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Urban Forms and Future Cities

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Commentary

Urban Forms and Future Cities: A Commentary

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Abstract
The commentary reflects on the critical ways in which the proliferation of private property rights and local planning powers constrain and delimit the changes in the forms of cities that will be required in the coming years to ensure that they remain productive, inclusive, and sustainable. It argues that the effective management of the coming disruptions now require a shift of power from the private and the local to the metropolitan and the regional.

Keywords
arterial roads; conservation; eminent domain; metropolitan labor markets; Nimbyism; property rights; public works; smart cities; urban form; urban renewal

Issue
This commentary is part of the issue "Urban Forms and Future Cities", edited by Luca D'Acci (Erasmus University Rotterdam, The Netherlands), Tigran Haas (KTH Royal Institute of Technology, Sweden) and Ronita Bardhan (Indian Institute of Technology Bombay, India)

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The forms of the cities of the future will be dictated by their past. Once streets and plot boundaries are laid out, they are very difficult to change. They are difficult to change because they demarcate and enshrine property rights.

When we look at the three-dimensional forms of cities we typically fail to see the underlying cadastral maps that chart the boundaries of individual plots. These invisible boundaries come to the fore only in times of change.

After the Great London Fire of 1666, Sir Christopher Wren quickly presented King Charles II a plan for rebuilding the city with modern street grids, wide avenues with open vistas, and public squares (see Figure 1).

But the King, fearful of an uprising, was reluctant to assume the power to confiscate the lands needed to implement the plans. The city was quickly rebuilt along the old property lines.

Whether it is the 1666 fire that destroyed London or the 2005 Hurricane Katrina that destroyed New Orleans, even great natural disasters cannot erase the old property boundaries that frustrate grand designs.

The property boundaries underlying our contemporary cities provide great protection for many and great barriers for many others. The future form of cities is entangled with our rather limited ability to change property boundaries.

Michael Heller's path-breaking book, *The Gridlock Economy* (2008), explores the consequences of allocating too many property rights to too many people. Too many property rights make it difficult, if not impossible, to change urban form.

Too many property rights make it difficult to widen streets; too many property rights make it difficult to straighten rail tracks so that trains can run faster; too many property rights make it difficult to assemble land for airport runways.

Most constitutions enshrine the right of government to acquire private property for public use with the payment of just compensation through what has come to be called 'eminent domain'. But eminent domain has proved to be quite cumbersome.

Surely, the application of eminent domain to the acquisition of lands for roads, railways, or other forms of public infrastructure such as ports, canals, or electrical grids, makes complete sense. Such lands could not be assembled otherwise.

Using eminent domain as a tool for changing urban form by assembling lands from private property owners and then giving it away to other private property owners

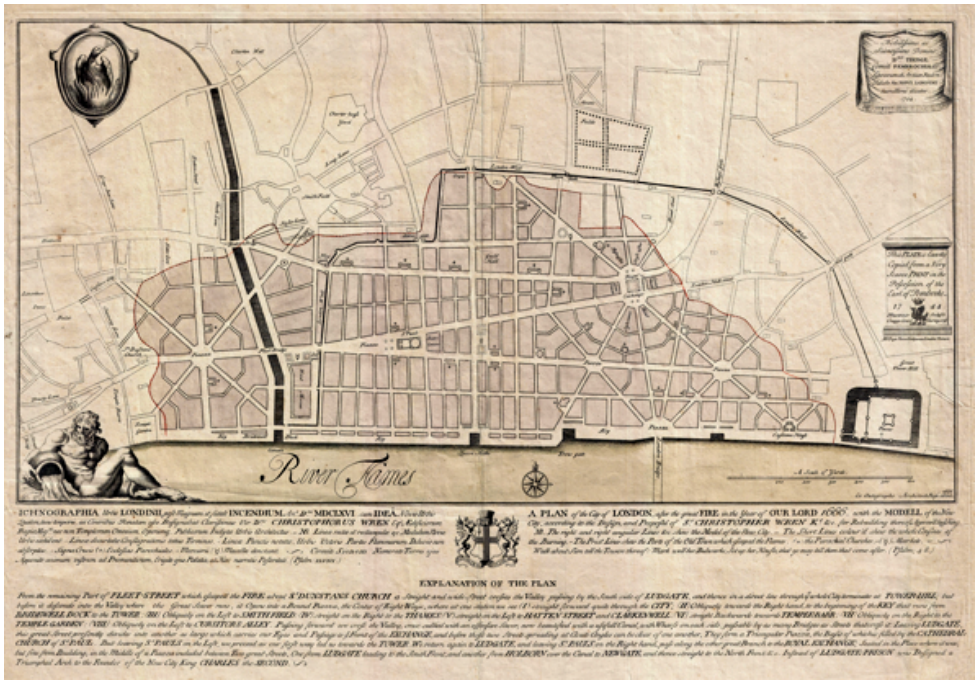

Figure 1. Sir Christopher Wren's plan, never realized, for rebuilding London after the Great Fire of 1666 (plan dated 1744).

is more problematic. In the U.S. it has led to a backlash against eminent domain.

Governments have also applied their eminent domain powers unconscionably for slum clearance, typically in the name of hygiene or crime prevention and most often to displace the poor by the not so poor. This practice must stop.

The settlements of the poor must be upgraded *in situ*, for the benefit of sitting residents, not to get rid of them. Attempts by great visionaries, like Le Corbusier, to clear the Left Bank in Paris and replace it by "towers in the park" must be resisted.

Still, in countries like China, where land ownership has been nationalized, acquiring land for infrastructure projects or clearing lands for large redevelopment projects by private interests is much easier than in countries like the U.S. or India.

This gives China an enormous advantage over the U.S. or India in executing large projects that require the assembly of large numbers of small plots, especially highways—and in the case of Chinese cities, ring roads—and new rail lines.

This advantage is translated into an economic advantage. Chinese cities, with twenty-first century infrastructure, can and will better compete in the global marketplace; Indian cities are falling behind and are unlikely to ever catch up.

Some large private projects, like college campuses, industrial parks, stadiums, or shopping malls have merit, but large projects, almost without exception are difficult to integrate to the existing fabric of cities and often remain "white elephants".

That said, the resistance of private property owners and local communities to allow for projects that may benefit larger metropolitan areas at their expense, no matter the compensation offered, limits future (and necessary) changes in urban form.

The cities of the future must be gradually renovated, or destroyed and rebuilt, as their economies and their cultures change. Living cities must remain responsive to the ever-changing needs, requirements, and preferences of their inhabitants.

Recent concerns with quality of life or with climate change have obscured the basic raison d'être of cities—their productivity, an inclusive productivity that is, to an important extent, a function of their size.

Other things being equal, larger metropolitan areas are more productive than smaller ones. Their economies are more resilient and more efficient but, most of all, their advantages stem from their larger, integrated metropolitan labor markets.

In large, integrated labor markets, all workers have access to all jobs. Workers are able to find the best jobs and workplaces are able to find the best workers. That is why larger labor markets are more productive than smaller ones.

Jobs in U.S. cities have already decentralized. Only one-eighth of jobs are in Central Business districts and only one-eighth of jobs are in employment sub-centers. The rest are dispersed. Cities in other countries are likely to follow suit.

Fixed rail public transit or fixed route bus lines are not capable of serving commuters when both residences and workplaces are dispersed throughout metropolitan areas. We should not fixate on fixed route mass transit.

Commuters will need to continue to rely on door-to-door transport. The cities of the future may benefit from a new generation of driverless cars that use limited

road space more efficiently and do not contribute to climate change.

Only one in twelve workers in U.S. metropolitan areas walks or bicycles to work. The rest take advantage of the entire metropolitan job market and travel quite far, but not too far, to their jobs (Figure 2). This pattern is not likely to change.

For large cities to have efficient labor markets, commuters need to traverse the city easily in all directions. Therefore, cities must have efficient networks of arterial roads or arterial railway systems that span their entire urban extents.

Think of the arterial road networks of cities, or more generally, the arterial infrastructure of cities—the main transport arteries, the main water, sewer and drainage arteries—as the glue that binds them together.

The evolution of a metropolitan network of arterial roads—wide roads that can carry public transport, and possibly bus rapid transport, trams, or light rail as well—requires powers that are usually out of reach of typical municipal authorities.

The jurisdiction for a metropolitan transportation network is typically fragmented among smaller municipalities, making it almost impossible to plan for it, let alone overcome the resistance of property owners to implementing it on the ground.

Metropolitan areas that can put in place transport systems that make it possible for all workers to reach all jobs within a tolerable time—say 30 to 60 minutes—will have stronger, more productive and more inclusive economies.

Those that fail to do that will have weaker, less productive, and less inclusive economies. Those that favor localism of one kind or another rather than "metropolitanism" of one kind or another, will have to suffer the consequences.

And the kind of metropolitanism required is one that favors longer commutes to shorter ones, one that sees the metropolitan area as a whole as a single economic unit, not as a patchwork of utopian and unrealistic live-work communities.

Small autarchic live-work communities are a thing of the past. Localism must give way to metropolitanism, and that can only happen when metropolitan power is strengthened at the expense of local power.

Otherwise, flourishing and self-righteous Nimbyism (Not In My Back Yard politics) of one kind or another will be able to prevent urban economies from staying competitive, productive, and inclusive by gradually evolving their forms.

The cities of the future may now need a new generation of Haussmann and Robert Moses types that can plan and implement large urban projects, carefully compromising local interests in the interest of metropolitan ones.

A new generation of large urban projects must be more sensitive and more reasonable, engaging in more modern forms of urban surgery than those of old, and respecting and giving voice, yet not surrendering, to local interests.

We need to re-envision the public good and we need to do it quickly. If the future power struggles to overcome the local resistance of the few for the greater benefit of the many are lost, again and again, we as a public will suffer the consequences.

The bright new "smart cities" planned and built at great expense from scratch at the edge of African cities, for example, far from the maddening crowd, are only expensive distractions. They reject existing cities, shying away from repairing them.

Large parts of cities need to be recycled and repaired—renovated or torn down and rebuilt anew—

Figure 2. Los Angeles (left) and Atlanta (right) are integrated metropolitan labor markets: People live everywhere and work everywhere. Source: Angel & Blei, 2016.

for these cities to survive the coming economic, technological, social and cultural changes that are already becoming apparent.

The densification of cities, particularly the cities in more developed countries, is a key component of the urban agenda to address climate change. It too will require substantial recycling of urban neighborhoods.

Some parts of cities, their traditional neighborhoods in particular, can be retrofitted and improved, little by little, by upgrading their infrastructure and by sensitively increasing their densities along historical property lines.

That said, conservation and preservation have their limits too. Surely, the Chinese have gone too far in destroying the last vestiges of their traditional urban neighborhoods, let alone the ancient temples of their illustrious past.

More of them should have been preserved. We need old buildings to remind us of our past, to tie us down to our past. But those can be few and far between. In a large metropolitan area, they can number in the thousands, but not more.

The rest need to be transformed again and again and they do not need any special protection from their coming destruction or renovation. The great majority of buildings can be torn down and rebuilt as they have been in the past.

This process of recycling buildings, let alone entire neighborhoods, is disruptive. Disruption is indeed the essence of urban renewal, restoration, and revival. And it needs to be done right, with proper respect to sitting residents.

Its burden must be shared. Surely, it need not favor some at the expense of others. But disruption in cities is always local and, being local, it will always hurt specific places and particular people and leave others untouched.

All urban interventions that are aimed at improving the metropolitan area as a whole are local, so the few will and must suffer for the benefit of the many. That is a reality that must be confronted, again with the minimum pain possible.

A dollar lost, we already know, has a greater value than a dollar earned. There must be ways of compensating local residents correctly, but that said, a few property owners should not be able to stop an entire public from improving its lot.

In fact, communities and cities at large can benefit from a rule that says that if a supermajority agrees to a real estate deal, the rest must go along. Eminent domain need not resort to such a rule, but private developments should resort to it.

There should be a clear separation between public projects that require eminent domain for their correct implementation—roadways are a typical example—and private projects that can choose between different locations.

Hospitals or college campuses, like residential developments or industrial estates, are private (or private-like) projects that can choose between different locations. Not so roads, rail lines, canals, or ports that must resort to eminent domain.

Such private or private-like developments should negotiate directly with locals, arrive at a reasonable deal with local representatives, and if such a deal is acceptable to a supermajority of locals, the rest should be mandated to go along.

This rule is already operational in some places—urban renewal projects in Israel are a good example—but needs to be accepted in many other places for cities to be able to accelerate their recycling processes in the future.

Zoning rules that have been promulgated to protect property values, not in the interest of health or safety, but in the interest of social or economic exclusion, should also be upended to accelerate the recycling of cities to meet new needs.

That said, the need to recycle cities is unlikely to be distributed evenly across world regions. It will need to be more pronounced in cities in more developed countries where urban population growth in future decades will be at a standstill.

Between 2015 and 2050, the urban population in more developed countries will only grow by 120 million. For every new urban resident in more developed countries, there will be 19 new urban residents in less developed ones.

Urbanization in the coming decades, understood as a growing share of the population residing in cities, will be largely an issue limited to less developed countries.

Cities in less developed countries will, on average, more than triple their land area between 2015 and 2050, while the land area in more developed countries is unlikely to double.

Cities that are going to triple or quadruple their land areas can plan for their orderly expansion by ensuring that lands converted to urban use contain arterial infrastructure grids and that future public open spaces are duly protected.

They can also adopt rules that ensure that all lands converted from rural to urban use reserve a third to forty percent of the land for streets, arterial roads, and public open spaces.

They can also adopt rules that minimize the size of city blocks while increasing four-way intersections, as well as rules that remove setbacks and allow buildings to reach their front property lines to facilitate the formation of streetscapes.

The key to improving future form of cities, especially cities that will need to house large numbers of poor people in less developed countries, is laying out streets in small blocks now, before development takes place.

Comás, a squatter invasion on the outskirts of Lima was laid out in the 1960s by engineering student volunteers before it was occupied. It is now one of the most desirable residential neighborhoods in Lima (Figure 3).

The forms of the cities of the future, especially those in less developed countries, can be determined, in large

Figure 3. The streets in the Comás squatter community in Lima, Peru, are 10-meters-wide and take up 25% of the area. A 160m^2 house there now costs $180,000. Source: Google Earth.

part, by acquiring the rights-of-way for arterial road grids now, by laying out streets now, and by acquiring lands for public open spaces now.

That said, the forms of the cities of the future will not be determined by grand designs but by a few public actions and a simple public regulatory regime that "set boundaries and provide support while relinquishing control".

Most of the designs that will determine the future forms of cities will be provided by market agents of one kind or another—be they households, firms, or civic actors—but these agents by themselves do not cities make.

There is an important role for all of us citizens, acting as a public, to lay out the infrastructure of cities—its public works—in advance, before any market agent can design, build, and thrive.

Evidence from the *Atlas of Urban Expansion—2016 Edition* (Angel, Lamson-Hall, Madrid, Blei, & Parent, 2016) confirms we are still failing to make this happen: areas built after 1990 are more chaotic, less planned, and have less land for public works than before.

This will not do. For the cities of the future to be more productive, more inclusive, more sustainable, and more resilient, they need their public works, and they need them in place before real estate markets can thrive and flourish.

The form of the cities of the future, to the extent that we can envision it, will be determined, first and foremost, by public actions, pragmatic actions that can organize property rights, and that can finance and layout public works.

Neither the actions of the free market, nor utopian grand designs, can make that happen. Only a pragmatic approach to city building can, one that recognizes and harnesses the forces that propel cities into existence and let them thrive.

References

Angel, S., & Blei, A. M. (2016). The productivity of American cities: How densification, relocation, and greater mobility sustain the productive advantage of larger U.S. metropolitan labor markets. *Cities*, *51*, 36–51.

Angel, S., Lamson-Hall, P., Madrid, M., Blei, A. M., & Parent, J. (2016). *Atlas of urban expansion—2016 edition, volume 2: Blocks and roads*. New York, Nairobi, Cambridge, MA: New York University, UN-Habitat, Lincoln Institute of Land Policy.

Heller, M. (2008). *The gridlock economy: How too much ownership wrecks markets, stops innovation, and costs lives*. New York: Basic Books.

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Article

‘Resources to Needs’: A Paradigm for Addressing the Potentiality of the Urban Volume

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Abstract
Underground resources are often addressed only out of necessity, leading to conflicts between uses and missing opportunities for productive synergies. The Deep City project is exploring a paradigm of ‘resources to needs’, which considers resource potentials prior to specific urban projects or plans. Mapping is central to the project and has been explored in several cities around the world. The ‘resources to needs’ paradigm, however, has received little theoretical or philosophical attention. To think resources before needs challenges common urban normative models and the process-oriented thinking of mechanical and ecological paradigms popular today. Where current methods for mapping the underground tend to enroll elements in a particular performance or resource use, Deep City seeks to facilitate an intermediate stage in which resource potentials can coexist without any pre-existing interaction or relationship. To think about the urban volume this way, this article works with the informational motor proposed by French philosopher Michel Serres. The logics of substitution and circulation of the map and its contents helps to think an alternative form of mapping in which the map itself becomes a reservoir of potentiality for thinking the urban volume less in terms of predefined functions and processes than a mass to be collectively cultivated.

Keywords
city models; contingency; information theory; mapping; Michel Serres; potentiality; underground resources; urban underground

Issue
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1. Introduction: The Deep City Project

Urban planning and theory has historically treated the mass of the underground as a support or infrastructural system for life on the surface. In practice, the development of the subsurface has responded to the pressing needs of the urbanization of the surface. This approach of exploiting resources out of necessity has led to problems like ground subsidence from uncoordinated aquifer management and building construction in the cities of Paris and Mexico City (Blunier, 2009; Ortiz-Zamora & Ortega-Guerrero, 2010). The uses of the underground are often managed separately by departments and disciplines that rarely develop common strategies addressing the multiple uses, opportunities and risks of the underground. The Deep City project at the École Polytechnique Fédérale de Lausanne in Switzerland was founded by an interdisciplinary team in 2005 to explore an alternative approach to underground resources, which is sustainable and resilient in its ability to address the multiple uses—excavation for underground space, geomaterials for building materials, groundwater for drinking or irrigation and geothermal energy (Parriaux, Tacher, & Joliquin, 2004). The team has called the paradigm ‘resources to needs’ (*ressources aux besoins*), which promotes a long-term reflection on the potential of the resources and

the interactions between them prior to orienting their use around a specific need or project (Parriaux, Blunier, Maire, Dekkil, & Tacher, 2010).

The core objective of the Deep City project has been to develop a mapping method that evaluates the suitability of the geology of an urban area using expert opinion and empirical evidence. The method has been tested and refined on a variety of case studies from Geneva (Blunier, 2009) to Suzhou (H. Li, Li, Parriaux, & Thalmann, 2013), San Antonio, Texas, Hong Kong, China, and Dakar, Senegal (Doyle, 2016b). While the methodology has moved forward, the Deep City project has given no additional attention to the 'resources to needs' paradigm it promotes. The theoretical framework drew initially on systems theory (notably that of Le Moigne, 1977), which has aided in developing methods for evaluating individual resource suitability, but requires a return to needs when combining the resources in a single map. The case studies of San Antonio (Doyle et al., 2016) and Dakar (Doyle, 2016b) test an alternative combination strategy that addresses the resources not as predefined interacting elements but as mixtures of potential whose uses have yet to be oriented towards any particular need. However, the theoretical and philosophical reflection underlying this strategy has yet to be explored in depth.

This article explores the resources to needs paradigm of the Deep City project, looking at the map as the key object around which a conversation on the potential of the urban volume can revolve. Mapping of the underground resources tends to be limited by the normative city models it consciously or unconsciously adopts and the processes it considers invariant. The normative models of the city of faith, city as a machine, and the ecological city (Shane, 2005) continue to condition the way in which the underground is addressed by urban planning and mapping. The mechanisms upon which these models operate can be understood as motors, particularly the vectorial motor of mechanical transport and the transformational motor born from thermodynamics. Increasingly popular theories today, notably actor-network (Latour, 2005) and assemblage theory (De Landa, 2006), adhere to these two motors. French philosopher Michel Serres proposes a third motor, the informational motor, founded notably on the work of physicist and information theorist Léon Brillouin (Brillouin, 1962/2013; Serres, 1977).

The article will begin by discussing the first two motors according to Serres and their roles in urban normative models before turning in the second section to the informational motor and its alternative logic of substitution and circulation. Then, the urban volume will be defined as an economy of communication, founded upon avoidance and encounter between not just people, but also the urban form and its underlying geology. Finally, the article will return to the resources to needs paradigm, examining how it seeks to address mass prior to its differentiation as matter. The map is described not as a passive representation of underground potential, but as a compass with directionality without direction—potentiality without prescription.

