

Municipal Finance Reform: Urban Adaptation Planning in Developing Contexts

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Introduction

As populations grow and rates of urbanisation increase around the world, climate change impacts and risks on people and urban societies become more concentrated. Providing effective and efficient municipal services is essential for building adaptive capacities of the most vulnerable groups in developing urban societies¹. However, financial constraints of public budgets in developing economies limit the extent of municipal service provision. Combining public budgets and overseas development finance options still fall short of addressing key financing gaps, including for urban infrastructure².

Urban climate change research needs to be grounded in the fiscal and financial realities of both countries and urban municipalities. Urban municipal revenue and expenditure models provide credibility to climate change adaptation and resilience building policies when commensurate resources are assigned from public budgets and/or a clear plan is in place to acquire them from alternative sources³ (However, observed climate change impacts have exposed flaws in extant municipal finance structures, which have potentially negative impacts on the adaptive capacities of vulnerable populations. This research explores the interlinkages between climate change impacts on urban municipal revenue and expenditure in the context of developing societies. There is specific focus on where at-risk revenue streams might compromise redistributive social, economic and environmental expenditure. Policy guidance and future research direction is outlined in relation to key entry points for municipal finance reform to promote urban climate resilience.

Urban Adaptation and Municipal Finance

The Global Commission on Adaptation estimates that investment in climate change adaptation will yield an estimated \$7.1 trillion in benefits from an illustrative global investment of \$1.8 trillion⁴. With a cost-benefit ratio of approximately 1 to 4, the rationale

¹ Nicholas Philip Simpson et al., "Municipal Finance and Resilience Lessons for Urban Infrastructure Management: A Case Study from the Cape Town Drought," *International Journal of Urban Sustainable Development* 11, no. 3 (September 2, 2019): 257–76, <https://doi.org/10.1080/19463138.2019.1642203>.

² Roland White and Sameh Wahba, "Addressing Constraints to Private Financing of Urban (Climate) Infrastructure in Developing Countries," *International Journal of Urban Sustainable Development* 11, no. 3 (September 2, 2019): 245–56, <https://doi.org/10.1080/19463138.2018.1559970>.

³ Marta Olazabal et al., "Are Local Climate Adaptation Policies Credible? A Conceptual and Operational Assessment Framework," *International Journal of Urban Sustainable Development* 11, no. 3 (September 2, 2019): 277–96, <https://doi.org/10.1080/19463138.2019.1583234>.

⁴ Global Commission on Adaptation (GCA), "Adapt Now: A Global Call for Leadership on Climate Resilience," 2019, https://cdn.gca.org/assets/2019-09/GlobalCommission_Report_FINAL.pdf.

for public sector investment in adaptation is clear. This investment rationale is accentuated in urban contexts where climate change risks are concentrated because more than half of the global population resides in urban areas⁵. The combined threat of rising sea levels and increased storm surges alone could potentially force hundreds of millions of people from their homes in coastal cities, with an estimated cost to coastal urban areas of more than \$1 trillion each year by midcentury⁶. Moreover, cities produce in excess of 80% of global GDP, which mean that both the economic and human risks of climate change come to a head in urban environments.

These trends are amplified in the developing world, where many cities are characterized by persistent poverty, homelessness and social inequality⁷. The United Nations Habitat World Cities Report 2016 highlighted that more than 880 million people now live in urban informal settlements where access to basic services such as water, electricity, basic healthcare, education and sanitation are scarce⁸. These poor living conditions also disproportionately impact already marginalized groups such as woman and the differently-abled who face greater barriers to escape the poverty trap. Ultimately, increasingly densified populations living in sub-standard housing with poor access to services, increases the vulnerability of these populations, leading to significant inequalities in risk and vulnerability to climate change within the same urban landscape.

The Sustainable Development Goals (SDGs) have brought increased attention to the challenges facing urban environments - particularly Goal 11: “make cities and human settlements inclusive, safe, resilient and sustainable”. Despite the magnified risks of inaction, cities are centers of opportunity and innovation that hold significant financial influence through both public and private budgets. Thus, cities in developing countries have a significant opportunity to implement effective and efficient adaptation actions that harness the benefits and minimize the costs of climate change in both the short and long term. Importantly, successful adaptation requires not only identifying adaptation options and assessing their costs and benefits, but also exploiting existing and readily available mechanisms for developing the adaptive capacity of both human and natural systems⁹.

