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Climate Change, Impact and Interventions: Comparative Analysis of LA and NYC

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Abstract

Coastal urban areas have been facing instability from sea level rise, natural disasters, and extreme heat that will significantly escalate if not mitigated properly. To minimize the socioeconomic impacts of climate change, coastal cities must create effective adaptation frameworks. Numerous case studies have been performed on existing adaptation programs, but they have focused on coastal urban areas clustered in an area – limiting their ability to draw generalizable conclusions. To fill this gap, this study compared the threats Los Angeles County (LAC) and New York City (NYC) - two coastal urban areas with drastic differences in climate, topography and layout - will face from climate change and examined existing and possible mitigation frameworks. Sea level rise/storm surge and extreme heat were identified as urgent climate-driven threats to NYC, while wildfires/landslides and extreme heat were identified as urgent climate-driven threats to LAC. Despite the climate-based threats to NYC and LAC, both were determined to have employed insufficient preventative, as opposed to reactive measures. Recommendations to fix this included 1) increasing precision of climate models through accelerating research into climate "tipping points" and ensuring government agencies are using recent data and 2) bridging the climate information usability gap by i) increasing information exchange between researchers and policymakers and ii) formatting policy briefs to be digestible by legislators. Another issue was insufficient compensation for the inequitable impact of climate risks on marginalized populations; fixes included numerically magnifying the importance of these communities in cost-benefit models and establishing discourse between community members and policymakers.

Keywords: Climate Change, Global Warming, Coastal Cities, Sea Level Rise, Extreme Heat, City Adaptation, Wildfires

1. Introduction

Coastal urban areas are a focal point of the global climate crisis. By 2015, most cities with populations over 1 million were within 62.1 miles of a coastline (World Urbanization Prospects, 2018), and 8 of the world's 10 largest cities are coastal. These areas are particularly vulnerable to sea level rise, storm surges (abnormally high water levels caused by cyclone winds pushing water towards shore), and extreme temperatures due to the Urban Heat Island Effect (the tendency of urban environments to entrap heat) which often disproportionately impact lower-income communities. Thus, if these cities do not adapt to climate change, it will cause significant socioeconomic harm.

Climate adaptation programs often contain large upfront costs and side effects, including disrupting natural processes and accelerating global warming. Studying current adaptation programs in coastal urban areas will grow global understanding of these challenges, and how best to navigate them. There have been various such case studies. Lee (2014) conducted a case study for the sea level rise adaptation prospects of Mokpo, Korea and recommended the protection of important infrastructure through multi-tiered terraces and the retreating of coastal developments. Abdel Kader and Haron (2020) identified a lack of "soft" adaptation among Northern Egypt coastal cities. However, the

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current literature tends to conduct case studies on either one urban area or urban areas concentrated in a geographic region, making it difficult to draw global conclusions regarding climate adaptation. This study aims to fill the gap by comparing New York City and Los Angeles County, two urban areas with drastically different climates, layouts, and topology. The advantage of this approach is that common challenges these cities face can be extrapolated to a broad range of coastal urban areas around the globe.

2. Methodological Framework for this Study

This study adopts an analytical, comparative case-study approach. By examining two urban areas—New York City and LA County—that exemplify diverse global climate challenges, this focused approach enables a detailed exploration of climate adaptation-related issues. It is important to note that LA County will be abbreviated as LAC, and the namesake city will be referred to as the City of LA.

Following an overview of NYC and LAC's key characteristics, the study is divided into two main sections. The first section analyzes climate impacts under insufficient adaptation efforts, focusing on Sea Level Rise (SLR) and Rainfall, Wildfires and Landslides (specific to LAC), and Extreme Heat. Each area is assessed for its socioeconomic impact on NYC and LAC. These areas were selected because they are the major climate-driven vulnerabilities for NYC and LAC and the ecological and climate-related challenges that are faced by coastal urban areas globally thus making the analysis and its policy conclusions more broadly applicable.

To evaluate the damage each area poses, this study drew upon existing literature and government reports for estimates of economic losses from climatic events, and future climate projections. Data was collected from Weather Underground to show an increase in extreme heat over time.