2. Motors and Models: Transport and Transformation in Urban Models

Normative models address a single or limited number of dynamics. Michel Serres addresses these dynamics as drivers or motors, of which there are three (Serres, 1977). The first is vectorial; the second is transformational. The vectorial motor is a machine, a transfer of forces. It transports. Its central concern is movement, a movement in a reversible time. From home to work, to the grocery, back home—eternal return. It is epistemic, viewed from a single point. The second motor was born with the thermodynamics of Carnot—from a difference in temperature comes a change in state. It is an apparatus, a system. It is no longer about the movement of single elements, but the flow of the mass. From difference comes transformation. It is diastemic, an irreversible change between states.

Each motor needs a reservoir, which precedes the cycle and the circulation. It is an invariance. In the 1970s, biologist Jacques Monod concluded by looking at cellular reproduction that this invariance *precedes* necessity. The work to avoid the dissolution of a system or organism originates in a chance event. As the event repeats, the structure of the system evolves and stabilizes around a new state, with no other 'goal' than the fight against a lasting, irreversible (thermodynamic) death. The repetition of the event (of the invariance) requires a transfer or preservation of information that can be constantly read back. Monod observed that the transfer of this information was never perfect (leading either to the evolution or collapse of the system) and concluded, looking at the work of French physicist Léon Brillouin, that such a perfect transfer was physically and statistically impossible. The fact that a system (or organism) maintains its structure—that is, to transfer information with only minimal loss—is so highly improbable that in fact all beings should be regarded as the result of high improbability—as 'strange objects'.[1] For Monod, the ultimate reservoir is chance (Monod, 1972).

The reservoir is the beginning of the chain, the *arche*. This sense is captured in the architectural notion of architectonics. However, where for architectural theory the origin (or *arche*) can be identified[2], this is not the case for Monod nor for Brillouin, for whom the source and origin of invariance is forever out of reach. Serres borrows from the architectonic model of Roman architect Vitru-

[1] See Monod, 1972, Chapter 1, entitled "On Strange Objects".

[2] Daniel Payot (1982), for instance, understands the arche in architectonics as an immediate source of authority ["*le commencement et l'autorité sans distance*" (p. 58)], where Serres addresses, from his reading of Monod and Brillouin, as a cipher, whose original meaning has been lost in the mechanisms of reproduction. These latter can be understood as the tekton in architectonics, which for the roman architect Vitruvius is the site of articulation of the arche ["*la scène où joue l'archè*" (p. 65)].

vius, the concepts of the *ichnographia*, *skenographia*, and *orthographia*, in exploring the dynamics of the three motors in relation to the work of Monod, Brillouin and information theory (Bühlmann, 2016a). The reservoir is the ichnography, void of project like footprints in the sand whose origin has been partially erased by time and tides.[3] The ichnography is informational entropy—a mass of information with no meaning or value. The motors that draw from the ichnography generate *scenographies*, particular viewpoints (*episteme*).[4] The scenography can be understood as a message intuited from the noise—the path detailed by Brillouin from information to negentropy (or information to which meaning has been ascribed) and back.

A tension exists between ichnography and scenography that is synonymous to the one between the footprints left in the sand (the material trace or *graphein*) and the attempts to tell their story in language (*logos*).[5] The orthography can be understood as that which encodes traces of the 'original' noise (the entropy or ichnography) but which does not adhere to any single scenography (negentropy). For Monod, this orthography would be the genetic code, which carries the traces of past invariances. For Brillouin, it is the informational fringe that accompanies any message and precludes the possibility of a single interpretation. Serres devotes his *Foundations* series (*Rome*, *Statues* and *Les origines de la géométrie*) to the orthography in the recurring figure of Hestia, as that which stands in (as a statue, gnomon or victim) for a multiplicity of scenographies, and where the two faces of information, knowledge (negentropy) and ignorance (entropy), mingle.[6]

Urban theories of city form tend to reflect a model or scenography. Drawing on a history of normative models and theories, from Sebastiano Serlio to Kevin Lynch and Spiro Kostof, urbanist David Grahame Shane identifies three recurring models: the city of faith, the city as a machine and the ecological city (Shane, 2005). The city of faith organizes its form around a ceremonial center. Its geometry draws on the divine as source of meaning and direction on earth (its *arche*). Its motor mediates and transports the values or norms of a society. The divine constitutes a reservoir from which a cosmological scenography is drawn by a unidirectional motor. Even if the city of faith is still very present in evolving notions of the divine,[7] the city as a machine remains the dominant normative model of our era. Where the city of faith is centered on stability, the city as a machine is a system of flows to be rationalized and programmed. Functions are separated following a logic of optimization and linked by communication networks separating different forms of transport. The reservoirs of the vectorial motor are multiplied and linked by movement networks. Activities are distributed in accordance with particular reservoirs, not only in terms of distance for movement but also within an overall balance between points of production, extraction and exchange.[8]

The ecological model addresses the city as an organism, where urban actors "struggle to maintain a delicate, 'organic' balance" (Shane, 2005). Borrowing from cybernetics and 19th century thermodynamics, the city is viewed as an organism whose metabolism drives towards "balanced flows of energy and materials between the human and natural subsystems of the material realm" (Moffatt & Kohler, 2008, p. 249). Its reservoir's driving force (*puissance motrice*) is the natural world, perceived as a benevolent force balancing destructive and conservative forces (Cuddington, 2001). This balancing force has often been perceived as synonymous with mathematical equilibrium, which addresses a system's *puissance motrice* as equations of inputs and outputs and resembles the flow and movement-oriented approach of the city as machine. Challenging this approach, 'the new ecology' underlines the importance of non-equilibrium in the balance of nature (Pickett, Cadenasso, & Grove, 2004). Rather than operate purely upon flows of certain quantities of matter, this approach focuses on the processes and performances of natural and human elements in an ecosystem. Everything, however, has a role and plays a part. Relationships that are considered unnecessary are excluded from the system.

3. The Urban Underground in Normative Models and Current Mapping Methods

The underground appears differently in each of these models. The city of faith sees the underground as a place of death or rebirth and purification. It is for the most part excluded from the city (which is oriented towards the heavens) or limited to ritual acts. As the main reservoir (the ultimate arche) is the ceremonial center, tied to otherworldliness, the underground is addressed according to local myth and practice (Shane, 2005). With increasing industrialization, the earth's subsurface was subjected to a mechanical logic of reservoirs from which resources were extracted for transport and transforma-

[3] The word ichnography (*ichnographia*) is composed of the Greek for footprint (*ichnos*) and trace (*graphein*), see (Serres, 1982).

[4] *Scenographia*: from the Greek *skene* for the stage, later taken up by Vitruvius to mean a viewpoint of a building.

[5] In his reading of the roman poet Lucretius's *De Rerum Natura* (*On the Nature of Things*), Serres argues that from the point of view of an atomist physics the ichnography is the chaos cloud with no direction (in French, sens) or meaning (also sens in French, an important double meaning for Serres). This is how scenography can be linked back to the material world and not limited to a logos of human origin.

[6] See, for instance, *Rome* (1983/2015, Chapter 2, The City of Alba), *Statues* (1987/2015, Chapter 11, The Statue of Hestia) and *Les origines de la géométrie* (1993, p. 138, Hestia et l'épistémè).

[7] Shane (2005) associates the work of economists Von Thünen (ca. 1826), Weber (ca. 1929) and Alonso (ca. 1964) with the continuation by other symbolic means of this dominant center as a reservoir of wealth through economic exchange of goods produced and sourced from the hinterland. The 'central business district' is a recognizable symbol of the modern relationship to this 'ceremonial' center. For more information on Von Thünen, Weber and Alonso, see also Portugali (2011).

[8] Shane situates the Central Place Theory of economists Walter Christaller and Albert Lösch within the city as machine normative model.

tion.[9] This logic recalls the spatial relationships explored by early location theory (e.g. Von Thünen and Alonso) of extraction, transformation and distribution to the local market.[10] The earliest and most well-known reflection on the underground in an urban context is the *Rue future* of the Parisian engineer Eugène Hénard (Figure 1), which is one of the best examples of both the city as machine normative model and the tendency at the turn of the 20th century to see the city as a unified system (Shane, 2005; Williams, 1990/2008).

With extension of urbanization to the planetary scale (Brenner & Schmid, 2015), the underground is but one layer of all 'altitudes of urbanization' (Bélanger, 2016). The emphasis by the ecological model on process and performance means that the underground is included where its role is evident—where it has already become meaningful or organized information (negentropy) and is perceived as necessary. It is sometimes labelled in this context as an ecosystemic or infrastructural 'service' (Bobylev, 2009; Bobylev & Sterling, 2016). Alternatively,

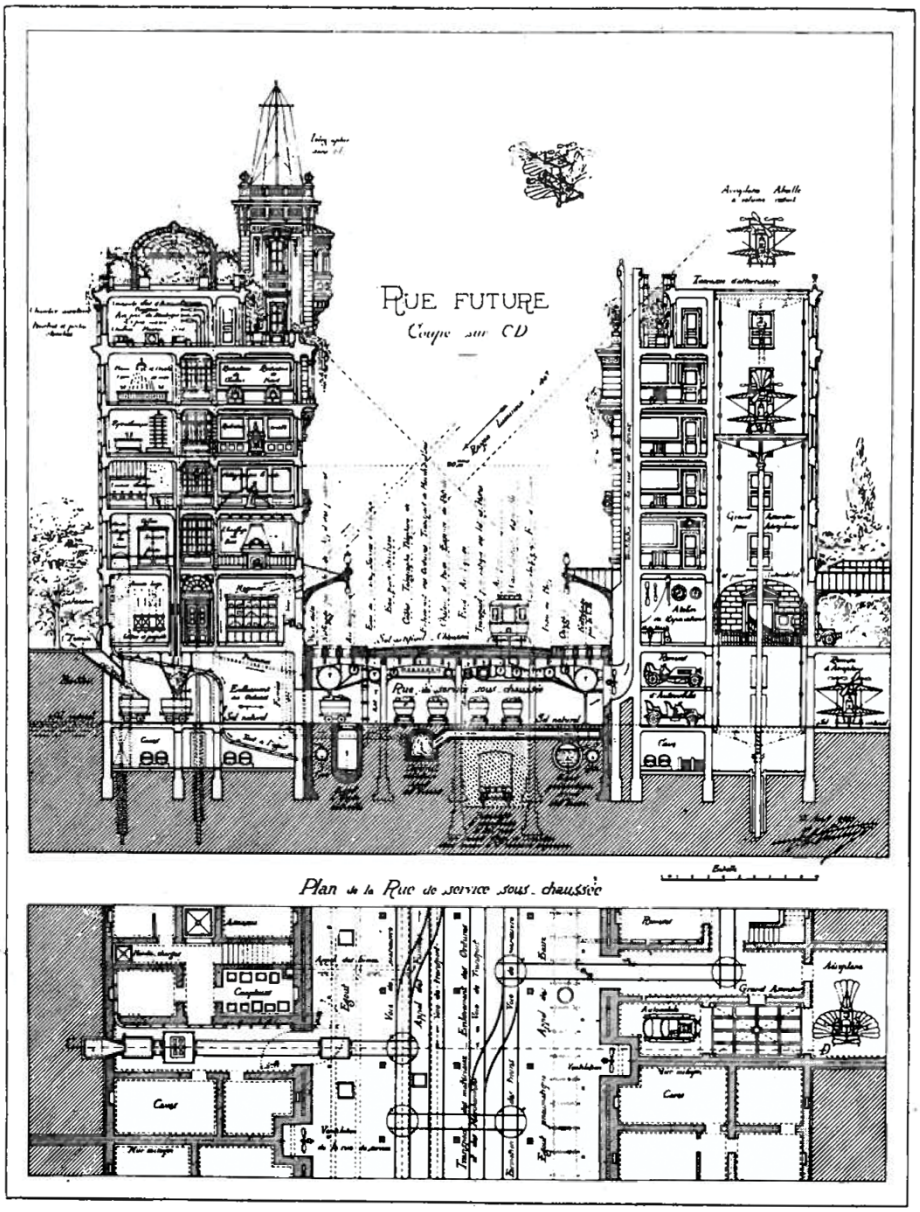

Figure 1. Eugène Hénard's *Rue Future* (future street) integrating the underground into a mechanical rationalization of flows of materials and people (Hénard, 1903/1982, p. 351).

[9] The scientific exploration of the earth's crust did not immediately eclipse the mythical dimension of the underground. With the birth of geological investigations in the 19th century, the earth's crust was equated with a deep time, or an archive of the earth's history. Many people thought geology would turn up the remains of the original sinners having died in the Biblical flood. The bodies that were found, however, did more to support Darwin's theory of evolution. The bodies of extinct species of animals inspired many of the fantastical adventure stories we recognize in the works of Jules Verne (Williams, 1990/2008).

[10] For illustrations and mathematical descriptions, see Portugali (2011).

it is an antagonistic (or 'sacred') force to be avoided and left alone—a source of uncertainty (entropic information) in the construction and planning process. Projects incorporating the underground tend to be oriented towards a single or limited set of pre-defined processes. By placing teleology and necessity at the fore (contra Monod), the ecological model adopts an essentialist approach to the role of function in nature. In this light, Bélanger's illustration of the altitudes of urbanization (Figure 2) could be misconstrued as a detailed account of all possibilities for the urban volume. It is, in fact, only one scenography of the ichnography.

Recent mapping techniques adopt different strategies for providing meaningful information on the underground. Of relevance is the way these strategies identify evaluation criteria and combine them proportionally in the map. The Helsinki and Hong Kong masterplans are both mandated and funded by public entities (Vähäaho, 2009; Wallace, Roberts, & Lau, 2014). Underground potential is understood as suitability for built space and is based principally on the geological conditions of the city. In both examples, the relationship between the criteria, leading to the identification of zones of high potential (which are further classified in Hong Kong's masterplan), are decided upon by the practitioners (geologists or geotechnical engineers) mandated by public entities. The difficulty of rigorously combining multiple criteria is addressed in the methods adopted in the Chinese case studies of Changzhou, Qingdao and Suzhou (H. Li et al., 2013; Peng, Wang, & Peng, 2014; Zhao, Peng, Wang, Zhang, & Jiang, 2016) using the Analytic Hierarchy Process (AHP) (Saaty, 1980). The AHP's use of pairwise comparisons situates the evaluation criteria on the continuous scale, as opposed to the methods adopted by Helsinki and Hong Kong where expert knowledge places criteria on an ordinal scale.[11]

For these recent projects, the maps provide valuable information on the territory-wide geological potential for buildable space. Communicating the suitability for construction is the main message and other information (not included in the evaluation of potential) is removed for legibility, notably the current distribution of urban form or of activities. Other resources (geomaterials, groundwater or geothermal energy) are absent or are included as limiting factors for the space potential. Even Deep City, in its evaluation of underground potential in Suzhou, orients the calculation of potential towards a single resource (space), incorporating groundwater and geomaterials as limiting factors on space potential (see especially X. Li et al., 2016). Although the information presented by these maps is undoubtedly valuable for the planning process, it remains oriented towards a pressing need for underground space. In this context, the map remains monofunctional—viewed from a single point (scenographic) and single need. The challenge for the resources to needs paradigm promoted by Deep City is the map's ability to provide information that could have meaning, but has not yet been given any value. To explore this further, and to argue for the map as an orthography, the next section will look at Serres's third—informational—motor.

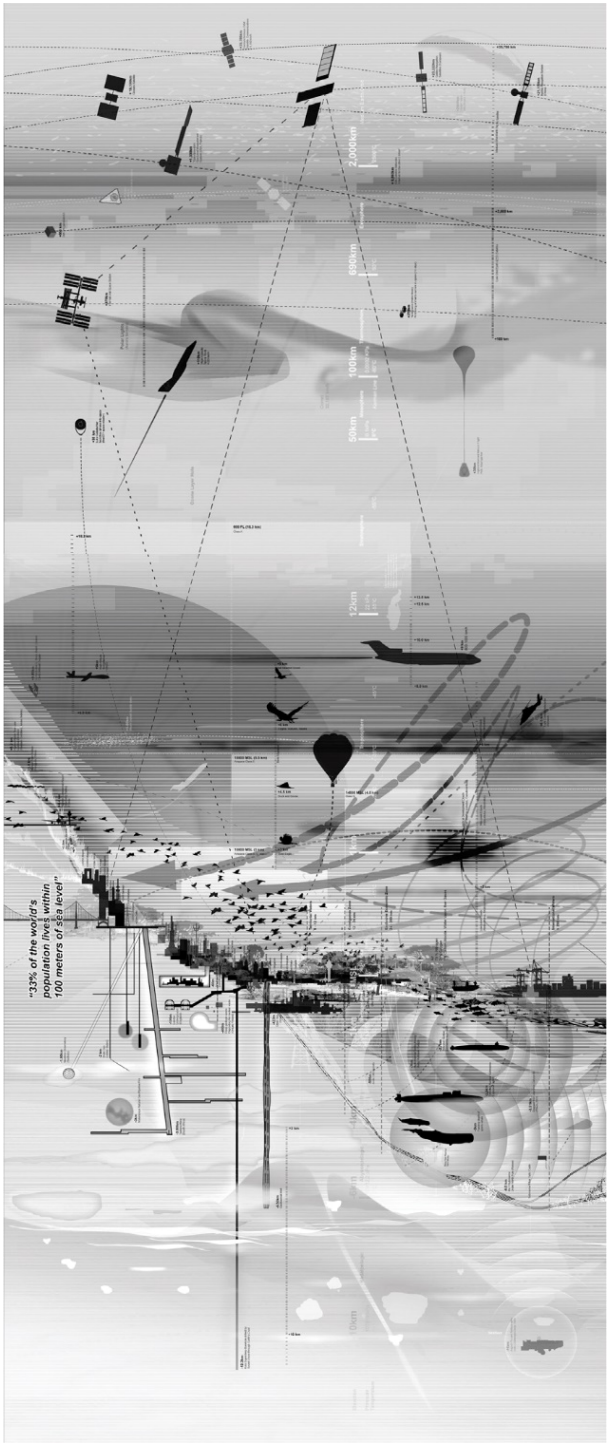

Figure 2. 'Altitudes of Urbanization' captures the many uses observed today in the urban volume, but it would be a mistake to presume that this is an exhaustive account of what the volume could be (Bélanger, 2016, p. 6).

[11] Lu, Wu, Zhuang, & Rabczuk (2016) demonstrate in a recent paper how the evaluation of geological suitability using the AHP can be further specified by applying membership functions borrowed from fuzzy set theory to the continuous-scale data.

4. The Informational Motor: Substitution and Circulation

Serres's informational motor addresses the dynamics of information-processing established by Brillouin, from noise (entropy) to message (negentropy) and back to noise. If the first generation of motors transports and the second transforms, the third codes (Serres, 1977). It combines the flow of messages with the place-holding, substitutive, roles of markers. Where systems thinking and cybernetics establish fixed roles and relationships between predefined elements, Serres seeks instead a systematization of that which has no (or no recognized) place in the system.[12] He is attempting to account for the noise that accompanies every message, to not sacrifice the residual entropy for the sake of a single form of negentropy. Serres views the act of harnessing residual entropy as similar to the role of the parasite, which in French is also the word used for noise on a channel. The parasite is responsible for the bifurcations of mass and meaning (in French, a change in meaning, *sens*, is also a change in direction, *sens*) and the contingent introduction of a new meaning to information (producing negentropy in the system) (Serres, 1980/1982). Per Monod, this new information as negentropy has the potential to lead to system collapse ('death') or evolution ('rebirth').

