundant

Temperatures in Mexico City have increased in the past decades, being greater in Benito Juarez than in Milpa Alta, and at least half of this rise can be explained by the urban heat island (UHI) effect (Romero 2010, Graizbord et al 2011). The UHI effect is caused by the lack of shade and vegetation, and to the presence of dark road and building surfaces (Friel et al 2011b). In addition, the frequency of heat waves has doubled in Mexico City from six to 16 events per decade during the second half of the twentieth century (Jauregui 2009).

Annual rainfall and extreme precipitation events have also augmented in Mexico City; the latter which has increased from one or two to six or seven per year during the twentieth century (Romero 2010). Although Milpa Alta has a higher annual rainfall, Benito Juarez has a greater number of extreme precipitation events per annum (Figure 6) (Graizbord 2011).

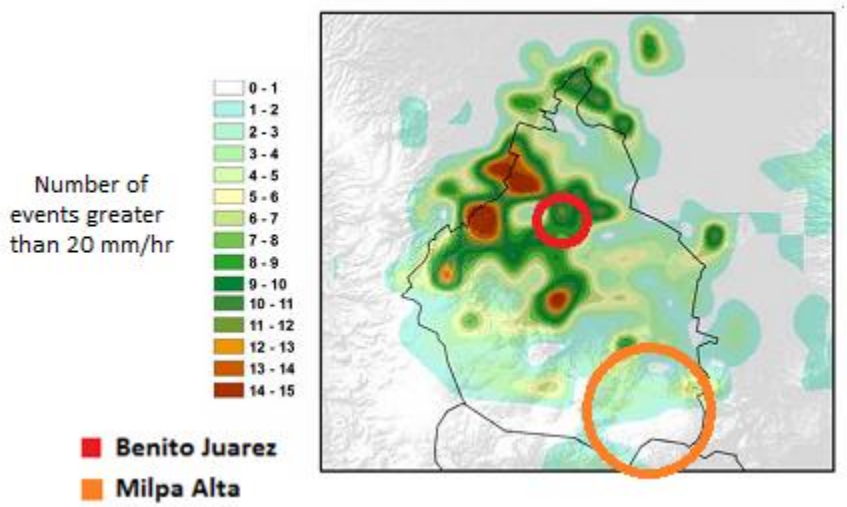

Fig.6 Mexico City's average annual extreme precipitation events. Adapted from Graizbord (2011).

When looking at more immediate determinants of health such as housing conditions and access to services, the richest borough has the best of the city and the poorest has the worst (Table 6) (CONAPO 2010, CONEVAL 2010). 25% of the households in Milpa Alta have precarious roofs and although 90% have access to piped-water, an important part of its population may still be water insecure because of their lower water supply (Figure 7) and water storage capacity (CONAPO 2010, INEGI 2011a & 2011b). In addition, they own fewer assets (INEGI 2011b), for example, 30% of the households have no refrigerator, with the consequent effect on food-borne diseases. Health-care coverage is also lower in Milpa Alta (46% of the population is uninsured vs. 24% in Benito Juarez), therefore they encounter a greater economic barrier when accessing health-care (CONEVAL 2010, McIntyre et al 2006).

Table.6 Housing and services indicators

Indicator	Benito Juarez (The richest borough)	Milpa Alta (The poorest borough)
Overcrowding (CONAPO 2010)	8%	43%
Floor made of soil (CONAPO 2010)	0%	4%
Households with precarious roofs (INEGI 2011b)	3%	24%
Household built by the family (INEGI 2011b)	8%	48%
Households with piped-water (CONAPO 2010)	99%	89%
Households with inside piped-water (INEGI 2011a)	98%	53%
Households with water tanks (INEGI 2011b)	88%	69%
Households with drainage (CONEVAL 2010)	99%	86%
Households with electricity (INEGI 2011b)	100%	99%
Households with electricity meters (INEGI 2011b)	95%	50%
Households with gas stoves (INEGI 2011b)	97%	96%
Households with wood stoves (INEGI 2011b)	1%	8%
Households with water heater (INEGI 2011b)	95%	48%

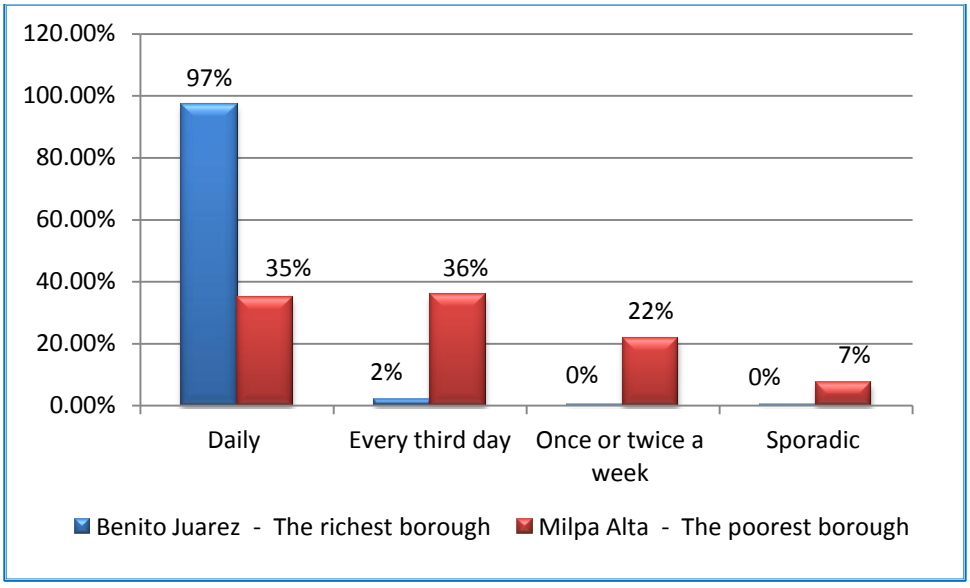

Fig.7 Household piped-water supply. Elaborated with data from INEGI (2011b).

In sum, factors such as Milpa Alta's environment and their lower exposure to higher temperatures and extreme precipitation events may favour its population's health when compared to Benito Juarez. In addition, they could be less exposed to air pollution, which may be evident by the lower importance of pneumonia and asthma as causes of morbidity (Teran et al 2009, Romieu et al 2002, Neupane et al 2010). However, their lower mobility capacity, and worse housing conditions and access to services compared to Benito Juarez, may act against its population's health. All of these factors are in turn determined by people's/boroughs' socioeconomic position.

3. Socioeconomic position

People's socioeconomic position depends mainly on three factors: educational attainment, occupation and income.

Although most of the population in both boroughs are literate, almost 60% of the richest borough's population have a university degree. This is only the case of 14% in the poorest borough, where basic education predominates (Figure 8) (INEGI 2011a). A higher educational attainment has been correlated with improved health because it provides access to better work and economic conditions, and greater health-knowledge enabling individuals to live healthier lifestyles (Salgado et al 2011).

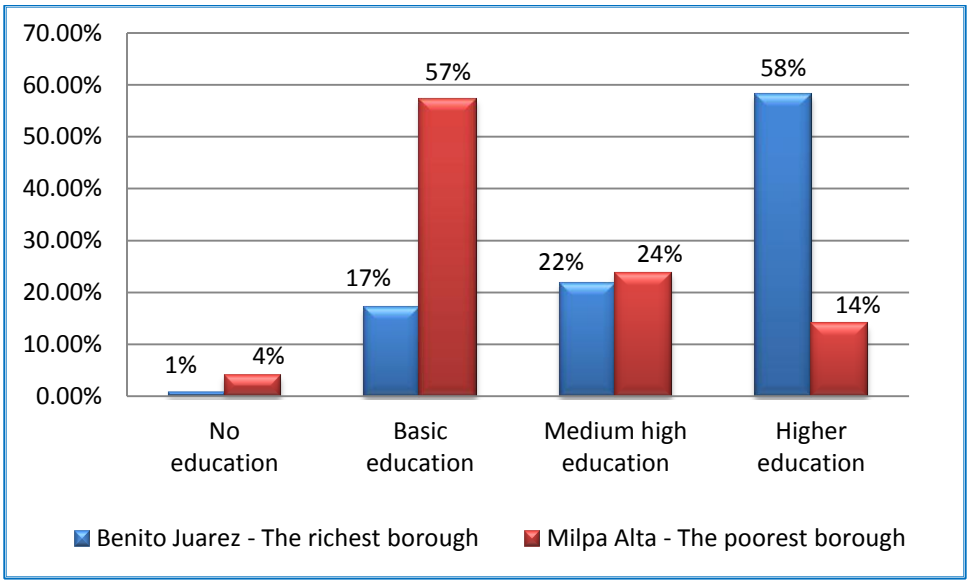

Fig.8 Educational attainment. Elaborated with data from INEGI (2011a)

In terms of occupation, most of Benito Juarez's population are white-collar workers (Figure 9) (INEGI 2012b). Therefore they are better paid, are entitled to employment benefits, have greater job security and greater control over their work tasks. In contrast, people in Milpa Alta are agricultural workers, industrial workers, merchants, or work as security guards or drivers (INEGI 2012b). These jobs have worse employment conditions and they expose workers to excessive heat due to outdoor activities or to indoor jobs in confined areas (Friel et al 2011a). Furthermore, many have to combine their activities with other occupations to supplement their income (Torres-Lima & Burns 2002, GDF 2007), and due to the lack of investment in agriculture and in local employment 50% work in other boroughs, increasing travel times and costs (Conolly 2003, Villarreal 2006, GDF 2007). All of these factors contribute to a greater physical and mental fatigue which impacts labour productivity and health, becoming a barrier to improve their living conditions (Villarreal 2006, Salgado et al 2011,Friel et al 2011a).

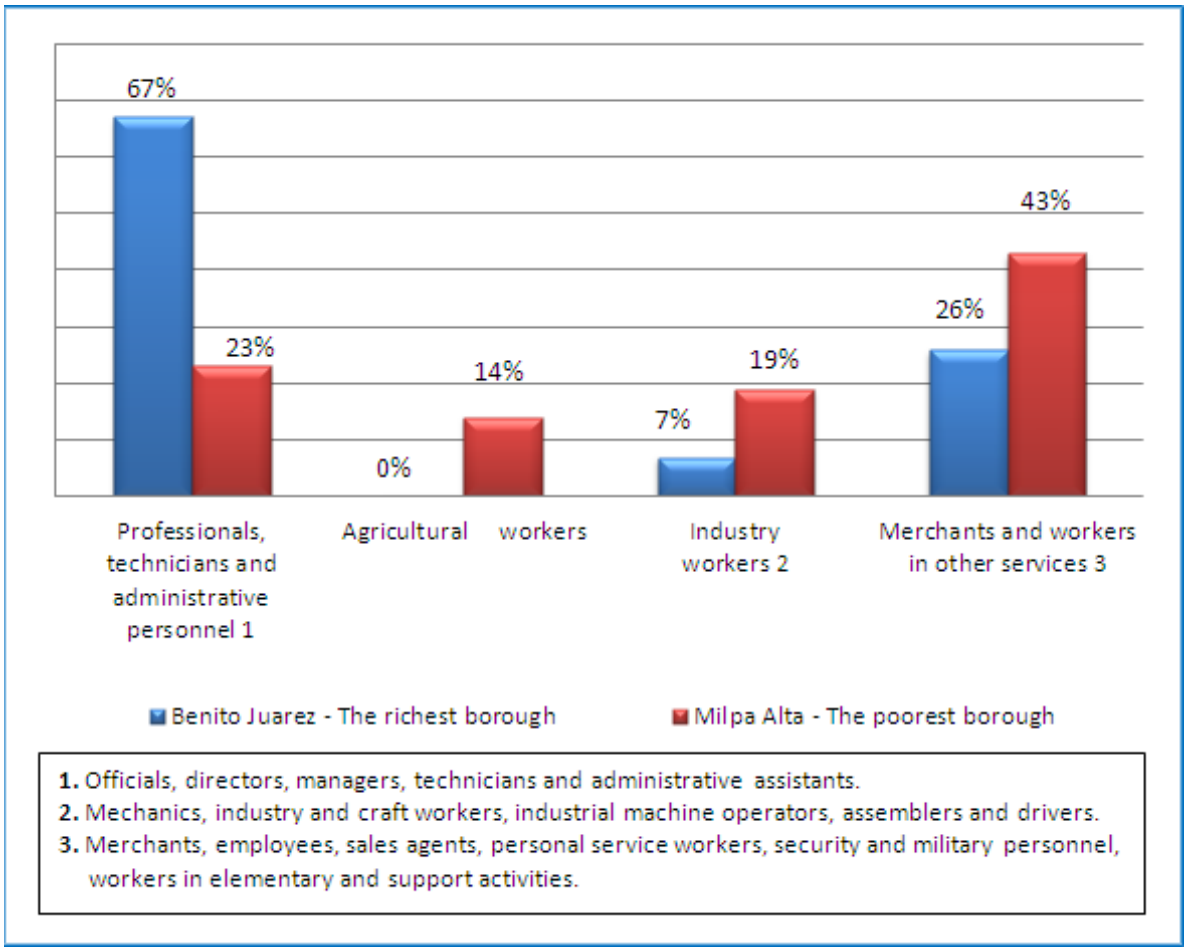

Fig.9 Employed population according to occupation. Elaborated with data from INEGI 2011b

As a result of Benito Juarez's population higher educational attainment and better employment conditions, 72% of the its population earn more than two minimum wages, whereas this is only 37% in the poorest borough (Table 7) (INEGI 2011b). A higher income has been correlated with an advanced stage in the epidemiological transition, as seen in this case study (Rydin 2012). However, although Milpa Alta has a greater percentage of its population living in poverty, Benito Juarez has a higher poverty concentration (number of poor people per sq km) (CEFP 2009, Vargas et al 2011).