The second section discusses adaptation strategies for NYC and LAC, evaluating existing measures, potential actions, and areas for further research. This part focuses on the most pervasive threats to each city: SLR and storm surge for NYC; wildfires and landslides for LAC; and extreme heat for both cities. Data for this section included government-issued documents outlining adaptation plans in LAC and NYC, which were qualitatively analyzed. In addition, existing literature was consulted for relevant scientific advancements and climatic projections. The conclusion presents recommendations for enhancing climate resilience in coastal cities, based on the faring of current adaptation systems.

3. Why NYC and LAC

The table below contains the most important differences between NYC and LAC.

This approach immediately assists NYC and LAC. As LAC's variable geography and dry climate contrast starkly with NYC's more uniform geography and humid, wet climate, the approach of comparing NYC and LAC also provides information for a "spectrum" of coastal cities with LAC on one end and NYC on another. Cities along the east coasts of the US, parts of Brazil, East Asia and Australia have similar climates to NY, while cities in the Mediterranean basin have a similar climate to LAC (Belda et al., 2014). The challenges climate change poses to cities in the same climate groups are similar, thus this study covers two important groups of coastal cities.

Table 1: An Overview of Similarities and Differences Between NYC and LAC

Category	NYC	LAC
Population	8,097,282	9,721,000 (2022)
Land (square miles)	305	4,753
Population Density (people/square mile)	~26,548	~2,430
Köppen-Trewartha climate classification	Humid Subtropical (Cfa)	Mediterranean
Highest Recorded Temperature 2023	93°F	96°F (Downtown LA)
Lowest Recorded Temperature 2023	3°F	40°F (Downtown LA)
Total Seasonal Rainfall	~25in	~4in
Most Common Natural Disasters	Floods, Storm Surges	Wildfires, Flooding, Landslides
References include but not limited to: United States Census Bureau, Office of the New York State Comptroller		

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4. Climate Change: its Nature and Impact, Comparing NYC and LAC

4.1 SLR and Changes in Rainfall

SLR, driven by glacial melt and thermal ocean expansion, is one of the most immediate effects of global warming. SLR threatens coastal cities by eroding shorelines, increasing coastal flooding risks, and salinating nearby freshwater sources. Due to differing topographies, LAC and NYC will face unique SLR impacts.

For LAC, SLR endangers the tourism industry, which generated $37.8 billion and 544,000 jobs in 2019. LAC's coastline, essential to its tourism, is at risk, with projections indicating that up to 75% of California's beaches could erode by 2100 (Vitousek et al., 2023). This erosion would not only impact tourism but also the real estate market. Studies show that properties exposed to SLR sell for about 7% less than equivalent properties not at risk, a gap expected to increase over time (Bernstein et al., 2019).

SLR poses a severe threat to all of NYC, as four out of five boroughs are islands. In Manhattan, for instance, nearly every home is within a mile of a river, making it especially susceptible to coastal flooding. Numerous ports and coastal infrastructure are at risk of permanent inundation by 2100 (NOAA, n.d). This risk is compounded by frequent hurricanes, nor'easters, and tropical storms, which generate storm surges that intensify flooding (New York State Sea Level Rise Task Force, 2010).

Storms are expected to produce more rainfall due to greenhouse gases (Knutson, 2024). Additionally, SLR exacerbates storm impacts by expanding the reach of storm surges. Thus, while the rate of tropical storm incidence may stay stable, each one is projected to cause significantly more economic damage.

The most socioeconomically devastating post-industrial storm to hit NYC was Hurricane Sandy. Sandy's impact included 43 fatalities, damage to nearly 800 buildings, extensive flooding of transportation infrastructure, and loss of power for millions of residents. The storm's total cost to NYC was estimated at $19.2 billion, with $8.1 billion attributed to historical SLR (Strauss et al., 2021), although the $8.1 billion figure does not account for climate-change driven increases in intensity of the storm. While NYC was able to rebuild its infrastructure, more frequent superstorms will hinder the city's development and cost significant lives. Due to SLR and more intense storms, the frequency of Sandy-like surges may increase 3–17 times from 2000 to 2100 (Lin et al., 2016) – upper edge cases indicate a Hurricane Sandy size event appearing once every 25 years.