Extant municipal financial structures, norms and processes present a critical entry point for intervention, particularly where these existing structures are rigid and incapable of adapting themselves to changing socio-economic and environmental conditions that climate change will bring. Colenbrander and Barau¹⁰ highlight that innovative approaches to urban planning and urban finance are needed to bridge the formal and informal sectors, aggregating and aligning climate change interventions to respond to these immense, interrelated challenges facing cities around the world. Reforming or adapting these

⁵ IRP (International Resource Panel), “The Weight of Cities: Resource Requirements of Future Urbanization” (Nairobi: United Nations Environment Programme, 2018), <https://www.resourcepanel.org/reports/weight-cities>.

⁶ S Hallegatte et al., “Future Flood Losses in Major Coastal Cities,” *Nature Climate Change* 3, no. 9 (2013): 802–806.

⁷ UNOSSC, “City-To-City Partnerships and South-South and Triangular Cooperation on Sustainable Urban Development,” 2019, <https://www.unsouthsouth.org/wp-content/uploads/2020/06/City-to-City-Report.pdf>.

⁸ UN-Habitat, “Urbanization and Development: Emerging Futures,” World Cities Report 2016, 2016.

⁹ Klein, R.J.T., G.F. Midgley, B.L. Preston, M. Alam, F.G.H. Berkhout, K. Dow, and M.R. Shaw, “Adaptation

Opportunities, Constraints, and Limits. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability,” in *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2014), 899–943.

¹⁰ Sarah Colenbrander and Aliyu Barau, “Planning and Financing Urban Development in the Context of the Climate Crisis,” *International Journal of Urban Sustainable Development* 11, no. 3 (September 2, 2019): 237–44, <https://doi.org/10.1080/19463138.2019.1673529>.

structures are particularly important in developing contexts. Firstly, because of the need for redistributive expenditure to provide basic services to the most vulnerable communities in highly unequal urban environments. Secondly, because of the extremely vulnerable and rapidly changing nature of informal settlements, these systems are closer to reaching thresholds where they cannot be secured from intolerable risk through adaptive actions (i.e. they are closer to reaching adaptation limits).

Methodology

This study adopts a comparative case study approach between the urban municipalities of Cape Town (South Africa) and Chennai (India), to assess municipal finance structures and mechanisms for the water and energy sectors, in the context of existing and projected climate change impacts. Comparative case studies are analysed to emphasise comparison across and within different contexts¹¹ In this case, this approach helps to understand and explain why different features within a certain context may influence the success or failure of a programme or policy. In the case of Chennai and Cape Town, this approach compares each city's municipal finance structures and assesses the existing or potential impacts on revenue and expenditure flows as a result extreme climatic events such as drought.

A literature and desktop review is conducted to identify the key climate change risks and vulnerabilities that exist for Chennai and Cape Town, and that pose both existing and potential future threats to municipal revenue and expenditure. Published city budgets and expenditure documents are reviewed to understand revenue flows in each city. Journal articles, news articles and other government documentation are reviewed to identify key climate change risks and vulnerabilities that present potential threats to municipal revenue and expenditure.

Whilst data is important for comparative case studies, this approach does require that extensive conceptual, synthesis and analytic work is done¹². Thus, a structured content analysis is applied, highlighting the different structures and process of the revenue models for Chennai and Cape Town in order to: 1) identify any possible and apparent causal relationships between key climate parameters and municipal revenue; and 2) assess how possible changes in revenue structures could impact necessary redistributive expenditure to the most vulnerable communities.

This approach requires more than the synthesis of comparisons to highlight similarities and differences. Rather, these comparisons help to strengthen or refute propositions as to why a certain intervention or structure fails or succeeds¹³. In this study, a key assumption is made that there is a causal relationship between the impacts of climate change, such as drought, and the revenue generation from water and/or energy in a city depending on their respective financing structures. Thus, whilst there may be many causal explanations to explain a decrease or increase in municipal revenue flows, this case study

¹¹ Delwyn Goodrick, "Comparative Case Studies: Methodological Briefs - Impact Evaluation No. 9," *Papers, Papers* (Methodological Briefs, 2014), <https://ideas.repec.org/p/ucf/metbri/innpub754.html>.

