



Climate Change, Urban Ecosystems and Environmental Governance: Strategies for Sustainable and Resilient Cities

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Abstract:

The climate issue is twofold centred on cities. They are the greatest contributors to emissions that accelerate warming and they focus the population and resources that are endangered by warming. That dual exposure is the beginning point in this paper and it poses a more difficult question than one can reasonably have with a typical survey. It is not merely the issue of what climate change does to urban ecosystems that are problematic, but why the instruments of managing urban ecologies continue to fail to match the magnitude of the challenge. It bases its argument on the numbers provided by Intergovernmental Panel on Climate Change, UN-Habitat, and some recent peer-reviewed literature, labeling the reaction to climate change in urban areas as being ambitious and lacking in coordination. Medellin green corridors and other examples of nature based interventions demonstrate that urban green areas can be used to quantifiably cool the city. However, their advantages are not equally spread and their form of governance is disregarded in a fragmented polycentric system of municipal networks, ministries of the national governments and private actors which are not accountable to each other. The discussion has come to the conclusion that it is no longer the knowledge or even technology that would be the decisive constraint on the action taken to improve the urban climate. It is the structure of governing: who governs, who funds and who cools off the first.

Keywords: urban climate governance; nature-based solutions; urban heat island; climate justice; polycentric governance; green gentrification

1. Introduction

This is a certain type of heat, which cities create. At the height of summer in a thick area, long after the sun has disgraced itself, the sidewalks are warm to the hand, and the breezes are unable to find their rest. A city, the stone and asphalt that enable it to be read in the light transform, in the dark, into some sluggish radiator. This does not apply to the climate crisis in the form of a metaphor. It is an actual, quantifiable aspect of the destiny of the urban, and it has that which the broader discussion usually neglects. Climate change is most commonly talked about on a planetary level, in parts per million, in the average temperature globally, in the melting of ice in the distant north. However the crisis is experienced on the level of the street.

It is in cities that the abstraction is made concrete. They will have, too, where a good part of the trouble is brought on. The emissions of that carbon dioxide represent 71-76 per cent of all final energy consumed globally, and about 70 per cent of all anthropogenic greenhouse gases in total, but only urban areas cover less



than three per cent of the total area of the Earth (Seto et al., 2014; UN-Habitat, 2011). Those grooves are the gist of it in a fine perspective. A huge portion of the site gets forged into a minuscule fraction of the area and is located at the apex of the very people most susceptible to the effects. Almost seven out of ten individuals are projected to be residing in urban areas by 2050, nearly all of that growth is going to be in Asia and Africa (UN DESA, 2019). It will be mainly in urban space that we will win or lose whatever we need to be doing by climate action.

This paper will not ignore this premise and it has gone beyond description into analysis. Much of the literature is left at the stage of the alarming fact. Cities emit a lot. Cities are increasingly warm. Trees should be more planted in the cities. All true, all false, all true. Relational, why, and political questions are more interesting. Why are cities that obviously are aware of their exposure unable to act swiftly enough? When ecological solutions prove to be effective, why is it that the dividends of the ecological solution are mostly reaped by the individuals to whom it was most unwarranted? And what is it to manage an urban ecosystem in conditions where the control of that ecosystem is distributed through the departments of the municipality, national ministry, transnational networks and individual developers, and there is no common line of control?

This argument here promotes that the binding limit to the response of urban climates is more and more a matter of governance than of knowledge or technology. We have a fairly accurate idea of the effect of a green corridor on the temperature of a city. We have learned that high density settlement is not necessarily high carbon but can also be low carbon. The most truly challenging aspect is the coordination problem: the challenge of coordinating actors operating at varying scales on varying timescales with greatly varying interests around interventions whose costs accrue today and whose benefits are slow and lumpy. To exemplify that the paper is organized in five moves. It begins with defining the issue of the duplicity of cities as the perpetrator and the victim of climate change. It then looks at stressful urban ecosystems, with physics of the urban heat island, and the evidence of ecological cooling. It then moves to the question of governance, where it follows the change of a monocentric to a polycentric model, and inquires what that change addresses and leaves unaddressed. At that point it faces the analytical tensions, the tension between analysis of adaptation and efficiency and the tension between analysis of equity, any honest account must face. Lastly it considers what the evidence can and cannot tell us prior to the extraction of the implications.