The probable state of a system is therefore not equilibrium, as it would have been for 19th century physical and statistical thermodynamics (the transformational motor), but rather its dissolution and thermodynamic death (Brillouin, 1962/2013). This is the view of equilibrium that is found in non-equilibrium versions of ecology where systems are open (Pickett et al., 2004). For this latter, the open system imports energy or information that it needs and ejects as waste that which it cannot use. The system is evolving to avoid death rather than simply returning to a stable state, in accordance with the second law of thermodynamics. As Brillouin argues, however, this work comes with a cost. The first and second motors try to balance the ledgers, thinking that information can be acquired for free—that it only has value and no cost. The acquisition of knowledge (e.g. measurement) converts entropy into negentropy, but that conversion process releases entropy, or noise.[13] In exchange for knowledge comes ignorance.[14]

The informational motor accounts for this ignorance by addressing entities in the world (from the living to the nonliving, the natural to the artificial) as black boxes. Black boxes have no identifiable origin, meaning that their *arche* remains out of reach. Like fading footprints in the sand, only the material trace, the ichnography is left. Rather than attempt to propose a single, mechanical or thermodynamic model (as the vectorial and transformational motors), the informational motor recognizes that there is no model better than the 'thing itself'. The attempt to make sense of the ichnography produces multiple models (points of view or scenographies) and the informational motor attempts to account for the multiplicity of these by embracing the entropic, the as-yet-meaningless or senseless information (Serres, 1977/2000). Scholarly investigation tries to make sense of the city as a black box. From meaningless information (undifferentiated masses), the crowd, community is formed, insiders differentiated from outsiders. Mass is articulated into buildings, streets, squares. Sometimes these acts of articulation and differentiation occur by chance and seem to share no common origin.[15] Other times, particularly when a single point of view (scenography) is adopted, they are subjected to normative models, imposing an observed or ideal order. Articulation comes with a price—every act of deviation, bifurcation or differentiation of the mass is paid for in the entropy generated by determination. Determination generates indeterminacy (as entropy or the loss of information).

5. Informational Motors of the Urban: Economies of Communication

The city, as a black box, is constituted by many hidden agencies. The inadequacy of normative models is their tendency to adjudicate for a limited number of agencies. In response to the weakness and relative inflexibility of the normative models of the city of faith, the city as machine and the ecological city, urban theory departed from holistic models and sought to identify the basic elements comprising the city. Referring to the work of Lynch (1960), Rowe and Koetter (1978) and Paola Viganò (1999), Shane (2005) identifies three main elements that have pervaded elementary thinking: the enclave, the armature and the heterotopia. These elements can be understood as the main agencies of the city as an *oikonomia* working on the mass of the urban volume. The logics of their combination establish a lawfulness (*nomos*). The enclave is an element of centralization and concentration, like squares, places, bounded spaces. Its perimeter is often controlled by rules, guardians or walls. The armature is a sorting device, linking the enclaves and organizing the relationships between them. The classic examples are streets, arcades, interior corridors and skyscrapers (vertical armatures). The hetero-

[12] "Le problème posé ne serait pas un problème logique, celui de la construction d'un système, mais d'un problème plus général: celui du systématisme d'un grand nombre de systèmes possibles. Peut-on passer de ces nouvelles scénographies à l'ichnographie?" [The problem is not a logical one of the construction of a system, but a more general problem of the systematism of a large number of possible systems. Can we move from these new scenographies to the ichnography?, author's translation] (Serres, 1990, p. 16).

[13] Even if that cost is a quantum of light, as he argues when working through the ability of Maxwell's demon to "freely" move electrons from one heated chamber to another, in contradiction to the second law of thermodynamics which postulates that systems move towards entropy or molecular disorder (Brillouin, 1962/2013).

[14] Literally, it is a "lack of information about the system" and a "disorder in the hidden degrees of freedom" (Brillouin, 1962/2013, Chapter 12).

[15] In *Rome*, Serres (1983/2015) is fascinated by Roman historian Titus Livius's account of the history of Rome and his tendency to recount not one, but many foundational moments. Rome, less so than Athens or Jerusalem, is a city born of contingency and multiple, often hidden or mythical, origins.

topia, borrowed from Michel Foucault, is "a place that mixes the stasis of the enclave with the flow of an armature, and in which the balance between these two systems is constantly changing" (Shane, 2005, Chapter 3). Heterotopias include Foucault's best known examples of the prison and the hospital, but also shopping malls, amusement parks and cruise ships. They challenge the dominant enclave-armature order.

With the armature, enclave and heterotopia, Shane tries to move beyond the limits of morphology and typology—the tendency to produce "detailed classifications of buildings and open spaces" (Moudon, 1994, p. 289). Such libraries and taxonomies of solids and voids offers "a speedy response and a standardized product", but they suffer from "inflexibility, lack of control by the user, [and] the elimination of variety and choice" (Shane, 2011, p. 128). They tend to fix the identity of the elements of a city, no matter how exhaustive and long the list.[16] There is a tendency to identify and reproduce types as necessary (rather than contingent) stabilities. This results in a conflict between those typomorphological elements that are allowed or elevated to artistic prominence and those that are considered *non-discursive* (Hillier & Hanson, 1984) or developed from a *spontaneous consciousness* (Cannigia & Maffei, 1987/2001). Adopting fixed types or forms as a language (*logos*) by which to 'read' the black box (e.g. the city), risks excluding contingently emergent forms that are characteristic less of the negentropic than the entropic. Shane hints at a return to the entropic information that Serres speaks of, arguing that "types emerge from a flow of energy and pressure, engineered by particular urban actors as specific times to deal with particular situations" (Shane, 2011, p. 133). He is aware of the contingency of the typical and morphic. But the motor he constructs with the three elements is a cybernetic (systemic) one—certain places are armatures, some enclaves and others heterotopias and they behave as such. It is a logic of combinatorics, of mechanical movements and 'pressures' that condition situations. It lacks the informational motor's operation of substitution.

Within an informational motor of the urban, the enclave, armature and the heterotopia are like complexions, with the first two, markers and messages, as stocks of negentropy. The heterotopia addresses entropy, that which could threaten the stability of the system. It can be as much about correction (e.g. prisons) as it can be about emancipation (e.g. amusement parks). But as complexions, these 'elements' would be "discrete configurations of the quantized physical system." (Brillouin, 1962/2013).[17] The enclave expresses 'centrality', the armature 'linearity' and the heterotopia a heterotopiality. In Platonic philosophy, these complexions concern the status of universals, which may be abstract or concrete. An abstract universal is one that is never instantiated in reality or that remains external to a given selection of entities (a set of houses is more or less similar to the ideal House as an archetype) (Ellerman, 2014). Normative city models deal regularly in these ideals, reading cities as machines or ecosystems. Typomorphological work extracts formal or typological stabilities from existing urban forms. Shane's argument highlights the problem of the status of these stabilities once they are applied elsewhere (Shane, 2011). Concrete universals, on the contrary, depend entirely on the context in which they appear and are internal to the given selection of entities (a set of houses establishes the concrete universal of 'House-ness') (Ellerman, 2014).

Investigating the concrete universals of the city challenges methods of scientific inquiry to dive into the shadows of the black box. Because its origin (*arche*) is hidden (or ciphered), the attempt to decipher its laws or language never eliminates the black box, but shifts it or multiplies it. It is radically contingent (as ichnography or trace). No single epistemology (no single scenography or point of view) can address it in its entirety. It is an economy whose laws (*nomos*) may be universal, but whose governing order and relationship to a reservoir (*oikos*) are distributed among the black boxes nested within each other.[18] The city as a black box encodes laws according to which the informational or entropic mass is differentiated—separated or combined. Differentiations of mass, whether populations of people or the laying or carving of stone, always articulate a combination of encounter (combination) and avoidance (separation) (Koch, 2016). Deciphering the *nomos* of the black boxes of the city considers the repetitive acts of differentiation as part of a (partially chance-, partially necessity-based) form of shared or common economy—an economy of communication.

The informational motor of the urban, like the other two motors, can be harnessed. The deciphering of the economy of communication seeks to identify the concrete universals of avoidance and encounter. The mass of the urban form encodes these universals in the materiality of the city. Spatial practices operate on this mass and contingently recode and decipher the ichnography. In the act of deciphering, given the fact that this congealing of mass has no single logic, lies the potential for multiple meanings, recoding, and algebraic substitutions.[19]

[16] Christopher Alexander's *Pattern Language* (1977) identifies 253 patterns.

[17] Brillouin conceived of entropy as the integral of these complexions. It is therefore potentiality, the "entropy of the system" which is an "extremely large, but finite" number (Bühlmann, 2016b).

[18] The Greek, *oikonomia*, from which the word 'economy' stems, refers to "the worldly manifestation of a given order" (Düppe, 2011, Chapter 4). The points of reference for this worldly manifestation were the seasons (*oikoi*), and ultimately the movements of the sun, around which the laws (*nomos*) were ordered (Düppe, 2011).

[19] This is one of the limits of seeing spatial configuration, or the differentiation of mass in human settlements as governed by a social logic. The economy of movement as Hillier defines it in *Space is the Machine* (1996/2007) addresses this differentiation of mass as a reservoir for a motor of transport governed by a single scenography and *logos* (socio-logy). In an economy of communication, the economy as a worldly order is prior to any *logos* that presumes to speak its language.

Speaking of urban infrastructure, Keller Easterling refers to the ichnography as 'disposition.' It is what is "hidden in the folds of infrastructure space" and is a "latent potential or tendency that is present even in the absence of event" (Easterling, 2014, Chapter 2). Disposition is not a single potential, a single actualization, but rather the bundle of all that could or could not be actualized. Instead of being a limited number of possibilities, potentiality is a spectrum, from which potentials can be discretized and actualized. The significant difference between potential and potentiality lies in the dual potential of being and non-being. Giorgio Agamben gives the example of the shadow of non-being or impotential as that which accompanies potential in potentiality (Agamben & Heller-Roazen, 1999). In the informational motor, this is similar to the dual of entropy and negentropy, where the latter is always accompanied by the former. If encounter is a potential, avoidance is also a potential and their "saturated relation" (Koch, 2016, p. 76) would constitute the potentiality of the economy of communication.

6. Mapping of Potentiality: Returning to the Mixture and Delaying Necessity

The 'resources to needs' paradigm proposed by Deep City seeks to delay the role of necessity in the planning process by divorcing potential from needs, by avoiding concrete universals and by addressing expert knowledge as ciphered. This divorce is accomplished, in economic terms, by removing demand from the equation and looking at the urban volume purely as supply. It is a return to the mass or—in Brillouin's terms—of information that has yet to be given value. The geothermal potential is best described in this way as dependent upon the conductive capacity or thermal gradient of the geology—not in terms of the value it may have for the local market or in relation to existing sources of energy. Furthermore, the interactions between the resources, which are multiple and synergetic or conflictual, are not given or determined. Where other techniques to calculate (and map) underground potential limit other resources (e.g. groundwater) to its interaction with underground spaces, Deep City calculates each separately and then evaluates the degree of similarity of each part of the city to combinations of potentials (Doyle, 2016a; Doyle et al., 2016). The areas of higher combined potentials are areas of interest because they constitute a larger quantity of entropy or uncertainty by containing several potentials whose overlap, or potentiality, increases the number of possible future states for the site (Figure 3).

The urban form (or human articulation of the urban volume) is addressed in the same way. As opposed to

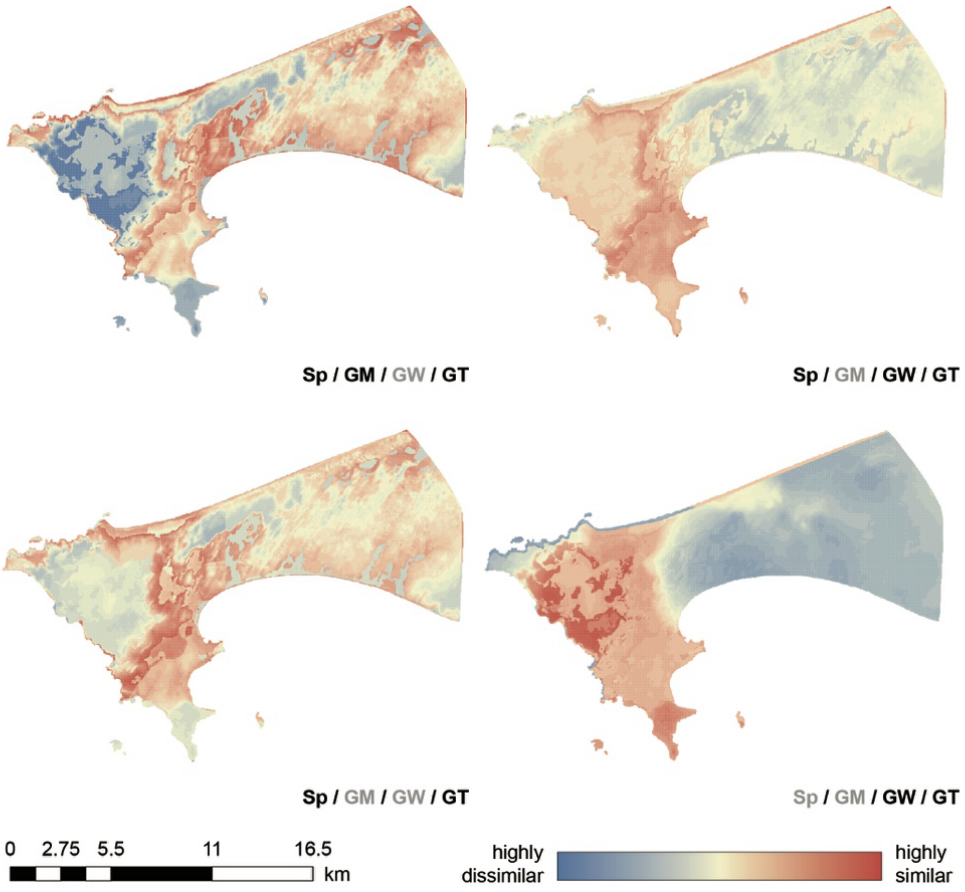

Figure 3. Degree of similarity to different combinations of resource potentials in the city of Dakar (Sp = space; GM = geomaterials; GW = groundwater; GT = geothermal) (Doyle, 2016b, pp. 198–199).

other mapping methods, the urban form is not indicative of a passive demand, but an entropic supply. Its potential is the cumulative opportunities for encounter or avoidance around a chosen unit (building, parcel, street segment, etc.). Potential in this way is similar to what Lars Marcus calls 'spatial capital' in that it creates "potentials for variations of urbanity" (Marcus, 2010, p. 32), a reservoir or black box of potential. The potential of the urban form is not *read* as a coherent language, but *deciphered* as improbable and contingent—as concrete universals. Despite attempts to prove that one or few distances for centrality best account for spatial agency (Hillier, Turner, Yang, & Park, 2010), centrality is distributed and pervasive (Hillier, 2009). Advocating for one metric is equivalent to making normative claims about the economy of avoidance and encounter (Dovey, 2010). In reality, multiple metrics are needed to capture the diversity of ways in which space is navigated and spatial relationships are articulated. The Deep City project has recently addressed the potential of the urban form using principal component analysis, which identifies invariances in the pervasive centrality of urban form, without resorting to descriptions of spatial configuration from other contexts (Figure 4) (Doyle, 2016b).

Like the previously-mentioned mapping methods tested in China, the Deep City project adopts the Analytic Hierarchy Process to quantify expert knowledge and to situate evaluation criteria on a continuous, rather than ordinal scale. Simply put, the AHP helps to establish a relationship between elements being evaluated per a set of criteria, chosen in response to a predefined goal (Saaty, 1980; Saaty & Vargas, 2012). Each element is compared per one criterion, producing a matrix of values that can be normalized and solved to produce an eigenvector. Deep City produces matrices for each resource separately through the comparison, first, of families of geotypes, and then other criteria that contribute to the potential of each resource. However, to delay the role of necessity in contexts in which the value of the underground is not yet given, the overall goal and criteria selected are kept relatively abstract.[20] The AHP provides a means to address expert knowledge as a black box, as an orthography, to be deciphered. Although the expert (geologist or geotechnical engineer) may be able to place the geological families or criteria on an ordinal scale, the AHP distances the expert from his or own preconceptions (scenography) and reveals the underlying order of evaluation through pairwise comparisons and matrix algebra.[21]

By treating the information on the urban volume in this way, the resulting maps are no longer passive representations of disciplinary knowledge (scenography), but

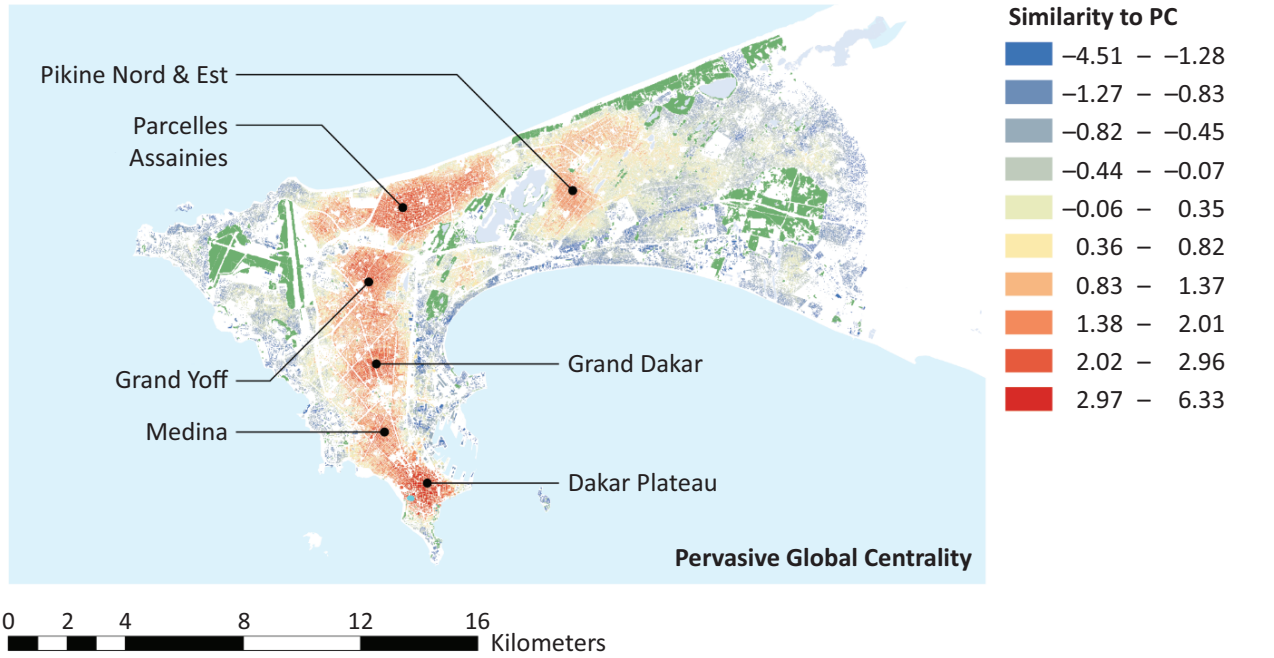

Figure 4. The use of the principal component analysis on centrality analyses conducted at multiple scales identify pervasive centers. The color coding represents (in red) the areas that are the most pervasive to the areas that are least pervasive (in blue) (Doyle, 2016b, p. 190).

[20] Indeed, when a project is well-defined, a geotechnical engineer would be able to evaluate the bearing capacity of the ground in function of the structure proposed. However, when evaluating potential as a strategic level (on a territorial scale of mapping), many contextual factors are absent and only a general appreciation of potential can be made. This appreciation does not replace, but only precedes, further investigation once a project has been defined.

[21] Rigor is by no means ensured purely by quantification, but by the various controls for inconsistency and sensitivity analysis that can evaluate the responses of the experts and identify areas of dissensus (Saaty, 1990; Saaty & Vargas, 2013).

an orthography generated by an informational motor. In contrast, mapping using GIS has historically operated within the vectorial motor in accordance with first cybernetics, which "equates it with an exchange and transport of goods" (Poore & Chrisman, 2006, p. 509), or the transformational motor in accordance with second cybernetics, in which information is transformed through interpretation by the receiver. In both cases, the "real world becomes the source, the map becomes the signal, and the map users are receivers of the message" (Poore & Chrisman, 2006, p. 513). The map is but a medium, it is not in itself productive of new information. The capacity of mapping to be an information-producing (entropic) agency, independently from quantitative geography's influence from cybernetics, was explored and theorized by the map overlay tradition initiated principally by Ian McHarg (Kuitert, 2013; McHarg, 1969) and further theorized in the work of James Corner, for whom mapping stages "the conditions for the emergence of new realities" (2002, p. 216). These conditions are generative of entropy, of an ichnography to be addressed orthographically, rather than scenographically.

This emergence of new realities is, in the informational motor, the role of the parasite or of negentropy in Brillouin's sense of 'free information'. In *Rome*, Serres refers to free information as a 'white arm', which "has an origin [but] has an undetermined end" (1983/2015, Chapter 3). It is information transmitted with no definite receiver. It is 'white' because it has not yet been interpreted or transformed into a message. It has the possibility to reconfigure relationships as they currently are. Explicitly referring to Serres, Hetherington and Lee (2000) call these white elements 'blank figures'. These figures refuse "to adopt a singular position in [the] semiotic order" (2000, p. 177). Relational ontologies that cannot account for "the kind of otherness that is 'outside' relations" (2000, p. 173) are unable to address free information—the negentropic information that the first and second motors exclude as undesirable noise. This problem is faced by both actor-network (ANT) and assemblage theories. ANT, in its reliance on 'following the actors' (Latour, 2005) requires the white arm to have not just an origin but also a destination or end. Being in relation is what permits the actor-network to emerge. The immanence of these relations facilitates the identification of assemblages or "wholes whose properties emerge from the interactions between parts" (De Landa, 2006, Introduction). For parts to interact, they have to be part of an explicit process. That which is outside the process, the interaction or the relation is excluded.