Table.7 Income and poverty indicators.

Indicator	Mexico City	Benito Juarez (The richest borough)	Milpa Alta (The poorest borough)
Income per capita in pesos (2005) (CEFP 2009)	$ 15,229 (1081 dollars)	$ 27,824 (1976 dollars)	$ 7,689 (546 dollars)
Population that earn more than two minimum wages (INEGI 2011b)	60%	72%	37%
Food poverty (2005) (CEFP 2009)	5%	0.5-3%	10%
Capability poverty (2005) (CEFP 2009)	No data available	1-5%	18%
Asset based poverty (2005) (CEFP 2009)	32%	0-6%	39-47%

Therefore, as evidenced by this case study, a higher socioeconomic position, such as that of Benito Juarez compared to Milpa Alta, is correlated with improved living conditions and better health outcomes (Rydin 2012, Salgado et al 2012, Friel et al 2011a). This also reflects the greater constraints of the poorest borough's population to articulate their demands and defend their interests. The unequal distribution of the levels of education, employment conditions and income across the population is in turn the result of the socioeconomic and political context.

It is important to mention that the data given above hide social and health inequities within boroughs as seen on Figure 10. A correlation has been found between worse levels of social development (education, health and housing conditions) and lower levels of income (EVALUADF 2006). Furthermore, specific populations such as women, indigenous population, and people with disabilities, have less access to education (except for women) and a decent employment, lower incomes and therefore a lower socioeconomic position,

which impacts their living conditions and health outcomes (GDF 2007, INEGI 2011a, UNDP 2009).

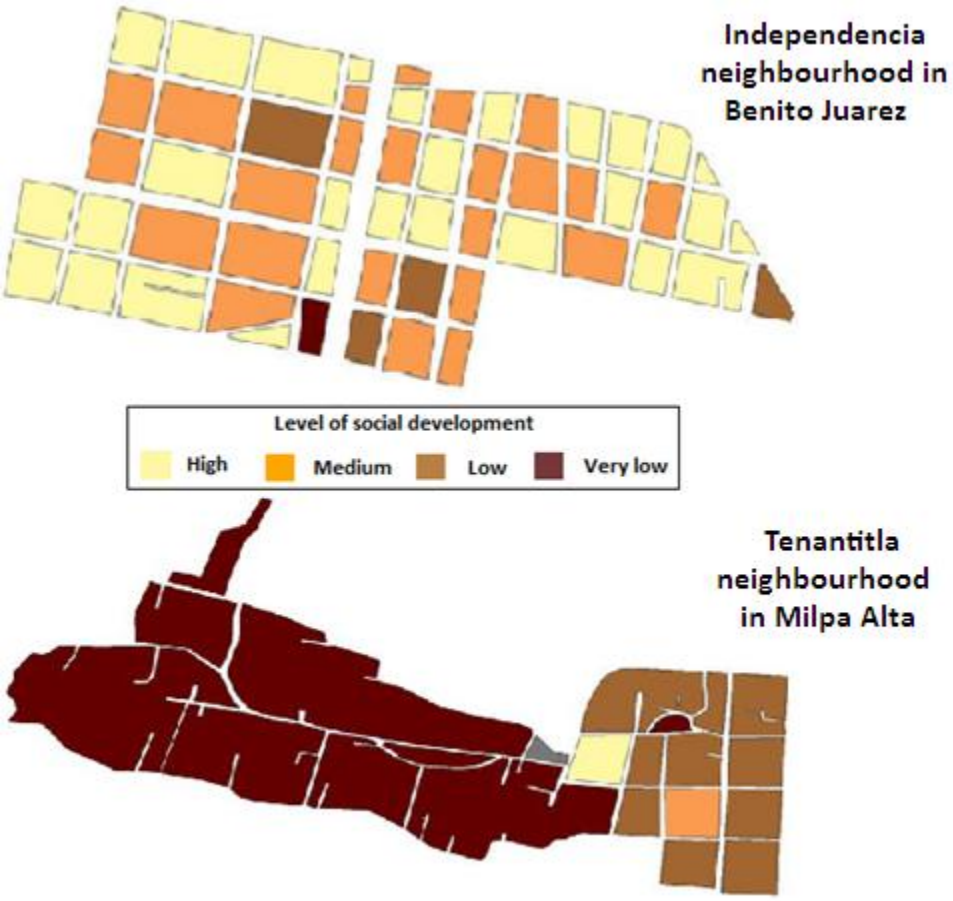

Fig.10 Level of social development in a neighbourhood from Benito Juarez and one from Milpa Alta. Adapted from EVALUADF (2006).

D. Socioeconomic and political context

a. Economy

Due to an unprecedented fiscal crisis, the 1980s was the era in which Mexico abruptly and "forcedly" substituted economic nationalism for a free-market economy (Conolly 2003).

Structural adjustment policies, which aimed to achieve accelerated economic growth by reducing public spending, privatizing public services, minimizing the role of the State and increasing free trade, were adopted in exchange of loans from international financial agencies (WHO 2012). These policies have had enormous impacts affecting population's health and increasing social inequities (Laurell 2003, Franco-Giraldo et al 2006, WHO 2012).

Since then, the private sector has expanded and foreign direct investment (FDI) augmented (CIA 2012). Although FDI is considered an engine of economic growth by creating more jobs and increasing exports (CEFP 2009), FDI worsens inequity (Angeles-Castro 2011). For example, even though Mexico City is the entity with the highest levels of FDI, it is also one of the most unequal entities in the country where income inequalities are increasing and more than half the population has an income below 4.1 dollars a day (CEFP 2009, Romero 2010, UN-HABITAT 2010, Ibarraran 2011). Furthermore, resting the economy on exports could increase the country's external vulnerability, as it happened in 2009, when Mexico's GDP dropped by 6.2% as global demands for exports plunged and investment declined (CIA 2012).

In addition, whereas most of the city's GDP is produced by the service sector, a declining primary sector contributes to less than 5% (CEFP 2009, INEGI 2012a). This favours the richest borough, where the service sector is predominant, and affects the poorest borough, which is one of the major agricultural and livestock producers of the city (INEGI 2012a).

b. Governance and public expenditure

Mexico is immersed in a globalized world. Many local decisions on healthcare, education, employment, economics and food supply are increasingly being determined by the global sphere (Friel et al 2011a). Health and education, among other Constitutional rights, are constantly being threatened by international financial agencies' recommendations such as those mentioned above (Franco-Giraldo 2006, WHO 2012). The present national government seems to be in agreement with these recommendations by maintaining a neoliberal policy (Laurell 2003).

In contrast, the Mexico City government has aimed for a more redistributive social policy (Laurell 2003). Yet, this has not been enough to counterattack neoliberal policies because even with macroeconomic stability and high governance, FDI does not benefit income distribution (Angeles-Castro 2011). In addition, although there has been a process of decentralization, the federal government has control over the city's budget (Conolly 2003). While the federal government receives 74% of the tax revenues, the Mexico City government only receives 13% (Romero 2010). This leads to the following paradox: more responsibilities are delegated to the local government but they lack the resources to undertake effective policies (Romero 2010). However, within its possibilities to reduce inequities, the Mexico City government has been unsuccessful. In 2005, the populations with the lowest human development index which included Milpa Alta, concentrated 32.6% of the development needs of the city and only received 20.9% of the budget, placing this city as the most inequitable entity in the allocation of expenditure in Mexico (UNDP 2011b).

In terms of education, federal expenditure has distributions assigned in inverse proportion to the educational needs of people, privileging those with higher income (UNDP 2011b). Therefore, schools that are attended by the poor tend to be inadequately equipped and their teachers have less education and experience (UNDP 2011b).

When looking at Mexico's health system, which is segmented into public services for the uninsured, the social security system and the private system without a real articulation between them (SSDF 2004); it is also unequal and regressive. The federal public expenditure per beneficiary is 50% more for the insured than for the uninsured (Tamez & Valle 2005, UNDP 2011b).

To this effect in 2001, Mexico City's government initiated, as the first step to achieve universal coverage, the "Program of Free Health Care and Drugs" for the uninsured. With this programme, people have unlimited access to all the interventions and drugs that are provided by the local health services (Laurell 2003).

Instead, the federal government initiated a partially subsidized voluntary health insurance also aimed at the uninsured, called "Popular Health Insurance". This insurance covers certain interventions and drugs and only people in the fifth income quintile and above have to pay an annual fee (SSDF 2011). A sufficient amount of resources to cover the health-care demand will be difficult to attain, making this programme likely to collapse (Laurell 2007). This is due to two factors: firstly, the poorest, for whom the insurance is free, have worse health and therefore greater health-care needs; and secondly, those who are not poor but willing to pay, are the ones whom consider themselves at high risk to

become ill, in contrast to those who believe they are at low risk and will very likely not pay (Wonderling et al 2005). A high usage of health services by both groups might be the result, but the resources gathered will possibly not be enough to cover it (Wonderling et al 2005). In this sense, the Popular Health Insurance is in line with neoliberalism, looking at health-care as a private good and not as a social right (Laurell 2007). Therefore, the lack of a strong initiative at the national level that integrates the various institutions and existing health services into a single national system creating the sufficient risk/fund pooling to provide a free universal health-care will limit the city's initiative (Laurell 2003).

Finally, various subsidy and cash transfer programmes have been implemented by the federal government, in addition to the general tax. These are aimed to compensate the effects of a free market economy on people's living conditions and health, and to reduce inequity by redistributing income (UNDP 2011b). Although in general they seem to benefit the poorest borough greater (INEGI 2012a, 2012b & 2012e), within populations, almost all of these programmes have been found to be regressive, benefiting those with higher income and rarely reaching the poorest (Table 8) (UNDP 2011b).

Table.8 Cash transfers, subsidies and general tax.

Programme	Aim	Beneficiaries in Benito Juarez (The richest borough)	Beneficiaries in Milpa Alta (The poorest borough)	Progressive or regressive (Data from UNDP 2011b)
PROCAMPO – Direct rural support programme (INEGI 2012a)	Cash transfer mechanism that aims to compensate agricultural producers for the subsidies that are given to foreigner producers.	0	450 producers	**REGRESSIVE**: The 20% largest producers concentrate 60% of the resources of the programme.
Liconsa (INEGI 2012a & 2012b)	Improve nutrition levels by supporting asset-based poverty families with subsidized food.	3.6% of families	37% of families	**REGRESSIVE**: The benefits of this programme are concentrated in the middle-income class.
Oportunidades (Palmer 2004, INEGI 2012e)	A conditional cash transfer program that aims at improving health, nutrition and education of poor families.	0	10% of the families	**PROGRESSIVE**: The only program that reduces inequity by assigning larger transfers to those groups who need them the most. However, its capacity to reach the poorest 20% of the population has significantly deteriorated in recent years.
General tax (UNDP 2011b)	Redistribute income across the population.	-	-	**PROGRESSIVE**: Even though it is progressive the amount contributed by the richest 20% decreased from 38% in 2006 to 21% in 2008; the poorest 20% contributed to 2% in both years.
Tax exemptions of food and medicines (UNDP 2011b)	Increasing the likelihood of accessing essential goods.	-	-	**REGRESSIVE**: Represent a subsidy for the rich: the richest 10% of the population gains 28% of

				it and the poorest 10% only 2%.
Gasoline and electricity subsidies (UNDP 2011b)	Increasing the likelihood of accessing essential goods and services.	-	-	**REGRESSIVE**: Up to 26% of the gasoline subsidy and 22% of the electricity subsidy is gained by the richest 10% of the population.

Good urban governance is defined as the one "concerned with the equitable distribution of power and resources and with ensuring an appropriate balance among the competing demands of the various stakeholders in the city for the health of all" (Friel et al 2011a p. 868) and therefore it is positively correlated with better income distribution (Angeles-Castro 2011). National and entity governments have failed to do so (UNDP 2011b).

The unequal distribution of resources and therefore power in Mexico City correlates with current health inequities. Having a national neoliberal government which favours economic arrangements over public needs and the environment, which seems indifferent to health and social inequities, and implements regressive social policies (Muntaner 2012, WHO 2008); in addition to a restricted local government, who cannot implement effective redistributive policies because of the unequal power between levels of government, are two of the core determinants of social and health inequities. This, added to the city's colossal complexity due to its geographic characteristics, urban infrastructure, population size and density, inequity and poverty levels, and so forth; might impede achieving some redistribution soon even with a high quality and capable local government. Programmes such as the local free health insurance or Oportunidades, are likely to be weak instruments to overcome Mexico's inegalitarian welfare state that favours the rich.

Yet, this is not it. Our economic model has had other consequences; it has damaged the environment, further exposing us to a new threat: climate change (Friel et al 2008).