The Urban Paradox: Cause and Casualty

The initial point to be made with regards to cities, and their relation to climate is, that they are in the same ledger, on both sides simultaneously, but that the sides are not in the same relation. The emission level on the emissions side is astounding. According to the accounting technique, metropolitan regions contribute 67 to 76 per cent of total energy consumption, as well as a similar percentage of the related carbon dioxide in the atmosphere (Seto et al., 2014). UN-Habitat has estimated the number of anthropogenic greenhouse gases at approximately 70 per cent and up to 80 per cent with the consideration of indirect emission that the urban residents consume being included (UN-Habitat, 2011). Most of the work here is done by transport and buildings, in the daily turnover of the people and the interior spaces, as well as maintaining them habitable. That is why decarbonisation of cities cannot be one of those silver bullets but it is indeed a question of rewiring mundane infrastructure of everyday life.

A counter intuitive twist to take a moment and consider, as it makes the simplistic narrative of cities being bad to the climate more complex. Density has the ability to reduce emissions per capita. In a low-density sprawl, a resident in a high density, transit served city has a smaller carbon footprint due to shorter trips, a presence of shared walls and smaller structures that are more efficient structurally (Seto et al., 2014). The issue, however, is not urbanisation per se but an urbanisation form. A car centric city, the depersonalized dwelling and carbon

richness of its materials entraps decades of high emissions within the sheer inertia of the physical structure. The reverse is true of a city constructed in the vicinity and transportation. This is critical to the 2.5 billion more urban inhabitants forecasted because of the rise in population towards mid century, the majority of whom will reside in the fast growing cities of Global South (UN DESA, 2019). What infrastructures those cities develop in the coming 20 years will determine their way of emissions into the remaining century. The window is none metaphorical. It is a construction scheme.

Another twist here is that the figures epitomized in the headline are more likely to hide than express a point, and it increases the argument made concerning the form issue. A huge and expanding proportion of a urban environment footprint is symbolic as opposed to functional. It is built into the concrete, steel and asphalt of the buildings, and even the roads, before they begin to turn on a light. The cement and steel made by humanity are some of the most carbon intensive substances, and the city life, with an accelerated construction pace, is, in fact, placing decades of emissions into one building boom. It is like this that the imminent urbanization of the Global South is so momentous and two sided. The very same bread and circuses that will shelter billions and push the standard of living up will, should it continue the carbon heavy template of the cities of North and South throughout the twentieth century, install the burnt-up carbon that no subsequent retrofitting by itself will ever entirely compensate. The materials and urban structure that are selected by a rapidly expanding urban centre presently is thus not a national issue but a global one, practised by municipal actors who only have global decarbonisation very low on their agenda or their budgets.

Opposite exposure sits exposure, and here the lack of symmetry is made sharp in terms of morality. The least contributing cities to the problem are often the cities the most susceptible to it. Megacities experiencing a rise in sea level and storm surge are coastal in nature. Cities that are inland are experiencing heatwave aggravation. Almost complete lack of protective infrastructure is seen in informal settlements constructed on the floodplain or not stable slopes. The Intergovernmental Panel on Climate Change is outspoken as to how these burdens disproportionately affect the economically and socially most marginalised elements of urban population, and how unplanned, rapid urbanisation is a primary contributor to risk in itself, where settlements are located on land which is prone to flooding or landslides (IPCC, 2022). Vulnerability, that is, is not a geographical or even bad weather issue. The planning, financing and permitting of cities to expand is what manufactures it.