In a paradigm of resources to needs, mapping seeks to constitute a reservoir where entropy and negentropy can mingle. Free information, without value or meaning, can emerge from the combination of potentials, where each potential captures a form of meaningful information. The potential gleaned from the urban form captures the negentropic information contained within it. Accessibility is currently actualized as such and is measurable, quantifiable. Potentiality, as opposed to potential, deals with the virtual, because it is entropy or noise out of which free information can be drawn. It is not yet actualized—the white arm has yet no receiver. It is not yet part of any particular process (which is why it cannot be 'assembled'). Rather, it is 'pre-specific' (Bühlmann, 2013, p. 147). Mapping the potential of the urban volume locates geographically the multiplicity of this potential in a single location, but it remains indifferent where potentiality is of interest. It is a reservoir of potential—a 'space of potentiality' (Wolf & Mahaffey, 2016)—from which potentiality can be drawn as unheard melodies or harmonies in the noise of possibility.

7. Conclusion: Co-producing Differentiations of the Urban Mass

The paradigm of 'resources to needs' has been promoted by the Deep City project at the EPFL in Switzerland since 2005. As opposed to a method of mapping underground potential, which has evolved extensively through a variety of case studies around the world, the theoretical framework of the research program has engaged little with urban theory and philosophy. This article began by examining the resources to needs paradigm as a claim for constituting underground potential prior to necessity, referring to the work of biologist Jacques Monod and physicist Léon Brillouin. Looking at the underground as it has been addressed in city models and within the vectorial, transformational and informational motors of Michel Serres revealed that the underground is excluded because it is considered outside of given or necessary relationships. The first two motors tend to characterize the way in which the mechanical and ecological normative models are founded upon functionalist concerns with processes, relations and fixed identities of elements. The informational motor, on the contrary, in its logic of substitution and mixture of elements without fixed identities or relations is better suited to constitute a reservoir of potentiality that is an intermediate point between resources and the needs of an urban agglomeration.

The operationalization of mapping within a paradigm of resources to needs is being worked out in more detail elsewhere (Doyle, 2016b), but some directions can be sketched out here. The map of underground potential as an orthography is not a message from geologists or engineers to be received passively by urban planners. Rather, it seeks to establish a closer collaboration across disciplinary boundaries and circulates in order to destabilize and stabilize a planning collective. This collective is founded upon the urban volume and concerns geologists, engineers, architects and urban planners, and so on—as a community of the urban volume. It is a community that calls for co-production, as Wolf and Mahaffey (2016) describe in a recent article, and not simply participation (which implies taking on pre-defined or fixed roles). As such, potential as it is mapped in abstraction

and prior to needs is an economy of communication that, downstream, undergoes the differentiating and articulation process of society and politics. Questions can be asked: What do we do with this potential? Preserve it for the future? Harness it now? The mapping, as it is proposed here, can only aid in working through these questions—it does not provide the answer.

In developing the resources to needs paradigm, the Deep City project pointed out the limits of the status quo—identifying needs (projects, plans, problems) and exploiting resources to execute or solve them. While this article recognizes recent advances in mapping underground potential (even on the Deep City project) as increasingly embracing a wider conception of the urban volume as comprised of multiple resources in interaction, it nevertheless offers several words of caution. The increasing availability of detailed data on the underground may give a false sense of certainty about ground conditions. Much aggregate information, from maps to 3D models is based on interpolation algorithms. Such accuracy, as Brillouin demonstrates, must be paid for in uncertainty, in that which chosen measures exclude or obscure. The mapping methods described here combine multiple sources of data either using expert opinion or a multi-criteria method like the AHP, thereby enabling the evaluation process to be specific about underground space potential, but at the expense of other resources. Experience has shown that neglecting potential interactions with other resources can lead to undesirable conflicts and untapped synergies (Blunier, 2009; Parriaux et al., 2010).

Finally, this article has focused on underground resources and on urban form, because it was in this context that the resources to needs paradigm was proposed. The larger philosophical questions posed however by the work of Michel Serres, Jacques Monod and Léon Brillouin challenge urban planning and architecture to reflect on the role of contingency and chance in a world dominated by and oriented towards necessity.[22] The fact that these questions stem from observations made outside the social sciences (yet are highly relevant for them, as Serres's body of work can attest) only highlights the importance of accounting for that which is outside language (*logos*)—in the ichnography, the entropic, the mass and the material. From the entropic, governed only by the law of chance, the radically new and improbable emerges (Monod, 1972; Serres, 1977/2000). As Monod claims, the irrationality of the improbable can be captured by rational forms of reasoning (for instance, principal component analysis in identifying concrete universals). Heterotopiality is a way the urban already tries to cope with the desire and the threat of the irrational (Shane, 2005). Can we preserve this noise? Make room for the improbable? Can uncertainty be creatively harnessed by the planning and design process? Or will we continue to condemn the noise of the urban volume to silence?

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Conflict of Interests

The author declares no conflict of interests.

References

Agamben, G., & Heller-Roazen, D. (1999). *Potentialities: Collected essays in philosophy*. Stanford, CA: Stanford University Press.

Alexander, C. (1977). *A pattern language: Towns, buildings, construction*. Oxford: Oxford University Press.

Bélanger, P. (2016). Altitudes of urbanization. *Tunnelling and Underground Space Technology*, *55*, 5–7. doi: 10.1016/j.tust.2015.09.011

Blunier, P. (2009). *Méthodologie de gestion durable des ressources du sous-sol urbain* (Doctoral Dissertation). EPFL, Lausanne, Switzerland. Retrieved from http://library.epfl.ch/theses/?nr=4404

Bobylev, N. (2009). Mainstreaming sustainable development into a city's Master plan: A case of urban underground space use. *Land Use Policy*, *26*(4), 1128–1137. doi:10.1016/j.landusepol.2009.02.003

Bobylev, N., & Sterling, R. (2016). Urban underground space: A growing imperative. *Tunnelling and Underground Space Technology*, *55*, 1–4. doi:10.1016/j.tust.2016.02.022

Brenner, N., & Schmid, C. (2015). Towards a new epistemology of the urban? *City*, *19*(2–3), 151–182. doi: 10.1080/13604813.2015.1014712

Brillouin, L. (2013). *Science and information theory*. Mineola, NY: Dover Publications. (Original work published 1962)

Bühlmann, V. (2013). Primary abundance, urban philosophy—Information and the form of actuality. In V. Bühlmann & L. Hovestadt (Eds.), *Printed physics: Metalithikum I* (pp. 114–154). Vienna: Springer.

Bühlmann, V. (2016a). Architectonic disposition: Ichnography, scænography, orthography. In R. Braidotti & M. Hlavajova (Eds.), *The posthuman glossary* (p. Forthcoming). London: Bloomsbury.

Bühlmann, V. (2016b). Negentropy. In R. Braidotti & M. Hlavajova (Eds.), *The posthuman glossary* (p. Forthcoming). London: Bloomsbury.

Cannigia, G., & Maffei, G. L. (2001). *Architectural composition and building typology: Interpreting basic building*. Florence, Italy: Alinea. (Original work published 1987)

Corner, J. (2002). The agency of mapping: Speculation, critique and invention. In D. E. Cosgrove (Ed.), *Mappings* (pp. 214–300). London: Reaktion Books.

[22] See, for instance, Serres's essay *Trahison: La Thanatocratie* in *La Traduction* (1968, pp. 73–104).

Cuddington, K. (2001). The "balance of nature" metaphor and equilibrium in population ecology. *Biology and Philosophy*, *16*(4), 463–479. doi:10.1023/A:1011910014900

De Landa, M. (2006). *A new philosophy of society: Assemblage theory and social complexity*. London and New York: Continuum.

Dovey, K. (2010). *Becoming places: Urbanism/architecture/identity/power*. London and New York: Routledge.

Doyle, M. R. (2016a). From hydro/geology to the streetscape: Evaluating urban underground resource potential. *Tunnelling and Underground Space Technology*, *55*, 83–95. doi: 10.1016/j.tust.2016.01.021

Doyle, M. R. (2016b). *Potentialities of the urban volume: Mapping underground resource potential and deciphering spatial economies and configurations of multi-level urban spaces* (Doctoral dissertation in Architecture and the Sciences of the City). EPFL, Lausanne, Switzerland.

Doyle, M. R., Thalmann, P., & Parriaux, A. (2016). Underground potential for urban sustainability: Mapping resources and their interactions with the deep city method. *Sustainability*, *8*(9), 830. doi:10.3390/su8090830

Düppe, T. (2011). *The making of the economy: A phenomenology of economic science*. Lanham, MD: Lexington Books.

Easterling, K. (2014). *Extrastatecraft: The power of infrastructure space*. Brooklyn, NY: Verso.

Ellerman, D. (2014). On concrete universals: A modern treatment using category theory. *SSRN Electronic Journal*. doi:10.2139/ssrn.2435439

Hénaff, M. (2008). *La ville qui vient*. Paris: l'Herne.

Hénard, E. (1982). *Etudes sur les transformations de Paris, et autres écrits sur l'urbanisme*. Paris: L'Equerre. (Original work published 1903)

Hetherington, K., & Lee, N. (2000). Social order and the blank figure. *Environment and Planning D: Society and Space*, *18*(2), 169–184. doi:10.1068/d215t

Hillier, B. (2007). *Space is the machine: A configurational theory of architecture*. Cambridge: Cambridge University Press. (Original work published 1996)

Hillier, B. (2009). Spatial sustainability in cities: Organic patterns and sustainable forms. In D. Koch, L. Marcus, & J. Steen (Eds.), *Proceedings of the Seventh International Space Syntax Symposium* (pp. K01.1–K01.20). Stockholm: Royal Institute of Technology.

Hillier, B., & Hanson, J. (1984). *The social logic of space*. Cambridge: Cambridge University Press.

Hillier, B., Turner, A., Yang, T., & Park, H.-T. (2010). Metric and topo-geometric properties of urban street networks: Some convergences, divergences and new results. *Journal of Space Syntax*, *1*(2), 258–279.

Koch, D. (2016). On avoidance: Reflections on processes of socio-spatial structuring. *Civil Engineering and Architecture*, *4*(2), 67–78. doi:/10.13189/cea.2016.040204

Kuitert, W. (2013). Urban landscape systems understood by geo-history map overlay. *Journal of Landscape Architecture*, *8*(1), 54–63. doi:10.1080/18626033.2013.798929

Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press.

Le Moigne, J. L. (1977). *La théorie du système général: Théorie de la modélisation*. Paris: Presses Universitaires de France.

Li, H., Li, X., Parriaux, A., & Thalmann, P. (2013). An integrated planning concept for the emerging underground urbanism: Deep City Method Part 2 case study for resource supply and project valuation. *Tunnelling and Underground Space Technology*, *38*, 569–580. doi:10.1016/j.tust.2013.04.009

Li, X., Li, C., Parriaux, A., Wu, W., Li, H., Sun, L., & Liu, C. (2016). Multiple resources and their sustainable development in Urban Underground Space. *Tunnelling and Underground Space Technology*, *55*, 59–66. doi:10.1016/j.tust.2016.02.003

Lu, Z., Wu, L., Zhuang, X., & Rabczuk, T. (2016). Quantitative assessment of engineering geological suitability for multilayer Urban Underground Space. *Tunnelling and Underground Space Technology*, *59*, 65–76. doi:10.1016/j.tust.2016.06.003

Lynch, K. (1960). *The image of the city*. Cambridge, MA: MIT Press.

Marcus, L. (2010). Spatial capital: A proposal for an extension of space syntax into a more general urban morphology. *Journal of Space Syntax*, *1*(1), 30–40.

McHarg, I. L. (1969). *Design with nature*. Garden City, NY: Published for the American Museum of Natural History by the Natural History Press.

Moffatt, S., & Kohler, N. (2008). Conceptualizing the built environment as a social–ecological system. *Building Research and Information*, *36*(3), 248–268. doi:10.1080/09613210801928131

Monod, J. (1972). *Chance and necessity: An essay on the natural philosophy of modern biology*. New York: Vintage Books.

Moudon, A. V. (1994). Getting to know the built landscape. In K. A. Franck & L. H. Schneekloth (Eds.), *Ordering space: Types in architecture and design* (pp. 289–311). New York: Van Nostrand Reinhold.

Ortiz-Zamora, D., & Ortega-Guerrero, A. (2010). Evolution of long-term land subsidence near Mexico City: Review, field investigations, and predictive simulations: Long-term land subsidence. *Water Resources Research*, *46*(1). doi:10.1029/2008WR007398

Parriaux, A., Blunier, P., Maire, P., Dekkil, G., & Tacher, L. (2010). *Projet deep city: Ressources du sous-sol et développement durable des espaces urbains*. Lausanne: vdf Hochschulverlag AG andETH Zürich.

Parriaux, A., Tacher, L., & Joliquin, P. (2004). The hidden side of cities—Towards three-dimensional land planning. *Energy and Buildings*, *36*(4), 335–341. doi:10.1016/j.enbuild.2004.01.026

Payot, D. (1982). *Le philosophe et l'architecte: Sur quelques déterminations philosophiques de l'idée d'architecture*. Paris: Aubier Montaigne.

Peng, J., Wang, Y., & Peng, F. (2014). Evaluation of underground space resource for urban master plan in Chanzhou City. In *Underground space: Planning, administration and design challenges* (pp. 30–35). Seoul, South Korea.

Pickett, S. T. A., Cadenasso, M. L., & Grove, J. M. (2004). Resilient cities: Meaning, models, and metaphor for integrating the ecological, socio-economic, and planning realms. *Landscape and Urban Planning*, *69*(4), 369–384. doi:10.1016/j.landurbplan.2003.10.035

Poore, B. S., & Chrisman, N. R. (2006). Order from noise: Toward a social theory of geographic information. *Annals of the Association of American Geographers*, *96*(3), 508–523. doi:10.1111/j.1467-8306.2006.00703.x

Portugali, J. (2011). *Complexity, cognition and the city*. Heidelberg: Springer.

Rowe, C., & Koetter, F. (1978). *Collage city*. Cambridge, MA: MIT Press.

Saaty, T. L. (1980). *The analytic hierarchy process: Planning, priority setting, resource allocation*. New York: McGraw-Hill.

Saaty, T. L. (1990). How to make a decision: The analytic hierarchy process. *European Journal of Operational Research*, *48*(1), 9–26. doi:10.1016/0377-2217(90)90057-I

Saaty, T. L., & Vargas, L. G. (2012). *Models, methods, concepts & applications of the analytic hierarchy process* (2nd ed.). New York: Springer.

Saaty, T. L., & Vargas, L. G. (2013). Sensitivity analysis in the analytic hierarchy process. In T. L. Saaty & L. G. Vargas, *Decision making with the analytic network process* (Vol. 195, pp. 345–360). Boston, MA: Springer US.

Serres, M. (1968). *La traduction*. Paris: Éditions de Minuit.

Serres, M. (1977). *La distribution*. Paris: Editions de Minuit.

Serres, M. (1982). *Genèse*. Paris: B. Grasset.

Serres, M. (1982). *The parasite*. (L. R. Schehr, Trans.). Baltimore: Johns Hopkins University Press. (Original work published 1980)

Serres, M. (1990). *Le système de Leibniz et ses modèles mathématiques: Etoiles, schémas, points* (3. éd.). Paris: Presses Univ. de France.

Serres, M. (1993). *Les origines de la géometrie: Tiers livre des fondations*. Paris: Flammarion.

Serres, M. (2000). *The birth of physics*. Manchester: Clinamen Press. (Original work published 1977)

Serres, M. (2015). *Rome: The first book of foundations*. London: Bloomsbury Academic (Original work published 1983)

Serres, M. (2015). *Statues: The second book of foundations*. (R. Burks, Trans.). London: Bloomsbury. (Original work published 1987)

Shane, D. G. (2005). *Recombinant urbanism: Conceptual modeling in architecture, urban design, and city theory*. Chichester: Wiley.

Shane, D. G. (2011). Transcending type: Designing for urban complexity. *Architectural Design*, *81*(1), 128–134. doi:10.1002/ad.1197

Vähäaho, I. (2009). *Underground masterplan of Helsinki: A city growing inside bedrock* (Extract from the Underground Masterplan of Helsinki). Helsinki: City of Helsinki.

Viganò, P. (1999). *La città elementare*. Milano: Skira.

Wallace, M., Roberts, K. J., & Lau, V. (2014). A geographic information systems approach for regional cavern suitability mapping for Hong Kong. In *Underground space: Planning, administration and design challenges*. Seoul, South Korea.

Williams, R. (2008). *Notes on the underground: An essay on technology, society, and the imagination*. Cambridge, MA: MIT Press. (Original work published 1990)

Wolf, G., & Mahaffey, N. (2016). Designing difference: Coproduction of spaces of potentiality. *Urban Planning*, *1*(1), 59–67. doi:10.17645/up.v1i1.540

Zhao, J.-W., Peng, F.-L., Wang, T.-Q., Zhang, X.-Y., & Jiang, B.-N. (2016). Advances in master planning of urban underground space (UUS) in China. *Tunnelling and Underground Space Technology*, *55*, 290–307. doi:10.1016/j.tust.2015.11.011

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Article

Sky View Factors from Synthetic Fisheye Photos for Thermal Comfort Routing—A Case Study in Phoenix, Arizona

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Abstract
The Sky View Factor (SVF) is a dimension-reduced representation of urban form and one of the major variables in radiation models that estimate outdoor thermal comfort. Common ways of retrieving SVFs in urban environments include capturing fisheye photographs or creating a digital 3D city or elevation model of the environment. Such techniques have previously been limited due to a lack of imagery or lack of full scale detailed models of urban areas. We developed a web based tool that automatically generates synthetic hemispherical fisheye views from Google Earth at arbitrary spatial resolution and calculates the corresponding SVFs through equiangular projection. SVF results were validated using Google Maps Street View and compared to results from other SVF calculation tools. We generated 5-meter resolution SVF maps for two neighborhoods in Phoenix, Arizona to illustrate fine-scale variations of intra-urban horizon limitations due to urban form and vegetation. To demonstrate the utility of our synthetic fisheye approach for heat stress applications, we automated a radiation model to generate outdoor thermal comfort maps for Arizona State University's Tempe campus for a hot summer day using synthetic fisheye photos and on-site meteorological data. Model output was tested against mobile transect measurements of the six-directional radiant flux density. Based on the thermal comfort maps, we implemented a pedestrian routing algorithm that is optimized for distance and thermal comfort preferences. Our synthetic fisheye approach can help planners assess urban design and tree planting strategies to maximize thermal comfort outcomes and can support heat hazard mitigation in urban areas.

Keywords
climate-sensitive urban design; desert city; heat; MRT; outdoor thermal comfort; PET; sky view factor; thermal comfort routing; urban form; walkability

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1. Introduction

Heat is the leading cause of weather-related mortality in the U.S and poses a significant threat to public health (National Oceanic and Atmospheric Administration [NOAA], 2015). Exposure to extreme heat is expected to increase in the future, as rapid urbanization continues and heat waves are projected to become more

intense, more frequent, and longer lasting (Jones et al., 2015). Past research has shown that daytime heat can be reduced through microclimate-responsive urban design that acknowledges the cooling potential of urban form and vegetation (Erell, Pearlmutter, & Williamson, 2012; Lenzholzer & Brown, 2016). Dense urban forms can create local cool islands during the day and are particularly effective at mitigating heat in hot desert environments where water is scarce (Middel, Häb, Brazel, Martin, & Guhathakurta, 2014; Pearlmutter, Bitan, & Berliner, 1999).

Heat is most commonly expressed as air temperature, but temperature alone is not a comprehensive indicator of outdoor thermal comfort or stress. Thermal comfort is influenced by numerous environmental factors, including temperature, radiation, humidity, and wind speed; and personal factors, such as clothing and activity level (Ng & Cheng, 2012; Nikolopoulou & Lykoudis, 2006; Vanos, Warland, Gillespie, & Kenny, 2010). In outdoor spaces, radiation is one of the most important variables affecting thermal comfort; perceived thermal comfort can vary several degrees in the shade and sun (Mayer & Höppe, 1987; Middel, Selover, Hagen, & Chhetri, 2016). Thermal conditions in urban areas vary widely due to complex shading patterns from buildings and trees that determine solar access at the pedestrian level. Therefore, air temperature maps fail to accurately represent the significant variation of thermal conditions in built environments.