¹² Krehl, A. and Weck, S, "Doing Comparative Case Study Research in Urban and Regional Studies: What

Can Be Learnt from Practice?," *European Planning Studies*, 2019, <https://doi.org/10.1080/09654313.2019.1699909>.

¹³ Goodrick, "Comparative Case Studies."

comparison aims to strengthen this initial assumption and causal explanation¹⁴. Comparative case studies allow for a greater understanding into causal relationships and can provide a probable explanation as to how and why a certain outcome prevails depending on the context in which it occurs. This enables a greater level of understanding and consequently, allows one to make suggestions as to how to achieve intended outcomes.

Cape Town

The City of Cape Town, the capital of South Africa's Western Cape Province, faces a myriad of climate change hazards and associated risks and vulnerabilities¹⁵. These include extreme drought, flooding, fires, sea-level rise, storm surge, strong wind and heat waves. Cape Town is the second most populous city in South Africa and the economic hub of the Western Cape province. The City experienced a widely publicized extreme 3-year meteorological drought starting in 2015, which saw the lowest rainfall in any 3-year period on record and estimated to occur approximately only once every 311 years¹⁶.

The exceptionally low rainfall coupled with a burgeoning population and rapidly increasing rates of in-migration resulted in a socio-economic drought and water crisis of global significance¹⁷. The central role of politics and poor planning has also been identified as key drivers of the urban water shortage in Cape Town¹⁸. Aside from the cause of the drought, in January 2018 the City announced the controversial possible implementation of 'Day Zero', when municipal water supplies would be turned off and people would be forced to queue for water on a daily basis. The City managed to hold off reaching Day Zero conditions, largely thanks to a concerted and extensive water demand management campaign that resulted in collective action and ultimately lower water use by consumers¹⁹²⁰. The City instructed residents to use less than of 50 liters of water per person per day and carried out other awareness raising activities. These actions bought just enough time until a good winter rainfall arrived in 2018.

Despite the positive collaborative efforts that managed to avoid a water crisis in the City, the drought exposed flaws within extant institutional and governance arrangements and the overarching municipal finance structures. With services accounting for ~50% of Cape Town's revenue in recent history, this creates perverse incentives when there is a shortage in resources such as water or electricity. When municipalities encourage or instruct residents to decrease consumption of these resources, it has a significant impact on municipal revenue generation. Thus, to make up for this shortfall tariff increases are regularly implemented. This is the case for Cape Town where significant tariff increases were introduced in response to the loss in revenue and the need to finance significant infrastructure spend (such as small scale-desalination plants) to build drought resilience. Moreover, there was a spike in households developing their own water supplies through

¹⁴ Wolski, P, "Facts Are Few, Opinions Plenty... on Drought Severity Again," 2018, <http://www.csag.uct.ac.za/2018/01/22/facts-are-few-opinions-plenty-on-drought-severity-again/>.

¹⁵ CL Davis-Reddy and K Vincent, *Climate Risk and Vulnerability: A Handbook for Southern Africa*, 2nd ed. (Pretoria, South Africa: CSIR, 2017).

¹⁶ Wolski, P, "Facts Are Few, Opinions Plenty... on Drought Severity Again."

¹⁷ Jonathan Rawlins, "Political Economy of Water Reallocation in South Africa: Insights from the Western Cape Water Crisis," *Water Security*, no. 100029 (2019), <https://doi.org/10.1016/j.wasec.2019.100029>.

¹⁸ Muller, M., "Cape Town's Drought: Don't Blame Climate Change," *Nature*, no. 559 (2018): 174–76.

¹⁹ Dustin E. Garrick, Alice Chautard, and Jonathan Rawlins, "Reallocating Water," in *Water Science, Policy, and Management* (John Wiley & Sons, Ltd, 2019), 141–58, <https://doi.org/10.1002/9781119520627.ch8>.

²⁰ Scott, D; Davies, H; New, M, *Mainstreaming Climate Change in Urban Development: Lessons from Cape Town*, 1st Edition (Juta and Company, 2019), https://juta.co.za/catalogue/mainstreaming-climate-change-in-urban-development_25689/.

drilling boreholes and installing rainwater tanks and other decentralised storage systems²¹.

