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Megacities and Global Change in Latin America. The Struggle for Sustainability

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(Fig. 1) I would like to thank the organizers of this event for their kind invitation. I would like to focus my presentation on the linkages between mega-cities and global environmental change in the developing countries. The main reason is that these countries have significantly less resources to confront the challenges and problems created by these linkages compared with the industrialized countries.

(Fig. 2) Let me begin by highlighting the importance of urban areas in our current societies. The discussion of present and future development in developing countries is intrinsically associated with the qualitative and quantitative growth of their urban areas. This figure shows fast rate of urban areas during the last 30 years and their project growth for the next 22 years. The large majority of the population in the world is already concentrated in urban areas.

(Fig. 3) Perhaps the best illustration of the importance of urban areas in the world is this illustration of this image of the world at night. The image reminds how closely is related the issue of population density and the use of natural resources

(Fig. 4) This chart reminds us about the increasing importance of mega-cities in our urbanized world.

(Fig. 5) This table illustrated the distribution of the world's total and urban population and its largest cities in the year 2000. It is remarkable the number of mega-cities in the developing countries. It is in these countries where the vast majority of future population growth will concentrate in the next 25 years.

(Fig 6) One major characteristic of this future growth is that population in urban areas will increasely be associated with poverty, particularly in developing countries. This chart illustrates the fast increase of the urban poor in Latin America and its importance

for future population growth. (70 % of the future poor will be in urban areas by the year 2025).

(Fig. 7) Urban areas are not only important because they concentrate the majority of the population around the world. They also concentrate the driving forces for economic growth and social well- being, particularly in the developing world. The concentration of important economic activities and population in major urban areas provides them with a leading role in development efforts. They are key interfaces between countries and global sociopolitical and economic processes. Mega- cities play a key role in this regard. They concentrate most of the national industrial activity, population, and generate large part of the national GDP. For example, Mexico City concentrates 22 per cent of the total population in Mexico, 30 per cent of the commercial employment, and 40 per cent of the industrial activity. Sao Paulo generates 47 per cent of the industrial GDP in Brazil, 36 per cent of the national GDP, and it concentrates 14 percent of the national population. Lima concentrates 55 per cent of the national population in Peru, it generates 43 per cent of the national GDP, and 50 per cent of the industrial GDP.

(Fig 8) Despite the importance of mega-cities, little has been done to understand their challenges for sustainability and the interactions with global environmental change. Current international efforts to study and better understand global environmental change has not provided enough attention to study the role of urban areas in this process. The joint international initiatives between IGBP, IHDP and WCRP focus on water, food systems and carbon. These initiatives seek to provide a more integrated perspective of these problems with contributions from the natural and social sciences. Urban areas do not appear yet with a major research emphasis in these projects.

(Fig. 9) Another example of the lack of attention to urban areas in the study of global environmental change is the study of climate change. This figure illustrates the model used in 52 country studies sponsored by EPA, the environmental agency in the US at the end of the 1990s. This agency funded 52 studies around the world, but as you can see, urban areas do not appear within their scope of interest.

(Fig. 10) This presentation seeks to illustrate some of the linkages of global environmental change and urban areas, particularly from the point of view of mega-cities. The departing point in the study of global environmental change is the interactions between society and nature. In our case, between mega-cities and biophysical process.

(Fig. 11) The way we conceptualize these interactions are illustrated here. On one side we know that the urban space in mega-cities is constructed by a rich array of global, regional and local geopolitical and socio-economic processes (the left side of the chart). At the same time, that urban space is also influenced by global, regional and local biophysical processes. The thematic areas listed here illustrate the diversity of topics that can be included in such research, from new theoretical and methodological interdisciplinary approaches, to particular issues like health, governance, the role of urban function and urban form, etc.

(Fig. 12) The creation of an interdisciplinary perspective of the linkages of global environmental change and mega-cities can be supported by contributions from diverse disciplines and research approaches in the social and natural sciences. Within the social sciences there is already a large tradition in the study of urban issues from an economic, social, political, cultural and environmental point of view. The same can be said from some of the natural sciences. Urban climate studies have generated valuable information and knowledge that help us understand how urban areas affect and are affected by climate, as well as the alternatives to improve local conditions and microclimates. Contributions from urban hydrology, geology or urban ecology have assisted us in the reduction of environmental problems in urban areas. Climate forecasts have contribute to a better understanding of the value of these forecasts for the daily function of urban areas and in the prevention and response to climate related natural disasters. The study of the linkages between global environmental change and mega-cities can take advantage of the knowledge generated by these research approaches and integrate them in an interdisciplinary perspective. Particularly useful for this purposes are multi-disciplinary and multi-scale concepts that create linkages between the natural and social sciences: vulnerability, livelihoods and resilience. These three concepts are interrelated and could help us create a comprehensive perspective of complex and dynamic perspectives realities in the mega-cities.