The paradox, however, is not that cities are the directions of the emergence of climate change, but the fact that they are victims of it. And the cause and the suffering populations are, it is, other people. The air pollution is propelled by the affluent use of consumption. Poor people end up bearing the brunt of the consequences. Two worlds can be contained in a few kilometres in one city, an air-conditioned business area and a heat pocket informal settlement, the one that produces the emissions that so that the other will become uninhabitable. This would be lost in any analysis that considers the city as a unit actor (unitary) having one unit of interest. The city is a distribution location and climate change cuts down the lines of that distribution as water locates the fissures.

Urban Ecosystems Under Pressure

The term urban ecosystem may have an amusing effect, creating an impression of reverence to, or a halt of ecology beyond, the city boundaries. It does not. A city is an operating, though greatly adapted, ecosystem, and climate behaviour in a city are dictated by the same set of physical principles as any landscape: the effects of surfaces to absorb and give up energy, the motions of vegetation to move water, to concentrate and lose heat. The problem is that, whether intentionally or unintentionally, cities are designed in such a way to be trapped by the heat. Dark surfaces absorbing the sun rays are impervious. High-rise structures minimize the

ventilation and re-radiate heat among them. The almost complete disappearance of vegetation eliminates cooling that would otherwise be brought by vegetation. This leads to the urban heat island which is the worst documented and consistent environmental pressure that urbanisation has on the natural world.

1.1. *The physics of the heat island*

The size cannot be listed among mere figures. The IPCC projects urned some two degrees of local warming due to urbanization in the form of urban sprawl, on top of pre-existing background warming by climate change (IPCC, 2022). Extreme cases, which occur especially at night, can have a temperature difference of more than 5 o C between a dense urban core and its more rural environment. It is the dangerous of its nocturnal effect. During the night when the temperature falls, human bodies cool off of the heat they have gotten during the day. The city is not ready to cool down and there is nothing like that recovery, and as night after night the physiological burden of a heatwave increases. The IPCC reports with high confidence that hot extremes have also increased in cities due to this very interaction of the effect of warming at the regional level and the heat island effect (IPCC, 2022). It also cautions that there will be an intensification of the warming signal on minimum temperatures, the overnight low, in the future with urbanisation that will make such a signal rival global warming in intensity.

What is even worse than an engineering nuisance, is who it kills. Heat has now become one of the most lethal climate risks in cities, with its victims being the significantly older, poor, the isolated, and the labourers who have their business outdoors, dominating. Distribution of heat in a city follows the distribution of vegetation and distribution of wealth follows the distribution of vegetation. A treeless low income neighbourhood a short distance away may be a few degrees colder than a leafy high income neighbourhood that is a short distance apart. The heat island is thus not a blanket that covers the city but a quilt and the cold points are likely to be located where the least resilient population will reside.

1.2. *What ecosystems do, in numbers*

To the extent that the heat island is an issue that the city causes by eliminating nature, the self-evident solution is to restore nature. That is the reasoning of nature dependent solutions, be it green roofs, trees in the streets, urban forests, parks or rehabilitated waterways and that they work now is fairly solid. In a meta analysis of nature based solutions conducted in 2024, spanning 70+ studies, trees demonstrated the biggest cooling benefits, cutting down surface temperatures by up to 8.0°C, with urban forests capable of producing gains of approximately 5.5o C to smaller interventions providing smaller benefits (Ferrario et al., 2024). These effects have been summarised in Table 1. The values do not follow a normal distribution and variability is high, since a tree in a dry and hot region will not act in the same way as a tree in a hot and humid region and the process of measuring it will be different. But the trend is undisputed. Plants relieve urban levels of heat by evapotranspiration, or water vapour release that, when done by trees, cools the surface by (acid) shade and cooling down the surrounding air.