As is the case throughout South Africa, Cape Town exhibits significant levels of economic inequality, which translates to inequality in access to basic services such as water and electricity²². With the enduring legacy of the drought translating to lower overall consumption and more people using off-grid water sources, this raises the questions about the sustainability and equity of the municipal financing model. Increased tariffs, although designed to exponentially increase costs for the highest water consumers, appear to be having some perverse impacts. Ziervogel²³ highlights that the City maintained its so-called social tariff, providing 10.5 kl per month for free to the ~270 000 residential properties with a property value below R400 000, and free water through public standpipes to a further ~180 000 households residing in informal settlements. However, as larger households generally reside in poorer and more densely populated areas, these social tariffs can be misleading. With the City's revenue from water sales increasing from 2018 to 2019 by 7% due to higher tariffs²⁴, the revenue challenge has been effectively dealt with but it is unclear the extent to which this greater taxation burden has fallen on more vulnerable communities as they could end up paying greater per capita water costs. Moreover, water and electricity revenue are not ringfenced in Cape Town, meaning that revenue generated from municipal services such as these are used to cross-subsidise other basic services and vice versa.

With revenue from water and electricity sales decreasing, there is less money available for redistributive expenditure to build resilience in the most vulnerable communities. In addition to volumetric tariff increases, the City increased the basic fixed charge for piped water supplies to help stabilize revenue and address some of the emerging equity-efficiency trade-offs in budget and resource allocations^{25 26}. This is critical because the operation and maintenance costs of water supply remain static (or even increase) regardless of the amount of water being sold.

Chennai

The City of Chennai, the capital of India's southern Tamil Nadu state, has experienced numerous natural disasters over the past couple of years ranging from intense flooding in 2015 to more recently, severe drought²⁷. Monsoon failure in 2016, 2017 and 2018 led to a water crisis in India, with the government reporting that 21 Indian cities would run out of groundwater by 2020, with Chennai being the first²⁸. Given that over 90% of groundwater

²¹ City of Cape Town, "City of Cape Town Resilience Strategy," August 22, 2019, https://resource.capetown.gov.za/documentcentre/Documents/City%20strategies%2C%20plans%20and%20frameworks/Resilience_Strategy.pdf.

²² Johan P. Enqvist and Gina Ziervogel, "Water Governance and Justice in Cape Town: An Overview," *WIRES Water* 6, no. 4 (May 26, 2019), <https://onlinelibrary.wiley.com/doi/full/10.1002/wat2.1354>.

²³ Gina Ziervogel, *Unpacking the Cape Town Drought: Lessons Learned*, 2019, <https://doi.org/10.13140/RG.2.2.36540.69760>.

²⁴ Moody's, "Moody's Revises the Outlook of the City of Cape Town's Rating to Stable and Affirms Its Ratings," *Moodys.com*, March 15, 2019, [http://www.moodys.com:18000/research/Moodys-](http://www.moodys.com:18000/research/Moodys-revises-the-outlook-of-the-City-of-Cape-Towns-PR_395926)

[revises-the-outlook-of-the-City-of-Cape-Towns-PR_395926](http://www.moodys.com:18000/research/Moodys-revises-the-outlook-of-the-City-of-Cape-Towns-PR_395926).

²⁵ Simon Dietz and Giles Atkinson, "The Equity-Efficiency Trade-off in Environmental Policy: Evidence from Stated Preferences," *Land Economics* 86, no. 3 (2010): 423–43.

²⁶ Rawlins, "Political Economy of Water Reallocation in South Africa: Insights from the Western Cape Water Crisis."

²⁷ van Oldenborgh, G.J., Otto, F.E.L., Haustein, K. and AchutaRao, K., "The Heavy Precipitation Event of December 2015 in Chennai, India.," *Bulletin of the American Meteorological Society* 97, no. 12 (n.d.): 87–91, <https://doi.org/10.1175/BAMS-D-16-0129>.

²⁸ D Karthikeyan, "Our Whole Life Is Disrupted': Hope Dries up as Chennai Battles Historic Drought," *The Guardian*, 2019,

is used for irrigated agriculture and the remainder supplies over 85% of the country's drinking water, this is problematic²⁹. The authorities in Chennai have been struggling to supply water to city residents and have been accused of inaction by the Tamil Nadu state government^{30 31}.