THE POTENTIAL IMPACT OF CLIMATE CHANGE ON HEALTH INEQUITIES IN MEXICO CITY

1. Causes, projections and vulnerability to climate change

Our type of economic development has not only polarized societies increasing social and health inequities but has also caused huge environmental damage (Friel et al 2008). An economy based on increasing levels of production and consumption, that assumes natural resources to be infinite and waiting to be disposed, and not acknowledging that they are the support of life on earth, is clearly unsustainable (Conolly 2003, Friel et al 2011b). This, in addition to a growing population, has led to a rise in fossil fuel use and an increase in GHG emissions (Figure 11), altering the atmosphere's composition (IPCC 2007a). As a result, the global average surface temperature has increased (Figure 12) and there is high confidence that it will continue do so (IPCC 2007a). At least 2°C by 2050 and a further increase of 1.8-4°C by 2100 is projected (Friel et al 2011b) leading to more frequent and severe heat waves, droughts, storms and floods, which could have several and, in some situations, catastrophic effects on human's livelihoods and health (IPCC 2007a).

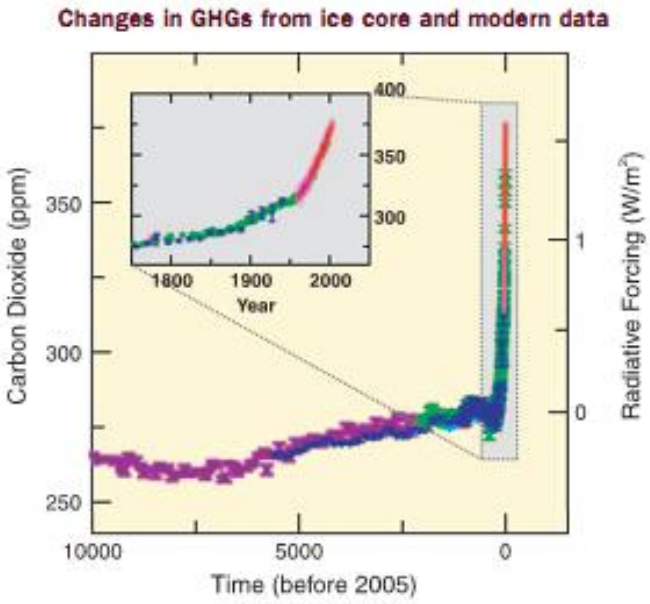

Fig.11 Atmospheric concentrations of GHGs (IPCC 2007a).

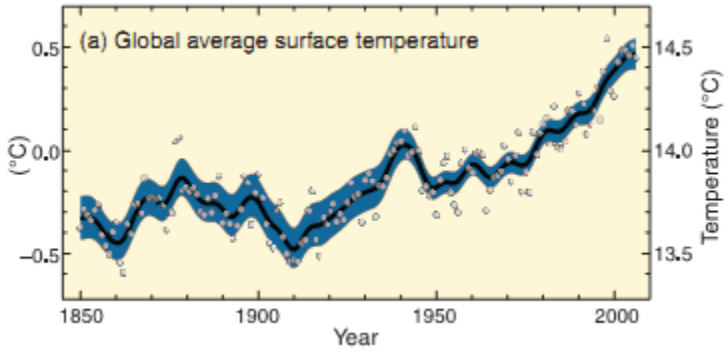

Fig.12 Observed changes in global average surface temperature (IPCC 2007a).

Mexico is considered to be especially vulnerable to climate change due to its location in the tropics and subtropics but also due to the prevalence of social inequities (Moreno & Urbina 2008). The greatest adverse effects are predicted to take place in cities, where people, resources and infrastructure are concentrated (Ibarraran 2011).

Mexico City is the entity with one of the highest levels of vulnerability to climate change of the country (Ibarraran et al 2008). Even with its greater human resources and economic capacity, it is fourth place from the bottom up, just above the three poorest entities of Mexico. The presence of a high population density, high levels of air pollution, low water availability, low crop production, vast social inequities, aging population, and the lack of capacity to cope with floods and droughts, as a result of its geologic characteristics and of the poorly maintained and aging water drainage and sanitation systems throughout the city, among other factors, reduces Mexico City's adaptive capacity (Riojas et al 2006, Ibarraran et al 2008, Romero 2010, Ibarraran 2011 in UN HABITAT 2010, CONAGUA 2011, Ibarraran 2011, SMADF 2012). This on top of a more intense hydrological cycle makes it more difficult for communities to recover from floods and droughts (IIED 2007, Ibarrarán 2011 in UN-HABITAT 2010).

Average annual temperature and extreme precipitation events have increased in Mexico City over the past decades in a greater extent in the richest borough compared to the poorest (Graizbord 2011). Moreover, when projecting scenarios of climate change for 2040, an additional increase in temperature and daily precipitation is apparent, especially in the richest borough (Figure 13 & 14). Spring heat waves are expected to intensify and last longer, and heavy storms are projected to increase (Romero 2010, Graizbord 2011).

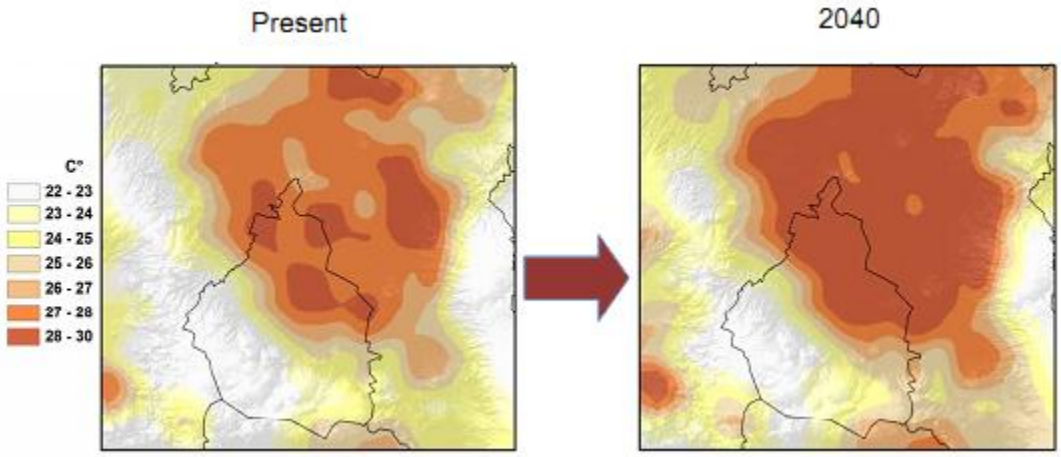

Fig.13 Maximum temperature under climate change scenarios in Mexico City (Graizbord 2011).

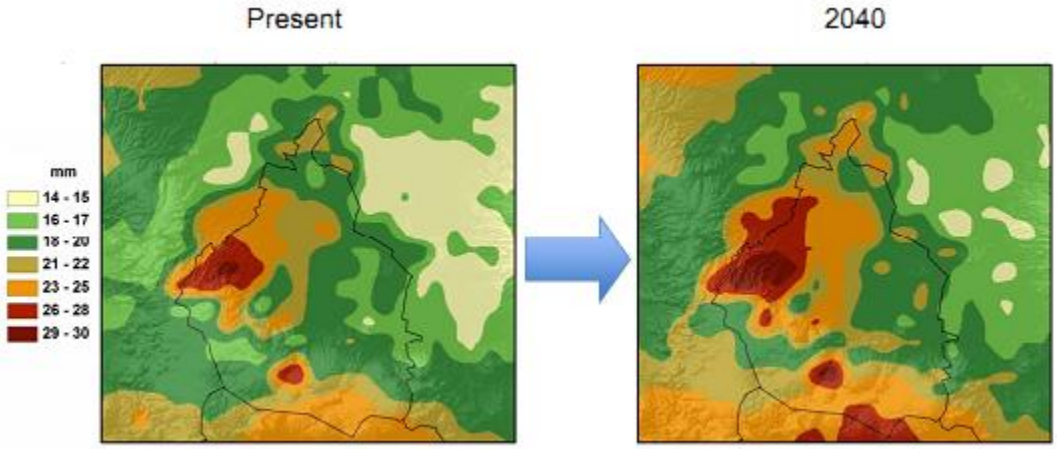

Fig.14 Daily precipitation under climate change scenarios in Mexico City (Graizbord 2011).

2. Potential social and health impacts of climate change on Mexico City

In Mexico there are only a few studies that identify the impacts of climate change on the welfare of individuals and families (Vargas et al 2011). There is also a lack of research on

its impact on human health due to the absence of retrospective data on climate, disease morbidity and mortality and population vulnerability of at least 30 years (Riojas 2006, SEMARNAT 2009). Fewer studies exist for Mexico City; however, the following have been described as potential climate change effects (Ibarraran 2011, SMADF 2012):

1. A rise in the average temperature and heat waves.
2. An increase in drought periods.
3. A decrease in extremely low temperatures.
4. Greater storm and flood events.

All of these may have different and simultaneous outcomes. Some of the potential social impacts and health effects on Mexico City are described in Box 1. Although direct health impacts such as an increase in heat strokes, injuries and deaths will be important; the greatest and long-term consequences are predicted to be due to the effects on crucial determinants of health that are essential for human survival such as food, water and shelter (Costello et al 2009). In addition, Mexico City, due to its reliance on outside resources, could also be affected by the impact of climate change on other entities and countries (Funfgeld 2010).

Box.1 Potential social impacts and health effects of climate change on Mexico City (Riojas et al 2006, Haines et al 2006, IPCC 2007b, Costello et al 2009, Moser & Satterthwaite 2010, Ibarraran 2011, Friel et al 2011b, SMADF 2012).

1. A rise in the average temperature, more extremely hot days and heat waves could lead to:
a. An increase in food-borne diseases such as **diarrhoea**. Mechanism: an increase in temperature could favour the growth of microorganisms and pathogenic bacteria especially in inadequately preserved food (Riojas et al 2006, SMADF 2012). b. An increase in respiratory diseases including **pneumonia and asthma** due to the worsening of air pollution and greater exposure to allergens. Mechanism: air pollution in itself exacerbates pollen allergenicity; in addition, a higher temperature increases ozone production and prolongs flowering stages increasing pollen quantities (Riojas et al 2006, Teran 2009). c. An increase in **cardiovascular disease** mortality due to excessive heat and/or an increase in ground-level ozone especially in the elderly who have a decreased ability to thermo-regulate (IPCC 2007b, McMichael et al 2008, Friel et al 2011c). d. An increase in **scorpion** sting incidence (Chowell et al 2005) e. A **worsening of working conditions** for those with outdoor jobs or in poorly ventilated confined spaces which could lead to lower productivity and an increased risk of **injury** (Friel et al 2011c). f. An increase in **mental health problems** due to heat stress amplifying the impact of social inequities on mental health (Friel et al 2011c). g. An increase in **migration** that could lead to overcrowding, communicable diseases and conflict due to the reduction of resources available per capita in the place of destination (Bowen & Friel 2012). h. An increase in the **demand** for **health-care** and social support (Friel et al 2011c, SMADF 2012)
2. An increase in drought periods during the summer months could lead to:

a. An increase in **water- and food-borne diseases** and **malnutrition** due to **water and food insecurity**. Drought decreases groundwater recharge and agriculture and livestock production with the consequent increase in food prices (Ibarraran 2011, Vargas et al 2011). Malnutrition affects early **child development** and as a consequence affects children's life chances, such as education and occupational opportunities (Marmot et al 2008).

b. An increase in **water-washed diseases** such as scabies that are caused by a lack of personal hygiene due to water scarcity and contaminated water (IPCC 2007b).

c. **Respiratory problems** due to an increase in **forest fires** (Friel et al 2011c, Moreno & Urbina 2008).

d. **Mental health problems** such as anxiety, depression, stress and suicide due to increased competition for scarce resources (Friel et al 2011c).

e. An increase in **unemployment** for agricultural and livestock farm workers (Bowen & Friel 2012).

f. **Decreased hydropower generation** due to a lack of water in dams to produce hydroelectric power which could increase electricity prices (Ibarraran 2008).

g. An increase in **migration** (Funfgeld 2010) due to a reduced access to food and water, and unemployment.

h. An increase in the **demand** for **health-care** and social support (Friel et al 2011c, SMADF 2012)

i. Greater probability of becoming poor or worsen **poverty** (Vargas et al 2011).

j. **Social unrest** and **conflict,** for example food riots due to food shortage and rapidly rising prices (Funfgeld 2010).

3. A reduction in extremely low temperatures and cold waves could lead to:

a. A potential **positive** impact on health by reducing **respiratory and cardiovascular** morbidity and mortality related to cold weather (Friel et al 2011c).

b. A greater range and activity of some **pest**s that could damage **crops** (IPCC, 2001d:II-7 in SMADF 2012) and contribute to food insecurity.

c. A greater range and activity of disease vectors (Riojas et al 2006, IPCC, 2001d:II-7 in SMADF

2012). Therefore **vector-borne diseases**, such as Dengue fever and Malaria, and even Chagas disease which is transmitted by the Triatoma bug (IPCC 2007b), could potentially emerge in Mexico City.

4. Greater storm and flood events could lead to:

a. **Injuries** and **deaths** due to floods, landslides and falling power lines (UN-HABITAT 2010).

b. Loss of **livelihoods** and disruption of **city's economy**: damages to households, possessions and businesses; unemployment and loss of income**;** risk of becoming or staying **poor;** and increased **migration** (Vargas et al 2011, Bowen & Friel 2012).

c. **Destruction of crops** and soil erosion which reduces food production increasing food prices and leading to **food insecurity** and **unemployment** (Friel et al 2011c).

d. **Damages to public infrastructure** (water and sewage systems, electricity, roads and public transport, health-care, schools) which leads to a lack of access to these services; a **reduced access to safe water** potentially increasing communicable diseases; and to **a** decreased **mobility** of people and flow of goods potentially increasing the prices of essential products such as food (Moser & Satterthwaite 2010)

e. An increase in the **demand** for **health-care** and social support (Friel et al 2011c, SMADF 2012)

f. **Mental health problems** (Bowen & Friel 2012).

g. **Social unrest** and **conflict** (Ibarraran 2011).

