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PENN: CURRENT RESEARCH ON SUSTAINABLE URBAN DEVELOPMENT

Hotspot Cities

Identifying Peri-Urban Conflict Zones in the World's Biodiversity Hotspots

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INTRODUCTION

In the small print of the Sustainable Development Goal (SDG) targets there are two statements that place biodiversity and urbanization in the same frame of reference. The first, under Goal 11, states that "...positive economic, social and environmental links [should be supported] between urban, peri-urban and rural areas by strengthening national and regional development planning" and the second, under Goal 15, states that by 2020, "...ecosystem and biodiversity values [should be integrated] into national and local planning and development processes" (UN 2015). These lines of text are important because they specifically seek to transcend a history of Manichean dualism between urban development and conservation. If we are to realize the overarching ambition of the ***New Urban Agenda*** and the SDGs then such text needs to be not only taken at its word but translated from theory into practice.

Here at the University of Pennsylvania in accordance with the SDGs we are also placing urbanization and biodiversity in the same frame of reference. We have done this in two ways: the first is an analysis of land use in the world's 36 biodiversity hotspots[1] (Figure 1) to reveal conflicts between protected areas and other land uses, and the second is an analysis of the 423 cities in the hotspots so as to identify the degree to which their forecast (2030) peri-urban growth is in direct conflict with remnant habitat and endangered species[2]. (Figure 2) As a subset of these 423 cities we have recently completed a second phase of research where we zoom in on 33 of the biggest and fastest growing cities in the hotspots (Figure 3) to ascertain the degree to which, as per SDG 15, their local planning cultures are inclusive of "...ecosystem and biodiversity values".[3]

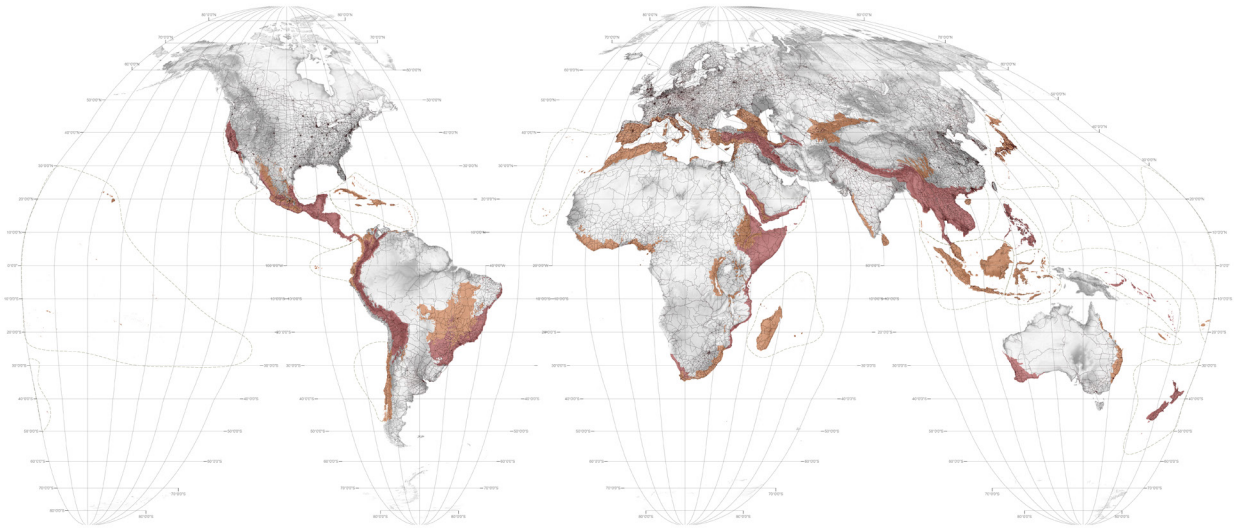


Figure 1: The world's biodiversity hotspots.

This paper presents the results of this analysis and also offers a brief discussion of how peri-urban landscapes have been, but can no longer be, overlooked or underestimated as ***peripheral*** territory. The peri-urban landscape of cities is being converted to urban lands faster and at a scale previously unseen (Dramstad and Fjellstad 2011) and much of it is occurring in, or up against the last vestiges of the world's biological diversity

1 In 1988, Norman Myers first identified 10 global hotspots featuring exceptional concentration and endemism of plant species under unusual threat of destruction. According to Myers, E.O. Wilson has said hotspots were "the most important contribution to conservation biology of the last century." As found in Myers and Mittermeier 2003. There are now 36 recognized hotspots. Together, these areas contain at least 50 percent of the world's total plant species and 42 percent of the world's terrestrial vertebrates as endemic. The original and unique habitat in these hotspots is at least 70 percent depleted and is under imminent threat of total destruction due to habitat fragmentation related to urbanization, agriculture, and related economic activities. Originally representing 16 percent of the Earth's surface, (excluding the 35th hotspot in North Eastern Australia which was added in 2010 and the 36th hotspot of the North American Coastal Plain which was added in 2016) the unique habitat of the hotspots has diminished to just 2.3 percent. As found in Mittermeier et al. 2004.
2 For full documentation of this research see Weller, Hoch, and Huang 2017.
3 This count does not yet include the cities in the 36th hotspot, "The North American Coastal Plain" (UN 2016).

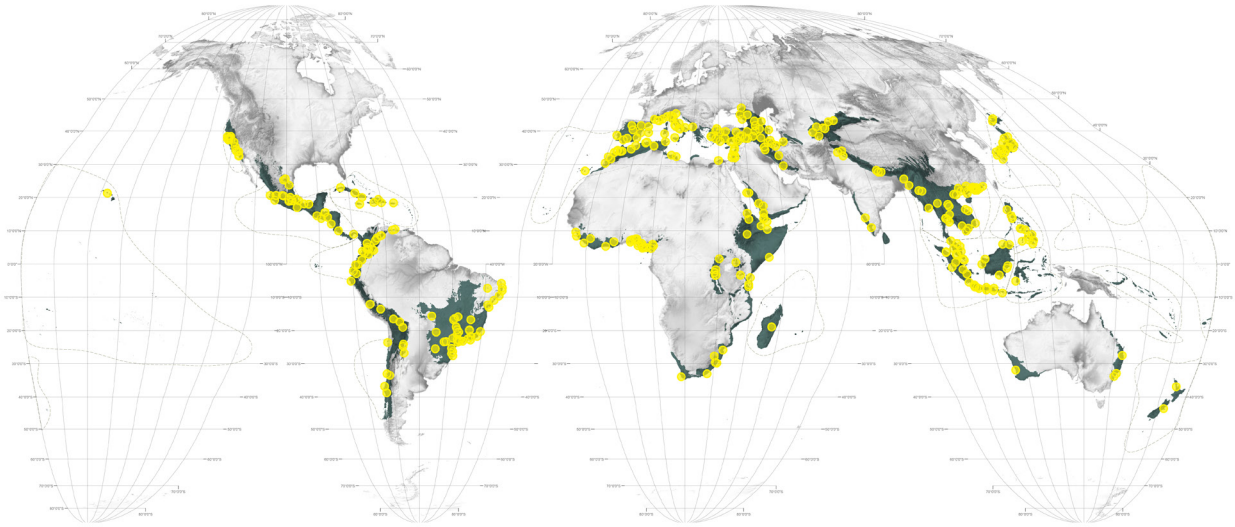


Figure 2: Cities in the world's biodiversity hotspots which are growing in conflict with biodiversity