In urban climate research, the Sky View Factor (SVF) has been widely used as approximation of the 3D urban geometry to assess the urban heat island (UHI) and longwave radiative heat loss in cities at night (Brandsma & Wolters, 2012; Gál, Lindberg, & Unger, 2009; Oke, 1981; Unger, 2004). SVF is defined as the fraction of visible sky on a hemisphere and ranges from zero to one, denoting the ratio of the radiation received (emitted) by a planar surface to the radiation emitted (received) by the entire hemisphere (Johnson & Watson, 1984). SVF is relevant to human thermal comfort, as it affects Mean Radiant Temperature (MRT), a synthetic parameter that summarizes the direct and reflected short and longwave radiation fluxes a human body is exposed to. MRT is one of the most important meteorological variables in the assessment of thermal comfort and the basis for many human thermal comfort indices (Johansson, Thorsson, Emmanuel, & Krüger, 2014; Lee, Holst, & Mayer, 2013; Thorsson, Lindberg, Eliasson, & Holmer, 2007).

Numerous models have been developed to calculate SVF and MRT in urban settings at different spatial scales and with varying data requirements. Matzarakis, Rutz and Mayer (2007, 2010) developed RayMan to model SVF and MRT from hemispherical photos and meteorological observations. The model has been shown to perform reasonably well in homogeneous urban environments (Lee & Mayer, 2016), yet it is limited to a single point in space. The SkyHelios model (Matzarakis & Matuschek, 2011) simulates continuous SVFs for small urban areas, but requires a geometric obstacle file. More recently, studies have presented continuous SVF calculations using 3D city models (Chen et al., 2012; Gál et al., 2009; Unger, 2009; White, Hu, Langenheim, Ding, & Burry, 2016), but these calculations usually do not incorporate vegetation. Tree canopy cover significantly reduces SVF at the pedestrian level and is an important shade source that should be incorporated in view factor analyses and outdoor thermal comfort assessments. The SOLWEIG model has been successfully applied to calculate SVF and MRT for urban areas using digital surface models (DSMs) as representation of the urban morphology (Chen, Yu, Yang, & Mayer, 2016; Lindberg & Grimmond, 2011; Lindberg, Holmer, & Thornsson, 2008). Although trees have recently been added into SOLWEIG, the use of DSMs does not allow to model complex urban forms, such as building overhangs and shade structures.

We developed a methodology to calculate SVFs for large urban areas at high spatial resolution using synthetically generated fisheye images from Google Earth. Our approach calculates SVFs for large urban areas incorporating the full 3D environment, including vegetation, and is independent of available 3D building databases or DSMs. As an example, we produced 5 m resolution SVF maps for two neighborhoods in the Phoenix metropolitan area overlaid over Google Earth terrain. To show the utility of our approach for thermal comfort and walkability assessments, we generated thermal comfort maps of Arizona State University's Tempe campus for a hot summer day in August 2016 using Google Earth hemispherical images and meteorological data from an on-site field campaign. We then utilized a routing algorithm for pedestrian navigation that is optimized for distance and individual outdoor thermal comfort preferences.

2. Methods

To assess intra-urban SVF variations in select neighborhoods in the Phoenix metropolitan area, we retrieved data from Google Earth on a 5 m resolution grid to generate synthetic 180° hemispherical views of the sky from 3D buildings, trees, and terrain. We removed the sky portion of the fisheye photos and calculated the SVF for each location on the grid through equiangular projection. Subsequently, we calculated MRT and a thermal comfort index using the synthetic fisheyes as input for an automated radiation model to inform our case study.

2.1. Retrieving Data from Google Earth

Google Earth version 7 allows users to render a 3D mesh of the ground that includes buildings, trees, shrubs, and other obstacles. The 3D mesh is generated from oblique imagery collected during Google overflight campaigns at a 45° angle in each cardinal direction and down. The aerial imagery is automatically converted into a 3D city model using stereo-photogrammetry and serves as texture for the 3D mesh so that the scene can be rendered.

As the current Google Earth Application Programming Interface (API) does not provide a function to export rendered images, we used a NodeJS server to remotely control a browser that runs the Google Earth plugin and takes screenshots of the browser window through the operating system API. First, our algorithm requests map tiles from the Google Maps service for an area of interest defined by an array of map tile coordinates and a sampling resolution, in our case 5 m, to determine sampling locations. Buildings and water bodies are excluded from the sampling. The algorithm generates a Keyhole Markup Language (KML) file with the coordinates of the locations to steer the virtual camera in Google Earth. Then, the camera takes a tour along the predefined route, and the operating system API takes a screenshot after the Google Earth plugin finishes loading the 3D mesh at each camera location. The camera view angle is set to 90° and the height is set to 1.1 m above ground level. 1.1 m is the recommended height for human thermal comfort applications, as it represents the center of gravity of the human body for standing subjects (ISO 7726, 1998). The algorithm takes five screenshots at each location—one in each cardinal direction and one upwards (Figure 1a).

2.2. Fisheye Projection

After data retrieval, we generate synthetic fisheye images using an angular fisheye projection of the surroundings on a 2D plane (Figure 1b). For the projection, we treat the images as a cube map and perform ray casting in WebGL. Specifically, we represent the fisheye image as a unit square with center $c = (0, 0)$ and calculate for each point $p = (u, v)$ with length $r = \|p\| \leq 0.5$ the corresponding position on the unit hemisphere. Points with $r > 0.5$ are not part of the fisheye and are therefore colored white. For all other points, the position on the hemisphere is given by

$$v = \begin{pmatrix} \sin(\theta) u_r \\ \sin(\theta) v_r \\ \cos(\theta) \end{pmatrix}$$

with latitude $\theta = r\,\pi$ and normalized direction vector

$$(u_r, v_r) = \begin{cases} \dfrac{p}{r} & \text{if } r > 0 \\ (0, 0) & \text{otherwise} \end{cases}$$

Subsequently, the vector v is used to sample the cube map, yielding the final fisheye image. The hemispherical view is then converted to black and white (white = sky; black = obstacles) using a deterministic sky color gradient (Figure 1c).

2.3. Sky View Factor Calculation

Several methods are available to calculate the SVF based on fisheye images: The SVF can be calculated using analytical methods that derive the horizon limitation from geometric properties of the urban canyon (Johnson & Watson, 1984); vector-based methods that calculate the SVF from projected building envelopes on the sky using a 3D building database (Chen et al., 2012; Gál et al. 2009; Gál & Unger, 2014; Unger, 2009); raster-based methods that use digital elevation models (DEMs) or DSMs to estimate SVFs based on pixel heights or shadow casting (Gál et al., 2009; Lindberg & Grimmond, 2011; Lindberg et al., 2008; Ratti, Baker, & Steemers, 2005; Zakšek, Oštir, & Kokalj, 2011), and photographic methods that use fisheye imagery of the upper hemisphere (Bradley, Thornes, & Chapman, 2001; Chapman & Thornes, 2004; Grimmond, Potter, Zutter, & Souch, 2001; Holmer, Postgård, & Eriksson, 2001). The hemispheric horizon limitation is usually projected on a 2D plane to calculate the amount of visible sky in the scene. The most widely used projection technique is the equiangular projection by Steyn (1980), where the projected image is divided into concentric annuli of equal width and then evaluated. We use a modified version of the manual Steyn-method for digitized fisheye photographs that was proposed by Chapman, Thornes and Bradley (2001). We partition the synthetic fisheye picture into n annular rings (default $n = 36$) and calculate the SVF by summing up the contribution of each ring:

$$\text{SVF} = \frac{\pi}{2n} \sum_{i=1}^{n} \sin\left(\frac{\pi(2i-1)}{2n}\right)\left(\frac{p_i}{t_i}\right)$$

where p_i/t_i is the ratio between the number of sky pixels to the total number of pixels in ring i (Figure 1d).

2.4. Thermal Comfort Modeling

Physiologically Equivalent Temperature (PET) is a widely-used thermal comfort index that is based on MRT, reported in °C, and expresses how people experience weather conditions, incorporating the radiative environment and personal characteristics, such as age, clothing, and metabolic rate (Höppe, 1999; Mayer & Höppe, 1987). The 1D RayMan model (Matzarakis et al., 2007, 2010) has been extensively employed to estimate MRT, PET, and other thermal comfort indices from fisheye photographs, meteorological, and personal factors (Coutts, White, Tapper, Beringer, & Livesley, 2016; Herrmann & Matzarakis, 2012; Johansson & Emmanuel, 2006; Krüger, Minella, & Rasia, 2011; Lin, 2009; Lin, Matzarakis, & Hwang, 2010; Oliveira, Andrade, & Vaz, 2011; Thorsson, Lindqvist, & Lindqvist, 2004), following equations outlined in the German VDI engineering standards (Verein Deutscher Ingenieure, 1994). We automated the Windows GUI using a script that simulates keystrokes to remotely execute the RayMan tool and batch process thousands of georeferenced synthetic fisheyes for a given day and time. The results are collected in a CSV file and can subsequently be imported in ArcGIS using the fisheyes' latitude-longitude coordinates to generate high resolution MRT and PET maps for further analysis.

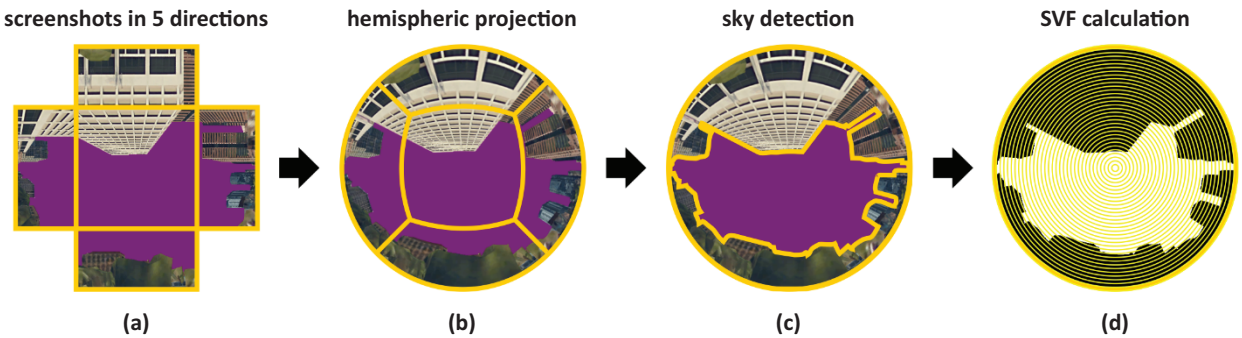

Figure 1. Sky View Factor calculation pipeline. Starting with five images of 90° field of view (a), we apply an angular hemispheric fisheye projection (b), detect sky regions (c), and calculate the Sky View Factor using 36 annular rings (d).

3. Sky View Factor Results

We evaluated the accuracy of our SVF approach in two steps. First, we compared the synthetic hemispherical images created from Google Earth to fisheye photos generated from Google Street View panoramic images using the SVF as accuracy metric. Second, we compared our SVF results to outputs from other algorithms using the same set of fisheye photos. After validation, we generated 5 m resolution SVF maps for two contrasting neighborhoods in Phoenix.

3.1. Evaluation of Sky View Factors

To assess the accuracy of the Google Earth fisheye images compared to real world photos, we generated 18,367 fisheye images from Google Street View panoramas across the Phoenix metropolitan area (Figure 2) using the Google Street View API. The fisheye generation process is similar to Google Earth, but requires a more sophisticated sky detection algorithm due to varying sky and cloud conditions. We used a modified Sobel filter algorithm for edge detection and a procedure developed by Laungrungthip, McKinnon, Churcher and Unsworth (2008). We then generated Google Earth fisheye photos at the Google Street View locations, using a camera height of 2.5 m to approximate the height of a Street View car. A comparison of SVFs calculated from Google Earth and Google Street View yielded an average difference in SVF of 0.022 with a standard deviation of 0.084. The largest differences in SVF were caused by two reasons. First, the Google Street View panoramas were acquired more recently than the Google Earth 3D mesh for Phoenix, which was generated several years ago. Thus, some buildings exist in Street View, but not in Google Earth, and vice versa. Second, Google Street View offers panoramas of building interiors that cannot be rendered in Google Earth. Filtering out 2,579 indoor panoramas and extreme cases of time discrepancies yielded a 0.01 average difference in SVF with a 0.028 standard deviation. This error is minimal and we conclude that the rendered output of Google Earth yields adequate results.

We evaluated the accuracy of the SVF calculations by computing the SVFs of 527 randomly selected Google Earth fisheye images in the Phoenix metropolitan area using our implementation of Chapman et al. (2001), the RayMan Pro model v2.1 by Matzarakis et al. (2007, 2010), the SkyViewFactor-Calculator v1.1 by Holmer et al. (2001), and the unweighted, naive approach of counting pixels. Since the SkyViewFactor-Calculator uses the well-established Steyn-method (Steyn, 1980), we chose the Holmer et al. SVF implementation as reference. As shown in Figure 3, our implementation of Chapman et al. (2001) produces SVFs that are not significantly different from the well-established Steyn-method. We confirm the findings of Hämmerle, Gál, Unger and Matzarakis (2011),

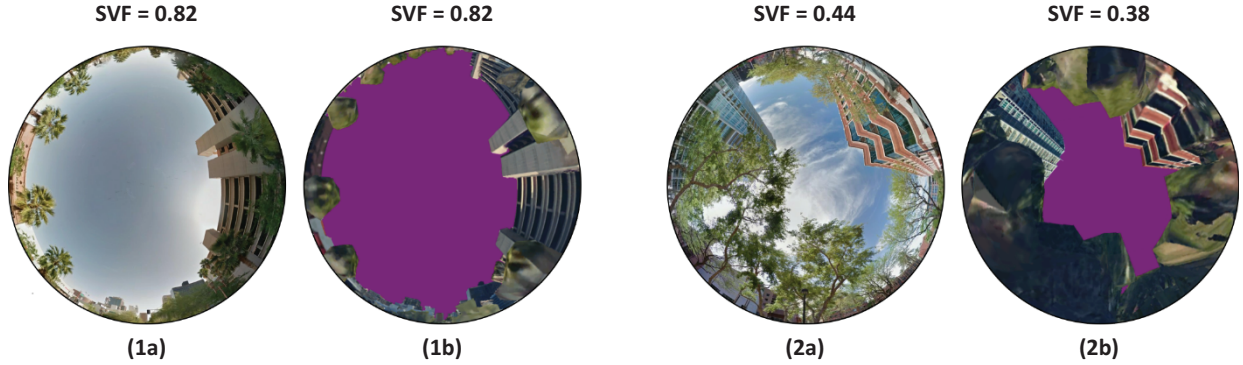

Figure 2. Comparison of fisheyes and Sky View Factors generated from Google Street View images (1a, 2a) and Google Earth 3D meshes (1b, 2b).

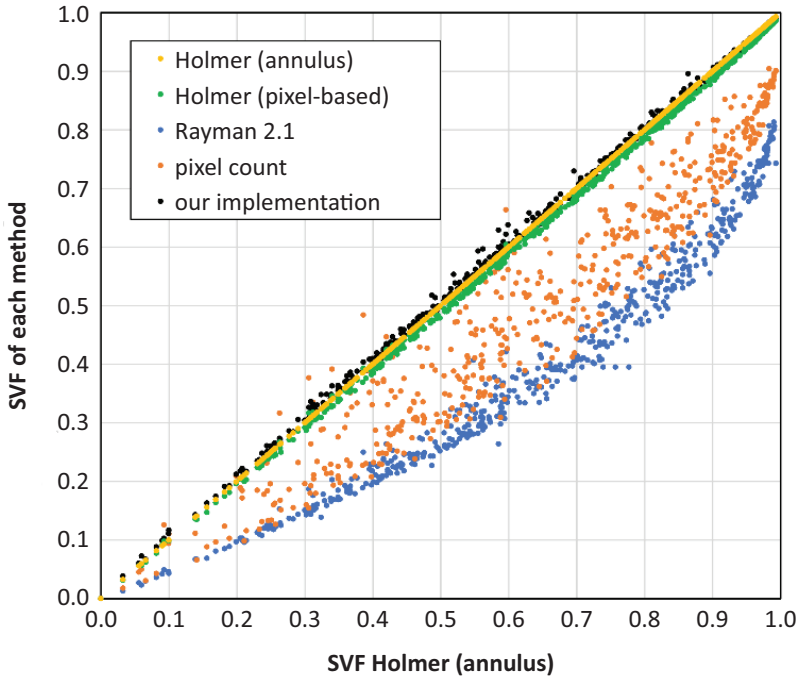

Figure 3. Our Sky View Factor implementation compared to other algorithms.

showing that the RayMan model significantly underestimates SVFs, especially in the midrange, when Lambert's law is not considered for the pixel weighting. Lastly, simply calculating the ratio between sky and non-sky pixels yields inaccurate results, since this approach does not account for angular distortion.

3.2. High-Resolution Sky View Factor Maps in 3D

To illustrate the spatial variability of horizon limitations in urban areas, we created SVF maps at 5 m resolution and 1.1 m height from synthetic Google Earth fisheye photos for two contrasting neighborhoods in the Phoenix metropolitan area—a residential area in the City of Phoenix (Ahwatukee, Lakewood community) and Phoenix Downtown (Figure 4). The residential subdivision is a neighborhood with detached single family homes, approximately 2.4 km by 1.8 km, and can be classified as an Open Lowrise Local Climate Zone (Stewart & Oke, 2012). The Downtown area is 2 km by 3 km and classified Open to Compact Highrise. The SVF maps were created in ArcGIS and exported as KML for display in Google Earth, clamped to the ground, with 3D terrain activated. While the core Downtown area exhibits low SVFs (< 0.40) near office buildings, SVFs in the central business district are generally high due to wide streets (number of fisheyes: 168,266; mean SVF: 0.76; standard deviation: 0.17). The Ahwatukee suburb is characterized by even higher SVFs (number of fisheyes: 97,393; mean SVF: 0.86; standard deviation: 0.14), except to the northwest, where a 3-story apartment complex lowers SVFs to 0.50. The close-up views of the areas clearly highlight the importance of trees for SVF calculations.

4. Case Study: Thermal Comfort Maps for Pedestrian Routing

We demonstrate the utility of our synthetic fisheye approach through a case study that highlights how urban form and vegetation impacts thermal comfort and walkability. As a study area, we chose Arizona State University's main campus, located in the City of Tempe, Arizona. Tempe is an ideal urban area for heat stress studies, because it is located in the Sonoran Desert and has a semi-arid climate with hot and dry summers. Average maximum air temperature peaks at 40.4°C between June and August, and monthly precipitation is less than 1 mm in June (Western Regional Climate Center, 2016). Most of Arizona State University's Tempe campus is designated as a walk-only zone during weekdays from 8:00h to 16:00h; no one may ride, drive, or park wheeled vehicles. With over 50,000 students and faculty on campus, increasing pedestrian thermal comfort through heat mitigation measures is especially important during the summer months. For this study, we selected a 3×3 Google Maps tile area (ca. 750 m $\times$ 750 m) that encompasses the north-west corner of the main campus and corresponds to an open low- to midrise Local Climate Zone with a mean SVF of 0.52 ± 0.18 (Figure 5).