3. Analysis of the potential impact of climate change on health inequities in Mexico City

a. Factors to be considered before the analysis

The analysis of the impact of climate change on health inequities needs to be analysed in the context of a lack of climate, health, and vulnerability data; a lack of research on the social and health impacts of climate change especially at the local level; and the

impossibility of taking into account all the factors that determine health and climate, and their interaction, a lot of which still remain unknown (Riojas et al 2006, IPCC 2007b).

Additionally, as we are speculating about the future using models, our predictions will never represent reality (Maslin & Austin 2012). This creates different degrees of uncertainty not only on the rate and intensity of future climate change but also on human responses to threats. In the case of climate models, uncertainty in projections of changes in temperature and precipitation and consequently uncertainty in their potential social and health impacts permeates all levels but are greater at the regional level (Moser & Satterthwaite 2010, Maslin & Austin 2012). Uncertainty is accentuated due to the fact that climate models are based on GHGs emissions scenarios that are derived from assumptions on population growth, possible economic paths and potential technology choices which are also uncertain (IPCC 2007a). Furthermore, models might lack inclusion of important variables and might not account for interactions and feedbacks which could be crucial (Ibarraran et al 2008).

Finally, the limited understanding of human adaptation, that is: to what extent, how fast, and what are the barriers and major drivers of adaptation of different populations, further increases uncertainty (IPCC 2007b). Although humans have had to adapt to changes in climate throughout history (Moreno & Urbina 2008) and its study may bring insights into how populations might respond, future climate change may be unprecedented, and therefore human responses are difficult to predict.

b. Comparing strengths and weaknesses in the face of climate change

Considering the social determinants of health inequities, climate projections, potential social and health impacts of climate change, and based on the adapted social determinants of health framework, all of which have been discussed previously, a list of possible strengths and weaknesses in the face of climate change was carried out for each borough. In addition, potential climate change social and health impacts on each borough were proposed and several adaptation strategies to increase resilience to climate change were suggested based on the literature reviewed. As a long list was developed (Appendix 5), I grouped them and selected a few to discuss in greater depth (see Table 9). It is important to mention that, ideally, this analysis should have been done at and with the communities to achieve a better picture of reality and ensure that adaptation strategies are in line with their believes, being potentially more effective. Additionally, the strategies proposed still need to be evaluated to ensure they contribute to health equity.

Table.9 Comparison of borough's main strengths and weaknesses in the face of climate change

BENITO JUAREZ – The richest borough	
Strengths	**Weaknesses**
1. **Higher socioeconomic position** and greater **political power** than Milpa Alta.	1. **Land coverage** (100% urban with less than 5% of green spaces) and possibly a **higher** exposure to **air pollution** than Milpa Alta.
2. **Better housing conditions,** access to **services**, public **infrastructure** and greater **mobility capacity** than Milpa Alta.	2. Higher **population density,** higher percentage of **elderly** population, and a **greater poverty concentration.**
3. **Better health outcomes** and greater **health-care coverage** than Milpa Alta.	3. Great **dependency** on other boroughs, entities and countries for food, water and air quality.
4. **Economy** not based on climate-sensitive systems (predominance of the service sector).	4. High risk of **floods.**
	5. **Worse climate projections** than Milpa Alta.

MILPA ALTA – The poorest borough	
Strengths	**Weaknesses**
1. **Land coverage** (10% urban; 40% cultivated and pasture-land; and 50% forest area) and lower exposure to **air pollution.**	1. **Lower socioeconomic position** and lower **political power** than Benito Juarez.
2. **Low population density** and a **younger** population than Benito Juarez.	2. **Worse housing conditions, services,** public **infrastructure** and lower **mobility** capacity than Benito Juarez**.**
3. **Primary sector** is still important. Therefore Milpa Alta has agriculture and livestock workers capable of producing their own food and the land to do it.	3. **Worse health outcomes** and lower **health-care coverage** than Benito Juarez.
4. **Better climate projections** than Benito Juarez.	4. Their **economy** is based on **climate-sensitive systems** such as agriculture. 94% of the cultivated land in Mexico City is rain fed (Conroy 2009 in Skoufias et al 2011).
	5. High risk of **landslides**

As we can see from the table, strengths in Benito Juarez are weaknesses in Milpa Alta and vice versa. To be able to determine if climate change may increase health inequities we have to compare them to define who is more vulnerable and therefore who could be more affected.

When evaluating determinants such as housing conditions, service provision and public infrastructure; livelihood sources and their level of dependence on natural resources; health-care coverage and disease profile, we may conclude that Milpa Alta is the most vulnerable to the impacts of climate change which could further increase poverty and health inequities (IPCC 2007, Moreno & Urbina 2008, McMichael et al 2008, Mearns & Norton 2010, Moser & Satterthwaite 2010, Vargas et al 2011, Friel et al 2011b, Bowen & Friel 2012). Conversely, Benito Juarez, by being totally urbanized, having a greater concentration of industries and vehicles, its lack of green spaces, higher population density and an aging population, in addition to a greater poverty concentration, could make it more vulnerable (Campbell-Lendrum & Corvalan 2007, IPCC 2007b, Moreno & Urbina 2008, McMichael et al 2008,) and therefore there could be a reduction in health inequities.

In addition, many factors need to be highlighted. Although Milpa Alta may suffer from a greater burden of disease, its population's perception of health status is better (Vargas et al 2011). A worse perception in Benito Juarez could be related to their greater poverty concentration and the greater exposure to higher temperatures and extreme precipitation events (Vargas et al 2011). Moreover, in Benito Juarez, pneumonia, asthma and NCDs are important causes of morbidity and mortality which could be exacerbated by climate

change; and due to the greater UHI effect they might be at greater risk of heat morbidity and mortality. Furthermore, although Benito Juarez has access to better infrastructure, the aging and poorly maintained sewage and water systems is prevalent across the city which could further increase its risk of floods. Finally, although Benito Juarez's economy is more resilient to climate change, it could still be affected by climate change via damaging buildings or telecommunication infrastructure.

On the other hand, even though Milpa Alta could have a lower exposure to air pollution, many have to travel to other boroughs to work which increases their exposure. Although a lower population density could be a strength in the face of climate change, it could also be a weakness by being in part the cause of their lower access to services due to isolation. Even though they produce food and contribute to the city's water availability via their forests, they are still dependent on other boroughs, entities and countries to access food and water, and as the agriculture sector is declining, the capacity of future generations to produce food could decrease.

In the case of climate projections, although they are worse for Benito Juarez, uncertainty at the local level is huge (Maslin & Austin 2012). In addition, climate projections might not be as important as people's living conditions when determining the potential impact of climate change (Funfgeld 2010, Maslin & Austin 2012).

As we can see, it becomes very complex to develop a conclusion of which borough could be more affected by climate change when comparing strengths and weaknesses. It is difficult to define which strengths are of greater benefit than others and could be more

effective to overcome the present weaknesses, and which weaknesses might greatly increase vulnerability to climate change. Even if this is achieved it might change overtime. No article reviewed for this dissertation mentions the possibility of climate change reducing health inequities or of having a greater impact on the rich. However, as seen in this case, it is difficult to define the final trajectory of the impact of climate change on the distribution of health when there are various factors acting in opposite ways and some possibly acting in both directions.

Yet, even though we cannot provide a definite forecast of the impact of climate change on health inequities, there is a crucial factor, not yet discussed, that might give us a hint. That is: the socioeconomic position (Friel et al 2011a). Benito Juarez's current political position, which is greater in comparison to Milpa Alta's, I believe is the crucial factor that could make Benito Juarez more resilient to the impacts of climate change. This is because it not only leads to superior living conditions and health outcomes, but it enables people to effect change in areas they define as important, and in this sense they could increase their adaptive capacity. This, in addition to what many authors argue, that climate change will have a greater impact on the poor, make Milpa Alta the most vulnerable to the consequences of climate change which may lead to an increase in health inequities.

However, even if we took this as true, with climate change the importance of Milpa Alta becomes central, because it is recognized, due to its forests, as part of the "lungs" of Mexico City. Its forests improve air quality; contribute to climate change mitigation by sequestering GHGs; are a very important source of rainwater which recharges the aquifers of the city (Milpa Alta 2012), and may impede a potentially greater UHI effect

(Baumgardner et al 2011). This, in addition to its cultivated-land, contributes greatly to the city's viability through access to food, water, and improved air quality.

In this sense, the benefits that Milpa Alta provides to the city could potentially be used to increase their political power and consequently be able "to represent their needs and interests strongly and effectively, and in so doing, to challenge and change the unfair distribution of material and psychosocial resources" (Friel et al 2011a p.864)**.** This may contribute to improve their access to better education, occupation and income, and therefore improve their living conditions and health status. The reduction of health inequities and an increase in Milpa Alta's resilience to climate change could be the result.

Furthermore, while it is practically impossible for Benito Juarez to achieve Milpa Alta's strengths, for Milpa Alta a more equitable distribution of resources and power could lead to achieving Benito Juarez's strengths, and with appropriate planning they might not lose their present strengths. Therefore they could even overtake Benito Juarez's "greater" resilience to climate change.

Conversely, both boroughs could use each other's strengths to overcome each other's' weaknesses. Milpa Alta by securing Benito Juarez's access to water, food, and air quality; and Benito Juarez by sharing power and resources, and make use of their greater economic capacity and human resources to improve Milpa Alta's living conditions. This will not only improve adaptive capacity of both boroughs, but may also reduce health inequities.

Another alternative is that, as Benito Juarez, currently has a greater political position, economic capacity and human resources, and probably greater knowledge about the potential impacts of climate change, they could use these advantages selfishly to increase their adaptive capacity. They could move to a place with a better environment or could even displace Milpa Alta's population.

However, Benito Juarez should be cautious. If Milpa Alta does not see their opportunity to gain power or, even if it does, Milpa Alta does not overcome the many barriers that exist to achieve it; and/or if Benito Juarez is not willing to share resources and power; and if climate change, as hypothesized, increases social and health inequities, this may contribute to reaching the tipping point where greater inequity may lead to social unrest and conflict. This could potentially crumble down the political power of Benito Juarez and reduce health inequities.

In addition, it may also be the case that we could have underestimated the impact of climate change as has been stated by some authors (Rahmstorf et al 2007), and reality could become worse than predicted. Therefore the "greater" adaptive capacity of Benito Juarez might not be enough to prevent the social and health impacts of climate change, worsening health outcomes but potentially reducing health inequities.

c. What do my findings mean?

A definitive result of the trajectory of the impact of climate change on health inequities is not as straightforward as it is normally stated and it may change overtime. Determinants of social and health inequities are also the cause of inequities in the vulnerability to the

impact of climate change (Friel et al 2008 in Bowen & Friel 2012, Costello et al 2009, Sanchez-Rodriguez 2009). Of these determinants, the socioeconomic position is proposed to be the crucial factor that could define the vulnerability to climate change. This is because it not only determines living conditions and health outcomes, but people's political power to intervene in decisions that affect their lives.

Even though Benito Juarez's political power and resilience to climate change could be greater than Milpa Alta's and climate change may therefore exacerbate health inequities, Benito Juarez could be more vulnerable than one might think, and a reduction of health inequities could potentially be a consequence of climate change. An important finding is that the richest and poorest boroughs may benefit from each other's strengths to increase their adaptive capacity. This may become a driver for the implementation of adaptation strategies that contribute to health equity, however, many challenges exist.

POLICY IMPLICATIONS

A wide array of strategies exists to adapt to climate change, such as those proposed on Appendix 5 for both boroughs. However, in order to be effective, they need to tackle the core causes of social inequity (Sanchez-Rodriguez 2009), that is, the unequal distribution of resources and power across the population (Marmot et al 2008). Therefore, empowerment is essential to achieve health equity (Friel et al 2011b) in the face of climate change. People/communities that are empowered materially (having the resources to live a decent life), psychosocially (having control over their lives) and politically (being able to participate in decisions that affect their lives and effect change in areas they define as important) may challenge the unequal distribution of resources (Marmot et al 2008, Friel et al 2011a). In doing so, the poor (Milpa Alta) may align their social position with the rich (Benito Juarez), and improve their living conditions, health outcomes and resilience to climate change. Progressive policies, which redistribute resources to the poor and address crucial determinants of health such as education, income, employment, housing and health-care, empower people, reduce health inequities and increase resilience to climate change (Marmot et al 2008, Salgado et al 2011, Friel et al 2011a & 2011b). However, many challenges exist to implement these policies (IPCC 2007a).