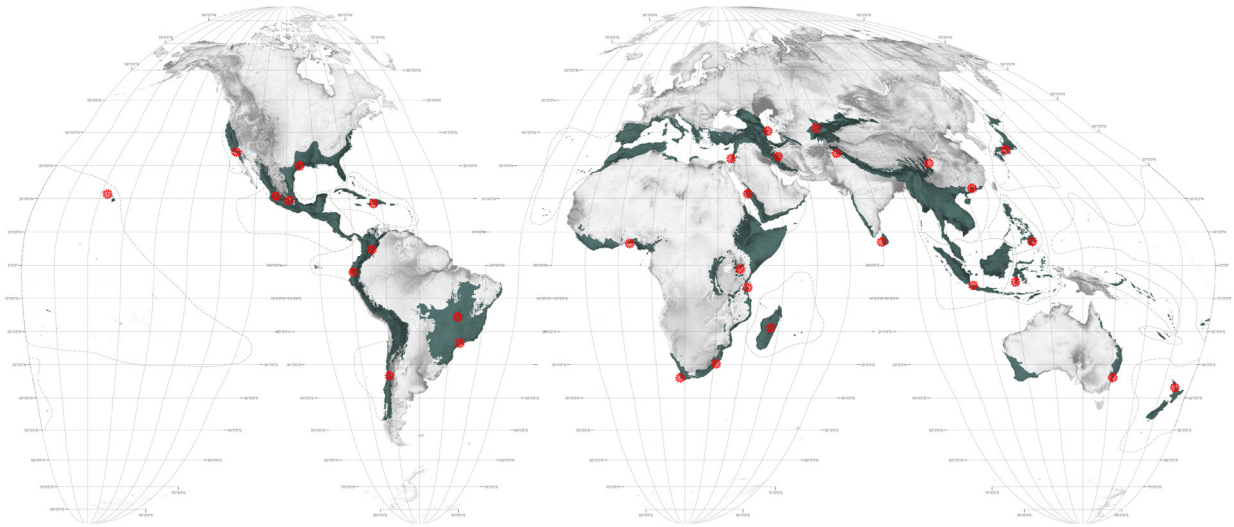


Figure 3: The locations of the 33 Hotspot Cities

(Cincotta,Wisnewski, and Engelman 2000). It is the peri-urban landscape and its regional connections beyond, that can not only support biodiversity, but also provide cities with essential ecosystem services they require. For the sustainable and resilient city, the periphery is for these reasons ***front and center***. As Harvard ecologist Richard T.T Forman writes "[y]ou can have a small impact in a city center, but if you want to have a big impact, go out to this dynamic urban edge where solutions really matter for both people and nature" (Forman 2015).

PERI-URBANIZATION?

Derived from the etymological root of the Greek prefix 'peri' (on or around) and located at the interface of urban and rural lands at the edge of the city, the peri-urban serves to establish the relationship of the (internal) city to its external parts (periphery) (Buxton et al. 2006). As a noun, it describes the heterogeneous, fragmented territory of rural and sub-urban lands and as a verb, the dynamic socioeconomic processes that create this territory. Denominated as "ex-urban,"[4] "rural-urban fringe,"[5] "peri-metropolitan,"[6] "edge city,"[7] or even just "open space," peri-urban territory is perceived as neither city nor country and accordingly has been largely overlooked in urban design and planning history. This lacuna is most recently reinforced by the Congress for the New Urbanism's (CNU) valorisation of "the transect" as an urban design tool.[8] Stretching from high-density urban cores at one end to wilderness at the other, the transect is a linear calibration of urban space into distinct typologies, the character of which should—as the new urbanists insist—be reinforced. According to the logic of the transect, territory at the edge of cities is either suburban (T3), rural (T2) or wilderness (T1), whereas in reality peri-urban territory can be all these things and more, simultaneously.[9] In a world where nature and culture are now so interwoven, we need a new language of urbanism that emphasises symbiosis, not differentiation.

Whereas the liminal zone of the peri-urban defies categorization in the orthodox language of urban design and planning, in the fields of geography and landscape architecture it has begun to be recognized for its social and ecological complexity, and its potential productivity.[10] In these readings, the peri-urban is positioned as new territory in which culture and nature might yet co-exist in a more integrated weave.[11] This appreciation of the peri-urban landscape as a hybrid and constantly evolving landscape is a prerequisite for the serious inclusion of biodiversity in the urban planning and development process.

METHOD AND FINDINGS

Our initial survey of all 423 cities of 300,000 inhabitants or more in the world's 36 biological hotspots revealed that 383 are rapidly sprawling directly into remnant habitat harboring endangered species.[12] To map this conflict, we layered each city's (2030) projected growth trajectories (sourced from the Seto Lab at Yale) over remnant vegetation data from the Global Land Cover Facility (Institute of Environment and Sustainability 2014) and the IUCN Red List of ranges for 3,245 mammal species that are either critically endangered or endangered (IUCN 2016). (Figure 4) Due to technical and time constraints, this first phase of mapping such a large number of cities was based only on the ranges of mammals as an indicator of threatened habitat. For this mapping, we included only those areas of projected urban growth that Seto's analysis assessed as having a likelihood of urbanization by 2030 at 50 percent or higher. The Convention on Biological Diversity (CBD) encourages what it refers to as "biodiversity friendly city design" and "holistic landscape management practices." Yet our review of the National Biodiversity Strategies and Action Plans (NBSAPs) (CBD 2017b) of countries whose territories overlap hotspot regions indicated that there is a marked lack of such design and planning in most of the 423 hotspot cities (CBD 2017a).