Table 1. Mean surface temperature reduction by type of nature based solution

Nature based solution	Mean surface temperature reduction (°C)
Trees	8.0
Urban forests	5.5
Parks and urban green spaces	3.1
Green roofs	3.0
Green walls	2.1

Source: Adapted from Ferrario et al. (2024). Values are absolute mean reductions and carry wide standard errors owing to climatic and methodological variation.

The best thing about it is the cooling. Urban vegetation also catches stormwater and minimizes flood hazard, cleanses particulate pollution, stores carbon, fosters biodiversity, and, like mental health, is more challenging to quantify, but has been shown and re-is repeatedly to improve mental health and attract people into equal open space. This is what ecosystem services is: the collection of services that a healthy ecosystem only provides a city needs to recreate through either costly grey infrastructure or do away with altogether. An urban tree is a mature tree, which is simultaneously an air conditioner, a stormwater drain, a carbon sink and a part of the infrastructure of administering public health, at the expense of planting and care. Control of the urban nature in this light was never a natural development act. It entailed the destruction of infrastructure whose services were then bought by the city again at a high price.

One can afford not to succumb to the urge to make urban nature a thermostat since the worth of a living city does not wear out itself in cooling. Urban ecosystems constitute habitat and the biodiversity they bear is not the aesthetic added value but a constituent of system resilience. Planting of a one-type of trees along all streets will keep the street cooler until one pest comes and opens up the tree tops clean in a season. A mixed city forest takes much longer to grow, but is much harder to blow down. The same argument plays within the parallelism of green and grey infrastructures. A concrete storm drain just one thing, until it breaks, when it breaks out it has to be replaced at full price. New urban wetlands or a system of rain gardens handle stormwater as well, but also filter water, promote wildlife, store carbon and only practice becoming better as it ages as opposed to getting older like a pipe. One of the real conceptual changes that the climate era has made on urban planning is thinking of urban ecosystems as multifunctional, self improving infrastructure, as opposed to ornamentation.

1.3. *A case that measured itself: Medellín*

Abstract numbers speak but the best testimony is given by a city which chose to experiment with the idea and then tally the outcomes. In 2016 Medellín, the second city of Colombia, introduced a programme of green corridors: a network of linked planting of vegetation along dozens of streets, and in former waterways, to make the grey transport corridors appear shaded and living. The city planted about 880,000 trees and 2.5 million smaller plants in about thirty corridors during a period of about three years (Sustainable Energy for All, n.d.).

The difference between Medellín and other cities that are green without reason is that the municipality took temperatures of the cities and after exhausting the pollution. Average air temperature dropped to about 27 to 28°C (previously reached about 31.6) and average surface temperature dropped by over 10 C (previously 40.5), to about 30.2 (Sustainable Energy for All, n.d.; Global Center on Adaptation, 2021) in the locations along the corridor. The results are in Table 2. Authorities believe that there will be additional cooling with a number of additional degrees in the next decades as the vegetation grows. The programme also reduced fine particulate pollution, enhanced respiratory health outcomes and trained urban gardeners with deliberate intent to train disadvantaged community residents to become urban gardeners, bringing an employment and equity aspect to the otherwise-possibly strictly-technical intervention. It was a relatively low cost, relative to urban infrastructure, ranging in cost between US\$16 million to install and less than a million dollars annually to operate.

Table 2. Measured outcomes of the Medellín Green Corridors programme, 2016 to 2019

Indicator	Result
Average air temperature at corridor sites	Fell from 31.6°C to about 27 to 28°C
Average surface temperature	Fell from 40.5°C to 30.2°C
Vegetation planted	About 880,000 trees and 2.5 million smaller plants
Establishment cost	About US\$16 million

Annual maintenance cost	About US\$0.6 million
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Source: Sustainable Energy for All (n.d.); Global Center on Adaptation (2021).