1. Challenges and drivers to implement adaptation policies that tackle the core determinants of health and social inequities

Different social groups have different needs. Policy-makers have to make difficult choices regarding which priorities they will support and which social groups to place first (IPCC 2007b). As it is practically impossible to meet everyone's needs, this may lead to conflicts. Social inequities lead to an imbalance in political power within society. Therefore, those social groups/boroughs with a higher socioeconomic position, in this case Benito Juarez, have a greater influence over the government and their needs may be addressed first. Moreover, national and external pressure from countries, international financial agencies and transnational corporations, constantly influence decisions at the local level (Friel et al 2011a). In addition, due to our neoliberal economic model, focus is on economic growth and not on the distribution of its benefits (IPCC 2007b). This leads to the prioritization of economic and commercial arrangements over social and health needs, and the environment. Finally, the presence of corruption and therefore of policy-makers who are not willing to set priorities based on public needs but on the benefit it will bring them, is an important problem in Mexico (PAHO 2007, UNDP 2011b)

In sum, the lack of coincidence in an ideology and an economic model that places people and the environment first at all levels of governance, and the unequal power between them, represent major challenges to implement these policies. However, the political party in power in Mexico City, which aims for redistributive policies (Laurell 2003), has recently won the elections for the fourth period in a row (SeattlePi 2012). Political parties

that are committed to egalitarian goals are more likely to act on health equity (Muntaner et al 2012) and the presence of the same political party since 1997 may allow the continuity of policies. For example, they have established an austerity program which cuts unnecessary government spending such as excessive salaries and trips of top officials, new cars and so forth; and have fought corruption (Laurell, 2003). With the savings yielded from both, they have funded programs such as the local health insurance (Laurell, 2003). Although, as discussed before, their policies are still regressive, they might have improved overtime; therefore an analysis of the trend is needed.

Other challenges faced when trying to implement progressive policies are the lack of data and research on health inequities and the impact of climate change, and a lack of dialogue between policy-makers and the scientific community (IIED 2007). This may in part be the cause of a low awareness and of limited understanding by policy-makers of existing health inequities and their determinants, the causes and impacts of climate change, and of the link between health inequities and vulnerability to climate change (Funfgeld 2010). This, in addition to climate change being an uncertain threat, and that its impacts may not be felt yet by the majority of the population, contribute to a lack of political and popular support for action on health inequities and adaptation to climate change (IPCC 2007b, Costello et al 2009).

However, awareness on the impact of climate change is growing. At the global level, this is evidenced by the new and increasing funding available for adaptation interventions which could be used to reduce health inequities (Bowen & Friel 2012). At the national level, the government has stressed the need to identify vulnerable populations to climate change

and design and implement appropriate policies (SEMARNAT 2009). At the local level, the Mexico City government has recognized that climate change is the most serious threat to the ecosystems of the city, with unquestionable socio-economic consequences for the population (Delgado 2008 & Casaubon et al 2008 in UN-HABITAT 2011). In addition, its Head of Government chairs the World Mayors Council on Climate Change which reflects strong political leadership (Sanchez-Rodriguez 2009, WMCCC 2012). However, strategies have focused more on mitigation than on adaptation (IIED 2007) and the latter should be a core component on the response to climate change because unavoidable impacts of climate change will occur (Bowen & Friel 2012, IPCC 2007a). Although uncertainty is a major challenge, adaptation actions are embedded in existing development and poverty reduction policies and programmes (IPCC 2007b, Magnan 2010 in Bowen & Friel 2012, Sanchez-Rodriguez 2009) therefore, even without climate change there is no excuse not to implement them.

Furthermore, there is a lack of institutional capacity to address climate change in terms of human resources, technology development and financial resources (IIED 2007, Funfgeld 2010, Satterthwaite 2011). Managing a complex system such as a megacity is not easy and a single solution to achieve health equity and adapt to climate change does not exist (Rydin 2012). It requires a long-term inter-sectorial approach, citizen involvement, and a dialogue between academics and policy-makers to develop inclusive evidence-based policies which need to be context specific and constantly evaluated (Barten et al 2007, IIED 2007, Moreno & Urbina 2008, Rydin 2012, Funfgeld 2010, Sanchez-Rodriguez 2009).

However, many factors may encourage the development and implementation of these policies: the increase in funding and awareness; the great concentration of academics and technicians that Mexico City has (GDF 2007); and the growing collaboration of the scientific community in initiatives implemented by the government, such as the Mexico City Virtual Centre for Climate Change (Fundacion Pensar 2011). Another factor that may contribute, is the fact that the costs of adaptation have been calculated to be lower than the costs of potential impacts of climate change (SEMARNAT 2009). In addition, social movements may increase pressure on governments to act and respond with supportive public policies (Martinez 2009). Empowering the poor to become aware of inequities and building capacity to act collectively, and to participate in the policy-making process, may ensure resource distribution (Barten et al 2007). The population of Milpa Alt has already started to claim compensation from the government for the environmental services they provide to the city (Milpa Alta 2012).

Finally, of great importance, is the fact that the richest and the poorest borough may complement each other to improve their adaptive capacity to climate change and achieve health equity. Sensitizing the population about this and about the serious social and health impacts of climate change, may encourage people's support to implement adaptation policies that may gradually build solidarity. The latter is essential to achieve redistribution of resources and health equity.

RESEARCH IMPLICATIONS

To attain a more robust analysis, empirical research by interdisciplinary groups is needed on the relationship between health and social inequities (Martinez 2009) and on the social and health impacts of climate change. With this in place, new pathways from climate change to health inequity/equity may be developed, and a thorough evaluation of the impact of climate change on health inequities may be achieved. This could provide the evidence for policy-makers to implement appropriate policies.

However, three main factors hinder the analysis of climate change impacts on health inequities: complete, valid, disaggregated and longitudinal health data is not available (Martinez 2009, IPCC 2007b); social and political indicators disaggregated across different social groups are rarely included in health surveys (Martinez 2009, Friel et al 2011a); and uncertainty will always permeate climate projections. Future climate models may not increase certainty (Maslin & Austin 2012). However, the great concentration of academics, institutions, and economic capacity in Mexico City (GDF 2007), in addition to increasing awareness, could help overcome these challenges.

CONCLUSION

Social and health inequities in Mexico City are evident when comparing the richest (Benito Juarez) and poorest (Milpa Alta) boroughs. They are the result of an unequal distribution of resources and power across the population, in part caused by the presence of a neoliberal government which has implemented regressive social policies; and a restricted local government which encounters many barriers to implement effective policies.

This economic model has also damaged the environment exposing us to a new threat: climate change. It is argued that the poor will be the most affected by its impacts, increasing health inequities. However, at least in this case study, the potential impact of climate change on health inequities is not as straightforward as it is normally stated: Benito Juarez could be more vulnerable than one might think and a reduction of health inequities could potentially be a consequence of climate change.

Some factors favour the richest borough and some favour the poorest. It is difficult to weight them and decide which are crucial and therefore who is more or less vulnerable. However, this thesis supports that people's/communities' political power might be vital when determining vulnerability to climate change because it defines the level in which communities may intervene in decisions that affect their lives.

Although at the moment Benito Juarez has a greater political power which is reflected on their better living conditions and health outcomes and could therefore be less vulnerable to climate change, Milpa Alta has a great potential to increase its political position due to

its crucial role in the city's viability. In this sense, Milpa Alta's population could gain political voice, which may lead to a reduction of health inequities.

To be effective, adaptation strategies need to empower people/communities. Progressive policies could be one option. Although many challenges exist to implement them, an important finding of this dissertation is that strengths of each borough may benefit each other's adaptive capacity to climate change. Therefore, sensitizing the population about this fact, in addition to the presence of a local government who may be committed to egalitarian goals, could build solidarity and popular/political support for policies that will benefit both boroughs. This could lead to health equity.

Finally, empirical interdisciplinary research is needed to achieve a more robust analysis which could lead to the development of evidence-based policies. Although the lack of data and the presence of uncertainty in climate predictions become barriers to achieve it, the great concentration of academics, institutions, and economic capacity in Mexico City, in addition to increasing awareness and funding on adaptation to climate change, could help overcome these challenges.

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20/05/12]

APPENDICES

Appendix 1. International and websites searched for grey literature.

INTERNATIONAL WEBSITES	
Website's name	**Link**
Intergovernmental Panel on Climate Change	http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#.T9dTfBfKGSo
International Institute for Environment and Development	www.iied.org
Pan American Health Organization	http://new.paho.org/mex/index.php?option=com_docman&Itemid=329
United Nations Development Programme Mexico	http://www.undp.org.mx/spip.php?page=publicaciones&id_mot=0
United Nations Habitat	http://www.unhabitat.org/pmss/
World Bank	http://www.worldbank.org/
World Health Organization. Health topics. Climate change.	http://www.who.int/en/ and http://www.who.int/topics/climate/en/

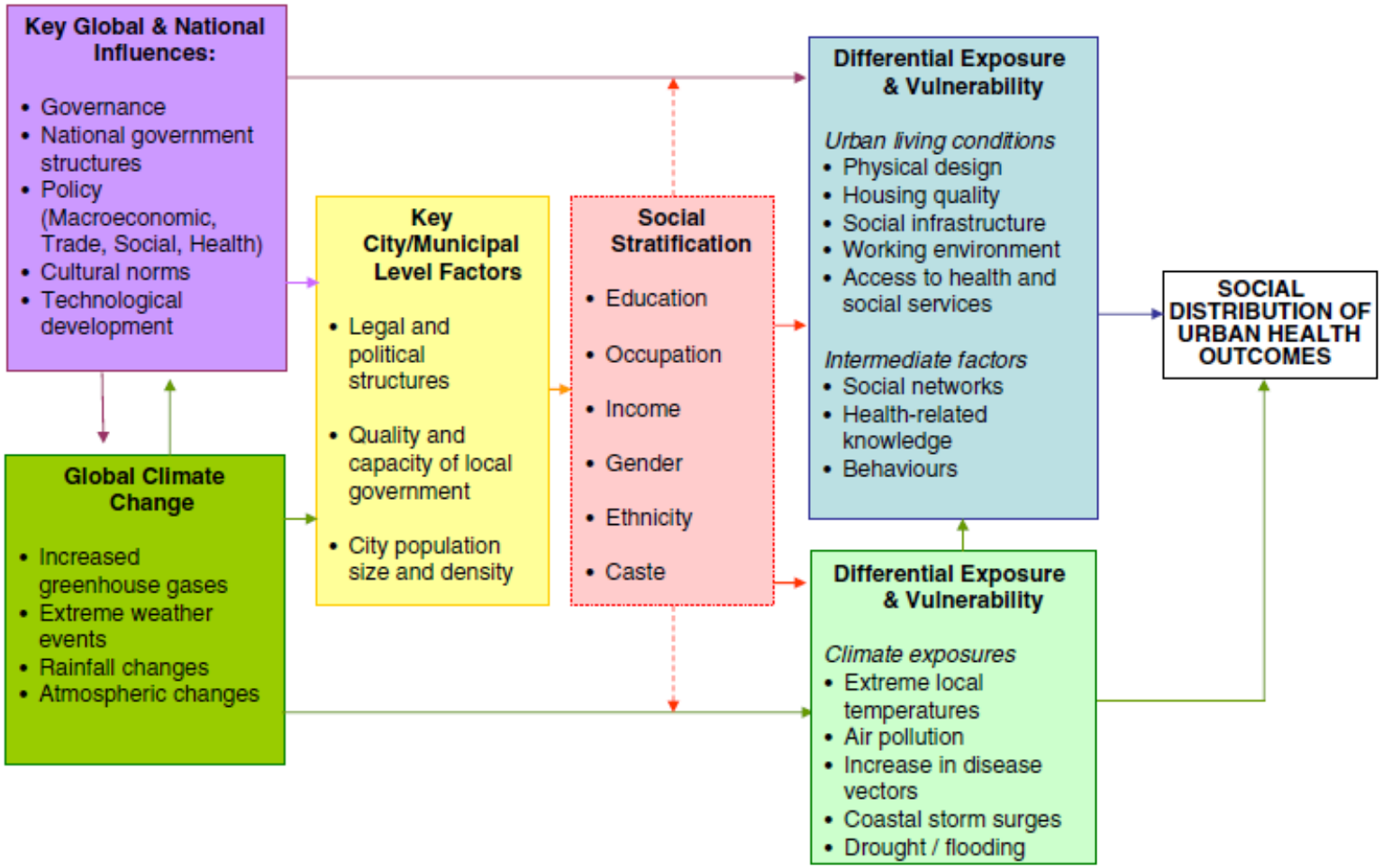
NATIONAL WEBSITES	
Website's name	**Link**
National Institute of Ecology with a specific climate change website - Instituto Nacional de Ecologia.	http://cambio_climatico.ine.gob.mx/
Ministry of Environment and Natural Resources with a specific site for climate change - Secretaría de Medio Ambiente y Recursos Naturales.	http://www.cambioclimatico.gob.mx/
Evaluate Mexico City. Mexico City's Committee for Evaluation of Social Development Policy - Evalua DF. Consejo de Evaluación de Desarrollo Social del Distrito Federal.	http://www.evalua.df.gob.mx/
Mexico City's Ministry of Environment - Secretaria de Medio Ambiente Distrito Federal.	http://www.sma.df.gob.mx/sma/index.php
Mexico City's Virtual Climate Change Centre - Centro virtual de Cambio Climatico Ciudad de Mexico.	http://www.cvcccm-atmosfera.unam.mx/cvcccm/
Milpa Alta's local government website	http://www.milpa-alta.df.gob.mx/
Benito Juarez's local government website	http://www.delegacionbenitojuarez.gob.mx

Appendix 2. International and national websites searched for various indicators.