4 See Nelson and Dueker 1990; Calthorpe 1993; Burnley and Murphy 1995; and McKenzie 1996.
5 See Audirac 1999; Gillham 2002; Bunker and Houston 2003; and McKenzie 1996.
6 See Hart 1991.
7 See Garreau 1992.
8 See Center for Applied Transect studies website: https://transect.org.
9 For a succinct overview see Simon 2008.
10 See Nassauer 1995; Antrop 2005; Van Riper et al. 2017; and Swyngedouw 2006.
11 This appreciation of the peri-urban as a hybridization of rural and urban is partially captured by the Bhasha (Indonesian) term "desakota" (literally meaning at once village and town) which is used to describe the diverse rural-urban spatial structures extending from peri-urban interfaces within Asia, consisting of high population density between major cities, with a mix of rural agricultural and manufacturing. See McGee 1991.
12 For full documentation of these cities see Weller, Hoch, and Huang 2017.

Of course, planning for biodiversity at the city scale might not (and need not) be referred to in the NBSAPs which each nation is obliged to submit to the CBD but this broad-brush conclusion was confirmed in a second level of analysis where we studied 33 nominal "hotspot cities" in greater detail.[13] (Figure 3) Given that our initial mapping showed a general correlation between projected population growth and biodiversity loss we chose to zoom in on the city in each hotspot with the greatest population growth and the largest projected destruction of biodiversity habitat. In a few cases, however, we chose alternative cities whose projected conflict zones appeared larger than those of the cities with the highest population growth.[14] In each case, we again superimposed 2030 growth forecasts from the Seto Lab onto updated remnant vegetation data from 2012 (GLCF 2017). We extended this analysis to include the ranges of all non-marine animals[15] included in the IUCN's Red List in the categories of Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Least Concern (LC) (IUCN 2017) (Figure 5).

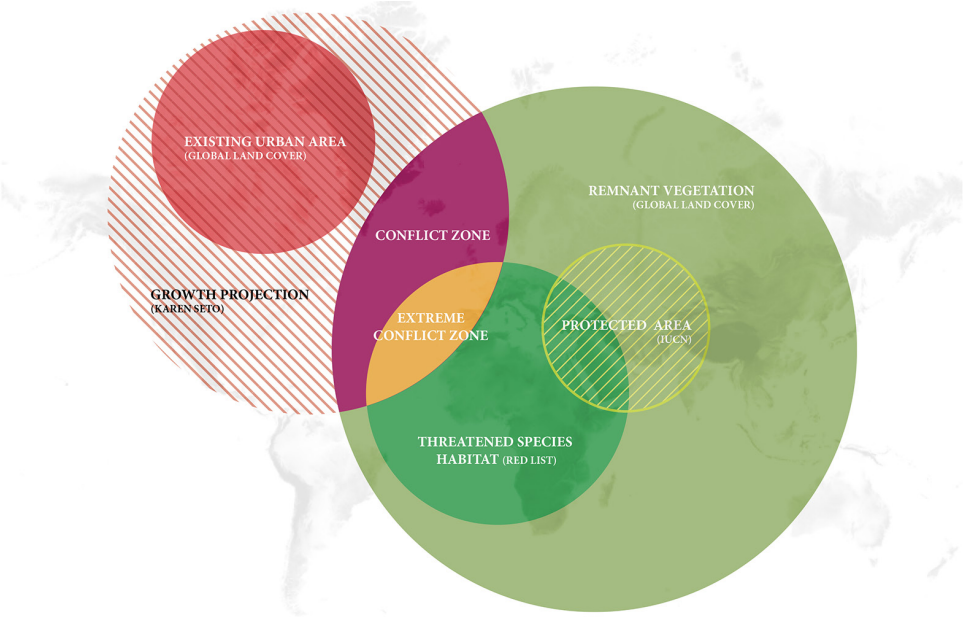


Figure 4: Diagram of the mapping method to identify conflict between biodiversity and urban growth

The 2016 UN-Habitat ***World Cities Report*** states that "urban and environmental planning provides opportunities and formal legal mechanisms for biodiversity conservation through design guidelines, building codes, zoning schemes, spatial plans and strategic choices, all coupled with effective enforcement" (UN-Habitat 2016). Through detailed (desktop) analysis we sought to gauge the degree to which these sorts of mechanisms have been leveraged in the sample of the 33 hotspot cities. Our conclusion is that the overwhelming majority of these cities have not adopted long-term planning visions that include biodiversity values or, if they do, then they do not make such planning documents available or refer to the existence of such documents online. A

13 At this point in time we have only mapped and researched cities in 33 of the 36 hotspots. Two hotspots—New Caledonia and the East Melanesian Islands—do not have cities over with populations over 300,000 people and the smaller cities that do exist in these hotspots are not projected to grow notably by 2030. Cape Town is the major growing city in both the Cape Floristic Province and Succulent Karoo hotspots. Finally, we are still in the process of mapping the most North American Coastal Plain hotspot, which was designated by CEPF in 2016. The 33 cities are listed here in order of hotspot, city, nation. 1) Atlantic Forest: Sao Paulo, Brazil; 2) California Floristic Province: Los Angeles, USA; 3) Cape Floristic Region: Cape Town, South Africa; 4) Caribbean: Port-au-Prince, Haiti; 5) Caucasus: Baku, Azerbaijan; 6) Cerrado: Brasilia, Brazil; 7) Chilean Winter Rainfall and Valdivian Forests: Santiago, Chile; 8) Coastal Forests of Eastern Africa: Dar es Salaam, United Republic of Tanzania; 9) Eastern Afromontane: Nairobi, Kenya; 10) Forests of East Australia: Sydney, Australia; 11) Guinean Forests of West Africa: Lagos, Nigeria; 12) Himalaya: Rawalpindi, Pakistan; 13) Horn of Africa: Mecca, Saudi Arabia; 14) Indo-Burma: Guangzhou, China; 15) Irano-Anatolian: Esfahan, Iran; 16) Japan: Osaka, Japan; 17) Madagascar and the Indian Ocean Islands: Antananarivo, Madagascar; 18) Madrean Pine-Oak Woodlands: Ciudad de México, Mexico; 19) Maputaland-Pondoland-Albany: Durban, South Africa; 20) Mediterranean Basin: Tel Aviv, Israel; 21) Mesoamerica: Guadalajara, Mexico; 22) Mountains of Central Asia: Tashkent, Uzbekistan; 23) Mountains of Southwest China: Chengdu, China; 24) New Zealand: Auckland, New Zealand; 25) Philippines: Davao, Philippines; 26) Polynesia-Micronesia: Honolulu, USA; 27) Southwest Australia: Perth, Australia; 28) Sundaland: Jakarta, Indonesia; 29) Tropical Andes: Bogotá, Colombia; 30) Tumbes-Choco-Magdalena: Guayaquil, Equador; 31) Wallacea: Makassar (Ujung Padang), Indonesia; 32) Western Ghats and Sri Lanka: Colombo, Sri Lanka, 33) North American Coastal Plain: Houston, USA.