Chennai relies on four small municipal reservoirs to provide water to its 11 million residents³². Moreover, the overall water supply from these four reservoirs only account for 35% of the city's water demand³³. The Chennai MetroWater Supply and Sewage Board, also known as Chennai MetroWater, was separated from the city government in 1980 and became a parastatal. It is responsible for expanding the water and sewerage supply systems within the Chennai and implementing water projects in Chennai Corporation under the direction of the State Government³⁴. While MetroWater has spent billions of rupees on repairing and replacing faulty water infrastructure and extending the grid to expand to unserved areas, an estimated 30-40% of the water supply is lost due to leaky pipes and the system is still not equipped to meet the demand of its citizens^{35 36}. Thus, when water reserves are low, or drought occurs, citizens closer to the water sources receive water first. However, for those on the tail ends of the system which are generally the urban poor living in informal settlements, their taps run dry³⁷. Furthermore, city tankers bring in water from the outskirts of Chennai to supply water to Chennai. However, the schedule for delivery is infrequent and the cost of water is unaffordable. The use of city tankers, drawing water primarily from agricultural wells and surrounding farms, has led to a depletion of groundwater with Chennai - overdrawing its groundwater by an estimated 185%³⁸. Given the poor service delivery in Chennai, households that can afford it, rely on private sources of water delivery, mainly through private water tankers, and have also dug private boreholes to adapt to the drought.

In terms of Chennai's municipal finance structure, revenue expenditure for utilities such as water and energy, are not entirely ring-fenced³⁹, despite the two entities responsible for water and energy provision being corporatized-public entities. For example, the

<https://www.theguardian.com/world/2019/jun/28/our-whole-life-is-disrupted-hope-dries-up-as-chennai-battles-historic-drought>.

²⁹ Schneider, K., "Groundwater Scarcity, Pollution Set India on Perilous Course" (Circle of Blue, December 4, 2018),

<https://www.circleofblue.org/2018/world/groundwater-scarcity-pollution-set-india-on-perilous-course/>.

³⁰ Karthikeyan, "Our Whole Life Is Disrupted': Hope Dries up as Chennai Battles Historic Drought."

³¹ Masih, N., and Slater, J., "As a Major Indian City Run out of Water, 9 Million People Pray for Rain," *The Washington Post*, June 28, 2019, <https://www.washingtonpost.com/world/2019/06/28/major-indian-city-runs-out-water-million-people-pray-rain/>.

³² Kumar-Rao, A., "India's Water Crisis Could Be Helped by Better Building, Planning," *National Geographic*, July 15, 2019, <https://www.nationalgeographic.com/environment/2019/07/india-water-crisis-drought-could-be-helped-better-building-planning/>.

³³ Kumar-Rao, A.

³⁴ Roumeau, S., Seifelislam, A., Jameson, S., and Kennedy, L., "Water Governance and Climate Change Issues in Chennai." (HAL, 2015), <https://hal.archives-ouvertes.fr/hal-01144122/document>.

³⁵ Piesse, M., "India: Water Supply Agency Declared Chennai Water Secure. Future Directions," November

20, 2019, <http://www.futuredirections.org.au/publication/india-water-supply-agency-declares-chennai-water-secure/>.

³⁶ Coelho, K., "Chennai Drought: How Water Distribution System Reflects Residents' Social Power, Bias against Poor" (Scroll.in, 2019), <https://scroll.in/article/930627/chennai-drought-how-water-distribution-system-reflects-residents-social-power-bias-against-poor>.

³⁷ Coelho, K.

³⁸ Santoshini, S., "A City in India Almost Ran Dry. What Will Prevent a Repeat?," *The Christian Science Monitor*, October 16, 2019, <https://www.csmonitor.com/World/Asia-South-Central/2019/1016/A-city-in-India-almost-ran-dry.-What-will-prevent-a-repeat>.

³⁹ M Makino, "India: Water Supply and Sanitation Bridging the Gap between Infrastructure and Service. Background Paper-Urban Water Supply and Sanitation," Background Paper-Urban Water Supply and Sanitation (The World Bank, n.d.), <https://documents.worldbank.org/en/publication/document-reports/documentdetail/134931468770505493/india-water-supply-and-sanitation-bridging-the-gap-between-infrastructure-and-service>.