Medellin is well deservedly praised, but the less celebratory but the more analytically honest reading is prudent. The programme did work and it worked measurably, that is why it should be careful scrutinized and not applauded. It has been successful based on political perpetuation, limited funding and a resolution to measure results of which none of these can be presumed elsewhere. And this history of the city itself has a caution. The construction of a greenbelt in the past pushed off the residents of poor areas. Green infrastructure, that is, is not necessarily simply infrastructures. The very intervention that cools down a city can, as long as the intervention is orchestrated and who around that orchestration, dislodge the vulnerable people. The presence of such tension is no accident to the story of urban ecosystems. It is its focal point and it is where governance re-comes into the argument.

2. The Governance Question: From Monocentric to Polycentric

In the major part of the twentieth century, the implicit model of addressing a global environmental problem was that of monocentrism. One, unquestioning centre, preferably a binding international treaty or accord, would establish rules and they would be carried out by the lower level government departments. This was its way to rule climate change, by the engine of world conferences and national pledges. Machinery has not collapsed at all, it has just been continually found too slow, too gridlocked and too stuck to the ground that it can provide as fast a delivery as the physics requires. Cities stepping in that gap.

2.1. *Polycentric governance and the rise of cities*

The words used to describe what followed are mostly theoretical elements borrowed and elaborated by Elinor Ostrom whose work on collective action transformed the way of thinking in studies concerning environmental governance. Ostrom contended that a polycentric system (where there is more than one governing authority at varying scales and not on a command centre) was able to deal with issues that monolithic bureaucracies cope poorly with (Ostrom, 2010). Instead of an ideal international accord, actors on numerous levels might experiment, adjust and do things semi independently, at their own level. Perhaps no better instance exists of a disorder diffuse in its cause and diffuse in its effects than climate change. There is no single one in charge of driving the urban emissions. They consist of millions of decisions being made on thousands of jurisdictions. An apparatus of governance constructed corresponding to that dispersion has obvious attraction.

Cities stepped up to the task with bang. They formed transnational municipal networks like C40, ICLEI and Global Covenant of Mayors through which mayors share strategies and knowledge base, collect targets and lobby national and global organisations. C40 in its own special expanded to take in approximately 97 member cities representing approximately 582 million people and a quarter of the entire global economy, compared to the pan-urban emissions scenario that is recorded by UN-Habitat (2011). The ICLEI is at the forefront in the local government constituency of United Nations climate negotiations, and in this event the cities are practically provided with a participative role in what has traditionally been the prerogative of nation states. The most crucial point is perhaps the most incredible: much more often the cities are pursuing more serious climate goals than their homeland countries, charging at their own national governments (Reckien et al., 2014). It is polycentric governance in a manner that flatteringly shows that it is nimble, ambitious, networked, and fills this gap that was left vacant by top down governance.

2.2. *The limits of the polycentric story*

One can readily stop the discussion of government there on an optimistic note of how mayors are going to rescue the world whilst the presidents fiddle about. The analytic image is not so neat. Polycentric governance is the solution to the paralysis issue, yet it brings on more issues of its own, and these are the issues, which the celebratory literature is inclined to downplay.

The initial one is coordination. Having several centres of power that work independently is a strength with no other option that does nothing, but the independence and coherence become a conflict. A polycentric system is never sure about its numerous actors pulling in the same direction, and that their efforts would be commensurate with the problem. A declaration of net zero by cities can be made; but in a city whose powers in transport, energy and building codes are not total, and whose authorities over these matters are often shared with local and national governments, can run out ahead of its powers. Equity at one level and power at another is a common aspect of urban climate governance, and generates a mismatch between promises made by cities and deliveries made by them.