14 There are a multitude of possible reasons why a city with the greatest potential growth may not have the greatest potential for habitat destruction in its hotspot, including: The city and/or its projected growth may not be fully located within a hotspot; urban expansion rates are not directly linearly correlated with population growth; in some areas urban spatial expansion rates outpace population growth rates.

15 These are sourced from the IUCN's data for Terrestrial Mammals, Amphibians, Birds, Reptiles and Freshwater Groups.

notable subset set of cities (examples include Sydney, Perth, Cape Town, Sao Paulo, and Los Angeles (Sydney Department of Planning and Environment 2014; Government of Western Australia 2017; City of Cape Town 2017; "Local Biodiversity Strategies and Actions Plan of Sao Paulo City" 2017; "Sustainability City pLAn" 2017) do, however, have transparent, readily available, variously integrated planning documents across levels of governance.

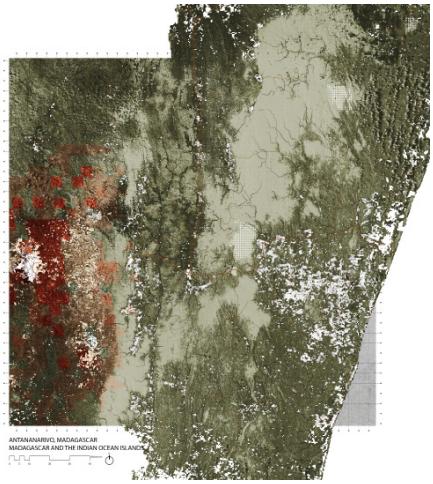
We also found that cities with well-developed integrated governance at the national, regional, metropolitan/ municipal, and local levels were far more likely to have appropriately scaled planning capacity. While cities that do not operate in relationship with regional planning or governance entities lack the ability to create plans that look beyond current legal municipal boundaries, cities with disempowered local or municipal governments were not able to turn big-picture visions from national, state, or regional plans into local, spatial planning mechanisms or built interventions. The recent push for the creation of metropolitan levels of governance—as proposed in the failed Osaka Metropolis Plan referendum of 2015, which followed on the heels of a similar but successful bid for centralized metropolitan planning in Tokyo (Harding 2015)—might have the potential to create a unified structure for conurbations that would be better able to engage with planning at the level of the entire urban and peri-urban footprint.

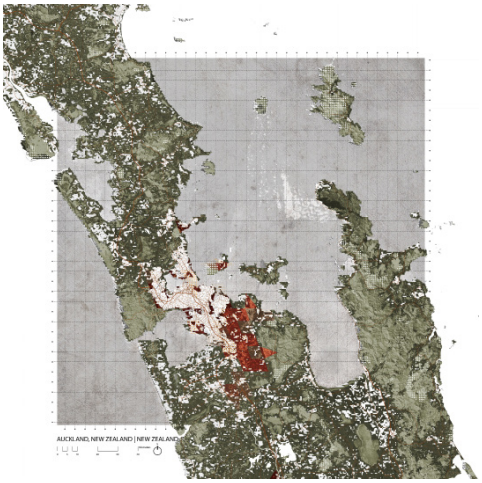
A survey of the cities' promotional materials, popular press, and institutional publications also indicates a low degree of cultural association with being "hotspot cities" or hotspot stewards. Typically, we find that a city's projected identity pertains to the characteristics of its urban core rather than its peripheral landscapes. A few cities--notably Cape Town, Perth, Sao Paulo, and to a lesser degree Los Angeles--have a robust narrative of their unique biodiversity, and their responsibility to preserve it.

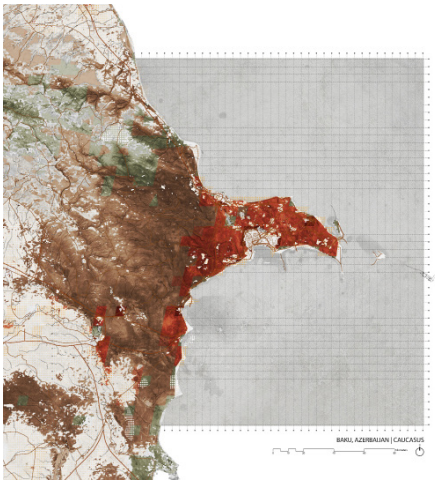
In the literature pertaining to the sample set of 33 cities, a major obstacle to the development of spatial biodiversity planning is the lack of baseline biodiversity data. Furthermore, this data, where it does exist, tends to focus on wildlife in the city rather than on ecosystem integrity at the periphery. If cities are to properly understand their relationships with biodiversity, there is a significant need to develop and share measurement and monitoring practices that relate to the peri-urban zone and how this zone functions as a filter and conduit for biodiversity both centripetally and centrifugally. Where particular cities have developed specific spatial assessments of biodiversity and long-term plans for biodiversity protection within their environmental departments, they still face significant challenges in finding common ground with other city agencies, especially in terms of allocating funds and resources towards biodiversity protection. Cape Town, arguably the city with the greatest biodiversity and greatest threats to that biodiversity in the world, is a leader in spatial, cross-municipal biodiversity planning. The city has developed a comprehensive, systematic, and spatially explicit biodiversity conservation network called Bionet that preserves critical areas for all remaining representative ecosystems in the city and which is being integrated into city planning policies (ICLEI 2012). Despite this commitment to planning for biodiversity across city departments, a Local Governments for Sustainability (ICLEI) case study report found that conducting a successful and integrated biodiversity and ecosystem services assessment did not correlate with the hoped-for increase in budget allocation for biodiversity conservation planning (ICLEI 2016). Additionally, some cities that adopt biodiversity protection measures with the primary goal of attracting biodiversity tourism have found that without effective management plans and sufficient staffing these measures can erode the very biodiversity they set out to protect. For example, Woolong Nature Reserve, outside of Chengdu, China, which was established to protect giant pandas in 1975, has become more fragmented and less well-suited for panda habitat since its creation due in part to the huge number of tourists who visit the reserve each year (Liu et al. 2001).

