

THE ASSESSMENT OF THE KEY CLIMATE IMPACTS AND POSSIBLE ADAPTATION
OPTIONS IN LUANDA

Ding Li (20866008)

GEOG 207

Daniel Scott

March 18, 2020

Introduction of the Article

Sub-Saharan region has always been known as an African region where concentrated population, poverty, and environmental problems exist and thus, hugely affected by climate change. As one of the biggest cities in the sub-Saharan region, Luanda is absolutely representative enough to be discussed about climate change impacts. Nevertheless, an introduction that clarifies the population distribution, the local economy, and the local environmental issues in Luanda is necessary before further discussion on the key climate impacts and possible solutions, which will be shown below. Also, discussions on the potential climate change impacts and the suggested adaptation options for those impacts will be proposed after the basic introduction. Finally, a comprehensive assessment of the vulnerability and a conclusive thought on a broader range based on Luanda will be at the end of the article.

Introduction of the Study Area

Demographic Study of Luanda

Luanda, as the capital of Angola, is also the hugest city in Angola with the largest population who speak Portuguese (Luanda Province 2020). According to the statistic website Knoema demonstrates in 2020, until 2014, 6542944 people live within a 2418-square-kilometer area, which means that the local population density has reached 2705.93 people per square kilometer. Other statistical figures are:

Birth Registration (%):26.2 (2012)

Preschool Education (%):12.0 (2012)

Child Labor (%):8.9 (2012)

Literacy (%):86.7 (2012)

Housing (%):70.9 (2012)

Electricity Network:83.7 (2012)

Malaria (%):19.1 (2012)

(African Development Bank Group - AfDB et al n.d. as quoted in “Sources - Luanda - Angola” 2020). Furthermore, Luanda’s population is keeping growing and is expected to become a megacity by 2030 (United Nation n.d. as quoted by The Guardian 2019). In conclusion, the population in Luanda is highly concentrated, keeping growing, less educated, fewer children protected, less accommodation supplied, and lack of health care. Those features, additionally, are strongly related to the local economy and the adaptive capacity that the article focuses on when Luanda is facing climate change impacts.

Economic and Social Study of Luanda

The local economy and public resources in Luanda have always been at stake until the new president came into power in 2018. The first reason is that Luanda is extremely dependent on the oil and diamond trade since 2002. As the result, Luanda is facing tough inequality after the closure of the route from London to Luanda, which used to bring enormous oil and diamond trades. The dilemma has led to a series of effects that worsen the economy in Luanda (The Guardian 2019). In addition, Luanda is interrupted by serious governmental corruption, which directly made most wealth gathered by the elite and the power class and thus, no adequate social resources for reduction of local inequity until the new president came into power (The Guardian 2019). Some statistical figures cited from Knoema, which has been mentioned before, can also illustrate the outcomes brought by the governmental corruption, which are persuasive enough to conclude that Luanda is a city with hugely deficient education conditions, children protection, accommodation supply, and public health resource. Generally speaking, the local economy in

Luanda is depressing because of the dependence on British Airways that can bring trades, and the social resources are poor because of governmental corruption.

Environmental Study of Luanda

Luanda is a less vegetated coastal city with a tropical climate surrounded by the Atlantic Ocean, whose biodiversity is abundant. (see Fig. 1.) (Ferreira-Baptista, L. and Eduardo De Miguel 2005).