The second issue is that the networks themselves are not as egalitarian as the polycentric ideal does suggest. Transnational municipal networks do not have even distributions of membership in the cities worldwide. It is concentrated in richer cities in richer more democratic nations, which are already a part of the environmental treaties. The largest cities able to do so are often those most able to benefit and to participate in the summits, to employ the sustainability officers and compose the climate action plans since they often have the least immediate need and the greatest resources available to them. In the meantime most of the cities to which the sharpest climate precarities fall, i.e. the fast growing and under-resourced settlements of the Global South, are disproportionately underrepresented within precisely the networks, which aim to democratise global climate governance. The so-called polycentric, horizontal structure which appears to be a polycentric and horizontal one at a distance proves to be stratified on closer examination. The bottom up system can generate the same inequalities that it was meant to mitigate that were produced by the top down regime.

The third issue is accountability. Even in a monocentric system, no matter how slow that may be, it is at least evident who the responsible one is. Responsibility is diffuse in a design in a polycentric one. With a decision between how a District will cope with heat divided between a private developer, a municipal planning department, a regional water authority and a national energy ministry, none of whom is answerable to the others, it becomes truly hard to say who is to bear the blame when there is a failure of adaptation, or even where there is apparently a success but not all residents benefit. Diffusion of authority is also too diffusion of blame. It is not a case against polycentric governance because monocentric alternative has proved not to work. It argues that it should look at its weak points as seriously as it does to its strong points, which the field has been reluctant to achieve.

2.3. *The shadow of the national state and the problem of money*

There is one last limit which is worth a title in itself, as oftentimes it is scarcely noticeable in the writing, and which even causes people to sing praises of the independence of cities. Even the most ambitious municipal government, however, can nearly never operate the levers set of its climate goals can demand, and can hardly ever control the money. The authority over energy systems, building codes, automotive policies, and giant infrastructure are generally shared or vested with regionally and nationally levied governments. A city thus serves under what can be referred to as the shadow of the national state with the liberty to take the lead but not to be independent. When national and municipal priorities coincide, an increase in reach of a city is multiplied. In places where they are at variance, an unfriendly or disinterested national government can

silently throttle the hopes of a city by denying it the lawful power or the purse which transforms a plan into pavement.

The most difficult aspect of this dependence is in the world of finance. Climate infrastructure turns out to be very costly and long run, which fits exactly the profile of political structures most ill adapted to finance, as it is many legal structures outlaw deficit spending and relies on transfers at the top. The most at risk cities are often those with least financial capacity to act, and the global climate finance of bridging that disparity has never been adequate to meet the demands of adaptation. What ensues is a vicious reverse of need with the ability to act being apportioned nearly inversely to the exposure. A seawall or a tree planting programme can be bonded by a rich City. They can not good in poor, who can not. No history of city life that overlooks the plumbing of the city-budget can answer the question why here cities who can plainly see their peril so often cannot act and this is another reason why the cordons of the bind is an institutional not an intellectual one.

3. Analytical Tensions: Mitigation, Adaptation and the Politics of Cooling

In case the governance section identifies that coordination is a difficult thing, this section identifies the reasons why it is a difficult thing. The options that cities have are not technical puzzles which have one correct answer, but real trade off, where progress of one objective will reverse another. Almost all urban climatic decisions are made in three tension positions and the delusion that they can be solvable is one of the most frequent mistakes of the optimistic literature.

3.1. *Mitigation versus adaptation*

The first tension is between mitigation, that is, the diminishing of the emissions to reduce the warming in the future, and the adaptation, that is, the change in the city to be able to adapt to the already existing warming. Theoretically these are complementary. Practically, they all vie over limited budgets, over political attention and space. A city struggling to get resources to pay large sums of money decarbonising its bus fleet has by so doing less spent on the cooling shelters and drainage improvements that stand the residents of that city against this decade of heatwaves and floods. Mitigation is a donation to a global common good that will benefit everybody and be experienced not by anybody specifically. Bringing a local investment benefits are visible and instantaneous, i.e. adaptation. The politics of both thus are very different and structural needs by a mayor who is an elector of getting re-election has some interest in favouring visible over diffuse.