In addition, Sandy-like storm surges may become even more expensive, especially as waterfront real estate and critical infrastructure in the 100-year floodplain continues to grow, with $242 billion in real estate and infrastructure at risk by 2050—a 38% increase from 2022 (NYC Bureau of Policy and Research, 2022).

In conclusion, SLR and changes in rainfall are a moderate threat to LAC, with impacts concentrated in the tourist industry and coastal real estate. Due to NYC's flat topography, lack of natural protection and proximity to multiple bodies of water, SLR and changes in rainfall are critical threats to NYC. Without flood mitigation, NYC faces drastically increased rates of disastrous storm surges, which damage critical infrastructure, halt businesses, take lives, and incur massive reparation costs.

4.2 Aggravation of Wildfires and Landslides in LAC

Wildfires pose an especially important issue for LAC. Due to LAC's dry summers, vegetation in the area serves as effective fuel for fires. It is proven that Global Warming causes wildfires to become more likely (Jones, 2020). Evidence in California is provided by NASA's GRACE, which recorded significant accumulated water loss from 2002-2014 ("NASA's GRACE sees a Drying California," 2014).

Southern California frequently experiences dry Santa Ana winds, which reduce fuel moisture and lead to more frequent wildfires. Wildfire smoke, which can travel hundreds of miles, poses a significant health risk even to those in the city of Los Angeles. Richardson et al. (2012) estimated that exposure to wildfire smoke costs $84.22 per person per day.

The Woolsey Fire, one of LA County's recent major wildfires, ignited in 2018 and was rapidly spread southward by Santa Ana winds, compounded by earlier fires that strained firefighting resources (Gabbert, 2019). Insured losses from the Woolsey Fire reached $3–$5 billion. With increasing drought due to climate change, such fires will become

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more frequent, impacting the economy through property damage and health costs.

Certain LAC neighborhoods, like Rancho Palos Verdes, face additional threats from landslides. Rancho Palos Verdes is situated on the Portuguese Bend Landslide Complex, an area with ongoing instability. Global warming increases this instability through fluctuating groundwater levels from increased drought and precipitation. In September 2024, accelerated landslides caused power outages for 200 homes and road damage (Paddison, 2024). Landslide instability carries severe economic impacts, including damage to infrastructure, homes, and businesses and disruption of transportation routes.

As climate change intensifies, landslides will increasingly endanger communities like Rancho Palos Verdes, underscoring the need for mitigation efforts.

4.3 Increase of Extreme Heat

Global warming has led to longer and more intense extreme heat events. From 2008 to 2017, each additional extreme heat day in the U.S. caused 0.07 additional deaths per 100,000 adults (Khatana et al., 2022). Extreme heat disproportionately impacts lower-income communities and ethnic minorities, who often lack access to air conditioning, increasing their vulnerability to heat-related mortality. Yin et al. (2023) found that lower-income neighborhoods in LA County experience higher land surface temperatures due to the Urban Heat Island effect. Additionally, these communities have limited access to cooling spaces like parks and malls ("Hot Cities, Chilled Economies: Los Angeles, United States", n.d.). Poverty-related health conditions, such as obesity, exacerbate heat risks for these populations (Żukiewicz-Sobczak et al., 2014), and elderly individuals or those with chronic conditions are especially at risk.

Extreme heat has far-reaching economic impacts in LA County. Riley et al. (2018) found that heat-related emergency department visits were higher in communities with many outdoor workers, such as in construction and agriculture. The Los Angeles Metropolitan area lost $5 billion annually in worker productivity due to heat, based on 2019 data ("Extreme Heat: The Economic & Social Consequences for Global Cities: Methodology," 2022). High temperatures are also linked to increased mental health disorders (Thompson et al., 2018), which negatively impact household spending and investment in children's education (Dahal & Fertig, 2013).