Chennai Metropolitan Water Supply and Sewerage Board (MetroWater) became an independent institution in 1978, taking direction from the State Government and not the Chennai Corporation⁴⁰. Prior to 2005, MetroWater had been able to maintain a positive balance sheet with income exceeding expenditure. However, since 2005, the parastatal has been running a deficit due in large part to growing salaries and wages within the utility and an increase in the number of projects regarding water and sewage supply⁴¹. As a result, MetroWater now draws revenue income from not only the sale of water plus water and sewage tax, but it also receives grants and subsidies from the State⁴². In order to decrease this growing expenditure deficit, MetroWater has revised its water tariff structure for both domestic and partly commercial consumers with domestic users now having to pay about 60% more than the existing rates⁴³. This is in response to extremely low tariffs that have not been revised for over two decades. Further measures that were taken in response to increase revenue was the installation of digital meters in the city to account for water usage and charge tariffs according to the quantum of water consumed⁴⁴. The impact of the drought could also compound the issue of revenue generation for MetroWater since decreased consumption (now encouraged by tariffs and water metering) could lead to decreased overall revenue.

While the middle class are just able to pay for the inflated price of water charged by private water-tanker companies, the poor are not able to access this avenue⁴⁵. Water tariff rates differ according to usage in Chennai with households consuming up to 20KL per month paying a rate almost equal to the cost of water⁴⁶. Whilst user charges have been kept low in order to keep water affordable for the urban poor⁴⁷ given that most of the urban poor are not connected to any form of formal service delivery, they do not benefit from these low tariffs and instead, have to source water from illegal or informal networks which raises the costs⁴⁸. In addition, the intermittent water supply also means that many poor people forgo going to work on days when water eventually arrives. These challenges place an extra social and financial burden on the poor with women and children paying a higher cost since they are the ones most likely to be involved in these household activities.

Findings and Discussion

The extreme droughts experienced by Chennai and Cape Town have highlighted important similarities and differences in these two case studies, specifically in relation to how climate change and municipal financing structures interact. A key similarity in both cases was that the drought exposed vast socio-economic inequality in both Chennai and Cape Town, emphasising the heightened vulnerability of the urban poor to climate

⁴⁰ Roumeau, S., Seifelislam, A., Jameson, S., and Kennedy, L, "Water Governance and Climate Change Issues in Chennai."

⁴¹ "Chennai Metrowater Faces a Sharp Dip in Revenue Due to COVID-19 Lockdown," *The Hindu*, May 22, 2020, <https://www.thehindu.com/news/cities/chennai/chennai-metrowater-faces-a-sharp-dip-in-revenue-due-to-covid-19-lockdown/article31645223.ece>.

⁴² CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD, "CMWSSB: Balance Sheet," March 31, 2016, <https://chennaietrowater.tn.gov.in/balancesheet.html>.

⁴³ Lakshmi, K, "Water, Sewer Charges Go up by 60% in Some Areas," June 8, 2018, <https://www.thehindu.com/news/cities/chennai/water-sewer-charges-go-up-by-60-in-some-areas/article24107992.ece>.

⁴⁴ "In a Few Months, Chennai Residents Will Pay Water Bill Based on Usage," *The Indian Express*, September 8, 2019,

<https://www.newindianexpress.com/cities/chennai/2019/sep/08/in-a-few-months-chennai-residents-will-pay-water-bill-based-on-usage-2030829.html>.

⁴⁵ Karthikeyan, "Our Whole Life Is Disrupted': Hope Dries up as Chennai Battles Historic Drought."

⁴⁶ PWC, "Bringing Water to Your Door Step: Urban Water Reforms for the next Decade" (PWC, 2011), https://www.pwc.in/assets/pdfs/publications-2011/water_report.pdf.

⁴⁷ PWC.

⁴⁸ PWC.

hazards. These vulnerabilities are largely a function of low levels of access to basic services such as electricity and water, which can be exacerbated through the impacts of extreme events such as droughts. The impacts of these types of climate extremes on poor communities is not only direct impacts such as interruptions to water or electricity supplies, but also indirect impacts that manifest through existing municipal finance structures.

In Chennai, given that large parts of the population remain unconnected to the piped water grid and the municipal water system, the urban poor are completely reliant on government supply which is unpredictable, causing many to miss work altogether out of desperation to acquire water⁴⁹. This vulnerability is exacerbated by the drought and climate change. However, the elites are not only able to afford to buy water from private tankers but are also able to exert socio-political power to direct water flows their way⁵⁰. In Cape Town, a similar trend ensued whereby richer households were able to sink boreholes and purchase rainwater tanks to adapt to the shortage of water supply. Poorer households on the other hand were reliant on government supply and had to queue for hours on end to fill up their water buckets or faced greater pressure reductions due to poorly maintained systems. These sudden livelihood changes impact the poorest households disproportionately, ultimately increasing their vulnerability during these times of crisis.