Interventions that have been able to do both simultaneously are the most valuable ones and this is where urban ecosystems have their niche within the argument. The green corridor both mitigates through carbon sequestration and reduction in the amount of energy required to cool down, and adapts by reducing the temperature of the streets and capturing stormwater. Nature based solutions are appealing not due to their low cost, but ordinarily so, but rather to the extent that the mitigation and adaptation trade off takes a single action. That is a real analysis point on their side, and it is more powerful than the wishful evocation of greenery with which it is commonly made to take the place.

3.2. *Efficiency versus equity, or the green gentrification trap*

The second antagonism is that to the foreseen conclusion of the previous greenbelt of Medellin, and it is the keenest. Turning city green will ensure that it becomes more attractive, and creative in turning a city greener will make it more costly. This creates what has been academically termed as green gentrification: the enhancement of the environment where the property price and the cost of living escalate to the extent that the low income residents who would have benefited most profited the most called the improvements out of

the very neighbourhoods which were being upgraded in their behalf (Gould & Lewis, 2016). The advantage exists. It just transpires to whichever one comes in after.

A case in point is that of Barcelona, where the process of greening projects has been proven to increase the costs of living locally, and displacing low-income earners, although it is general and not specific to any single city. The research on the spatial urban green instances is persistent in showing that greening activities have a preference to the high-income neighbourhoods and the resultant mapping of cooling solution onto the already existing divisions of class and ethnicity. Researchers in the United States refer to a tree equity gap where renters (who are disproportionately people of colour) have much less tree canopy than homeowners so that increasing the number of trees across the city is nothing but a futile effort to reduce the gap, instead of narrowing it, in terms of who is shielded against heat. The uncomfortable conclusion is that nothing intrinsic to nature sets the bases solutions based on nature as being just. The ability to decrease or solidify inequality through a green infrastructure will wholly depend on how it is designed, funded and managed: whether it is foisted onto communities, constructed with them, whether it is accompanied by measures to prevent displacement, and whether its advantages are consciously directed to the segment of the population with the greatest need.

What is more significant is that fairness in greening in cities does not merely seem to be concerned with the allocation of benefits when a project is completed. It concerns who the pen is in the hands of when it is being written. Scholarship of environmental justice separates the concept of distributive justice that inquires who gets the cooling and the canopy with procedural justice that inquires who at the time of making the decision. The two are linked. Any greening on the neighbourhood, regardless of its good intention, imposes on the neighbourhood, but by designing it in liaison with the inhabitants, greening that develops in response to the real needs of the inhabitants has much higher chances of securing them from displacement, and is far more likely to be responsive to their real needs. The choice made by Medellin to educate inhabitants of the poor areas in their neighborhoods into the gardeners of their own pases is a minimal yet enlightening instance of incorporating procedure into outcome, transforming the people to be beneficiaries into people to be beneficiaries. In the absence of that involvement even a technically superior project may turn out to be the one done to and not on a community.

This reframes the whole discussion of urban ecosystems. The issue is not whether the greening of cities cools down cities or not, the answer is obviously yes, but to whom and whom do we cool the city. They are questions of governance and not ecological. One can carry out a technically perfect greening programme and yet exacerbate the workings of injustices in a city when the political and distributional pattern is overlooked. The physics is the simple bit.

3.3. *The Global South and the problem of transferred models*

The third conflict is that of context. A lot of the powerful theory of how cities should be governed (such as polycentric networks) was produced in and about the affluent, formally planned cities of the Global North. However, most of the future urbanization is concentrated in the fast growing and largely informally constructed cities of the South, and much of the highest climate risk (UN DESA, 2019). Cities with highly municipal finance systems, in-depth land use regulation and good data may not translate well into a city with high number of people in informal settlements out of the formal planning system, with sparse municipal budgets, and with incomplete basic infrastructure, such as water and sanitation.

4. What the Evidence Can and Cannot Tell Us

A piece of analysis owes some honesty to its reader about the weaknesses of its own evidence, and a review of evidence base on urban climate is more imbalanced than the cheery statistics it presents. There are three caveats which do well to be mentioned.