We ran the automated version of RayMan for 19,600 synthetic fisheye photos in the study area at 1.1 m height on a 5 m grid for August 7, 2016, a week before classes started. Weather conditions were hot and clear, with a daily maximum temperature of 43°C, minimum temperature of 30°C, average dew point of 14°C, and light wind (< 1.5 ms^{-1}). As meteorological model input, we used observations from an hourly microclimate transect that

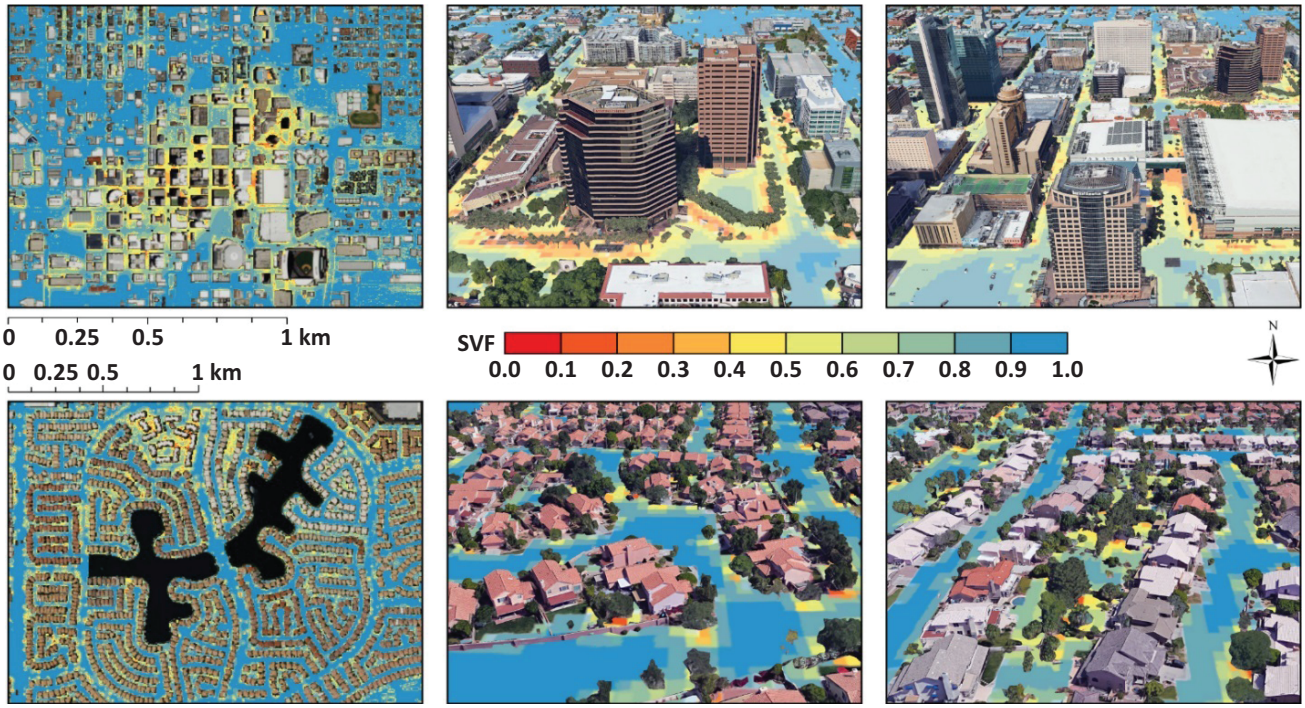

Figure 4. High-resolution Sky View Factor maps (1.1 m height) for Phoenix Downtown, Arizona, USA (top) and a residential subdivision in Phoenix, Arizona, USA (bottom) superimposed on Google Earth 3D terrain; bird's eye view and two tilted close-up views.

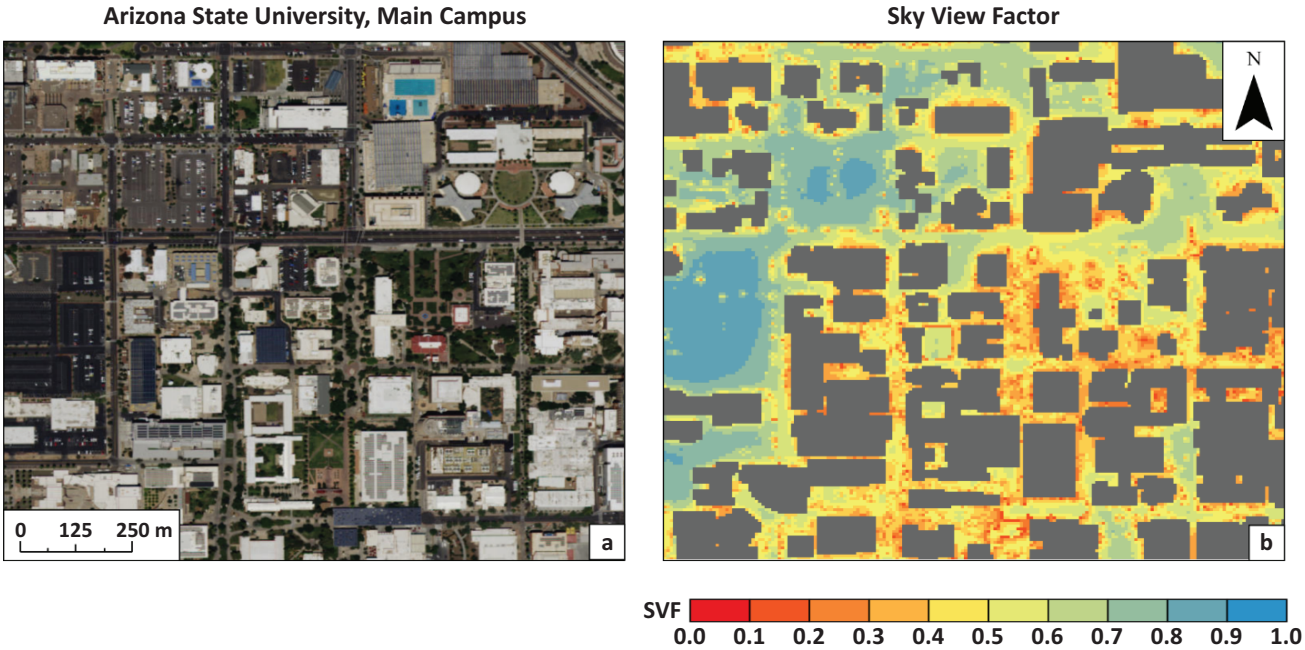

Figure 5. Aerial photo (a) and high-resolution Sky View Factor map at 1.1 m height (b) for the north-west corner of Arizona State University's Tempe campus.

was conducted on campus between 8:00h and 19:00h on August 7, 2016. Air temperature, relative humidity, and wind speed were logged at 1.5 m and 2 s intervals during the transect, linearly time-detrended to the full hour, and spatially averaged to yield representative mean values for the study area. For the thermal comfort routing application, we focused on 9:00h in the morning and 17:00h in the late afternoon, shortly after peak air temperature, and assumed a walking 35 years old male in a t-shirt and shorts (Table 1).

4.1. Thermal Comfort Model Performance

The fine-scale modeling results for Arizona State University's campus highlight direct radiation as an important driver of MRT. Shade, i.e. the absence of direct incom-

Table 1. Meteorological data for August 7, 2016, and personal characteristics used as input for thermal comfort modeling.

	Air Temperature [°C]	Relative Humidity [%]	Wind Speed [ms^{-1}]	Age	Gender	Weight [kg]	Height [m]	Clothing [clo]	Metabolic Rate [Wm^{-2}]
09:00h	33.6	35.8	0.9	35	Male	75	1.75	0.5	110
17:00h	41.6	23.1	0.6						

ing shortwave radiation, causes discontinuities in MRT, illustrated by two separate color-schemes for shaded and unshaded locations on the map (Figure 6). Shaded locations range from 49.0°C to 50.0°C MRT (49.4°C to 50.1°C MRT) in the morning (afternoon), while sun-exposed areas are upwards of 58.6°C MRT (57.2°C MRT). The map further suggests that MRT is slightly increased near vertical urban features. Although an increase in emitted longwave radiation is expected from sun-facing walls that are or have been exposed to direct radiation, and therefore become a source of radiant heating, the same does not necessarily apply to permanently shaded surfaces and trees. This is a known limitation of the RayMan model; it assumes the same thermal properties for all solid surfaces in the fisheye image and the lower hemisphere, which can lead to an overestimation of longwave radiation from surfaces.

To test model performance, we compared the RayMan simulated MRT results to six-directional radiant flux density observations from an on-campus field measurement campaign on August 7, 2016 (Figure 6). 3D radiant flux densities were sampled at 20 locations across campus every hour from 8:00h to 19:00h using three Hukseflux 4 component net radiometers mounted on a mobile instrument platform at 1.1 m height above ground. The sampling sites were traversed within 45 minutes, including a one minute stop at each location to account for sensor lag. MRT was calculated from the observations following ISO 7726 (1998). The sites were selected to span a wide variety of sun-exposure and surface cover combinations (Table 2). Exposure settings include open sites, shade from trees, east-west canyons, and a building overhang; surface cover varies between concrete, grass, soil, and gravel.

A comparison of modeled and observed MRT shows considerable differences for most locations (Table 2). Although RayMan explains 84.4% of the variance in MRT, the model consistently overestimates shaded and underestimates sun-exposed sites (*RMSE*=7.33; *MBE*=3.69; *MAE*=6.83; *d*=0.72). This indicates that the model accurately captures the differences in MRT between shaded and sun-exposed locations due to incoming shortwave radiation, but has difficulties to resolve the heterogeneity of urban form. Our results are in agreement with

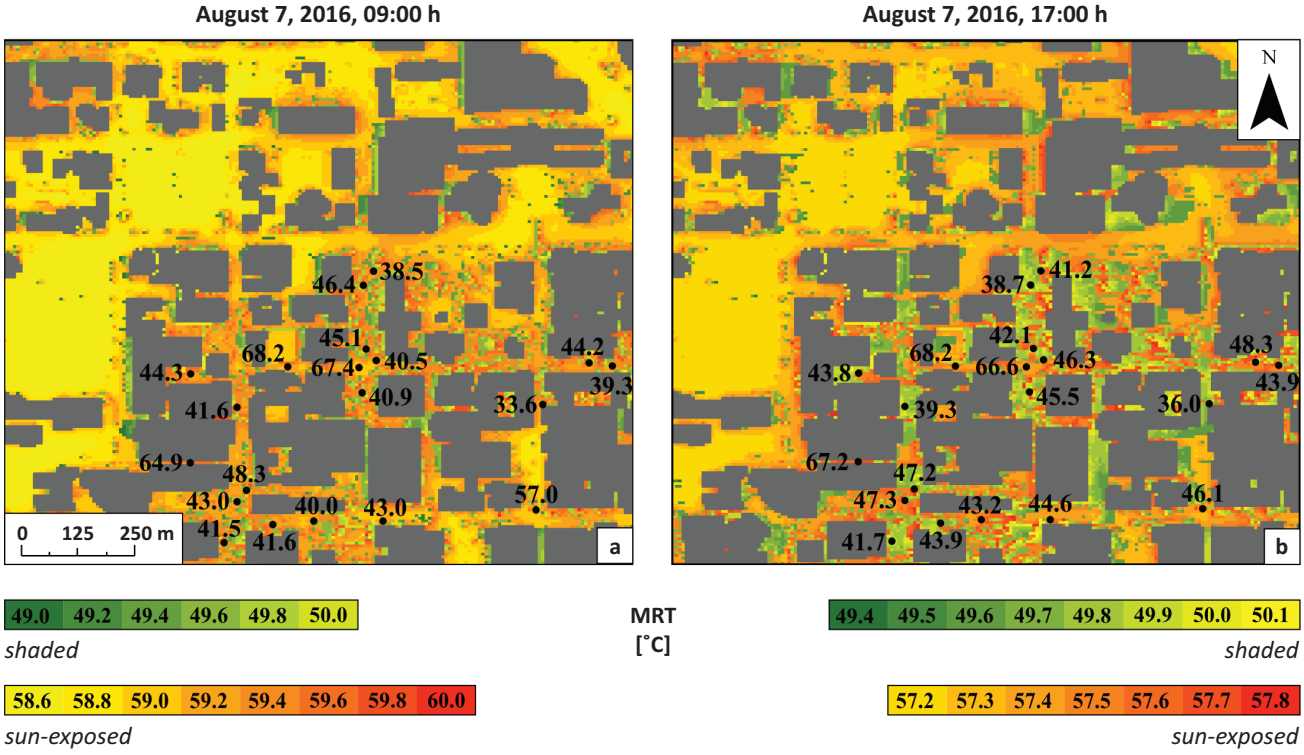

Figure 6. Simulated mean radiant temperature (MRT) map of the study site for 09:00h (a) and 17:00h (b) on August 7, 2016, with on-site mean radiant temperature observations.

Thorsson et al. (2007) who found that RayMan underestimates sun-exposed sites under clear conditions in Göteborg, Sweden, and with Lee and Mayer (2016) who found that RayMan overestimates low and underestimates high MRT observations in Freiburg, Germany. Yet, RayMan performed better in our setting than during a field experiment in Glasgow by Krüger, Minella and Matzarakis (2014) who reported RMSE values upwards of 10°C in a comparison of various methods to estimate MRT. Despite the divergence between observed and modeled MRT values, we conclude that RayMan yields reasonable estimates to demonstrate the utility of our thermal comfort routing application. Improving MRT simulations is beyond the scope of this paper, but implementing a refined radiation scheme for our synthetic fisheye approach is part of ongoing work.

4.2. Pedestrian Routing

Based on the RayMan model output for PET, we suggest walking routes across campus that are tailored to thermal comfort preferences. We employed the Dijkstra (1959) algorithm to calculate the shortest path between two locations in the study area and incorporated a weighting that accounts for PET preferences of an individual. The "comfort over distance" parameter α controls the importance of thermal comfort for navigation, i.e. $\alpha = 0$ yields the shortest path and $\alpha \to \infty$ yields the most comfortable path, minimizing average PET of a route. For our case study, we selected a route starting at the Ira A. Fulton Schools of Engineering Brickyard north-west of the Tempe campus and ending at the Memorial Union in the campus center. The Brickyard building complex is located on Mill Avenue, a pedestrian-friendly street in the heart of Tempe with many restaurants, cafes, bars, and shops. The Memorial Union offers student support services and is a major activity hub at the campus core. We calculated the shortest path ($\alpha = 0$), a more comfortable path ($\alpha = 2$), and the most comfortable path ($\alpha \to \infty$) from the Brickyard to the Memorial Union for August 7, 2016, 9:00h and 17:00h (Figure 7). With increasing willingness to walk further, optimal comfort routes divert from the shortest path to navigate pedestrians through shade from buildings and trees instead of exposing them to the sun. Routes also vary by time of day, as the sun position changes shade patterns from buildings and trees. At 9:00h, shade is generated to the west of urban features and the most comfortable route leads through a tree-lined north-south canyon between midrise buildings. At a walking speed of 1.4 ms^{-1}, the route is 65 m and 48 s longer than the shortest route (995 m, 11 min and 48 s), lowers sun exposure by 7.5%, and increases average thermal comfort from 43.4 to 42.9°C PET (Table 3). At 17:00h, when shade is generated to the east at a low sun angle, the most comfortable path leads along the east side of a group of high-rise buildings through an almost completely shaded north-south canyon. The route is 97 m longer than the shortest path (997 m, 11 min and 54 s), adding 1 min and 6 s to the trip but reducing sun exposure by 10%.

Table 2. Site description and comparison of simulated vs. observed mean radiant temperature for 20 locations in the study area for August 7, 2016 at 9:00h and 17:00h.

				09:00 h			17:00 h		
Stop ID	**Exposure**	**Location**	**Surface Cover**	MRT_{obs} [°C]	MRT_{calc} [°C]	$MRT_{calc} - MRT_{obs}$ [°C]	MRT_{obs} [°C]	MRT_{calc} [°C]	$MRT_{calc} - MRT_{obs}$ [°C]
1	shade	under tree	concrete	44.3	49.6	5.3	43.8	49.9	6.1
2	sun	E-W walkway	concrete	68.2	59.6	−8.6	68.2	57.5	−10.7
3	shade	under tree	soil	46.4	49.8	3.4	38.7	49.4	10.7
4	shade	under tree	grass	38.6	49.8	11.3	41.2	49.6	8.4
5	shade	under tree	grass	45.1	50.0	4.9	42.1	49.9	7.8
6	shade	under tree	gravel	40.5	49.4	8.9	46.3	49.7	3.4
7	sun	intersection	concrete	67.4	58.9	−8.5	66.6	57.4	−9.2
8	shade	under tree	concrete	40.9	49.6	8.7	45.5	50.0	4.5
9	shade	under palm trees	concrete	44.2	50.0	5.8	48.3	50.0	1.7
10	shade	under tree	soil	39.3	49.8	10.5	43.9	49.9	6.0
11	shade	under overhang	concrete	33.6	49.4	15.8	36.0	49.9	13.9
12	shade	under tree	concrete	57.0	49.2	−7.8	46.1	49.7	3.6
13	shade	under tree	concrete	43.0	49.4	6.4	44.6	49.8	5.2
14	shade	under tree	grass	40.0	49.3	9.3	43.2	49.8	6.6
15	shade	under tree	concrete	41.5	49.4	7.9	41.7	49.9	8.2
16	shade	under tree	concrete	41.6	49.5	7.9	43.9	49.8	5.9
17	shade	under tree	concrete	43.0	49.5	6.6	47.3	49.8	2.5
18	shade	under tree	concrete	48.3	49.3	1.0	47.2	49.8	2.6
19	sun	E-W canyon	concrete	64.9	59.5	−5.4	67.2	57.7	−9.5
20	shade	under tree	concrete	41.6	49.9	8.3	39.3	49.9	10.6

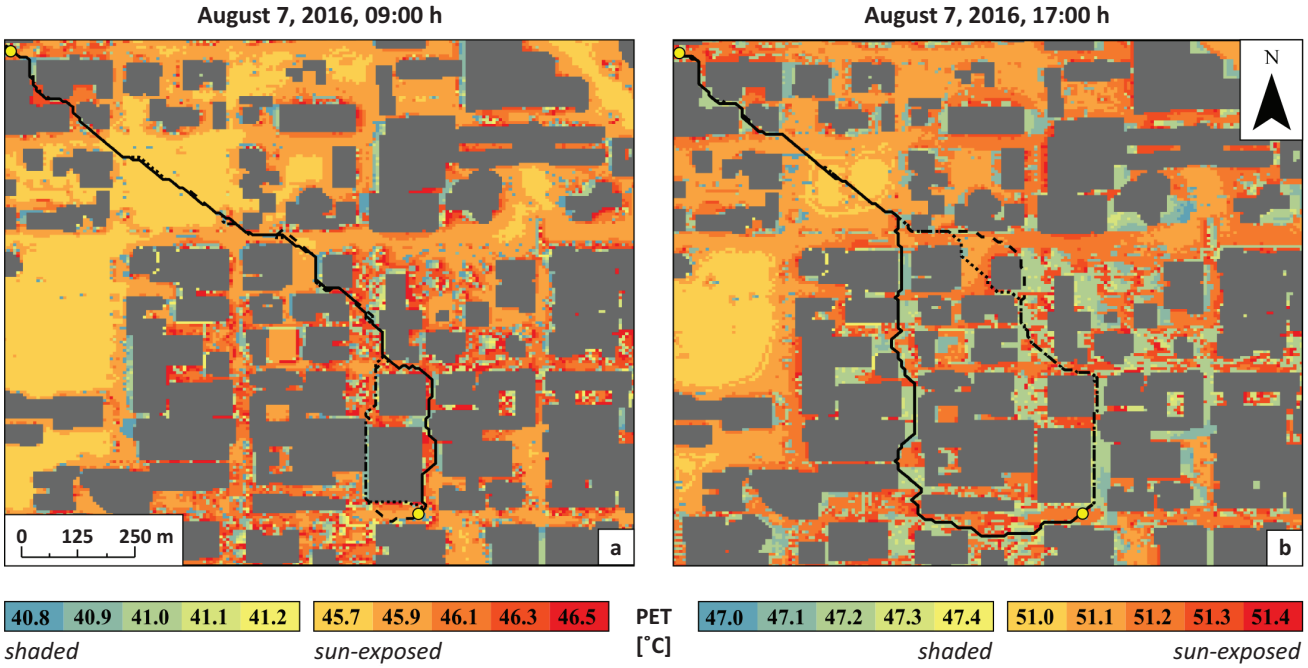

Figure 7. Thermal comfort map (Physiologically Equivalent Temperature, PET, in °C) for Arizona State University's Tempe campus for August 7, 2016, 09:00h (a) and 17:00h (b); Shortest path (dotted line) from the Ira A. Fulton Schools of Engineering (Brickyard) to the Memorial Union, slightly longer, but more comfortable route (dashed line), and most comfortable path (solid line).

Table 3. Route statistics on length, walking duration (at 1.4 ms^{-1}), average thermal comfort (PET), and sun exposure for three thermal comfort preferences ($\alpha = 0, 2, \alpha \to \infty$) at two different times of day (9:00h and 17:00h) on August 7, 2016.