INTERNATIONAL WEBSITES	
Website's name	**Link**
Central Intelligence Agency. The World Fact book. Mexico.	https://www.cia.gov/library/publications/the-world-factbook/geos/mx.html
Pan American Health Organization	http://new.paho.org/mex/index.php?option=com_docman&Itemid=329
United Nations Development Programme Mexico	http://www.undp.org.mx/spip.php?page=publicaciones&id_mot=0
World Bank	http://www.worldbank.org/
World Health Organization	http://www.who.int/en/

NATIONAL WEBSITES	
Website's name	**Link**
National Institute of Statistics and Geography - Instituto Nacional de Estadística y Geografía.	http://www.inegi.org.mx/
National Population Committee - Consejo Nacional de Población.	http://www.conapo.gob.mx/
National Committee for Evaluation of Social Development Policy - Consejo Nacional de Evaluación de la Política de Desarrollo Social.	http://web.coneval.gob.mx/Paginas/principal.aspx
Mexico City's Population Committee -Consejo de Población del Distrito Federal.	http://www.copo.df.gob.mx/
Mexico City's Ministry of Health - Secretaria de Salud del Distrito Federal.	http://www.salud.df.gob.mx/ssdf/index.php?option=com_content&task=view&id=85&Itemid=105
Evaluate Mexico City. Mexico City's Committee for Evaluation of Social Development Policy - Evalua DF. Consejo de Evaluación de Desarrollo Social del Distrito Federal.	http://www.evalua.df.gob.mx/
Mexico City's Institute of Science and Technology - Instituto de Ciencia y Tecnología del Distrito Federal.	http://www.icyt.df.gob.mx/
Mexico City's Ministry of Finance - Secretaría de Finanzas Publicas del Distrito Federal	http://www.finanzas.df.gob.mx/
Mexico City's Ministry of Environment - Secretaria de Medio Ambiente Distrito Federal.	http://www.sma.df.gob.mx/sma/index.php
Milpa Alta's local government website	http://www.milpa-alta.df.gob.mx/
Benito Juarez's local government website	http://www.delegacionbenitojuarez.gob.mx

Appendix 3. Friel et al's (2011b) social determinants of health framework.



Appendix 4. Top 15 morbidity causes in both boroughs per year from 2006-2011 (Cortés, R 2012, pers. comm., 21 June).

BENITO JUAREZ – The richest borough						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
1	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections
2	Gastrointestinal infections	Gastrointestinal infections	Gastrointestinal infections	Gastrointestinal infections	Gastrointestinal infections	Gastrointestinal infections
3	Urinary tract infection	Urinary tract infection	Urinary tract infection	Urinary tract infection	Urinary tract infection	Urinary tract infection
4	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis
5	Accidents in motor vehicles	Hypertension	Acute otitis media	Hypertension	Hypertension	Gingivitis and periodontal disease
6	Hypertension	Accidents in motor vehicles	Hypertension	Type 2 diabetes	Gingivitis and periodontal disease	Hypertension
7	Type 2 diabetes	Type 2 diabetes	Type 2 diabetes	Acute otitis media	Type 2 diabetes	Conjunctivitis
8	Acute otitis media	Acute otitis media	Conjunctivitis	Conjunctivitis	Acute otitis media	Acute otitis media
9	Intestinal amebiasis	Asthma and status asthmaticus	Accidents in motor vehicles	Chickenpox	Conjunctivitis	Type 2 diabetes
10	Conjunctivitis	Conjunctivitis	Gingivitis and periodontal disease	Gingivitis and periodontal disease	Urogenital candidiasis	Urogenital candidiasis
11	Other helminthiasis	Chickenpox	Chickenpox	Asthma and status asthmaticus	Chickenpox	Chickenpox
12	Asthma and status asthmaticus	Pedestrian injured in transport accident	Pneumonia and bronchopneumonia	Urogenital candidiasis	Accidents in motor vehicles	Accidents in motor vehicles
13	Gingivitis and periodontal disease	Gingivitis and periodontal disease	Asthma and status asthmaticus	Accidents in motor vehicles	Pneumonia and bronchopneumonia	Asthma and status asthmaticus
14	Pedestrian injured in transport accident	Pneumonia and bronchopneumonia	Pedestrian injured in transport accident	Pneumonia and bronchopneumonia	Burns	Burns
15	Ischemic heart disease	Urogenital candidiasis	Urogenital candidiasis	Burns	Asthma and status asthmaticus	Pedestrian injured in transport accident

MILPA ALTA – The poorest borough						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
1	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections	Acute respiratory infections
2	Urinary tract infection	Urinary tract infection	Urinary tract infection	Urinary tract infection	Urinary tract infection	Urinary tract infection
3	Gingivitis and periodontal disease	Gingivitis and periodontal disease	Gastrointestinal infections	Gingivitis and periodontal disease	Gingivitis and periodontal disease	Gingivitis and periodontal disease
4	Gastrointestinal infections	Gastrointestinal infections	Gingivitis and periodontal disease	Gastrointestinal infections	Gastrointestinal infections	Gastrointestinal infections
5	Other intestinal infections caused by protozoa	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis	Ulcers, Gastritis and duodenitis
6	Ulcers, Gastritis and duodenitis	Acute otitis media	Acute otitis media	Other intestinal infections caused by protozoa	Other intestinal infections caused by protozoa	Other intestinal infections caused by protozoa
7	Acute otitis media	Conjunctivitis	Conjunctivitis	Acute otitis media	Acute otitis media	Human Papilloma Virus
8	Conjunctivitis	Other intestinal infections caused by protozoa	Chickenpox	Conjunctivitis	Conjunctivitis	Mild and moderate cervical dysplasia
9	Type 2 diabetes	Type 2 diabetes	Dog bite	Mild and moderate cervical dysplasia	Type 2 diabetes	Conjunctivitis
10	Hypertension	Dog bite	Other helminthiasis	Type 2 diabetes	Mild and moderate cervical dysplasia	Acute otitis media
11	Dog bite	Chickenpox	Type 2 diabetes	Dog bite	Hypertension	Mild malnutrition
12	Chickenpox	Hypertension	Mild malnutrition	Mild malnutrition	Human Papilloma Virus	Chickenpox
13	Mild malnutrition	Mild malnutrition	Urogenital candidiasis	Human Papilloma Virus	Mild malnutrition	Domestic violence
14	Asthma and status asthmaticus	Other helminthiasis	Intestinal amebiasis	Other helminthiasis	Dog bite	Dog bite
15	Human Papilloma Virus	Intestinal amebiasis	Urogenital trichomoniasis	Intestinal amebiasis	Domestic violence	Hypertension

Appendix 5. Strengths and weaknesses in the face of climate change; potential social and health impacts of climate change and suggested strategies to reduce vulnerability in Benito Juarez and Milpa Alta.

NOTE: This analysis was based on the information gathered for and on the discussion established in this dissertation.

BENITO JUAREZ – The richest borough

Theme	Strengths in the face of climate change	Weaknesses in the face of climate change	Potential social and health impacts of climate change (Based on Table.11)	Suggested adaptation strategies
Health	It is in an **advanced** stage of the **epidemiologic transition**, that is: malnutrition and communicable diseases, maternal and perinatal conditions are not important causes of death anymore (SSDF 2007a, SSDF 2007b). There is a **low infant mortality rate** (SSDF 2010a) and **infectious** diseases are **not** causes of infant mortality (SSDF 2007a, SSDF 2007b). **Infectious diseases** are **not** as important causes of	High prevalence of **NCDs** (Cortés, R 2012, pers. comm., 21 June, SSDF 2007a, SSDF 2007b). **Pneumonia and asthma** are important morbidity causes (Cortés, R 2012, pers. comm., 21 June). **Homicides** rate in the productive age is twice Milpa Alta's rate (SSDF 2007a, SSDF 2007b). **Suicide** is also among the main causes of death in the productive age but is higher in Milpa Alta (SSDF 2007a, SSDF 2007b).	**Climate change could:** Increase **heat** morbidity and mortality (heat strokes). Exacerbate **NCDs,** especially cardiovascular disease by amplifying the UHI effect. Increase incidence and prevalence of **pneumonia and asthma** due to worsening of air pollution and increased pollen exposure. Bring back other **communicable diseases** and **malnutrition** as important causes of morbidity and mortality due to food and water insecurity.	**Strengthening the health system** (IPCC 2007a) to be able to cope with the potential increase in demand; improve **early warning systems** and increase surveillance for infectious diseases (Bowen & Friel 2012, Moreno & Urbina 2008, SEMARNAT 2009, IPCC 2007b); provide greater and enhanced **health promotion** and **preventative measures** including mass vaccination campaigns **(**Moreno & Urbina 2008, SEMARNAT 2009**)** to limit exacerbation of **NCDs, pneumonia and asthma, a resurgence** of communicable diseases and

	morbidity as in Milpa Alta, except for pneumonia (Cortés, R 2012, pers. comm., 21 June). No **vector**-borne diseases (Cortés, R 2012, pers. comm., 21 June).	**Low health perception** compared to Milpa Alta, which could be related to the greater poverty concentration and the greater current exposure to higher temperatures and extreme precipitation events (Vargas et al 2011).	Further increase **social tension** (possibly already present due to high inequities), **crime, homicides and suicides** through different paths (water and food insecurity, extreme events, unemployment, loss of properties, mental health problems, among others). Although not projected yet, **vector-borne diseases,** such as dengue and malaria, could emerge. Could worsen **health perception** due to a further increase in temperature and extreme precipitation events, and possibly to a greater concentration of the poor. Could increase the **demand for health-care** and social support.	malnutrition, and emergence of vector-borne diseases. This could work together with Benito Juarez's **higher educational leve**l, possibly greater **health-knowledge** (Salgado et al 2011) and greater resources, therefore being more likely that they implement these measures. Design **heat-health action plans** (IPCC 2007a). **Mitigation strategies** that reduce car use, such as encouraging and creating the conditions for active and public transport, could improve **air quality** and also increase **physical activity** reducing the risk of NCDs. However p**ublic transport** will face the challenge of higher temperatures, increasing the need for **air-conditioning. This** increases GHGs emissions and as a consequence climate change. In addition, walking and cycling could increase population's exposure to air pollution and excessive heat. Therefore, in parallel,

				preventative measures such as adequate clothing, skin protection and hydration are needed. Implement strategies to preserve the city's and country's **forests,** attain strategic reserves of ground water, and build infrastructure to **harvest rainwater,** reuse and **recycle** water and treat water before reincorporating it to the environment (SEMARNAT 2009, CONAGUA 2011, IPCC 2007a). In addition, provide environmental **education** programmes to raise awareness (Vargas et al 2011). Invest in rural areas in conservation areas in Mexico City and in other entities, especially on **sustainable agriculture** and livestock production to contribute to **food security** (Bowen & Friel 2012). Encourage and provide the conditions to implement **urban agriculture** (Rydin

				2012). Strategies to achieve social and health **equity** such as **progressive policies** could increase **social cohesion** and reduce poverty, potentially reducing **homicides and suicides** rates.
Population density, population growth and population structure	Greater concentration of **highly educated/qualified people** than Milpa Alta (INEGI 2011a). The population is slowly **shrinking** (INEGI 2009).	2nd **highest population density** in Mexico City (SSDF 2010b). Greater **concentration of the poor** than Milpa Alta (Vargas et al 2011). Although the fixed population is shrinking, **the mobile population** is increasing (GDF 2007) that is: people that live in other boroughs or entities but travel to Benito Juarez to work. Greater percentage of **elderly** population (INEGI 2011a).	**<u>Climate change could exacerbate existing threats:</u>** Due to their high **population density,** Benito Juarez is at increased risk of **spread of infectious** diseases, including those that could emerge or re-emerge due to climate change, and at increased risk of climate events turning into **disasters** (IPCC 2007b). The greater **concentration** of the **poor** could reduce **social cohesion** and lead to **conflict**, social unrest, crime and **homicide**. The increase in **mobile population** could further worsen **air** and **noise pollution** and reduce **mental health** due to a greater amount of vehicles travelling to or across the	Highly qualified people could **work together** with the government to improve **adaptation capacity** and design policies that reduce these threats. Although there could be potential for **better planning,** due to a fixed diminishing population, the increasing **mobile population** becomes a **barrier** to it. In terms of **housing,** there might not be a problem because fixed population is stable. Therefore the focus should be on making existing houses and flats more energy efficient and resilient to climate change, on placing the infrastructure to harvest rainwater, among others.

			borough. Additionally, it could increase the **demand of public services** including health-care and education as they tend to use those services where they work rather than where they live. The **elderly** are more vulnerable to climate change (especially to heat waves and communicable diseases) (IPCC 2007b).	However, this could be expensive. In terms of **services**, they need to plan provision taking into account the increased demand. In terms of **road infrastructure,** they also need to take into account the amount of mobile population going to or crossing the borough. They could **implement restrictions for travelling** to or across the borough such as the congestion charging in the UK. However, this might not be enough and could be regressive. Gradual **decentralization** of industry and businesses and provision of the **conditions and incentives** to **work locally,** are crucial. Improve **disaster prevention, response and recovery** programmes (Bowen & Friel 2012, Moreno & Urbina 2008), and improve **urban**

				infrastructure including water and sewage systems (Vargas et al 2011)**.** Increase institutional capacity in **conflict management** (Moreno & Urbina 2008). Greater attention/care to the **elderly** population. Increasing **awareness** of the health personnel and **families** to the potential risks.
Geographic characteristics, environment and climate	**High altitude and temperate** climate inhibit vector breeding (Patz et al 1998) and therefore the presence of **vector**-borne diseases. 99% of green spaces are **trees** (SMADF 2010).	High risk area for **floods**, **subsidence** and **earthquakes** due to Benito Juarez's location in the centre of a closed basin on the flat bed of what was once a series of lakes (ICYTDF 2011, UN-HABITAT 2010, Conolly 2003). **Temperature,** especially minimum temperature, and extreme **precipitation** events have **increased** over the past decades (Graizbord 2011). It is totally **urbanized** (INEGI 2012b). Land coverage is mostly **concrete** and less than 5% are green spaces (SMADF	**Climate change could exacerbate existing threats:** Due to the geologic characteristics of the city and the type of land-use (constructed surfaces), **water cannot infiltrate naturally** into the ground (Romero 2010). This in addition to a deteriorated **drainage system** (CONAGUA 2011) and the potential increase in extreme precipitation events due to **climate change** (Graizbord 2011) could further increase the risk and impact of **floods**. Projected **higher temperatures**	Improve and expand **water and drainage systems** (Vargas et al 2011) taking into account climate change projections. Rescue public spaces, plant trees and create new **green spaces such as** green roofs to reduce the UHI effect (Vargas et al 2011, IPCC 2007b). Modify the built environment. Gradually change as possible the **colours and materials** of buildings and houses to reduce heat retention;