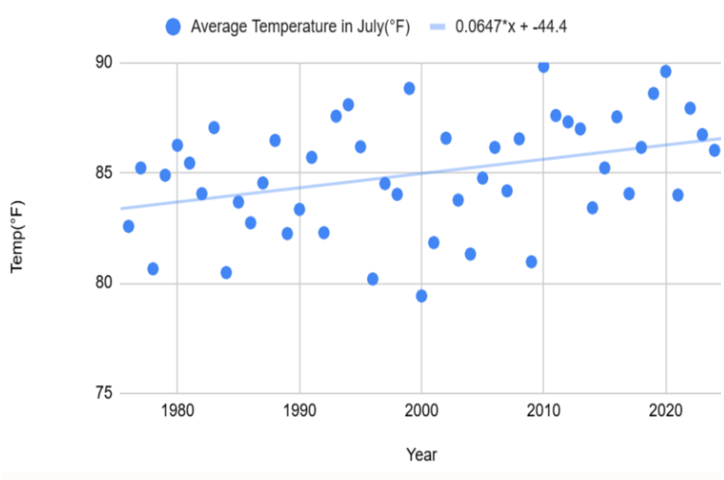

Figure 1. Trend in Average July Temperature of NYC 1975-2024. Data collected from Weather Underground. The slope of the regression line represents the average yearly increase in temperature over this period.

New York also faces serious threats from temperature rise; based on data from the Laguardia Airport Station, average NYC temperatures in July increased by around 0.0647°F per year from 1976-2024.

The New York City Climate Impacts Assessment also projects NYC will experience 45–50 days above 90°F by 2050, up from an average of 18 between 1981–2010 (Lamie et al., 2024).

Currently, NYC records 350 heat-exacerbated deaths each summer ("Protecting New Yorkers from Extreme Heat", n.d.). As extreme heat days increase, this number is expected to rise. NYC's humid subtropical climate further intensifies these effects, as humidity impedes the body's cooling process through evaporation.

In conclusion, the increase of extreme heat is a critical threat for both LAC and NYC as the Urban Heat Island effect exacerbates global warming related increases in temperature; extreme heat leads to significant losses in worker productivity, upticks in worker hospitalizations, decrease in mental health, and heat-exacerbated deaths.

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5. Existing Mitigation Systems and Policy Recommendations

The previous section outlined the moderate and critical climate-driven threats to NYC and LAC. This section will analyze the strength of existing and potential adaptation measures to the critical threats.

5.1 NYC: Storm Surges and Flooding

Flood mitigation involves developing accurate flood forecasting systems and creating flood-resilient infrastructure. Accurate flood risk mapping is crucial to prevent development in future flood zones and ensure adequate insurance. NYC uses Flood Insurance Rate Maps (FIRMs), which analyze topography, historical flood data, and climate projections to classify flood risks. However, NYC's FIRMs currently rely on 1983 data – since then, sea levels at the Battery have risen approximately 7 inches ("Relative Sea Level Trend: 8518750 The Battery, New York," 2023), thus the FIRMs likely underestimate the true extent of the 100-year floodplain, leaving homes uninsured and vulnerable to storm surges.

Without accurate floodplain mapping, homebuyers and communities lack a clear understanding of flood risks, potentially leading to real estate development in high-risk areas. FEMA should incorporate future climate projections into FIRMs, and more research is needed for accurate flood modeling.

Flood-resilient infrastructure is also crucial. The U.S Army Corps of Engineers (USACE) in 2022 proposed a set of plans for storm protection across the NY-NJ harbor area. However, USACE's plans have limitations. Lower-cost options, like Alternative 3B, exclude key areas such as LaGuardia and Hunts Point, critical to NYC's food supply, as well as many disadvantaged communities. The most comprehensive plan, Alternative 2, would protect 96% of the harbor area but at $112.3 billion, while Alternative 3A, at $76.9 billion, covers 87% but leaves parts of NJ unprotected, including Keansburg and Sandy Hook (U.S Army Corps of Engineers, 2022).

Storm surge barriers in both Alternatives 2 and 3A may disrupt natural equilibriums, causing saltwater intrusion and reduced marsh inundation in the Hudson River Estuary, potentially impacting NYC's water supply (Ralston, 2022). These trade-offs underscore the complexity of NYC's flood mitigation challenges, balancing costs, environmental health, and equitable protection. Alternative 3B also shows the limits of cost-benefit models; they often underprotect marginalized communities, with less calculated economic impact.