(Fig. 13) The interactions between global environmental change and mega-cities can be illustrated by analyzing the case of climate variability and global climate change

(Fig. 14) The exposure to extreme climatic events is defined by changes in extreme daily temperature and precipitation. Most of the time, data on climate variability and climate change is presented in actual or potential average changes. For example, climate change is presented in terms of 1 or 2 oC of increase in temperature or 10 % of increase or decrease in precipitation. But at the local level (mega-cities), it is important to consider extreme daily precipitation or temperature that define the magnitude and importance of the impacts (floods, heat wages, drought, etc.) and their potential social, economic, and environmental consequences. Also important are the changes in the intensity and frequency of seasons that are an important element to understand the likelihood of extreme events. For example, changes in the season and frequency of precipitation can have devastating consequences in the supply of water resources for mega-cities.

(Fig. 15) The attention provided so far to climate change and mega-cities has focused on the emissions of green house gases from transportation and industrial activities in the major urban areas and to the associated effect known as heat island. This infra red satellite image shows the gradient in temperature in New your city compared with its hinterland. The diagram in the upper right corner shows that in the case of Athens, Greece, this gradient in temperature can vary at noon from 39oC in the central part of the city to 27oC in the outside of the city.

(Fig. 16) But mega-cities are also increasely vulnerability to a diversity of impact related to climate variability and climate change. Perhaps the most visible of those impacts are climate related natural disasters. The number of casualties caused by hurricane Mitch or

the landslides in Venezuela in the recent years is a good illustration of this type of problems. Although these type of events do not have the same impact on mega-cites, every year a number of these cities suffer severe consequences due to extreme climatic events (floods, draught, heat wages, etc.). Incomplete urbanization in the mega-cities of developing countries, together with the lack of economic and technological resources resources to prevent and adapt to these problems, aggravate the negative consequences of these events.

(Fig. 17) Other type of consequences can have severe health consequences affecting thousands of people in mega-cities. Incomplete urbanization and poor sanitation are breading ground for disease organisms and vectors. An increase in temperature in mega-cities can accelerate the reproduction of vectors within the urban area. Recent studies have documented how climate variability associated with El Nino has expanded the threshold of some vector-borne diseases like dengue and malaria. Other health problems associated with climate variability ad climate change are associated with extreme temperatures. The negative consequences of heat wages are associated with cardiovascular and respiratory illness. For example, close to 400 people died in Chicago in 1999 as a result of a heat wage. This year several thousand people died in France as a result of another heat wage. Deficient urban and housing conditions affecting millions of people in mega-cities in developing countries, together with the lack of access to resources, and the increase of urban poor mentioned above, aggravate the negative health consequences of this type of events.

(Fig. 18) An additional health consequence of extreme climatic events is related to an aggravation of air quality problems that already affect many mega-cities in developing countries. Higher temperatures affecting mega-cities will likely aggravate tropospheric ozone (smog) problems in a number of mega-cities (Mexico City, Santiago, Bangkok, Sao Paulo, etc.). Deficiencies in critical urban functions (transport), conflicts in land use, and uncontrolled urban growth will aggravate the impact of extreme climatic events of this type.

(Fig. 19) Other set of consequences of extreme climatic events are related to water supply, water distribution and water quality. Almost all mega-cities in developing countries face already severe problems to warranty their water supply. Changes in the intensity and time of the raining seasons triggered by climate variability and climate change can dramatically affect the supply of water in mega-cities. Unfortunately, water problems in mega-cities are also associated with water distribution and water quality. All mega-cities in developing countries have water distribution problems with severe social and health consequences. The percentage of people with access to the municipal water system varies from as high as 89 to 90 per cent in some mega-cities in Latin America, to only 20-30 per cent in some mega-cities in Asia and Africa. Water distribution problems are also associated with deficiencies in the operation of public services and the lack of resources to maintain their operation. People without access to drinking water from the municipal system pay 3 to 30 times more from each liter of water they obtain from secondary sources (street vendors). There is no quality control of this water. Deficiencies

in water supply associated with climate variability and climate change would aggravate further the already severe water distribution and water quality problems in mega-cities.

(Fig. 20) Sea level rise is another potential impact associated with climate change. A number of mega-cities in developing countries are located in costal areas and can be impacted by an increase of sea level rise. A large number of inhabitants in these cities can be affected by an increase in the sea level. An additional problem associated with this problem is salt intrusion that can affect drinking water sources in urban areas.

(Fig. 21) A different set of interactions with global environmental change are established by the relationship of mega-cities and regions. Mega-cities and urban areas in general are supported by extended regions. The supply of natural resources (water, energy, building materials) and food to mega-cities is a critical function of peri-urban areas and extended regions. Urban processes also affect regions through the outflow of pollution and waste. The impacts of mega-cities in their regions have important consequences in terms of induced changes in land use and land cover.

(Fig. 22) For example, fast urban and population growth in Mexico City during the 1960s and 1970s triggered a massive process of deforestation in Tabasco in the South East part of Mexico. Vast areas of rain forest in Tabasco were cut to create extensive grassland for cattle rising and agriculture. Tabasco became a major supplier of food (mainly meat) for the growing market in Mexico City. Tabasco represented one of the last large areas of rain forest in Mexico. Its deforestation was a significant lost of biodiversity.