		2010) causing the **UHI effect.** High outdoor **air pollution** exposure due to the amount of vehicles in the centre of the city, and to the fact that as the city is surrounded by **mountains** air pollutants cannot spread to other areas increasing their concentration (Conolly 2003). This could be in part the reason why pneumonia and asthma are important causes of morbidity. Benito Juarez **depends** on other boroughs and entities that have forests, cultivated- and pasture-land to access **water** and **food,** and determine its **air** quality.	(Graizbord 2011) could further increase the intensity and duration of **heatwaves**; worsen **air quality**; and enable the emergence of **vector-borne diseases**. **Food and water shortage** could be caused by deforestation due to **urban sprawl, by a lack of investment** in agriculture and, by a reduction in food production in other boroughs, entities and countries, due to drought caused by **climate change**.	improve **ventilation** to reduce air-conditioning usage; and implement **renewable energies**. However, this could be expensive. **Invest in local employment. Gradually decentralize** businesses, industries and government offices; and create **local shops, pharmacies, schools and health-services** at a walkable distance, preferentially run by local people, to develop the conditions for local employment. Additionally, incentives could be provided for people to **move closer to work.** Improve **public transport**, **bike schemes** and cycle and pedestrian paths to reduce car use. Increase the number of **pedestrian** streets. Create the conditions, encourage and expand **urban agriculture** as it has been done in Cuba (Rydin et

				al 2012). Products to be sold preferentially in local shops and used in local restaurants – to reduce travel and GHG emissions. However, due to the high population density and the lack of space and knowledge to produce food, this **will not be enough** to produce sufficient food for its population. Furthermore, climate change becomes a big challenge for the implementation of urban agriculture. **Support Milpa Alta** and other boroughs and states to preserve their **forests** and **agricultural and livestock production** which are crucial for the city's air quality, and water and food security. Develop and subsidize the infrastructure for **rainwater harvesting** (Vargas et al 2011, IPCC 2007a) **and water reusing, recycling and treatment** before incorporating it into the environment. Take into account the projected intensity of precipitation

				events which could damage this infrastructure and the insufficient roof surface to capture enough water for the existing population. Need to **raise awareness** to avoid wasting water and **stop overexploiting aquifers** (Vargas et al 2011). Many **challenges** exist to implement these strategies: it is difficult and expensive to modify a city already built, to create green spaces where there is concrete, to create cycle paths where roads have been planned for cars, to decentralize business and industries, and so forth. In order to achieve this, investment is needed and, the lack of social cohesion and therefore of **solidarity** limits the distribution of the benefits of these strategies across the population.
Housing conditions, services and infrastructure	Better **housing conditions** and good access to all **services** (piped-water, sewage and electricity) (CONAPO 2010, CONEVAL 2010, INEGI 2011b).	**Poorly maintained** and **aging** water and sanitation systems all over the city (Ibarraran 2011 in UN-HABITAT 2011). Infrastructure is **still not enough** to cope with floods	**<u>Climate change could:</u>** Increase the frequency and intensity of **floods.** This could **reduce mobility capacity** and access to goods and services	Improve **water and drainage systems** (Vargas et al 2011) taking into account climate change projections. Increase health promotion

	Almost 100% of the households own a **refrigerator** (INEGI 2011b). Therefore, Benito Juarez could have a greater adaptive capacity to food-borne diseases, even with a greater exposure to higher temperatures than Milpa Alta. Less than 10% of households are **overcrowded** (CONAPO 2010). Greater **mobility capacity.** Some of the most important avenues of the city cross the borough (INEGI 2012b) and it has a great diversity of public transport options. This leads to a greater **flow** of and **access** to **goods and services** which may lead to food at **lower prices** (Villarreal 2006).	(CONAGUA 2011).	and therefore increase their prices; **damage water and sewage systems** with the risk of water shortage; and damage **houses and cars**. Increase frequency and severity of storms, which may increase **injury and death** due to **falling power lines**. However, this might be greater in Milpa Alta. Due to an increase in temperature, the population is at higher risk of **food-borne** diseases when eating in the **streets**. Could decrease **hydropower generation** in other entities due to the lack of water in dams which could increase electricity prices. However, due to their higher income they could be less affected than Milpa Alta.	and prevention (Moreno & Urbina 2008, SEMARNAT 2009). Implement **regulations on street food stalls**. However this process might be difficult because most food stalls are illegal. Build smaller **dams** (Moreno & Urbina 2008).
Working conditions	**Comfortable** conditions. Not exposed to excessive heat.	Tend to be **sedentary** jobs (office jobs) that could be a risk factor for NCDs.	Climate change could further exacerbate **NCDs**.	Promote **healthy diets**, and design and implement **physical activities** at work to reduce the risk of NCDs.

Health-care	Greater **coverage** and **access (**CONEVAL 2010)**.** Greater **health-knowledge,** because of greater educational attainment (Salgado et al 2011). It makes it more likely for to implement preventative measures.	**Health system is still not prepared** to face potential climate change impacts. Coverage is **not universal**.	**<u>Climate change could:</u>** Damage health **infrastructure**, and reduce **access** and **quality** of services. Increase the **demand** for health-care and it could change Benito Juarez's **disease** profile.	**Strengthen health systems by improving and expanding infrastructure and train staff** to be able to face climate change impacts, to cope with increased demand and the potential emerging diseases (IPCC 2007a). **Increase** health-care **coverage** aiming to achieve universal coverage (Vargas et al 2011).
Social cohesion		**Low** social support and solidarity due to high social inequity (Martinez 2009), that could contribute to **social tension, conflict, crime and homicides**.	Although still debated, climate change could further increase poverty and inequities, and therefore decrease social cohesion which could make **policies that benefit the poor quite unlikely.** Climate change could worsen **social tension**.	Increase **social networks**. Increase institutional capacity in **conflict management** (Moreno & Urbina 2008). By increasing **equity through progressive policies,** social cohesion is increased, **mental health** improved, and people might **work together** designing inclusive adaptation strategies. This takes time; they should be implemented gradually empowering the poor.
High or low - carbon lifestyle		More dependent on **consumption and production**, and are more **responsible** of climate change (an increase in		Advocate/campaign for a low-carbon lifestyle. However, many challenges exist; first of all it threatens

		consumption and production further increases GHG emissions and the intensity of climate change and its consequences).		the current economic model.
Socioeconomic and political position (Income, education and occupation)	**Higher social status.** Their greater **economic capacity and political position,** due to their higher educational level and income (CONEVAL 2010, CEFP 2009), leads to their greater control over money and resources, and to their greater capacity to set their priorities at the top of the **political agenda** than Milpa Alta. Greater **assets in the form of money enables them to move** somewhere else if necessary. Due to their **greater income,** if food, electricity and water prices increase they are less affected than Milpa Alta. Greater jobs with **employment benefits,** including pensions.	More **unequal** and a greater **concentration of the poor** than Milpa Alta, leads to a weaker **social cohesion**.	Depending on the **degree of climate change** their income and employment could be affected, threatening their socioeconomic position.	**Redistributive social policies** to level the political position among the city's population is necessary. **Sensitizing the population** of the importance of Milpa Alta's and others' forest and food production for the viability of Benito Juarez and the city. This could contribute to **solidarity** once they have understood their **needs**, those of other boroughs and how each other's **strengths** could **overcome** each other's weaknesses, increasing **adaptive capacity to climate change** in both boroughs and the city as a whole.
Economy	A **stronger** economy than	**Dependent** on **global**	Depending on the **degree of**	Rebuild the primary sector

	Milpa Alta's which is not based on a climate sensitive sector – the service sector.	**economy** and on **foreign direct investment.** Therefore they are vulnerable to financial **crises**.	**climate change** even the service sector could be affected. Damaging infrastructure, buildings, telecommunications, and exports, among others.	(Vargas et al 2011) aiming for self-sufficiency. A percentage of the money earned in the service sector could be invested in the primary sector.
Climate projections		Compared to Milpa Alta, Benito Juarez is expected to have a higher increase in **temperature and heatwaves** and a greater number of extreme **precipitation** events.		Improve **climate forecasts** to advise the population of the measures they need to implement.
Governance	The government's aims for redistributive policies in Mexico City could be seen as a weakness for Benito Juarez, because at the moment they have greater control over resources and political power. and with redistributive policies they could lose this. However, if equity is achieved, the population as a whole will be benefited, especially in the face of climate change.	Different **ideologies** and **power** at different levels of government, **limit decisions at the local level**. **Corruption**.		**Sensitize the population about the consequences of climate change and the need for adaptation. This may** increase **social pressure** for the government to adopt appropriate policies.
Policies	**Local health insurance** which aims to be universal (Laurell 2003).	Lack of interest and investment of the government in the **primary sector**, which could make them more vulnerable to food insecurity. **Climate change policies** have concentrated on **mitigation**		**Redistributive policies** are crucial to increase adaptive capacity for the population as a whole. Every policy should be **evaluated** for equity and unintended consequences

		rather than on adaptation.		before being implemented.
Technological development/ choices	Starting to change in Mexico City with the **Mexico City's Pact** (Fundacion Pensar 2011). Mexico's recent climate change **law** which has established the goals to achieve a reduction of 50% of GHG emissions by 2050 (Maslin & Austin 2012).	Almost 90% of primary energy production comes from fossil fuels.		Invest in **research** to improve technology but ensure equity in terms of benefits and always think of adaptation in addition to mitigation. Use of **renewable sources** to reduce dependence on single sources of energy (IPCC 2007a).

MILPA ALTA – The poorest borough

Theme	Strengths in the face of climate change	Weaknesses in the face of climate change	Potential social and health impacts of climate change (Based on Table.11)	Suggested adaptation strategies
Health	Better **health perception** than Benito Juarez (Vargas et al 2011).	Although **NCDs** now dominate Milpa Alta's causes of death, they are in a lower **epidemiological transition** stage than Benito Juarez. **Malnutrition** and **perinatal** and maternal conditions are still important causes of death (SSDF 2007a, SSDF 2007b). As they suffer from NCDs and communicable diseases they are experiencing the **double burden** of disease.	**Climate change could:** Exacerbate **NCDs,** especially cardiovascular disease. Increase **communicable diseases** and **malnutrition** due to food and water insecurity, further delaying the epidemiologic transition. Increase **social tension** (possibly already present due to high social inequities), **crime,**	**Strengthening the health system** (IPCC 2007a) to be able to cope with the potential increase in demand; improve **early warning systems** and increase surveillance for infectious diseases (Bowen & Friel 2012, Moreno & Urbina 2008, SEMARNAT 2009, IPCC 2007b); provide greater and enhanced **health promotion** and **preventative measures** including mass vaccination

		Infant mortality rate is twice that of Benito Juarez (SSDF 2010a) and **respiratory and gastrointestinal infections** are still causes of infant mortality (SSDF 2007a, SSDF 2007b). The **suicide rate** in the productive age is three times higher than in Benito Juarez. Although the **homicide** rate is lower than Benito Juarez it is still in the top 15 causes of death (SSDF 2007a, SSDF 2007b). **Domestic violence** is an important cause of morbidity (Cortés, R 2012, pers. comm., 21 June) which could contribute to the high **suicide** rates (Gonzalez et al 2002).	**homicides and suicides** through different paths (water and food insecurity, extreme events, unemployment, loss of properties, mental health problems, among others). Could decrease **health perception** due to a further increase in temperature and extreme precipitation events and possibly due to a greater concentration of the poor (Vargas et al 2011). Although not projected yet, **vector-borne diseases** such as dengue and malaria could emerge. Could increase the **demand for health-care** and social support.	campaigns (Moreno & Urbina 2008, SEMARNAT 2009) provide greater and enhanced **health promotion** and **preventative measures** including mass vaccination campaigns (Moreno & Urbina 2008, SEMARNAT 2009) to reduce the exacerbation of **NCDs,** an increase in communicable diseases, malnutrition and the emergence of vector-borne diseases. **Progressive policies** are needed to improve Milpa Alta's **educational** level and living conditions, which will enable its population to implement preventative measures. These policies will also reduce **inequity** and poverty that could strengthen **social cohesion** and reduce crime, homicide and suicides rates. Implement strategies to preserve the city's and country's **forests,** attain strategic reserves of ground water, and build infrastructure to **harvest**

				rainwater, reuse and **recycle** water and treat water before reincorporating it to the environment (SEMARNAT 2009, Vargas et al 2011, CONAGUA 2011, IPCC 2007a). In addition to environmental **education** programmes to raise awareness (Vargas et al 2011). Invest in **sustainable agriculture** and livestock production to contribute to **food security** (Bowen & Friel 2012)**, increase employment, and improve working conditions.**
Population density, population growth and population structure	**Low population density** (the lowest of the city). **Younger** population than Benito Juarez. Greater concentration of population **capable of producing food** (agricultural and livestock production workers).	Low population density creates more **isolated** communities with less **access to health-care and other services.** **Population is growing** with a projected increase of 60% by 2030 (GDF 2007, INEGI 2009, SSDF 2010b). A growing population leads to **greater GHG emissions** and added climate change. An important percentage of	**<u>Climate change could exacerbate existing threats:</u>** Population growth could lead to **urban sprawl** placing **forests** and **cultivated-** and pasture-land at great **risk** and subsequently **food and water security.** In addition urban sprawl could **expand** the **UHI** effect. Climate events such as storms could further **increase** community **isolation**.	Although it is one of the largest boroughs of Mexico City, there is **little housing land left** because most of the land is covered by forest and cultivated and pasture-land. This stresses the need to plan its development (CONAGUA 2011) providing different alternatives for housing and, implement effective **family planning programmes** to reduce population growth.