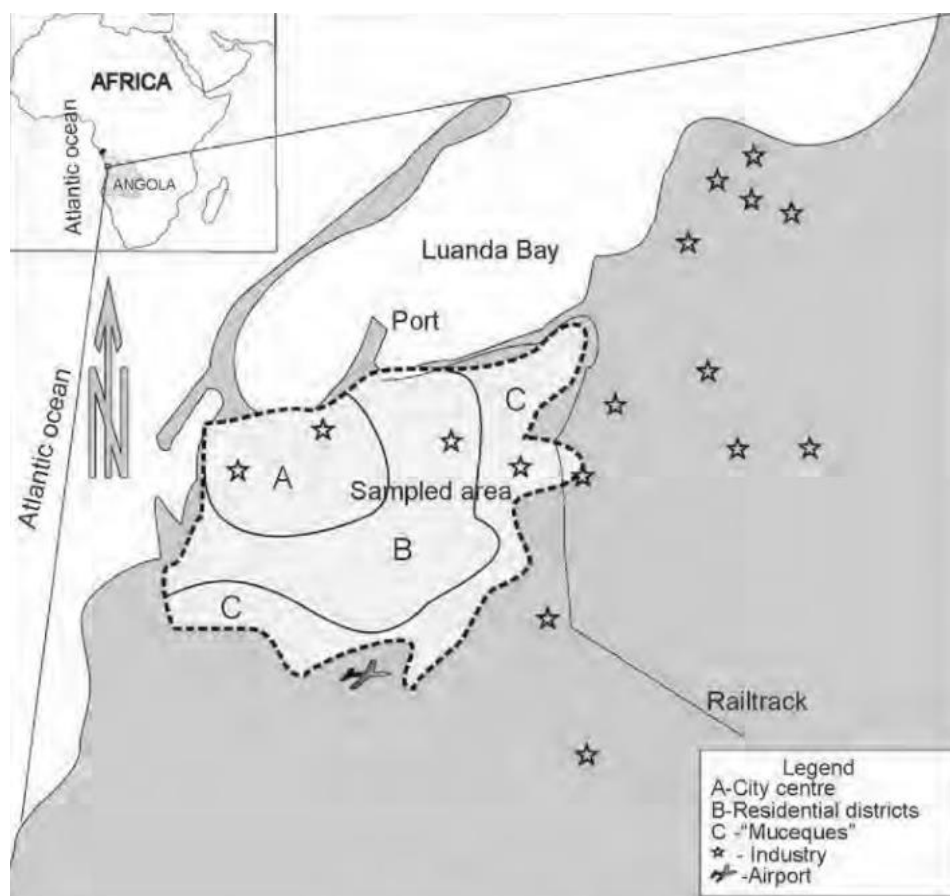


Fig. 1. Abstract map of Luanda. Created by Ferreira-Baptista, L. and Eduardo De Miguel. From “Geochemistry and risk assessment of street dust in Luanda, Angola: A tropical urban environment.”

Environmentally, Luanda has an extremely low vegetation rate, which is 21% (WeatherSpark.com 2020). Spatially, Luanda is a coastal city near the Atlantic Ocean, and most

of Luanda is surrounded by the ocean. From the perspective of climatology, Luanda has a tropical climate with a temperature of 26 Celsius degrees, and precipitation of 350-400 millimeters each year. From the perspective of biodiversity, Luanda has remarkable richness in biodiversity according to the book *Biodiversity of Angola: Science & Conservation: A Modern Synthesis* (Huntley, et al. 2019 p. 543). Therefore, Luanda is worse vegetated; Luanda is a coastal city surrounded by the Atlantic Ocean; Luanda has a tropical climate, which makes the region warm and rainy; And Luanda has rich biodiversity.

Potential Climate Change Impacts in Luanda

Two Climate Change Impacts on Human Systems

Possible Pollution in the Local Water Supply System

Climate change may bring water pollution problems in the urban area of Luanda by causing soil erosion in the urban area. A coastal city with a tropical climate (such as Luanda), can be very exposed to the rise of sea level, storm frequency and intensity variation, and precipitation increase caused by climate change (EPA 2016). Furthermore, according to MA Nearing, F.F. Pruski, and M.R. O'Neal's article, the changed rainfall amounts, rainfall intensities, precipitation patterns, and some other variables caused by climate change can contribute to soil erosion (2004). Therefore, a huge amount of sediment is expected to deposit in urban waterways when soil erosion in the urban area occurs (Environmental Protection Agency 2016). Also, the erosion of the seashore will lead the seawater from the ocean into the freshwater aquifers, which can reduce freshwater availability (Awuor, Cynthia Brenda, Victor Ayo Orindi, and Andrew Ochieng Adwera 2008). Thus, as the conclusion, climate change can cause water pollution in Luanda urban area for the reason that as a coastal city with a tropical climate, soil and seashore erosion have a huge possibility to occur, so that the production from the soil erosion will become

much sediment deposited in the local waterways with which water is supplied to local residents, and the eroded seashore makes saltwater more likely to flow into the freshwater aquifer to lessen the local freshwater supply.