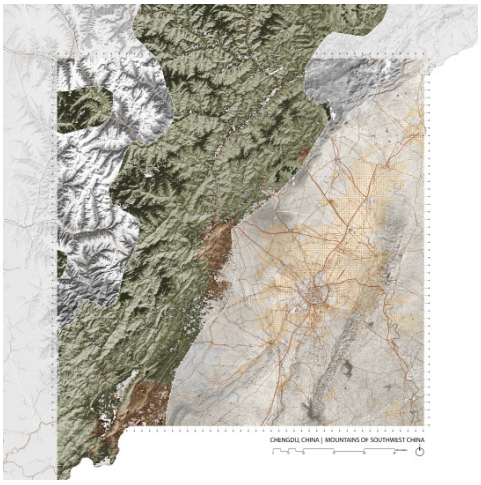
In looking at cities' approaches to environmental planning and how biodiversity is viewed in relationship to other environmental issues, we found that there is a kind of Maslow's hierarchy to a city's commitment to environmental planning. For example, cities prioritize environmental issues that have urgent human health consequences, such as solid waste removal and drainage in Lagos through the Cleaner Lagos initiative (http://

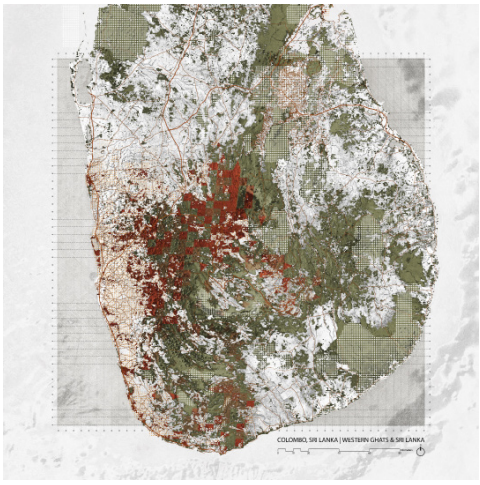
Figure 5 (Pages 7-10): Examples of hotspot city maps identifying areas of conflict between urban growth and biodiversity.