		the population are **children.** Even though there is a low percentage of **elderly** population, it is growing.	The **elderly** and the **children** are more **vulnerable** to the impacts of climate change.	Improve **disaster prevention, response and recovery** programmes (Bowen & Friel 2012, Moreno & Urbina 2008), and improve **urban infrastructure and services**. Place greater attention to the elderly and children. Increase **awareness** of health personnel and **families** to the potential risks.
Geographic characteristics, environment and climate	**High altitude and temperate** climate inhibit the presence of **vector**-borne diseases. Only 10**% is urban land**, the rest is cultivated- and pasture-land, and almost 50% is forest (INEGI 2012c). This could lead to a much lower **UHI effect** and exposure to **air pollution** than Benito Juarez.	Due to the presence of mountain **slopes** there is an increased risk of **landslides** (Milpa Alta 2008), especially for informal settlements. As a result of the **porosity** property of Milpa Alta's soil (Milpa Alta 2008) it lacks a permanent flow of **water**. Rainwater infiltrates into the ground and recharges the city's aquifers. Therefore they are still dependant on the city's water and sewage system. Average **temperature** and the number and intensity of	**Climate change could exacerbate existing threats:** **An additional rise in temperature** and in the number and intensity of **precipitation** events, could lead to droughts and floods that could further increase the risk of **landslides**, **forest fires**, **food and water insecurity**, **communicable** diseases and to the emergence of **vector-borne diseases**, among others.	**Relocate** informal settlements and improve **housing** (Vargas et al 2011, IPCC 2007a)**. Design building standards and regulations that consider climate change** and provide housing **insurance** (IPCC 2007a). Provide and subsidize **rainwater harvesting** infrastructure (Vargas et al 2011, IPCC 2007a). Improve the water system (Vargas et al 2011), increase frequency of water supply and secure a sufficient **water storage capacity** (IPCC 2007a).

		precipitation events have increased over the past decades but not as much as in Benito Juarez. High exposure to **forest fires** which could lead to respiratory diseases (Friel et al 2011c, Moreno & Urbina 2008).		When **planning their development:** - Limit the use of concrete; select colours and materials appropriately to avoid the **UHI** effect. - Keep and build **shops, schools and health services** at a walkable distance. - Build **safety paths** for pedestrians and cyclists. - Increase and improve **reforestation** programmes (CONAGUA 2011). Provide fair payment schemes for environmental services (SEMARNAT 2009). - Invest in **sustainable agriculture and livestock** production including the provision of adequate **technology to increase crops' resilience** (Bowen & Friel 2012, Moreno & Urbina 2008). - Create and expand **green spaces** within urban land, plant trees and create the conditions and encourage **urban agriculture** (Vargas et al 2011, IPCC 2007b).

				Milpa Alta could be essential for the future **viability** and **sustainability** of the city. This could increase their **political position** and be able to articulate their demands and improve their **living and working conditions**.
Housing conditions		30% of households lack **refrigerators** (INEGI 2011b) having less capacity to preserve their food and higher risk of **food-borne diseases**. 25% of households have precarious **roofs** and most of them have been **self-built** leading to **unsafe** houses (INEGI 2011b). **Overcrowding** is prevalent in more than 40% of the households (CONAPO 2010) which could contribute to **communicable** diseases and **mental health** problems. Even though the **coverage** of services in Milpa Alta is high, it has the worst coverage of the city (CONAPO 2010, CONEVAL 2010); and the **quality**, **accessibility** and service	**Climate change could contribute to:** Increase exposure to **food-borne diseases**. Increase the risk of **damage to unsafe houses, injuries and deaths**. Further increase **communicable diseases**. Through greater **heat stress**, increase **mental health** problems. In addition to **poor housing conditions** could lead to the development of **vector**-borne diseases. It could **damage water and sewage systems** with the risk of **water shortage**.	**Home improvement** programmes that get to the poorest. Improve housing and building **standards**. **Increase access to micro-credits** to acquire assets such as **refrigerators** and improve housing. Increase investment to improve and expand coverage of **water and drainage systems,** and **electricity** taking into account climate change projections. Harvest **rainwater** (IPCC 2007a). Set **appropriate prices** of **public services** to improve

		provision are important issues. In addition to the p**oorly maintained** and **aging** water and sanitation systems all over the **city** (Ibarraran 2011 in UN-HABITAT 2011). **Low mobility capacity** of Milpa Alta's population (Vargas et al 2011) due to fewer roads and less public transport options than Benito Juarez, reduce their access to goods and services.	Could decrease **hydropower generation** in other entities, due to lack of water in dams which could increase electricity prices, affecting Milpa Alta the greatest. Could increase the frequency and intensity of **floods** further reducing **mobility capacity**, access to goods and services and face higher **prices**.	accessibility. Improve access to Milpa Alta through **better road infrastructure** (Vargas et al 2011) and **public transport**. This has the **disadvantage** that it could encourage urban sprawl. Therefore, specific measures need to be implemented to avoid this adverse effect.
Working conditions	Greater **physical activity**.	Tend to have jobs that expose them to **excessive heat** that could exacerbate NCDs and mental health problems (Friel et al 2011b). **Long and expensive commutes** to work that lead to physical and mental fatigue, reduced social cohesion, and could further expose them to air pollution (Vargas et al 2011, Friel et al 2011a).	Climate change could **worsen heat and air pollution exposure**.	**Regulations and preventative measures** to ensure employees safety (Vargas et al 2011). Decentralize businesses, industries and invest in **local employment**, including agriculture.
Health-care		**Lower coverage** and less access to good **quality** services than Benito Juarez. **Lower educational level** that could imply lower **health-**	**<u>Climate change could:</u>** Damage health **infrastructure**. Reduce **access** and **quality** of services.	**Strengthen health systems by improving and expanding infrastructure and train staff** to be able to face climate change impacts, to cope with increased demand and the

		knowledge (Salgado et al 2011), and fewer resources. All of which contribute to a lower potential to implement **preventative measures.**	Increase the **demand** for health-care and it could change its **disease** profile.	potential emerging diseases (IPCC 2007a). **Increase** health-care **coverage** aiming to achieve universal coverage (Vargas et al 2011).
Social cohesion	**More equal** than Benito Juarez. Greater percentage of **catholic** population (INEGI 2011a). Agricultural farmers and their families obtain emotional attachments to the region and to nature by cultivating crops (Torres-Lima & Burns 2002).	But still **highly unequal** (CEFP 2009) that leads to a **weak social cohesion** (Martinez 2009) and a lack of solidarity that could contribute to **social tension, conflict, crime, homicides** and suicides. The lack of social cohesion makes **policies that benefit the poor quite unlikely.** Their **longer commutes** to work could further weaken social cohesion (Vargas et al 2011, Friel et al 2011a).	Climate change could worsen **social tension**.	Increase **social networks**. This may improve health outcomes (Salgado et al 2011). Increase institutional capacity in **conflict management** (Moreno & Urbina 2008). By increasing **equity through progressive policies** social cohesion is increased, **mental health** improved, people might **work together** designing inclusive adaptation strategies. This takes time; they should be implemented gradually empowering the poor.
High or low - carbon lifestyle	Less dependent on consumption and production than BJ and therefore are less responsible of climate change			

Income, education, occupation (SEP)		**Lower SEP** than Benito Juarez due to lower education and income (CONEVAL 2010, CEFP 2009), leads to a **weaker political position** which reduces their chances to set their priorities at the top of the political agenda (Friel et al 2011b). They have fewer **opportunities** to move to another home if necessary, because their **assets are fixed** to the area where they live (land, livestock, and crops). They have not many assets in the form of cash reducing their capacity to move, to evacuate or rebuild damaged structures. Greater percentage of **poverty** and **marginalization** than in Benito Juarez (CEFP 2009, CONAPO 2010). Poverty could increase **deforestation,** becoming a form to earn a living, which will potentially increase climate change. There is a lack of decent employment. Therefore they are exposed to low **wages** and	**<u>Climate change could:</u>** Further increase **poverty** through different pathways: destroying households and assets, worsening health, increasing isolation, food and water insecurity, increasing food prices, loss of employment due to reduced agriculture production, among others. Reduce **access to education and health-care** by damaging infrastructure and/or further reducing mobility capacity; **and worsen working conditions. This could** further decrease their political position**.**	**Redistributive social policies** to level up the political position and living conditions among the city's population. **Sensitizing the population** of the importance of Milpa Alta's and others' forest and food production for the viability of Benito Juarez and the city. This could contribute to **solidarity** once they have understood their **needs**, those of other boroughs and how each other's **strengths** could **overcome** each other's weaknesses to increase **adaptive capacity to climate change** in both boroughs and the city as a whole.

		no **employment benefits**.		
Economy	Greater **self-sufficient** capacity. Milpa Alta is able to grow their own food which could protect them in part from high food prices.	Dependent on **climate - sensitive systems** such as agriculture, livestock and honey production. 95% of the city's cultivated land is rain fed. They **lack** adequate **technology**, crop and livestock **insurance** and **government** support which are the reasons why this sector is declining and many have to search for jobs in other boroughs and entities. As they are dependent on the prices of products such as food, they are **also dependent on the global economy**. Therefore they are vulnerable to financial crises.	**<u>Climate change could:</u>** Reduce **yields** and affect **livestock** production leading to food insecurity, unemployment, poverty, migration, **mental health** problems such as anxiety, depression and **suicide** as among others (Friel et al 2011c).	Invest on **sustainable agriculture** (SEMARNAT 2009, Bowen & Friel 2012) especially supporting s**mall** producers to protect them from high food prices. Make existing programmes that support producers such as **PROCAMPO, progressive**. Subsidize or provide new **technology** and **knowledge,** to increase adaptive capacity, such as irrigation technology to reduce the need of great amounts of water, and new methods to improve land management (SEMARNAT 2009, IPCC 2007a). Enable the conditions for producers to acquire agriculture **credits** and **insurance (**SEMARNAT 2009, IPCC 2007a, Moreno & Urbina 2008**)**. **Protect** producers from **price volatility** through subsidies.

				Encourage '**protected agriculture**' which is done under built structures (greenhouses) being able to control temperature, water use and plant nutrition better (SEMARNAT 2009). Increase the provision of **climate diagnoses and forecasts** which could be of great benefit to plan agriculture activities (adjustment of planting dates and crop variety), especially crops that are rain fed and therefore avoid great losses (SEMARNAT 2009, Moreno & Urbina 2008, IPCC 2007a). Seek for **plants or grains** that could be grown in Milpa Alta that do not need that much water, are resilient to higher temperatures and could contribute to the borough's economy. C**actus** is one example already being implemented in Milpa Alta (Torres-Lima & Burns 2002, Milpa Alta 2012). All of these actions could

				increase **local employment**.
Climate projections		Even though Milpa Alta is expected to have a lower increase in **temperature and heatwaves** and a fewer number of extreme **precipitation** events than Benito Juarez, it will still be affected.		
Governance	Left ideology in Mexico City that aims for redistributive policies.	Different **ideologies** and **power** at different levels of government which **limits decisions at the local level**. **Corruption**.		**Empower** the people materially, psychosocially and politically (move the power from higher levels to the people) to increase **social pressure** to adopt appropriate policies.
Policies	**Local health insurance** which aims to be universal (Laurell 2003). **Oportunidades**: the only conditional cash transfer that seems to be progressive (UNDP 2011), that is: benefiting the poor in a greater extent than the rich.	Almost all social policies are **regressive** increasing inequities. Lack of interest and investment of the government in the **primary sector**. **Climate change policies** have concentrated on **mitigation** rather than on adaptation.		**Redistributive policies** are crucial to increase adaptive capacity for the population as a whole. Every policy should be **evaluated** for equity and unintended consequences before being implemented.
Technological development and choices	Starting to change in Mexico City with the **Mexico City's Pact** (Fundacion Pensar 2011).	Almost 90% of primary energy production comes from fossil fuels.		Invest in **research** to improve technology but ensure equity in terms of benefits and always think of

	Mexico's recent climate change **law** which has established the goals to achieve a reduction of 50% of GHG emissions by 2050 (Maslin & Austin 2012).			adaptation in addition to mitigation. Use of **renewable sources** and reduce dependence on single sources of energy (IPCC 2007a).