Possible Worse Health Situation

Climate change can worsen the local health situation through especially intensive Urban Heat Island Effect in Luanda. First, Luanda is short of vegetation, which is just like what has been proposed before (WeatherSpark.com 2020). Also, Luanda has a very concentrated and large amount of population (Knoema 2020). Therefore, the lack of vegetation and the dense population distribution all contribute to more intensive Urban Heat Island Effect, which describes a case where some urban areas' temperatures are obviously higher than the surrounding places (Hardy, C. H., and A. L. Nel 2015). Unfortunately, the Urban Heat Island Effect and the precipitation occurs in the urban induced convergence zone caused by the Urban Heat Island Effect can raise the ozone concentration, which is regarded as the process of ozone pollution. The ozone pollution is significantly responsible for cardiovascular and chronic lower respiratory diseases (Lo, C. P., and Dale A. Quattrochi 2003). Conclusively speaking, climate change may worsen the local health situation in Luanda by causing heavy Urban Heat Island Effect because of the lack of vegetation and the dense population in Luanda, which can make ozone pollution in the urban area of Luanda lead to more cardiovascular and chronic lower respiratory disease occurrences.

Two Climate Change Impacts on Nature Systems

Potential Decrease in the Ocean Ecosystem Biodiversity

Due to climate change, a profound deduction of local ocean ecosystem biodiversity in Luanda is expected to occur. First, Luanda is a coastal tropical city, and the ocean around

Luanda will become warmer and warmer because of climate change. Then, according to an article written by Fujita, species of fish are expected to migrate poleward to seek another place with a more suitable temperature (2018). Unfortunately, In a book, Huntley and some other researchers argue that Angola has one of the most abundant ocean biodiversity (2019), which means that a relatively large part of species of fish and other ocean species may migrate away from the ocean surrounding Luanda. And the huge change in the local ocean ecosystem can be remarkable through further amplifying effects, such as the break of the food chain due to the disappearance of several fish species to cause further extinction of the species which rely on the previously disappeared species. Generally speaking, climate change can influence the local ocean ecosystem biodiversity in Luanda through the raise of the local ocean temperature that may lead to marine species migration.

Possible Extinction of the Sea Turtles in Luanda

The sea turtles living in Luanda may extinct due to the great harm climate change may do to the reproduction of the sea turtles. Carr, Thomas, and Nicole Carr claimed in an article that five sea turtle species had been confirmed to exist in Angola, which all nested on the local beaches. Nevertheless, the population of the sea turtles in Angola was not considered to be positive because of the weak execution situation of the law by which the sea turtles are protected (2016). To make the situation even worse, the coastal squeeze is very likely to occur in such a coastal city, which is defined as the loss of the intertidal habitat because of the block of high watermark as well as the low water mark migration toward the land as the result of the rise of sea level (Pontee 2013). And the recovery of the sea turtle population, nonetheless, depends much on hatchling production related to the nest condition, which is unfortunately expected to be hugely impacted by any coastal squeeze (Mazaris, Antonios D., Giannis Matsinos, and John D. Pantis

2009). Therefore, the sea turtles in Luanda undertake the risk of being extinct due to coastal squeeze caused by climate change.

Adaptation Options for Previously Proposed Potential Impacts

Adaptations for the Climate Impacts on Human Systems

Adaptation for the Possible Water Pollution

Luanda is recommended to implement a series of water safety plans to mitigate the water pollution at the source. Due to the poor economy and social resources in Luanda, more expensive approaches can be too hard to execute. Nevertheless, a series of water safety plans are a relatively cost-effective method that is possible for poorer regions like Luanda according to an article (Climate Technology Centre & Network 2019). Therefore, a risk assessment system is recommended to be developed to test the security of the local water supply according to a handbook. Then, every phase of the whole water supply has to be assessed by the system effectively to make sure that each risk that exists in the whole water supply process is discovered and given adequate interruption (Bertule et al. 2018). In summary, developing a local risk assessment system that may contain some easily accessible technologies such as water quality test, and establishing regulations that supervise, regulate, and interrupt every step in the water supply process as the water safety plans are expected to solve the possible water pollution that may brought by climate change in Luanda.

Adaptation for the Possible Worse Health Situation

The possible worse health situation in Luanda can be improved by making the local primary level of health care supply in Luanda focus more on the population with a high risk of being impacted by cardiovascular and chronic lower respiratory disease. According to Bovet, Pascal, and Fred Paccaud's article, noncommunicable diseases treatment can be extremely

challenging in Luanda as a low-income region. However, the primary level of health care can be much more accessible and economic. Therefore, more cost-effective primary health care resources concentrated on the population with a high risk of being exposed to those non-communicable diseases can be absolutely efficient (2011). In conclusion, primary health care resources are recommended to be concentrated on the high-risk individuals that are expected to increase due to climate change.