5.2 LA: Wildfires & Landslides

The primary vegetative ecosystem in LAC is Chaparral, a shrubland community where fires naturally play a role in ecosystem health. Large-scale wildfires, like the Woolsey fire, require prevention efforts. Effective fire mitigation requires understanding LAC's fire regimes, which the USDA Forest Service categorizes into five classes based on frequency and intensity, from low severity to stand replacement. To minimize wildfire risks, high-intensity, stand-replacement fires should be reduced, while maintaining the natural fire regime range to support ecosystem health. However, climate change complicates fire regime patterns, making future modeling challenging (Keeley & Syphard, 2016).

One well-known mitigation technique is prescribed fire—controlled burns to reduce fuel and restore ecosystems. Properly timed prescribed burns reduce wildfire risk (Prescribed Fire, n.d.), though the optimal approach remains debated. Additionally, prescribed burns face legal and regulatory barriers. Miller et al. (2020) highlighted challenges, including full liability on burners for fire loss, funding priorities skewed toward wildfire suppression, and conflicting regulations on burn days, indicating that California's systems often react rather than preventatively manage fires.

The LAC Fire Department should prioritize preventative measures like prescribed burns, while shifting liability partially to the state to encourage risk-taking in fire management. More research is needed to determine an optimal fire regime landscape that balances wildfire risk with natural conditions: Minnich and Vizcaíno (1999) suggested fire regimes in Southern California should replicate conditions in Baja, California, but Keeley and Zedler (2009) contested this model, and there has been no ultimate consensus. In addition, new technologies like the polyphosphate fire retardant developed by Yu et al. (2019) offer potential preventative tools by allowing fire retardants to be applied proactively, and need to be developed further.

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Mitigation plans are also underway for the landslides in Rancho Palos Verdes, where the $33 million Portuguese Bend Landslide Remediation Project seeks to slow landslide progression. However, recent acceleration in the landslide complex undermines these efforts. Despite emergency stabilization methods like dewatering wells and fissure filling, costs are escalating. The landslide's rapid progression underscores the need for proactive mitigation.

Rancho Palos Verdes serves as a case study for other California communities vulnerable to landslides, such as Malibu and Hollywood. Key considerations for future protection include:

1. Landslide insurance: Homeowners in areas like Rancho Palos Verdes lack landslide insurance, risking severe financial losses. A statewide insurance program could offer critical protection.
2. Earlier mitigation: Due to unpredictable precipitation, measures like dewatering wells should have been implemented sooner.

LA County's disaster response has been largely reactive. Sadly, the Palisades fires have once again exposed this weakness, and have corroborated the necessity for more proactive legislation.

5.3 NYC and LAC: Extreme Heat

Extreme heat presents significant social and economic challenges for NYC and LAC, though their differing climates and layouts affect policy choices. Air conditioning (AC) units are essential for heat resilience, significantly improving survival during heatwaves. In 2017, 90% of NYC households reported AC access, though this was as low as 76% in low-income neighborhoods (Protecting New Yorkers from extreme heat, n.d.). In contrast, only 65% of LAC residents had AC as of 2022 (Ahn & Uejio, 2022). While NYC's humid climate increases heat-related health risks, LAC's central areas are expected to see three times more days above 95°F by mid-century, especially in the San Fernando and San Gabriel Valleys, requiring greater AC access.

NYC has taken steps toward closing this gap. In 2024, Lincoln Restler proposed a bill mandating building owners to maintain an internal temperature of 78°F when outdoor temperatures reach 82°F or higher, requiring central AC installation where none exists (The New York City Council, 2024). Such legislation indicates a proactive approach to extreme heat, though there are compatibility concerns for low-income households. The City of LA is moving forward with similar initiatives, consulting stakeholders on maximum internal temperature standards for rentals (Zavala et al., 2024) and launching AC programs targeting vulnerable populations, such as the Cool LA Heat Relief for Seniors.