	09:00h			17:00h		
	$\alpha = 0$	$\alpha = 2$	$\alpha \to \infty$	$\alpha = 0$	$\alpha = 2$	$\alpha \to \infty$
Length [m]	995	1020	1057	997	1016	1094
Duration [min]	11.8	12.1	12.6	11.9	12.1	13.0
Average PET [°C]	43.4	43.2	42.9	48.7	48.5	48.3
Sun Exposure [%]	50.5	45.0	43.0	37.1	33.3	27.4
Sun Exposure [min]	6.0	5.5	5.4	4.4	4.0	3.6

Considering the hot dry thermal conditions on August 7, detours from the shortest path are short and reasonable, and at the same time significantly reduce sun exposure, especially in the late afternoon when sun angles are low. Thermal comfort differences in the shortest and most comfortable path are expected to be more pronounced for longer distances and in more heterogeneous urban forms. Results will also differ in other climatic conditions where humidity or wind speed might play a more significant role in determining thermal comfort and during the winter when deciduous trees have lost their leaves.

5. Discussion and Conclusions

We developed a methodology to generate synthetic fisheye images based on Google Earth 3D data for urban areas at fine spatial resolution. The hemispherical images can be used to derive urban form and climate metrics such as SVF, duration of sun exposure, MRT, and the thermal comfort index PET. Our approach is novel in that it combines several advantages of existing approaches. First, urban form and climate metrics can be calculated automatically for large urban areas independent of available 3D building databases, DSMs, or DEMs. Second, trees are included in the 3D urban geometry; trees are important shade providers at the pedestrian level that must be considered in fine-scale outdoor thermal comfort applications. Our synthetic fisheye images compared well to real world hemispherical photos retrieved from Google Street View, but are currently more difficult to generate, because the most recent Google Earth API does not support direct access.

The presented SVF approach integrates well with existing thermal comfort models that use fisheye photographs to model radiation fluxes. However, refinement

of the physical properties and sun-exposure of the solid surfaces in those fisheye-based models is needed to resolve the heterogeneity in urban areas and estimate thermal comfort more accurately.

In a heat mapping case study, we demonstrated the utility of our synthesized fisheye images for pedestrian thermal comfort routing on Arizona State University's Tempe campus. We introduced the "comfort over distance" parameter α that minimizes average PET exposure for a route based on a pedestrian's willingness to walk further. Integrating personalized thermal comfort preferences as a weighting factor, we estimated a pedestrian's exposure time to direct sun given a route, walking speed, and overall thermal comfort. The current routing algorithm minimizes average PET with increasing α, but the duration, frequency, and magnitude of personal exposure to heat affects thermal comfort as well (Kuras et al., in press). The time spent walking above a certain PET threshold presents an alternative metric similar to the Extreme Degree-Minute approach employed by Karner, Hondula and Vanos (2015) that could be implemented as weighting factor. Our algorithm can further be extended to provide more individualized thermal comfort routes incorporating multiple weighting factors, e.g., traffic-related air pollution and accessibility to cooling facilities such as water fountains, shops, and cooling centers.

Our individualized thermal comfort maps demonstrate how urban form, represented here by the SVF, impacts walkability and pedestrian outdoor thermal comfort. As navigational aid, these maps have the potential to significantly reduce thermal stress on pedestrians. They can help the public to better prepare for outdoor activities by visualizing how thermal conditions "feel" and how they vary within the urban area. Thermal comfort maps can also provide useful information for urban planners. They can be employed to assess neighborhood walkability, determine hotspots, and support heat hazard mitigation efforts, e.g., inform targeted tree planting in cities to maximize thermal comfort outcomes.

Thermal comfort outcomes are significantly influenced by how we design cities, i.e. the layout and types of buildings, streets, and vegetation. Thermal comfort maps from synthetic fisheye photos provide important insights that, integrated into urban planning processes, can inform future city design to create more climate-sensitive outdoor spaces.

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Conflict of Interests

The authors declare no conflict of interests.

References

Bradley, A. V., Thornes, J. E., & Chapman, L. (2001). A method to assess the variation of urban canyon geometry from sky view factor transects. *Atmospheric Science Letters*, *2*(1-4), 155–165.

Brandsma, Theo, & Wolters, Dirk. (2012). Measurement and statistical modeling of the urban heat island of the city of Utrecht (The Netherlands). *Journal of Applied Meteorology and Climatology*, *51*(6), 1046–1060.

Chapman, L., & Thornes, J. E. (2004). Real-time sky-view factor calculation and approximation. *Journal of Atmospheric and Oceanic Technology*, *21*(5), 730–741.

Chapman, L., Thornes, J. E., & Bradley, A. V. (2001). Rapid determination of canyon geometry parameters for use in surface radiation budgets. *Theoretical and Applied Climatology*, *69*(1-2), 81–89.

Chen, L., Ng, E., An, X., Ren, C., Lee, M., Wang, U., & He, Z. (2012). Sky view factor analysis of street canyons and its implications for daytime intra-urban air temperature differentials in high-rise, high-density urban areas of Hong Kong: A GIS-based simulation approach. *International Journal of Climatology*, *32*(1), 121–136.

Chen, L., Yu, B., Yang, F., & Mayer, H. (2016). Intra-urban differences of mean radiant temperature in different urban settings in Shanghai and implications for heat stress under heat waves: A GIS-based approach. *Energy and Buildings*, *130*, 829–842.

Coutts, A. M., White, E. C., Tapper, N. J., Beringer, J., & Livesley, S. J. (2016). Temperature and human thermal comfort effects of street trees across three contrasting street canyon environments. *Theoretical and Applied Climatology*, *124*(1-2), 55–68.

Dijkstra, E. W. (1959). A note on two problems in connexion with graphs. *Numerische Mathematik*, *1*(1), 269–271.

Erell, E., Pearlmutter, D., & Williamson, T. (2012). *Urban microclimate: Designing the spaces between buildings*. London: Earthscan.

Gál, T., Lindberg, F., & Unger, J. (2009). Computing continuous sky view factors using 3D urban raster and vector databases: Comparison and application to urban climate. *Theoretical and Applied Climatology*, *95*(1-2), 111–123.

Gál, T., & Unger, J. (2014). A new software tool for SVF calculations using building and tree-crown databases. *Urban Climate*, *10*, 594–606.

Grimmond, C. S. B., Potter, S. K., Zutter, H. N., & Souch, C. (2001). Rapid methods to estimate sky-view factors applied to urban areas. *International Journal of Climatology*, *21*(7), 903–913.

Hämmerle, M., Gál, T., Unger, J., & Matzarakis, A. (2011). Comparison of models calculating the sky view factor used for urban climate investigations. *Theoretical and Applied Climatology*, *105*(3-4), 521–527.

Herrmann, J., & Matzarakis, A. (2012). Mean radiant temperature in idealised urban canyons—Examples from

Freiburg, Germany. *International Journal of Biometeorology*, *56*(1), 199–203.

Holmer, B., Postgård, U, & Eriksson, M. (2001). Sky view factors in forest canopies calculated with IDRISI. *Theoretical and Applied Climatology*, *68*(1-2), 33–40.

Höppe, P. (1999). The physiological equivalent temperature—A universal index for the biometeorological assessment of the thermal environment. *International Journal of Biometeorology*, *43*(2), 71–75.

ISO 7726. (1998). *Ergonomics of the thermal environment—Instruments for measuring physical quantities*. (International Standard, 2nd ed.). Geneva: International Organization for Standardization (ISO).

Johansson, E., & Emmanuel, R. (2006). The influence of urban design on outdoor thermal comfort in the hot, humid city of Colombo, Sri Lanka. *International Journal of Biometeorology*, *51*(2), 119–133.

Johansson, E., Thorsson, S., Emmanuel, R., & Krüger, E. (2014). Instruments and methods in outdoor thermal comfort studies—The need for standardization. *Urban Climate*, *10*, 346–366.

Johnson, G. T, & Watson, I. D. (1984). The determination of view-factors in urban canyons. *Journal of Climate and Applied Meteorology*, *23*(2), 329–335.

Jones, B., O'Neill, B. C., McDaniel, L., McGinnis, S., Mearns, L. O., & Tebaldi, C. (2015). Future population exposure to US heat extremes. *Nature Climate Change*, *5*(7), 652–655.

Karner, A., Hondula, D. M., & Vanos, J. K. (2015). Heat exposure during non-motorized travel: Implications for transportation policy under climate change. *Journal of Transport & Health*, *2*(4), 451–459.

Krüger, E. L., Minella, F. O., & Rasia, F. (2011). Impact of urban geometry on outdoor thermal comfort and air quality from field measurements in Curitiba, Brazil. *Building and Environment*, *46*(3), 621–634.

Krüger, E. L., Minella, F. O., & Matzarakis, A. (2014). Comparison of different methods of estimating the mean radiant temperature in outdoor thermal comfort studies. *International Journal of Biometeorology*, *58*(8), 1727–1737.

Kuras, E. R., Bernhard, M. C., Calkins, M. M., Ebi, K. L., Hess, J. J., Kintziger, K. W., . . . Hondula, D. M. (in press). Opportunities and challenges for personal heat exposure research. *Environmental Health Perspectives*.

Laungrungthip, N., McKinnon, A. E., Churcher, C. D., & Unsworth, K. (2008). *Edge-based detection of sky regions in images for solar exposure prediction*. Paper presented at the 2008 23rd International Conference Image and Vision Computing New Zealand.

Lee, H., Holst, J., & Mayer, H. (2013). Modification of human-biometeorologically significant radiant flux densities by shading as local method to mitigate heat stress in summer within urban street canyons. *Advances in Meteorology*, *2013*, 13.

Lee, H., & Mayer, H. (2016). Validation of the mean radiant temperature simulated by the RayMan software in urban environments. *International Journal of Biometeorology*, *60*(11), 1775–1785.

Lenzholzer, S, & Brown, R. D. (2016). Post-positivist microclimatic urban design research: A review. *Landscape and Urban Planning*, *153*, 111–121.

Lin, T. P. (2009). Thermal perception, adaptation and attendance in a public square in hot and humid regions. *Building and Environment*, *44*(10), 2017–2026.

Lin, T. P., Matzarakis, A., & Hwang, R. L. (2010). Shading effect on long-term outdoor thermal comfort. *Building and Environment*, *45*(1), 213–221.

Lindberg, F., & Grimmond, C. S. B. (2011). The influence of vegetation and building morphology on shadow patterns and mean radiant temperatures in urban areas: Model development and evaluation. *Theoretical and Applied Climatology*, *105*(3-4), 311–323.

Lindberg, F., Holmer, B., & Thorsson, S. (2008). SOLWEIG 1.0—Modelling spatial variations of 3D radiant fluxes and mean radiant temperature in complex urban settings. *International Journal of Biometeorology*, *52*(7), 697–713.

Matzarakis, A., & Matuschek, O. (2011). Sky View Factor as a parameter in applied climatology—Rapid estimation by the SkyHelios Model. *Meteorologische Zeitschrift*, *20*(1), 39–45.

Matzarakis, A., Rutz, F., & Mayer, H. (2007). Modelling radiation fluxes in simple and complex environments—Application of the RayMan model. *International Journal of Biometeorology*, *51*(4), 323–334.

Matzarakis, A., Rutz, F., & Mayer, H. (2010). Modelling radiation fluxes in simple and complex environments: Basics of the RayMan model. *International Journal of Biometeorology*, *54*(2), 131–139.

Mayer, H., & Höppe, P. (1987). Thermal comfort of man in different urban environments. *Theoretical and Applied Climatology*, *38*(1), 43–49.

Middel, A., Häb, K., Brazel, A. J., Martin, C., & Guhathakurta, S. (2014). Impact of urban form and design on microclimate in Phoenix, AZ. *Landscape and Urban Planning*, *122*, 16–28.

Middel, A., Selover, N., Hagen, B., & Chhetri, N. (2016). Impact of shade on outdoor thermal comfort—A seasonal field study in Tempe, Arizona. *International Journal of Biometeorology*, *60*(12), 1849–1861.

Ng, E., & Cheng, V. (2012). Urban human thermal comfort in hot and humid Hong Kong. *Energy and Buildings*, *55*, 51–65.

Nikolopoulou, M., & Lykoudis, S. (2006). Thermal comfort in outdoor urban spaces: Analysis across different European countries. *Building and Environment*, *41*(11), 1455–1470.

National Oceanic and Atmospheric Administration. (2015, September 29). *Natural hazard statistics*. Retrieved from http://www.nws.noaa.gov/om/hazstats.shtml

Oke, T. R. (1981). Canyon geometry and the nocturnal urban heat island: Comparison of scale model and field observations. *Journal of Climatology*, *1*(3), 237–254.

Oliveira, S., Andrade, H., & Vaz, T. (2011). The cooling effect of green spaces as a contribution to the mitigation of urban heat: A case study in Lisbon. *Building and Environment*, *46*(11), 2186–2194.

Pearlmutter, D., Bitan, A., & Berliner, P. (1999). Microclimatic analysis of "compact" urban canyons in an arid zone. *Atmospheric Environment*, *33*(24), 4143–4150.

Ratti, C., Baker, N., & Steemers, K. (2005). Energy consumption and urban texture. *Energy and Buildings*, *37*(7), 762–776.

Stewart, I. D., & Oke, T. R. (2012). Local climate zones for urban temperature studies. *Bulletin of the American Meteorological Society*, *93*(12), 1879–1900.

Steyn, D. G. (1980). The calculation of view factors from fisheye-lens photographs: Research note. *Atmosphere-Ocean*, *18*(3), 254–258.

Thorsson, S., Lindqvist, M., & Lindqvist, S. (2004). Thermal bioclimatic conditions and patterns of behaviour in an urban park in Göteborg, Sweden. *International Journal of Biometeorology*, *48*(3), 149–156.

Thorsson, S., Lindberg, F., Eliasson, I., & Holmer, B. (2007). Different methods for estimating the mean radiant temperature in an outdoor urban setting. *International Journal of Climatology*, *27*(14), 1983–1993.

Unger, J. (2004). Intra-urban relationship between surface geometry and urban heat island: Review and new approach. *Climate Research*, *27*, 253–264.

Unger, J. (2009). Connection between urban heat island and sky view factor approximated by a software tool on a 3D urban database. *International Journal of Environment and Pollution*, *36*(1-3), 59–80.

Vanos, J., Warland, J. S., Gillespie, T. J., & Kenny, N. A. (2010). Review of the physiology of human thermal comfort while exercising in urban landscapes and implications for bioclimatic design. *International Journal of Biometeorology*, *54*(4), 319–334.

Verein Deutscher Ingenieure. (1994). *VDI 3789 part 2: Environmental meteorology, interactions between atmosphere and surfaces; calculation of the short-and long wave radiation VDI guideline* (Vol. 3789, pp. 52). Berlin: Beuth.

Western Regional Climate Center. (2016). *NCDC 1981–2010 normals for Tempe ASU, Arizona (028499)*. Retrieved from http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?az8499

White, M., Hu, Y., Langenheim, N., Ding, W., & Burry, M. (2016). Cool city design: Integrating real-time urban canyon assessment into the design process for Chinese and Australian cities. *Urban Planning*, *1*(3), 25–37.

Zakšek, K., Oštir, K., & Kokalj, Ž. (2011). Sky-view factor as a relief visualization technique. *Remote Sensing*, *3*(2), 398–415.

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Article

‘Our Changes’? Visions of the Future in Nairobi

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Abstract
In Kenya, the Vision 2030 masterplan is radically reimagining Nairobi as a ‘world class’ city of the future. This has generated dramatic digital imagery of satellite cities, skyscrapers and shopping malls. For tenants in rundown public housing, these glossy yet speculative visions are enticing, but also provoke anxieties of exclusion. Yet so far, little has materially manifested. This article explores the effects these future vistas produce in the present, in the gap between the urban plan and its implementation. It argues that the spectacle of official planning has generated anticipatory actions, as Nairobians’ engage with the future promised by such schemes. These actions are characterised by dissonant temporal experiences, in which local residents experience the future city as both near at hand and forever out of reach.

Keywords
Kenya; megaprojects; Nairobi; temporality; urban planning; visual culture

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1. Introduction

New urban fantasies have been flourishing across Africa in recent years. Rwanda, Ghana, Angola, Tanzania, Nigeria, Democratic Republic of Congo and Kenya have all seen their governments launch urban megaprojects that promise to radically reshape African cities. Typified by spectacular infrastructural projects and new satellite cities, these schemes are also envisioned as gateways for global capital, forming a new node in a network of hub cities that include Singapore, Kuala Lumpur, Dubai and Hyderabad. This article focuses on such visions of the future in Nairobi, Kenya, and in particular the disconnect between the government’s ‘Vision 2030’ initiative and the lives of ordinary citizens. Fantasies of the city’s future form are already visible in Nairobi, through advertisements, billboards and computer-generated imagery that circulate in the present. But the actual realisation of such plans has been slow to materialise. Yet even though little may have materially manifested on the ground, nevertheless the spectacle of official planning has set in motion many kinds of anticipatory actions, as Nairobians engage with the future promised by such schemes. In the temporal and spatial gap between the plan and its manifestation, I argue, Nairobi residents experience the future as simultaneously close at hand and impossibly far off.

2. Vision 2030 and the ‘World Class’ City

‘Vision 2030’ is the Kenyan government’s development blueprint for the country’s future (see Linehan, 2007; Manji, 2015; Myers, 2014). Launched in 2007 by the then President Mwai Kibaki, Kenya Vision 2030 mobilises the now-familiar vocabularies of neoliberal development, emphasising competition, management, performance and accountability as it seeks to create an ‘issue-based, people-centred, results-oriented and accountable democratic system’ (Kenya Vision2030, n.d.). Nested within this larger vision is ‘Nairobi Metro 2030’, a strategy to reinvent Nairobi as a ‘world class African metropolis’ and ‘an iconic and globally attractive city’ oriented towards

ICT services, global corporations and business investment (Government of Kenya, 2008). In 2008, the Kenyan government launched a new ministry, the Ministry of Nairobi Metropolitan Development, tasked with implementing this vision for the city. The flagship projects of Nairobi Metro 2030 are not located in the existing city, but are two satellite cities planned for Nairobi's periphery: Tatu City and Konza Techno City—dubbed 'Silicon Savannah' by the Kenyan and international media. To be financed by conglomerates of private capital and developed and managed through private partnerships, such urban plans exemplify 'the spread of neo-liberal ideology that brings state and national governments into close collaboration with corporations' (Moser, 2015, p. 31).

Vision 2030 presents a hyper-capitalist, technologically futuristic vision of Nairobi as a model 'global city' (Sassen, 1991). Far from developing an urban strategy that would enhance the distinctive qualities of Nairobi, Vision 2030 conforms to the spatial logics and aesthetics of a certain brand of global city masterplanning. In a process Bunnell and Das have described as 'urban replication', a small but seductive set of visions, policies and templates have duplicated the same spectacular skylines, neoliberal structuring and corporate management systems in multiple city plans across Asia and Africa (Bunnell & Das, 2010, p. 278). This process has had the effect of producing an aspirational uniformity; a placeless urban morphology that is at once nowhere and everywhere (Moser, 2015, p. 32). Such imitative practices are in part a consequence of the promise of spectacular technological and infrastructural transformation. In the eyes of many regional leaders, the perceived success of early adopters of the 'world class' approach made them worthy models for emulation. The global reach of cities such as Kuala Lumpur, Dubai and Singapore has validated a set of urban planning approaches rooted in economic liberalisation, corporate-led urban development and management, and gleaming, high-rise architecture.

But urban replication is not just emulative from a distance; it is also rooted in specific corporate practice. Notably, a small network of experts and consultants have been involved in the masterplanning of many of these 'world class' cities. Kenya's Vision 2030 strategy was developed in conjunction with the international consultancy firm McKinsey and Company, who over the last few decades have been at the heart of this trend (Linehan, 2007). Before arriving in Kenya, McKinsey previously worked in India on 'Vision Mumbai', also framed as a 'world-class city' (McKinsey, 2003) and on 'Andhra Pradesh 2020', which centred on the revisioning of Hyderabad through the construction of 'Cyberabad', a high-tech, IT-dominated satellite city. Earlier, in the 1990s, McKinsey had already set the standard for the new 'world class' city with the 'Malaysia 2020' strategy. Based not only on spectacular infrastructure but strategic imaging and brand management, this heralded the rise of the 'Asian tiger' economies and reinvention of Kuala Lumpur as a node for global investment. A new IT city called Cyberjaya was conceived, along with a 'Multimedia Super Corridor' and the Petronas Twin Towers: the iconic skyscraper of the new Asian order (Bunnell & Das, 2010, p. 278).