Adaptation for the Climate Impacts on Nature Systems

Adaptation for the Potential Decrease in the Ocean Ecosystem Biodiversity

Potential decrease in the ocean ecosystem biodiversity can be mitigated by planning protected areas with localized ocean ecosystem study in the ocean. According to an article, locally-managed marine areas are promoted in many tropical coastal regions by the local governments. In addition, a more localized study in the local ocean ecosystem by a group of committees makes climate change be able to be evaluated as the main factor in the design and management of the protected areas (Hedley, et al. 2011). Comprehensively speaking, the features of specific species with the near ocean can be clarified by localized study in the local ocean ecosystem, and therefore, more specific and effective management and design can be implemented in the protected areas to avoid further climate change impact on the ecosystem biodiversity.

Adaptation for the Possible Sea Turtle Extinction

Sea turtle extinction may be prevented by implementing setback regulation. An article which focus on mitigation of sea turtle's nesting beach loss introduces a method called setback regulation, which is a rule to prevent any construction activities taken place within an appropriate length of distance from the ocean. Fortunately, by a series of research, little beach

area within which the sea turtles nest will be lost when the set distance within which no construction is allowed reaches or exceeds 90 meters (Fish et al. 2008). Thus, sea turtles' nesting land area in Luanda can be protected from the coastal squeeze. In summary, setback regulations that prohibits construction activities within over 90 meters away from the ocean can help prevent the beach area where sea turtles nest from losing through the coastal squeeze, which can lessen the possibility for the sea turtles in Luanda to extinct.

Conclusion and thoughts on a broader picture

Luanda is typical enough to represent a wide range of coastal, tropical, densely and concentrated populated, and underdeveloped urban regions all over the world, whose features make those regions extremely vulnerable than other regions. First, the concentrated and dense population makes this type of region extremely sensitive to climate change, since energy, food, and water supply functions are densely gathered but dispersed with natural resources. Therefore, the impact brought by climate change such as water pollution on human systems in those regions can be difficult to recover and may cause huger influence and impact population than in other regions (Hardoy 2009). Also, the poverty and inequity make the regions and the residents in those regions have limited resources, technologies, and the economy to adapt to the impact of climate change (Hardoy 2009). For instance, Luanda is lack of education services, public health resources, and housing resources. Thus, the potential decrease in public health situation can be tough to deal with using such limited resources. Additionally, Luanda has a high grade of governmental corruption, which causes some trouble in some of the adaptation options comprising policy establishment, supervision, and management (The Guardian 2019). For example, the suggested protected area plan to protect the ocean ecosystem in Luanda as the adaptation options, as well as the setback regulation in order to prevent the sea turtles in Luanda

from extinction can be negatively affected by governmental corruption. Finally, the unchangeable locations of the regions like Luanda give the regions tropical climate and the near-ocean features, which lead to an even higher temperature than in other places, and more exposure to extreme climate events such as sea-level rise which occurs much more frequently in coastal areas. Those features, combined with the dense and concentrated population, make the regions further exposed to climate change impacts, such as the Urban Heat Island Effect, decrease in the local ocean ecosystems, and the extinction of some amphibious species which live near the ocean. In conclusion, the Luanda-like regions all suffer from extremely high vulnerability in terms of the sensitivity, exposure, and adaptation capacity: high sensitivity due to the concentrated urban functions, high exposure due to the dense and centralized population, the tropical climate, and the near-ocean feature, and severely inadequate adaptation capacity due to the terrible economy, public health, education conditions, and some extent of governmental corruptions.