Whilst a large proportion of Cape Town's municipal revenue is derived from service charges, the impacts of the drought which led to decreased water usage and increased independent adaptation of richer households, severely decreased the municipalities revenue in the short term. This in turn resulted in a disproportionate expenditure focus on long-term infrastructure development to build the overall resilience of the City's water supply system and increased tariffs which have a greater financial impact on larger households. This is critical as decreased revenue results in less redistributive expenditure or cross-subsidisation of the most vulnerable communities, while the resultant measures to increase revenue have also had disproportionate impacts on these groups.

On the other hand, the Chennai MetroWater Supply and Sewage Board (CMWSSB) receives revenue from water and sewage tax, the sale of water and grants from the government⁵¹. Given that water tariffs had not increased in over two decades until recently, coupled with growing expenditure due to new water projects and increased salaries and wages, MetroWater was and is facing severe budget deficits. Consequently, these deficits were offset with government subsidies and grant derived from other revenue sources such as property and commercial tax. Thus, during drought, this revenue was mostly unaffected given that government earmarks funds for this parastatal. Despite this fact, poorly maintained infrastructure and management of water systems has led to the rise of private water providers. During drought, this trend is perpetuated as communities have no choice but to buy water at a higher price from private tankers which perpetuates the existing inequalities in the city. More recently, the impacts of COVID-19 have led to a substantial decline in revenue from tax collection as well as a decline in industrial and commercial demand for both the City of Cape Town and Chennai⁵². This has decreased municipal revenue and consequently, decreased funds earmarked for the CMWSSB.

⁴⁹ Coelho, K., "Chennai Drought: How Water Distribution System Reflects Residents' Social Power, Bias against Poor."

⁵⁰ Coelho, K.

⁵¹ "Chennai Metrowater Faces a Sharp Dip in Revenue Due to COVID-19 Lockdown," *The Hindu*, May 22, 2020,

sec. Chennai, <https://www.thehindu.com/news/cities/chennai/chennai-metrowater-faces-a-sharp-dip-in-revenue-due-to-covid-19-lockdown/article31645223.ece>.

⁵² "Chennai Metrowater Faces a Sharp Dip in Revenue Due to COVID-19 Lockdown," May 22, 2020.

Building system resilience is an important objective to have when responding to a crisis, but this needs to be done hand-in-hand with building the resilience of the most vulnerable populations. Water is considered a basic human right in the both the South African and Indian Constitutions. This creates an important intergenerational equity planning paradox where cities have to provide water at an affordable rate to all citizens today while simultaneously building system resilience to future climate and environmental change. In both the cases of Chennai and Cape Town, large proportions of the population are faced with a lack of access to basic water supply services, while the more affluent groups are able to independently adapt in a crisis situation. Although going off-grid might reduce pressure on the water supply system in the short term and help to alleviate the drought, it is largely those who can afford to pay for water who do this. Ultimately, this leads to a positive feedback loop that sees continued decreases in revenue generated from water sales through a diminishing customer base and an ever growing need for cross-subsidisation of the urban poor.

Another key issue that was highlighted by the drought in both cases was the lack of effective planning for such an event. In Chennai, unplanned urbanisation and increased consumption of water has worsened Chennai's water scarcity in recent decades and has led to overconsumption of water and depleted groundwater sources⁵³. This, coupled with unchecked pollution has affected rivers and lakes, preventing the ability of the city to capture the valuable monsoon rains, and ultimately, perpetuated this crisis⁵⁴. The City of Cape Town was also criticised for poor planning in that similar drought scenarios had been presented in the past but not acted on. However, much of this responsibility lies at the level of national government as the City is limited in its ability to manage bulk water infrastructure development because of national legislation⁵⁵. Despite Cape Town's poor planning leading up to the drought, the city's demand management response has been hailed as a global success in many regards, which has produced many important lessons learnt⁵⁶. In Chennai, there is an urgent need for effective demand management, conservation and rainwater harvesting to recharge water supplies.