However, the widespread use of AC raises emissions concerns. LAC architects designed the Orange Grove Project, an affordable housing development in Pasadena using high thermal mass, roof insulation, and ventilation. Milne and Kohut (2010) found that residents could achieve comfortable temperatures with wholesale fans instead of AC, though this was ineffective during extreme heat waves over 97°F. With projected temperature rises of 4.1–4.7°F by mid-century, fully forgoing AC may no longer be feasible (Kim, Sun, & Irazábal, 2021).

NYC and the City of LA are also addressing the Urban Heat Island effect. NYC's PlaNYC 2023 report outlines goals including coating 1 million square feet of rooftops annually with reflective materials and creating "cool corridors" with shaded streets. Additionally, NYC aims to increase tree canopy cover to 30%, reducing carbon emissions and guarding against heat (The City of New York Mayor Eric Adams, 2023). LA's heat relief initiatives include:

1. Cool Spots LA
3. Swim LA
4. Reflective white street coatings

While these measures are promising, their long-term effectiveness depends on political stability, accurate climate forecasts, and intra-city information exchange. Increased knowledge exchange between communities, scientists and policymakers on climate adaptation can improve the cultural sensitivity and effectiveness of heat resilience strategies for NYC and LAC (Bridges et al., 2024).

6. Concluding Remarks

A concerning pattern seen in NYC and LAC's adaptation programs is a tendency for both governments to take reactive, not proactive measures. Emergency measures in Rancho Palos Verdes aim to slow landslide activity, but these may come too late to prevent disaster. Similarly, storm surge programs in NYC only accelerated post-Hurricane Sandy, which caused $19.2 billion in damages. In LAC, wildfire prevention funding often shifts to immediate suppression efforts – leading to disasters such as the Palisades and Woolsey fires. Two possible reasons for this are 1) uncertainties in climate models and 2) the discrepancy between total and usable climate information.

To invest in preventative measures, policymakers must be comfortable that the upfront costs are less than avoided costs in the future. Future costs must rely on projective climate models – uncertainty in these models adds risk to adaptation measures that prevents them from being passed. As shown by the FIRMs reliance on outdated data, government agencies must ensure their models are running on recent data. However, the main drivers of uncertainty in climatic models are "tipping points," natural feedback loops such as melting permafrost or the slowing of the Atlantic Meridional Overturning Circulation (AMOC), that, if activated by global warming, will further accelerate temperature rise. These tipping points are hard to model because they interact with each other in complex ways, there is a shortage of adequate data, and many tipping points are overlooked (McPherson et al., 2023). Steps to reduce this uncertainty include integrating AI into climate models, increasing data collection efforts, furthering research into complicated potential tipping points such as the AMOC and how the tipping points interact with each other, and greater recognition of the tipping points in International Panel on Climate Change reports.

There also is a gap between total and usable climate information. Bouali et al. (2019) discovered instability in parts of the Portuguese Bend Landslide Complex, 5 years before the 2024 landslides – had this concern been converted into actions the damage could have been mitigated. Lemos et al., (2012) argues that interactions between information producers and users can allow users to "fit" knowledge into their decision process. An effective model for stimulating co-production in climate policies is NYC's Climate Knowledge Exchange (CKE), which held workshops with participants from community organizations, academia, and government agencies to identify essential knowledge gaps. Coastal cities around the world should adopt a similar approach to tackle the information usability gap. In addition, the formatting of policy briefs need to be easier for policymakers to understand; a persistent problem is the over-reliance on quantitative representations of data. Climate researchers should experiment with alternate methods of communication such as storytelling. Finally, policy briefs should be at an 8th-9th grade level of readability (Stamatakis et al., 2010).

The other issue seen in both cities is adaptation programs insufficiently accounting for the disproportionate risks for lower-income populations. Examples are the lack of disaster insurance in California, and most glaringly, the exclusion of certain, lower income communities in the USACE's flood mitigation plans. This lack of "climate justice" is due to the usage of cost-benefit models from a purely economic standpoint, which de-prioritize lower income communities that have less economic impact. To fix this, cost-benefit models should include numerical factors amplifying the costs of lower-income communities with significant populations. In addition, measures such as the CKE are recommended, to share the perspective of residents in such communities with policymakers.

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