References

- “After the Oil Boom: Luanda Faces Stark Inequality – Photo Essay.” The Guardian. Guardian News and Media, January 22, 2019. <https://www.theguardian.com/cities/2019/jan/22/after-the-oil-boom-luanda-faces-stark-inequality-photo-essay>.
- “Average Weather in Luanda, Angola, Year Round - Weather Spark.” WeatherSpark.com. Accessed March 20, 2020. <https://weatherspark.com/y/74193/Average-Weather-in-Luanda-Angola-Year-Round>.
- Awuor, Cynthia Brenda, Victor Ayo Orindi, and Andrew Ochieng Adwera. "Climate change and coastal cities: the case of Mombasa, Kenya." *Environment and urbanization* 20, no. 1 (2008): 231-242.
- Bertule, Maija, Lars Rosendahl Appelquist, Jason Spensley, Sara Lærke Meltøfte Trærup, and Prakriti Naswa. "Climate change adaptation technologies for water: A practitioner's guide to adaptation technologies for increased water sector resilience." (2018).
- Bovet, Pascal, and Fred Paccaud. "Cardiovascular disease and the changing face of global public health: a focus on low and middle income countries." *Public Health Reviews* 33, no. 2 (2011): 397-415.
- Cain, Allan. "Climate Change & Land Markets in Coastal Cities of Angola—the case of Luanda." (2015).
- Carr, Thomas, and Nicole Carr. "Surveys of the sea turtles of Angola." *Biological Conservation* 58, no. 1 (1991): 19-29.
- “Climate Impacts on Coastal Areas.” EPA. Environmental Protection Agency, October 6, 2016. https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-coastal-areas_.html.
- Ferreira-Baptista, L. and Eduardo De Miguel. “Geochemistry and risk assessment of street dust in Luanda, Angola: A tropical urban environment.” (2005).
- Fish, M. R., I. M. Cote, J. A. Horrocks, B. Mulligan, A. R. Watkinson, and A. P. Jones. "Construction setback regulations and sea-level rise: mitigating sea turtle nesting beach loss." *Ocean & Coastal Management* 51, no. 4 (2008): 330-341.
- Fujita, Rod. “5 Ways Climate Change Is Affecting Our Oceans.” Environmental Defense Fund. Environmental Defense Fund, August 23, 2018. <https://www.edf.org/blog/2013/10/08/5-ways-climate-change-affecting-our-oceans>.
- Hardoy, J., & Pandiella, G. (2009). Urban poverty and vulnerability to climate change in Latin America. *Environment and Urbanization*, 21(1), 203-224.
- Hardy, C. H., and A. L. Nel. "Data and techniques for studying the urban heat island effect in Johannesburg." *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences* 40, no. 7 (2015): 203.
- Hedley, et al. “Ecosystem-Based Adaptation in Marine Ecosystems of Tropical Oceania in Response to Climate Change.” *Pacific Conservation Biology* 241, no. 258 (March 17, 2011): 251–53.
- Huntley, Brian J., Vladimir Russo, Fernanda Lages, and Nuno Ferrand, eds. *Biodiversity of Angola: Science & Conservation: A Modern Synthesis*. Springer, 2019.
- Jenkins, Paul, Paul Robson, and Allan Cain. "Luanda." *Cities* 19, no. 2 (2002): 139-150.
- Lo, C. P., and Dale A. Quattrochi. "Land-use and land-cover change, urban heat island phenomenon, and health implications." *Photogrammetric Engineering & Remote Sensing* 69, no. 9 (2003): 1053-1063.

- “Luanda Province.” Wikipedia. Wikimedia Foundation, March 10, 2020.
https://en.wikipedia.org/wiki/Luanda_Province.
- Mazaris, Antonios D., Giannis Matsinos, and John D. Pantis. "Evaluating the impacts of coastal squeeze on sea turtle nesting." *Ocean & Coastal Management* 52, no. 2 (2009): 139-145.
- Nearing, M. A., F. F. Pruski, and M. R. O'neal. "Expected climate change impacts on soil erosion rates: a review." *Journal of soil and water conservation* 59, no. 1 (2004): 43-50.
- Pontee, N. “Defining Coastal Squeeze: A Discussion.” *Ocean & Coastal Management* 84 (2013).
<https://doi.org/https://doi.org/10.1016/j.ocecoaman.2013.07.010>.
- “Sources - Luanda - Angola.” Sources - Luanda - Angola. Knoema. Accessed March 15, 2020.
<https://knoema.com/atlas/Angola/Luanda/sources>.
- “Water Safety Plans.” Climate Technology Centre & Network, August 3, 2019. <https://www.ctc-n.org/resources/water-safety-plans>.
- “World Bank Climate Change Knowledge Portal.” World Bank Group. Accessed March 17, 2020.
<https://climateknowledgeportal.worldbank.org/country/angola/vulnerability>.