It is clear that cities need to recognize and address key uncertainties in their financial models relating to the revenue generation and provision of fundamental services such as water and electricity⁵⁷. Climate change will increase the severity and frequency of these extreme events and municipal finance reform thus presents an important entry point to build system resilience to these shocks and stressors, while serving to reduce the vulnerability of the most vulnerable communities.

Conclusions

Effectiveness of basic municipal service delivery is largely influenced by the structure and function of municipal finance models. The cases of Cape Town and Chennai illustrate how climate change creates financial stress on municipalities through different pathways. In both Cape Town and Chennai, the impacts of climate change disproportionately impact

⁵³ Palanichamy, B, "How Does a Flood-Prone City Run Out of Water? Inside Chennai's 'Day Zero' Crisis" (World Resource Institute, June 25, 2019), <https://www.wri.org/blog/2019/06/how-does-flood-prone-city-run-out-water-inside-chennai-day-zero-crisis>.

⁵⁴ T Ha, "Parched Lives on the Fringe: How Water Scarcity Has Widened Inequality in Chennai," *Eco-Business*, September 18, 2019, <https://www.eco-business.com/news/parched-lives-on-the-fringe-how-water-scarcity-has-widened-inequality-in-chennai/>.

⁵⁵ Rawlins, "Political Economy of Water Reallocation in South Africa: Insights from the Western Cape Water Crisis."

⁵⁶ Johan P. Enqvist and Gina Ziervogel, "Water Governance and Justice in Cape Town: An Overview."

⁵⁷ Simpson et al., "Municipal Finance and Resilience Lessons for Urban Infrastructure Management: A Case Study from the Cape Town Drought."

the most vulnerable populations living in these urban areas. Both municipal finance models are highly vulnerable to the current and projected impacts of climate change, which in turn appear to exacerbate existing vulnerabilities of underserved communities.

Cape Town's municipal finance structure is more directly vulnerable to the impacts of climate change due to the significant proportion of revenue generated from water and electricity. Whereas in Chennai, the direct impact on revenue is less because tariffs have not increased in over two decades and thus produce a notably lower proportion of overall revenue. However, Chennai does face significant budget deficits which are being offset by other forms of public revenue. In both cities, the rising costs of infrastructure expenditure, being partially driven by changes in climate, are placing other government revenue streams under pressure. Regardless of how the financial stress of climate change manifests, these impacts constrain potential redistributive expenditure, limiting the adaptation potential of the urban poor and in turn, resilience building of cities.

These cities present contrasting, yet paradigmatic cases where severe drought has led to affluent communities independently adapting through decentralised water and energy solutions. In both cases, it is the urban poor that bear the brunt of the negative consequences. Understanding these complex relationships between climate change impacts on municipal revenue streams and urban populations is critical for municipal finance reform to improve adaptation planning.

Recommendations

Municipal revenue streams need to be sustainable and resilient to the impacts of climate change to enhance the adaptive capacity of groups who rely on service delivery the most. To break the positive feedback loops of climate change impacts and decreasing urban resilience, municipal revenue streams need to be systematically decoupled from climate risks. However, this must happen while implementing relevant transition contingencies to maintain adequate service delivery and avoid revenue fluctuations that push systems towards emerging adaptation limits. Specific recommendations include:

- Cities need to place greater emphasis on understanding and linking municipal (and other) finance models to climate change.
- Research should be focused on exploring innovative and adaptive opportunities for financial reform in cities, focusing on diversifying revenue streams to limit both direct and indirect climate change risks.
- Municipal finance reform should be viewed as an iterative and ongoing process, which requires a supportive legislative environment and institutional arrangements. Reform should be proactive to avoid knee-jerk responses during a crisis, such as a drought, and be built on the key principles of redundancy, robustness and resourcefulness^{58 59 60}.
- South-South cooperation and learning should be upscaled given the unique developmental challenges that intersect with climate change responses.

⁵⁸ Simpson et al.

⁵⁹ The Rockefeller Foundation, ARUP., "City Resilience Index," 2014.

⁶⁰ Torres CD, "The Future of Water in African Cities : Why Waste Water? Urban Access to Water Supply and

Sanitation in Sub-Saharan Africa, Background Report" (New York, 2012), <https://openknowledge.worldbank.org/handle/10986/12276>.

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