The former has to do with measurement. The frequently reiterated assertion that urban centers contribute approximately 70 per cent of the emission is solid as a estimation but rubbish considering the specifics, in the sense that it relies greatly on the methods used to assign the emission. Is it the emissions of a city that a city should be taxed on, or it is the emissions that a city puts in everything its inhabitants eat, much of which is produced elsewhere? The two accounting approaches may predispose significantly different values, and the fact that only a small amount of urban carbon dioxide data have been measured directly signify that most numbers on a city level are estimated instead of being observed (Seto et al., 2014). This does not call into question the fundamental argument that cities are at the centre of emissions. The point is that, one should be careful about the exact comparisons of cities.

The second one is the ecological evidence. Large standard errors attached to the cooling numbers mentioned above are exactly due to the fact that what a green roof is in a certain climate is not a green roof in another, and research quantifies other things in different ways (Ferrario et al., 2024). The direction of effect is not disputed but the discipline itself recognises that its measurement regimes are not so standardised as yet that averages can be confidently obtained. Anybody who quotes one figure to the extent to which a tree cools a city is playing down actual heterogeneity. The free assertion is that vegetation cools predictably, in the sense that variation depends on circumstances, and this variation is interesting in itself, not to be averaged out.

The third relates to causation of governance. There is the lure to attribute climate development in a given city to its being in a network or to adopting a plan but ambition and capacity are mixed. Climate networks with cities that make bold targets are often cities that already had the financial capability, political stability and governmental infrastructure to take action. It is indeed hard to dis-teach the role of the governance intervention on the pre-existing circumstances which both allowed the intervention and the result, and much of the life-affirming literature does not do so. There is a true correlation between good governance structuring and good climate performance. It is less easy to draw the causal arrow than it presently appears.

5. Conclusion: Governing the Warm City

All the argument of this paper can be summarised in one reversal. The standard narrative is that global warming is experienced by urban centers, an external risk that is being posed by natural factors which can be opposed by more advanced technologies and a greater number of greener spaces. Closer to the truth is that framing cities as climate change. Here it is produced, here it is wounded, and here the battle over the defence of whom is in reality fought. The heat island is no natural calamity that comes to the innocent city. It is a design consequence, an anticipated consequence of covering an ecosystem with oily tarmac and then scraping the vegetation upon which it cooled off.

And, assuming that to be the case, then the most relevant levers are governance levers. In most cases we are not waiting upon scientific discovery. We understand that high-density cities can be low-carbon, that trees cool the street environment, and that, in Medellin, the temperatures of the streets were reduced by all the trees planted and the performance of the thermometers. The coordination problem we have not resolved is the question how to coordinate the actions of municipal, national, transnational and privately-owned actors, with varying scale and interest, around interventions that are cheap, local and immediate in cost and slow,

diffuse and polarizing in benefits. Polycentric administration was to the twenty first century what the paralysis of the twentieth was to the twenty first, and it was in actual fact to release a surge of urban ambition. But it replaced the issue of paralysis with the issues of coordination, representation and accountability, and they have not yet been solved.

The distributional aspect is to which the analysis eventually leads, since here the ecological and the political come together. Green corridor can cool down a poor neighbourhood or make its residents unaffordable, and the distinction between this two scenarios is all about the way the intervention is regulated. This implies that the key question in the urban climate policy is not, in fact, a technical issue. It is a matter of equity in the machineries of engineering: who determines, who makes payment, who raises the temperature and who cools down instantly. A city may become green in an imperfect manner and still become a failure to the people it becomes green. There is a need to get the physics correct. It is intentional and distributive governance that will get the governance right, making the warm city world-friendly to all residents within and not its fringes, that will actually make the difference between making the warm city livable by all within its boundaries or by those who were already financially positioned to afford the shade.

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