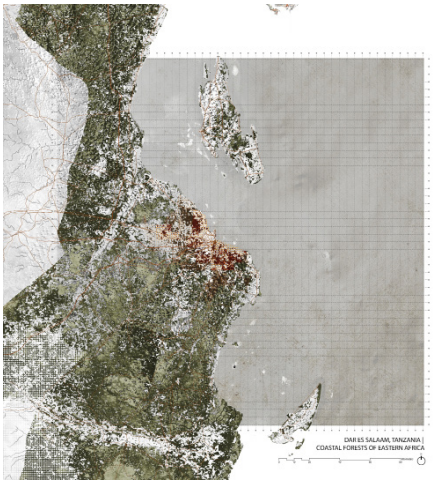


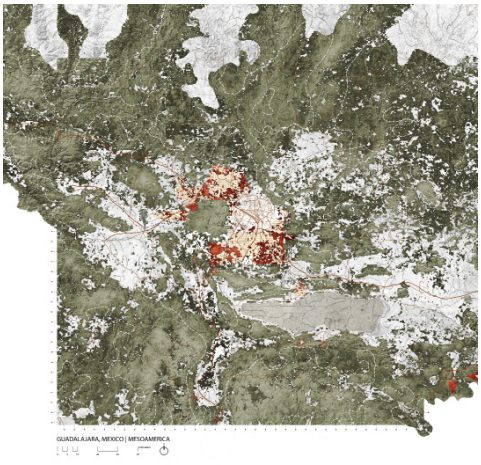


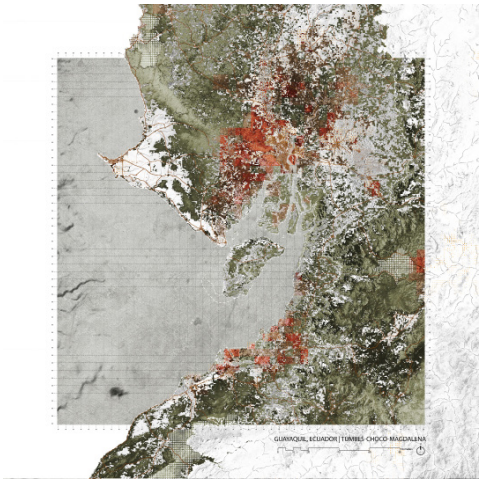


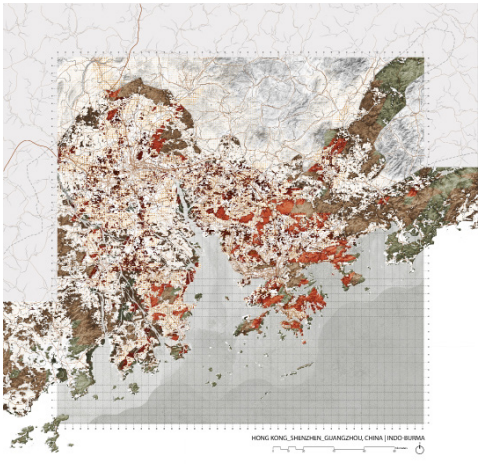


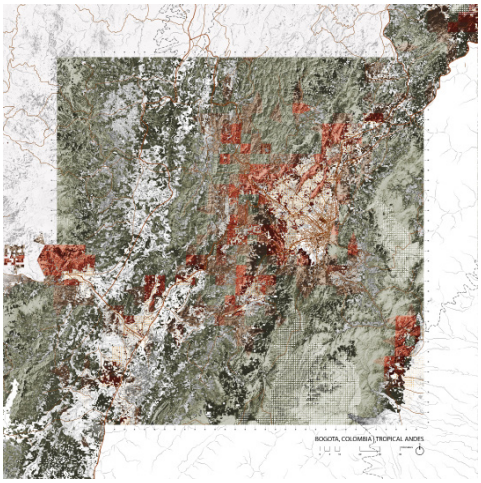








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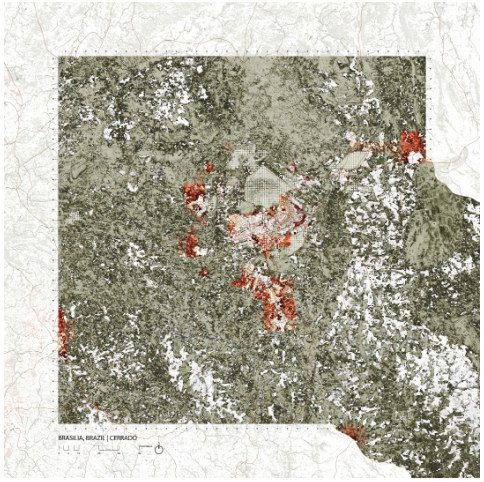
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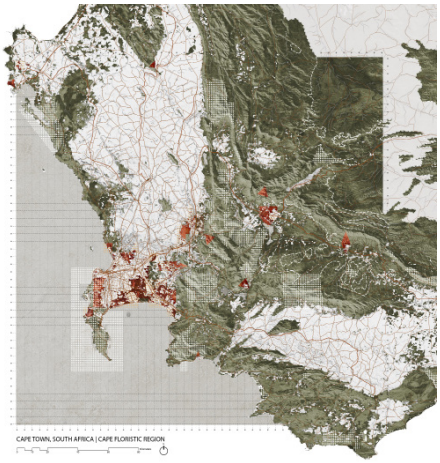
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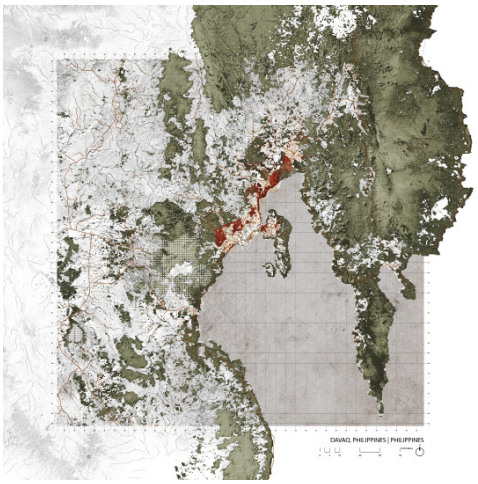
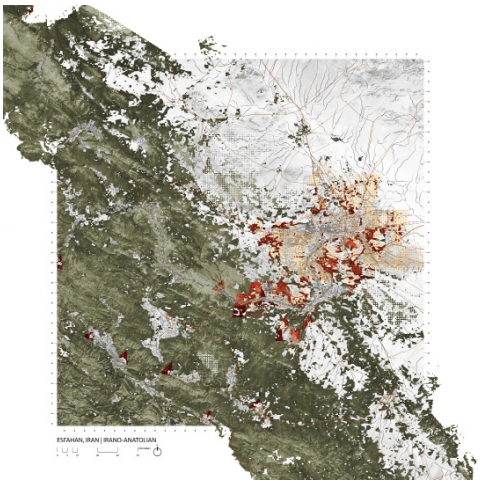
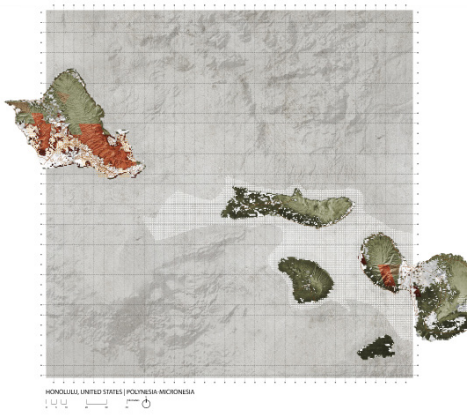