(Fig. 23) Mega-cities are becoming increasely vulnerable to the negative consequences of Global environmental change

(Fig. 24) Although there are many ways to interpret vulnerability, I follow the contribution from Geographers and anthropologists that consider vulnerability as the exposure of individuals, groups or communities to harmful perturbations from nature at a specific time and in a specific space, where the level of vulnerability is defined by the dynamic balance between the external side of events or perturbations, and the internal side created by a wide range of social and economic relations that condition the access to resources needed to cope with minimum damaging loss.

(Fig. 25) The urbanization process in mega-cities helps us understand the internal side of their vulnerability. These are some of the major characteristics of that process.

(Fig, 26) Particularly important in developing countries is the social context of urbanization.

(Fig. 27) And the challenges of a number of environmental problems that mega-cities already face.

(Fig. 28) This figure illustrates the internal dimension of vulnerability in the context of the conceptual framework presented above. The driving forces are related to the global,

regional and national socio-economic and geopolitical processes presented at the beginning of this presentation (macroeconomic imbalances in developing countries, economic, financial and political crises, neo-liberal ideologies, etc.). The context relates to local and regional socioeconomic processes (inequality, poverty, unemployment, marginality, etc.) that condition and limit the access to resources to resist an external event (natural disaster).

(Fig, 29) illustrates this internal context of vulnerability of individuals and groups in Latin American countries and the type of urban space they generate. For example, almost 60 % of Mexico City are settlements constructed outside any regulation.

(Fig. 30) One of the major challenges we face in the study of vulnerability, and global environmental change in urban areas in general, is the study of the dynamic interactions that occur between the different dimensions of urban areas (economic, social, political, cultural, and ecologic). We need to construct new theories and methods capable of supporting interdisciplinary perspectives of complex and dynamic processes.

(Fig. 31) These processes take place at different scales. For example, the socio-economic and geopolitical processes at a global, regional and local scale that define the driving forces in the construction of the urban space, have also differentiated impacts within the urban area. This implies that we also need to consider different analytical scales at the city level (household, neighborhood, and city level). For example, direct foreign investment (financial and construction capital, manufacture, trade and services) are major driving forces shaping the urban space and its path of growth. This growth is differentiated by neighborhood and household. By the same token, global environmental change have also impacts at different scales on urban areas. For example, not all neighborhoods in a mega-city are vulnerable to floods or landslides. Not all individual and households are vulnerable to shortages in water distribution ad water supply.

(Fig. 32) There are several interdisciplinary approaches to can prove to be useful in the study of global environmental change in mega-cities. Socio-ecological resilience and landscape planning are two of them that seek to combine an ecosystem approach with the socio-economic and political dimensions. Both approaches seek to expand a sound use of natural resources and enhance the use of ecological services as a way to create a balance between the use and conservation of ecosystems and social and economic benefits to society.

(Fig. 33) For example, Among 17 main ecological services identified by Contanza, some of them are particularly useful in urban areas. They can provide very effective to reduce the vulnerability of neighborhoods and individual households to extreme climatic events, reduce environmental problems, and support key urban functions (recreation).

(Fig. 34) Ecological services can be particularly helpful in the creation of microclimates to reduce the negative consequences of extreme events, and the heat island effect. For example, this satellite image of Salt Lake City shows the gradient in temperature within the urban area (the constructed space, vegetated areas and water bodies.

(Fig. 35) A study in Athens, Greece, shows the benefit of green areas in the city. Additional benefits can be obtained from reflective capacity of building materials and colors. The creation of microclimates to mitigate the negative consequences of extreme increases in temperature can have significant benefits for the population (health, index of comfort) that will in turn improve social life and function in mega-cities. It will also reduce the use of energy and the emission of pollutants.

(Fig. 36, 37, and 38) describe some of the benefits of ecological services in urban areas.

(Fig. 39) The movement of wind is an additional factor in the creation of microclimates in mega-cities. Building and other high construction in mega-cities create cannons that accelerate wind movement in urban areas. Wind speed have a significant impact in the index of comfort in urban areas.

(Fig. 40) For example, in the dry tropic climates, the movement of wind can reduce the index of comfort for urban inhabitants. The wind is warmer than the skin in this climate. The exposure of the skin to the wind will make it wind additional warm. Traditional architecture in the Middle East has long recognized the importance of reducing wind circulation in urban areas and inside the dwellings. For example, the streets in El Cairo are narrow and winding to hinder wind speed. Narrow streets also provide shadows and reduce solar radiation on the streets. Dwellings have small ventilation and illumination spaces for the same purposes.

(Fig. 41) In contrast, the design of new housing and neighborhoods in El Cairo has abandoned traditional patters of urban and architectural design for traditional western urban design poorly adapted to extreme local climatic conditions.

(Fig. 42) I sought to illustrate the importance to better understand global environmental change in mega-cities. I would like to finish highlighting some issues from the presentation.

(Please, read the issues presented in this figure).

Thank you very much.