DAVAO, PHILIPPINES | PHILIPPINES

DURBAN, SOUTH AFRICA | MAPUTALAND-PONDOLAND-ALBANY


ESFAHAN, IRAN | IRANO-ANATOLIAN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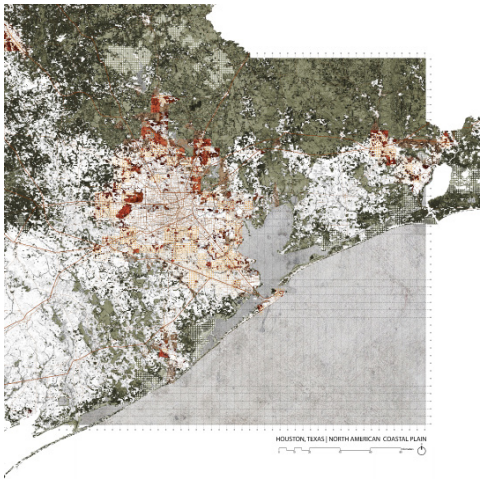
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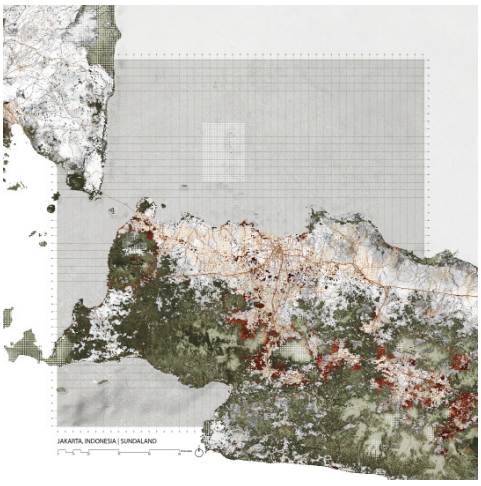
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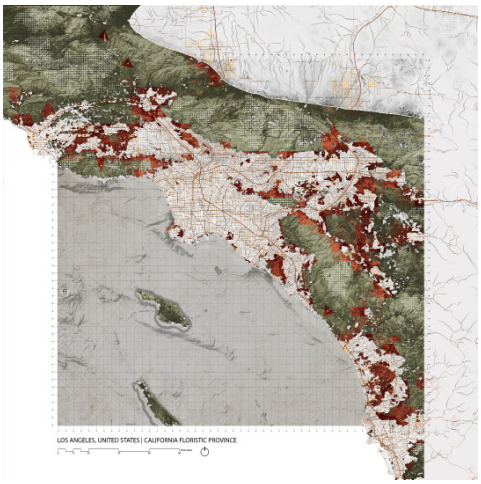
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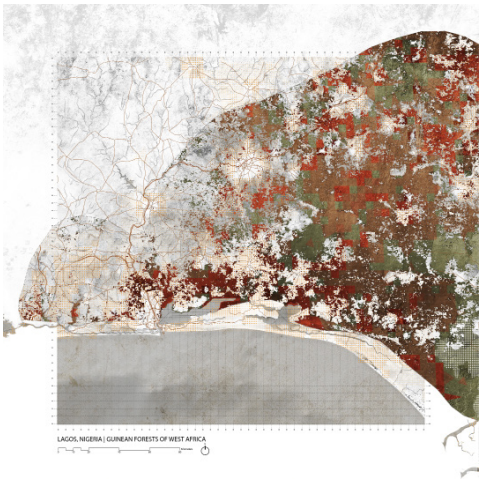
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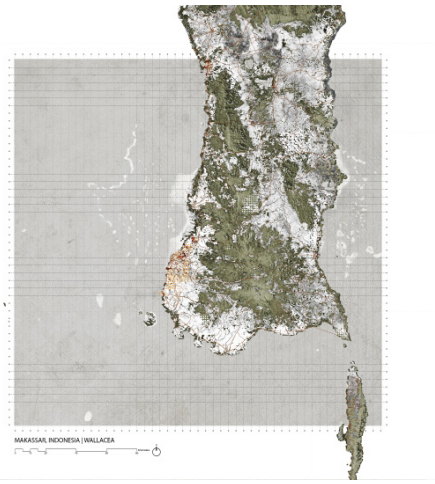
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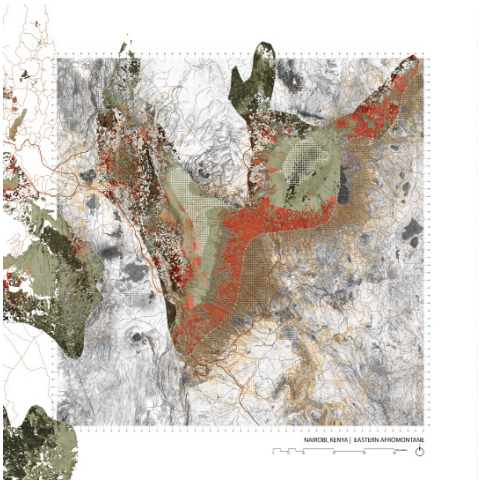
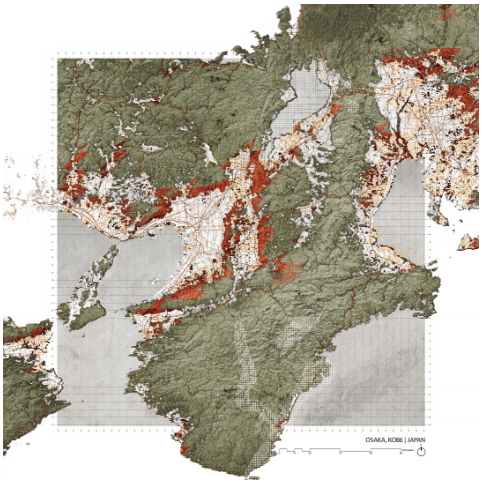
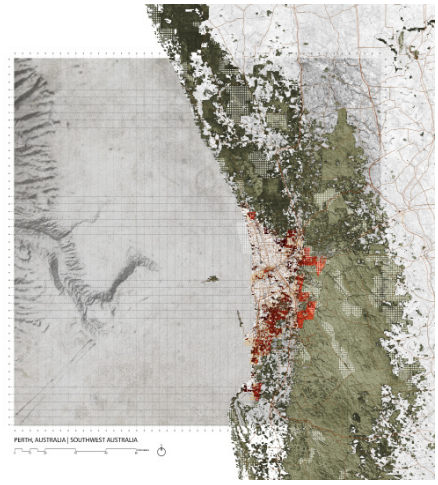
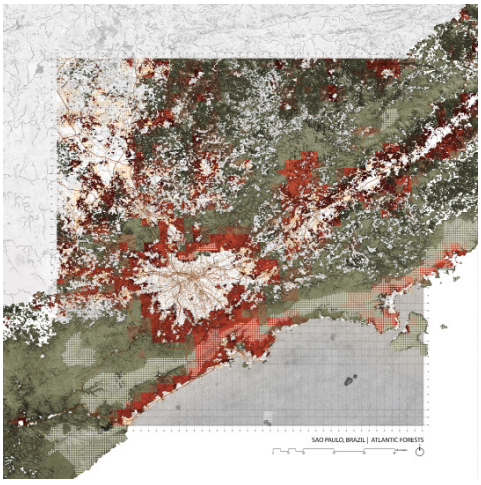
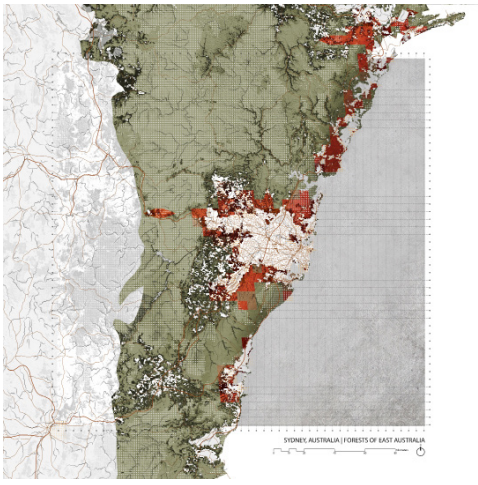

NAIROBI, KENYA | EASTERN AFROMONTANE

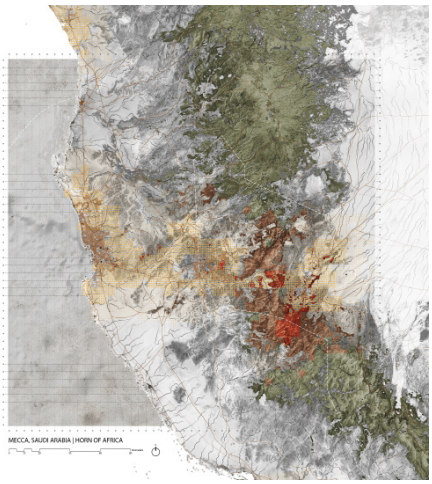

OSAKA, KOBE | JAPAN

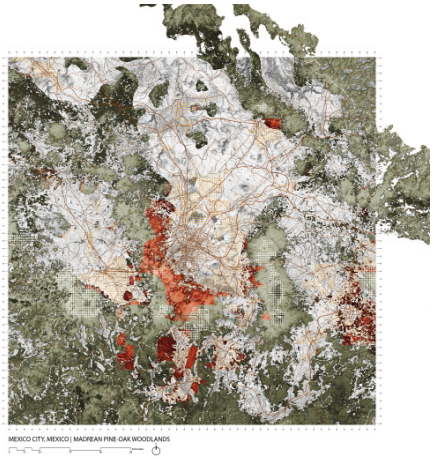

PERTH, AUSTRALIA | SOUTHWEST AUSTRALIA

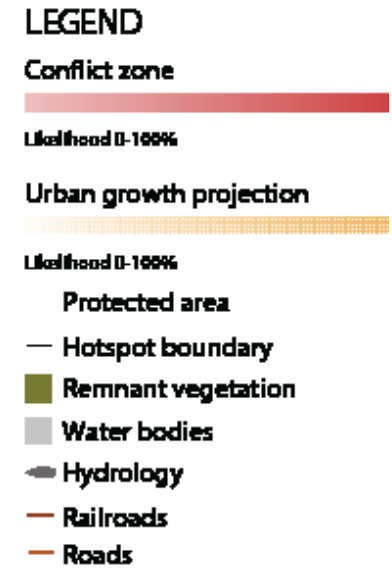

SAO PAULO, BRAZIL | ATLANTIC FORESTS

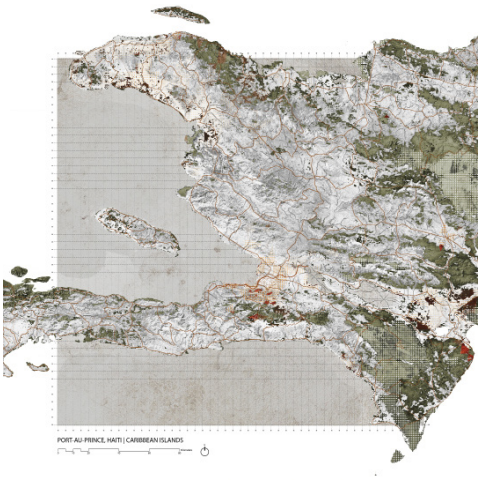
SANTIAGO, CHILE |
CHILEAN WINTER RAINFALL VALDIVIAN

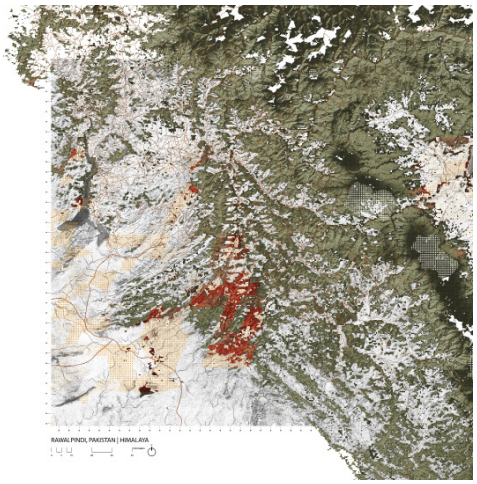

SYDNEY, AUSTRALIA | FORESTS OF EAST AUSTRALIA





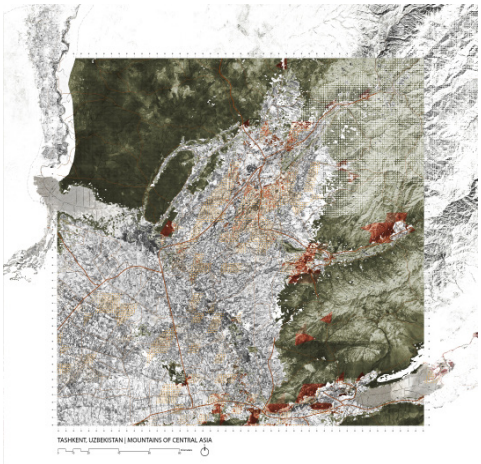






Left to right, row by row, across whole spread.

Previous Spread:
1. Antanaviro, Madagascar
2. Auckland, New Zealand
3. Baku, Azerbaijan
4. Bogotá, Colombia
5. Brasília, Brazil
6. Cape Town, South Africa
7. Chengdu, China
8. Colombo, Sri Lanka
9. Dar es Salaam, Tanzania
10. Davao, Phillipines
11. Durban, South Africa
12. Esfahan, Iran
13. Guadalajara, Mexico
14. Guayaquil, Ecuador
15. Hong Kong, Shenzhen, Guangzhou, China
16. Honolulu, United States of America
17. Houston, United States of America
18. Jakarta, Indonesia



This spread:
19. Lagos, Nigeria
20. Los Angeles, United States of America
21. Makassar, Indonesia
22. Mecca, Saudi Arabia
23. Mexico City, Mexico
24. Nairobi, Kenya
25. Osaka & Kobe, Japan
26. Perth, Australia
27. Port-au-Prince, Haiti
28. Rawalpindi
29. São Paulo, Brazil
30. Santiago, Chile
31. Sydney, Australia
32. Tashkent, Uzbekistan
33. Tel Aviv, Israel

www.cleanerlagos.org/) and a major river water treatment in Guangzhou that the World Bank is funding to clean up the Pearl River (The World Bank 2017). In this context, we suggest that water resource protection can be a particular point of synergy between these basic environmental concerns and biodiversity preservation.

CONCLUSION

The overarching question to ask is whether the growth trajectories of these hotspot cities can be redirected to avoid the further destruction of biodiversity, and if so how? Having taken the first step of identifying likely conflict areas it is important now to recognize and understand the true complexity of the problem. The conflict between sprawl and biodiversity cannot be approached reductively or simplistically as if sprawl (formal and informal) is only an outcome of economic and demographic growth, and conservation only a matter of fencing off areas in its path. As alluded to earlier, the peri-urban territory of cities is a complex mosaic of different and often contradictory land uses in high states of flux. Indeed, the alteration of peri-urban land is not caused solely by urbanization but is also a consequence of extracting many of the resources required to support cities and their residents (McPherson, Andersson, Elmqvist, and Frantzeskaki 2015). The often invisible and myriad forces shaping these landscapes are not yet well understood by the urban design and planning professions, just as the novel ecology of these lands is not yet well understood by the scientific community (Nassauer 2012; Radford and James 2013).

The need is for case studies which approach the conflict between biodiversity and urban growth holistically. Epistemologically this means approaching the issue from both the sciences and the humanities. From a planning perspective it means appreciating that the small and large scales of urban geography are interconnected. Upon the basis of sound socio-economic and ecological analysis interdisciplinary teams can generate alternative urban growth scenarios which can be evaluated for their costs and benefits. It is not enough to just cast anti-sprawl platitudes or make mere recommendations in planning reports that pay lip service to the Convention of Biological Diversity and the SDGs, what is needed are realistic spatial plans for these conflict zones, tuned to local cultures, which would concentrate urban growth in areas of least impact whilst simultaneously forging multi-scalar landscape connectivity for biodiversity. Without new pathways for migration, biodiversity will not endure climate change, let alone urbanization. Simply designating islands of protected area presupposes an unchanging landscape whereas, in an era of rapid urbanization and climate change, the opposite is true.

As both the custodians and immediate beneficiaries of the unique biodiversity at their doorsteps, the hotspot cities described here have a global responsibility and leading role to play in integrating biodiversity with development. It is our belief that a better understanding of peri-urban territory, and the forces shaping it, is a prerequisite to the mitigation of further loss of biodiversity and that this is not only relevant to cities in the world's biodiversity hotspots but to cities everywhere. To that end, we propose that the hotspot cities come together to form a global knowledge-creation and knowledge-sharing alliance to support innovative urban design demonstration projects and lead the way in making the intent of SDG Goals 11 and 15 a reality.

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