In this way, the re-imagining of Nairobi as a gleaming hub for global capital is another iteration of a limited range of transnationally circulating urban policies and architectural aesthetics which are restructuring cities in ways that suit the interests of multinational corporations and affluent, global elites (Murray, 2015, p. 92). The official websites of Konza City and Tatu City present dramatic, glossy visions of skyscrapers, lakes, parkland and shopping malls, with promises of 'exclusive urban living' that will 'redefine the quality and scale of urban development in Kenya' with the 'potential to become a benchmark for Africa' (Konza City, n. d.; Tatu City, n.d.). Such imaginings bear little relation to the congested, polluted, densely populated city of Nairobi of today; instead they present an idealised 'capsular' city, sealed off from a much messier urban reality (De Cauter, 2004). Often advertised as a 'city within a city' or 'self-contained', this enclaved existence is regarded as one of the attractions of such a plan (Watson, 2013, p. 229). For those with the economic and social capital to gain access, Konza and Tatu promise insulation from the supposed disorder and chaos of existing Nairobi life. Following a mode Roy has described as 'worlding', this is a typology for a future city that abandons the perceived failures and decay of the extant city, seeking to begin afresh on vacant land, creating new enclaves for a hyper-connected global elite (Roy, 2011). Such 'city doubles' are often privately operated: spaces where companies act as proxies for civic administration, managing urban security, infrastructure, waste management and other facilities for urban elites, whilst ordinary, lower income citizens make do with an increasingly decrepit urban landscape elsewhere (Murray, 2015, p. 99). In this regard, these urban megaprojects reproduce the spatial logics of colonial cities, perpetuating segregated urbanscapes underwritten by the languages of neoliberal capital that privilege 'world class' status over the spatial and economic justice of local inhabitants (Moser, 2015; Myers, 2014; Watson, 2013).

3. Visions and Realities

Yet despite its sweeping vision, pervasive imagery and presence in Kenyan public debate, very little of Vision 2030 has tangibly materialised in the ten years since it was launched. Many Kenyans now jokingly refer to it 'Vision 3020' to reflect the rate at which implementation has been proceeding. Konza City is little more than an enormous fenced-off site in the Ukambani plains; the same grass growing on the inside and the outside of the fence. Both Tatu and Konza have been plagued with political infighting, accusations of land grabbing and community tensions (Kamau, 2016; Nzuma, 2014). As Manji has noted, there are overlapping and sometimes contradictory external and internal factors that shape how infras-

tructural development proceeds in Kenya (Manji, 2015). Some commentators question whether the political will at the highest levels is even there: these were projects launched by the last president, and current President Uhuru Kenyatta seems to have little taste for them.

In addition to Konza and Tatu, Nairobi Metro 2030 also works as an umbrella for other fragmentary and less high-profile infrastructural plans in the city. These include a new mass transport strategy, the Nairobi Integrated Urban Plan (NIUPLAN) and the Nairobi Metropolitan Improvement Programme (NaMSIP). Far from being streamlined, these projects are often in competition with each other. Often launched under the aegis of different political factions, there is considerable confusion over institutional responsibility. Analysing the mass transport strategy, Klopp has outlined several factors behind its inadequate implementation that also speak to complications in realising Vision 2030 more broadly:

> No single agency or institution deals with all transport matters for the metropolitan region…The current fragmentation and lack of a public focal point works to allow the existing decision-making network a great deal of leeway to operate. It also allows decisions to be made in ways that favour interested parties within networks of politicians and bureaucrats linked to key ministries, while defusing responsibilities. (Klopp, 2011, p. 11)

Indeed, the Kenyan Anti-Corruption Commission has reported 'rampant corruption in the road construction contracts and collusion between contractors and government' (cited in Klopp, 2011, p. 11). In such a fragmented and murky climate—and in the wake of a global financial downturn that has undermined the investment of corporate capital—it's perhaps unsurprising there is little of Vision 2030 to be seen on the ground.

Nevertheless, despite its lack of implementation, delays and issues of corruption, Vision 2030 has still had a significant impact. The utopian vocabularies and visualisations of Nairobi as a world class city that are currently in circulation are powerfully affective in their own right. Several scholars have observed how these 'technologies of seduction' have been as crucial to developing the global brand of cities such as Kuala Lumpur, Shanghai and Hyderabad as any physically tangible infrastructure projects (Bunnell & Das, 2010, p. 281; Brosius, 2010; Jansson & Lagerkvist, 2009). In Nairobi, glossy digital simulations of brand new cities, billboards showing desirable homes, elaborate websites promising a 'competitive and prosperous nation' and 'middle income status by 2030' are aspirational and enchanting (Konza Techno City, no date). They influence not only policies but also everyday lives in the city, exerting a seductive hold over ordinary Nairobians and producing important material and imaginative effects. In the following sections I argue that rather than seeing the absence of infrastructural transformation on the ground as indicative of Vision 2030's failure, its visual and linguistic culture is materially and temporally significant in its own right. Attending to the digital, virtual and visual realm of Vision 2030 can also help to recalibrate scholarship on the efficacy of urban masterplanning, away from notions of success or failure based on the realisation or not of a specific plan, towards a more speculative, open-ended approach which recognises how digital simulations, consultancy reports, billboards and images of the future city act in the world. They are part of the 'stuff' out of which urban lives are remade and futures are reoriented—technologies of seductive power that become enmeshed in the fabric of urban life (Bunnell & Das, 2010, p. 282).

4. Image, Word, Form

Nairobi is far from the only place to experience a breach between urban dreams and their materialisation as physical realities. Discussing the reconstruction of central Berlin after the end of the wall, Andreas Huyssen noted the dazzling power exerted by visualisations of architecture in a mediatised cultural economy. He observed that the monumental effect of architecture can be just as easily—possibly better—achieved through a 'totalising image of architecture. No need even to build the real thing' (Huyssen, 2003, p. 47). Instead of demonstrating a future that is to be made actual, 'the very image of the city itself becomes central to its success in a globally competitive market' (Huyssen, 2003, p. 60). A similar process can be seen in the restructuring of Shanghai, where spectacular digital imagery, promotional videos, and graphics-heavy websites have turned the city into a 'visual sign', the production of which is increasingly a political project (Jansson & Lagerkvist, 2009, p. 26). Branded, packaged urban panoramas are not simply or even necessarily premonitions of actual built space to come, but achieve monumental seduction in themselves.

In Kinshasa, capital of the Democratic Republic of Congo, the urban techno-fantasy *Cité du Fleuve* imagines a vast new satellite city, to be built on artificial islands in the middle of the Congo River. An improbably huge leap from Kinshasa's current chaotic reality, *Cité du Fleuve* is more 'spectral' and 'chimerical' than convincing urban morphology (De Boeck, 2012). So vast is the gap between disintegrating urban present and futuristic megalopolis that the otherworldly skyline 'escapes from the real order of things', and 'it almost doesn't seem to matter whether the new city is physically built or not' (De Boeck, 2012, p. 323). Whereas for Huyssen or Jansson and Lagerkvist, it is the seductive power of imagery that constructs the future city without the need for actual materials, in Kinshasa, De Boeck argues, it is words: 'the only place where the city is constantly being built is in language, in the architecture of words' (2012, p. 324). Rather than expecting these fantasies to produce actual built forms, De Boeck argues that we should focus instead on 'the sheer force of the word' and accept that it is words that offer 'one of the most important building

blocks with which to conquer, alter, and erect the city over and over again' (2012, p. 324).

In Nairobi, the words and images of Vision 2030 are indeed erecting the city afresh, without seeming to advance towards tangible materiality. But this is not the only form of urban envisioning at work. The fantasies of Vision 2030 intersect in important ways with ordinary residents' own modes of imagining and constructing the future. Far from remaining in the distant future, the dazzle of these promised scenes, I argue, can have very powerful imaginative and material effects in the present. During fourteen months of ethnographic research in Kaloleni, a low-income, public housing project in the Eastlands area of Nairobi, I investigated how local residents are engaging with the radical re-envisioning of their city (see Smith, 2016). I found that, though they may live far from the proposed sites of Konza and Tatu, residents are nevertheless caught up in their swirling image trail. These urban fantasies become entangled with the mundane actualities of ordinary life, in a process Jane Bennett has described as 'the marvellous erupting in the everyday' (2001, p. 8).

Kaloleni is one of several surviving colonial-era public housing estates in Eastlands, a diverse quarter of Nairobi to the northeast of the city centre. Kaloleni was built in the 1940s as part of a colonial masterplanning initiative to reinvent Nairobi as an orderly, segregated 'city in the sun' (Thornton White, Silberman, & Anderson, 1948). As well as designing dramatic boulevards and monumental city architecture, this masterplan was intended to improve housing conditions for Africans in the city (Anderson, 2001). Following garden city principles of urban planning that were popular across the empire at the time, Kaloleni was designed as a model urban neighbourhood that would inculcate colonially-sanctioned values and produce amenable urban subjects. There are a number of continuities in rhetoric and practice between Nairobi's colonial masterplanning and the current discourses of Vision 2030, not least regarding the perceived dangers of the pre-existing urban fabric and the need to plan secure, self-contained neighbourhoods on empty land (see Smith, 2015). Colonial concern about public health and morality feared informal settlements as unchecked breeding grounds not only for disease, but also vice and degeneracy (White, 1990). Such fears find their echo in current commentary about the rampant growth of slums, overcrowding and urban crime (Moser, 2015, p. 33). More specifically, in an early case of urban replication, the architect of Kaloleni was A. J. S. Hutton, formerly senior colonial architect in the British colony of Malaya (now Malaysia). He was seconded to Nairobi Municipal Council in 1942 to help reconceive the city's form, following his experience of designing new urban neighbourhoods in Malaya—an intriguing historical reverberation of McKinsey's role in the 'world class' re-visioning of both Kuala Lumpur and Nairobi (Bunnell & Das, 2010).

Today, decades of mismanagement by city authorities have left Kaloleni dilapidated and decayed. Houses are rundown, water no longer runs in the pipes and infrastructure is at breaking point. Despite being public tenants, residents no longer receive services from the council. As in other public housing estates in Eastlands, such as Jerusalem, Jericho and Shauri Moyo, the original housing of Kaloleni is now interspersed with informal settlements, while stretches of public land have been grabbed and illegally developed. After decades of neglect, Vision 2030 promises long-awaited urban renewal of the Eastlands public housing. The project, titled the Nairobi Metropolitan Services Improvement Project (NaMSIP), is a less ostentatious constituent of Nairobi Metro 2030, and is intended to combat 'urban decay' in the city. However, exactly what this strategy will mean in practice is hard to tell: announcements and documentation are riddled with contradictions, and exactly what will be demolished, what will be built, and how residents might be affected remains unclear (Smith, 2016, ch. 1; Waitatu, 2013). For example, some news coverage has suggested that new housing will be for sale rather than rental, but the government has also stated that residents will not be displaced, despite the fact that very few would have the capital needed to purchase property (see Wanga, 2014). NaMSIP is partly facilitated by the World Bank in conjunction with both the Nairobi city authorities and the national Ministry of Nairobi Metropolitan Development. These different units all have different agendas and are also highly politicised, leading to considerable delays and hiatuses with the scheme. Their various tiers of intersecting and sometimes competing authority do not shed much clarity on the direction of the strategy (see Myers, 2014).

Unsurprisingly, such uncertainty has caused much consternation in the affected communities. Local residents remain ambivalent about what regeneration might mean: on the one hand urban renewal might offer a brighter future if it means increasing employment, raising living standards and reducing poverty, but many are anxious that it will happen at their expense. One professional Nairobi architect predicted that the scheme will be 'the biggest gentrification [project] in Africa', bringing the displacement of thousands of poorer households in favour of high net-worth renters and buyers' (personal communication). In Kaloleni, the uncertainty surrounding Nairobi Metro 2030 and its proposals have sparked endless discussion and debate. In De Boeck's terms, residents' words—in the form of verbal approvals, evaluations or castigations—do indeed 'erect the city over and over again', as Boniface, a Kaloleni resident, made clear:

> There's been stories. There's a time [I heard] they'd secured contractors to come down and build these structures but it was only politics. It fades away, some other stories come. So nobody knows. Nobody knows for sure.

But these promised futures do far more than simply generate words and debate. The gap between the dream of

the plan and its realisation is full of action: new ways of being and doing, of grasping the future and trying to make it real.

5. The Not-Yet

One of the counterintuitive aspects of Vision 2030 is just how popular the imagined vistas are across all sectors of Nairobi's population. The 'world class' visions of capsular, enclaved futures—though they would seem intended to exclude Nairobi's low-income residents—are regarded as desirable, 'beautiful', 'smart'. This is something that scholars of fantastical masterplanning have noted in other cities. In Baku, capital of Azerbaijan, Bruce Grant observed the popularity of exclusive imagery among poorer residents: 'whether there is an actual place for them in these new structures or not, this new spate of building has had a profoundly inclusive effect' (Grant, 2014, p. 503). In Kinshasa, De Boeck noted how even those struggling to get by 'revel as much in this dream of the modern city as the ruling elites' (2012, p. 323). In Georgia, Pelkmans has suggested that it is the prospective nature of plans that makes them attractive; the fact that these scenes remain unbuilt, unpeopled, is significant. Their emptiness and potentiality affords the possibility of a future of fulfilled aspirations, and the lack of implementation in fact enables the maintenance of that dream: 'they belonged to the realm of the future and therefore remained potentially accessible to everyone' (Pelkmans, 2006, p. 207).

Whilst this has certain resonances with the popularity of Vision 2030 in Nairobi, I think a slightly different form of engagement is at work. As I explore further below, local residents *are* concerned about their potential exclusion from the seductive vision, but they nevertheless agree that the future it imagines is desirable. Even when the promises of Vision 2030 start to appear fragile, their instability exposed by lack of implementation, political wrangling, corruption or abandoned projects, the expectation and seductive weight of Vision 2030 still seems to hold fast. In a different context, Harvey and Knox have argued that it is not despite the disorderly excesses of planning but *because* of them that infrastructural schemes are able to maintain their capacity to enchant: 'It is through an articulation with the lived, material encounters of stasis, rupture and blockage that infrastructural promises become reinvigorated and recast' (Harvey & Knox, 2012, p. 534). This fragility leaves space for residents to enact their own interpretations of promised futures, to reconfigure them and make them anew.

Temporally speaking, residents also hold on to the forms of linear development that Vision 2030 proposes: the unfolding of processual time that is inherent to governmental planning (Abram & Weszkalnys, 2013). Even where residents fear their capacity to reach it is being thwarted, they still aspire to the destination of Vision 2030. The question of why people might approve of models that would appear to exclude them is a tricky one. Of course, we should not assume that everything people say need be fundamentally coherent; ideas and opinions are worked out in the process of discussion and encounter. Furthermore, across a whole neighbourhood like Kaloleni—inevitably shot through with factions and conflicts, like any community—many different perspectives will be in circulation. Nevertheless, I suggest, residents' approval of the fantasy of Vision 2030, even as they fear exclusion from it, is based on particular disjunctive temporal experiences in which present and future become entangled in important ways. As residents try to anticipate and live towards the future, they inevitably do so from the present—a present in which fantastical images of the future are in circulation. By embedding the 'not yet' into the 'now', these juxtapositions create disconcerting temporal simultaneity. The schemes of Vision 2030 are based on linear developments and project timelines that envisage a future-perfect city as a destination that will be reached within a specific timeframe. But in their anticipation of this destination, the imaging strategies also give the impression of the future having arrived already (see also Lagerkvist, 2007, p. 160).

Nevertheless, the gap between the plan and the future it envisages is filled with discrepancies (Abram & Weszkalnys, 2013, p. 21). Multiple temporalities are in play: the idealised orders imagined in the plan are often disrupted, not only by obstinate landscapes or political reappraisals, but by the anticipations, speculations and anxieties it invokes through its potentiality, its status as 'not-yet' (Elliott & Smith, 2015). Thus planning may compel other types of action in the present, upsetting processual time with recursive eddies of social, material or political consequence, which in turn may initiate new judgements of the plan, as well as recalibrations of aspiration and ambition (Abram & Weszkalnys, 2013, p. 22; see also Kracauer, 1995). For residents in Nairobi, this has considerable import for temporal experience. In one of these eddies, the future appears to be receding ever further into the distance, seemingly out of the reach of ordinary citizens, whilst in another eddy, time is experienced as compressed and the future already at hand.

6. 'Our Changes'?

On 11 December 2013, a new advertisement appeared on a huge billboard just outside Kaloleni, along the main road running through Eastlands (Figure 1). The billboard came with no warning, and was not accompanied by any public meeting or distribution of information to explain its meaning or presence. The image it presents is of a digital rendering of high-rise apartment blocks arranged around a large multi-lane highway. In the foreground, in the centre of a landscaped roundabout, is a circular grey sign that reads *Karibu Kaloleni:* Welcome to Kaloleni. The text emblazoned across the billboard states *Mabadiliko Yetu*, Our Changes, as though this is the promise of an inclusive future. The thirteen-floor high-rises are uni-

Figure 1. The billboard showing the architects' rendering of a 'New Kaloleni'. Jogoo Road, Nairobi, December 2013. Photo by the author.

formly coloured cream and rust-brown, and arranged in orderly rows that recede into the distance. In the foreground, tiny pedestrians—dwarfed by the scale of the project—can be seen walking along yellow footpaths under mature trees. Cars move unimpeded along a smooth tarmacked highway, the speed of their movement indicated by digitally rendered blurring. Later that December, the image from the billboard appeared online on Jambonewspot, an informal news blog, along with other images of the same project. These were even more fantastical than the billboard. One was a radical reimagining of the infrastructure along Jogoo Road, featuring futuristic geometric glass and steel skyscrapers, palm trees, and a large highway. A sign saying 'New Kaloleni' directs traffic into the reimagined estate.

These digitally rendered visions are in stark contrast to the present reality of Kaloleni: a neighbourhood of decaying bungalows interspersed with corrugated iron informal dwellings. Previously tarmacked roads have turned to dust, broken streetlights lean precariously at awkward angles, rubbish is no longer collected and lies piled up around the estate. The contemporary experience of Jogoo Road is also drastically different from the vista that appeared online. Jogoo Road is the main artery of Eastlands, but it is usually clotted with a tight mass of barely moving traffic, thick clouds of fumes choking the atmosphere. The edges of the street are a mishmash of dirt paths, broken streetlights, thickets of informal hawkers, verges clogged with rubbish and more corrugated iron. The disjunct between image and reality is vast. The fanciful panoramas certainly do not seem oriented towards the current life of the area, a place where unemployment is high and those in work are concentrated in a miscellany of jobs in the informal economy. The strategy behind these images was never made clear—there were no related public announcements—but it would seem highly unlikely that they would be available or affordable to current residents, even if subsidised.

And yet the images were generally regarded positively. The billboard and associated images generated intense discussion both within the estate and on social media after photos were uploaded to Facebook. Online, many comments were favourable, from straightforward 'Wow! Great project' and 'This is amazing!!!' to ones flavoured with the language of development and progress, including 'This is what I see in the first world'

and—in an echo of colonial masterplanning—'The real city in the sun'. Such approval also characterised discussions with local residents. In comparison to the extant housing, with its rundown infrastructure and piles of rubbish, the clean, orderly vision on the billboard seemed attractive to many. The image was described as 'smart', 'beautiful' and in Kiswahili '*poa sana*'—very cool. 'These places are very modern. Who wouldn't want a new kitchen?' one man asked rhetorically.

7. The Future Now

The futures anticipated in Vision 2030's plans have not yet been realised, and may well never manifest at all. But though they are digital imaginings, they are also of the present. They circulate via billboards, advertising hoardings, on websites and in newspapers, giving them a physical presence in the everyday city and thrusting them into people's lives. By capturing the imaginations of a whole range of Nairobians, these images set in motion hopes, anxieties and speculations, influencing lived experiences of the city, as well as personal horizons for the future. As such, the images work to reveal the potentiality of the 'not-yet' in the present: the productivity of its enchantment, as well as its disenchantment.

In a discussion about the scene on the billboard with a young man named Eric, the conversation quickly turned towards his own domestic aspirations. Born and brought up in a crumbling house in Kaloleni and earning a meagre income working in a small café, Eric was nevertheless ambitious: 'I want to build my own house', he said, 'Imagine coming home to a house that is yours'. He frequently imagines the kind of place he will build, he told me: a three-bedroom detached house on its own plot. 'There is nothing like the feeling of coming home from work to a house that is yours, that you do not rent', he anticipates. In his mind he fills the rooms with new furniture, making sure everything is organised and colourful. In particular, he longs for a modern bathroom. In Eric's imagination, all the bedrooms are en suite, the running water is reliable and he can shower any time. 'Just in your house, relaxing, taking a shower, feeling it's yours…' he mused. Eric was quite clear that his dreams of the perfect house are in part shaped by the sleek images of urban panoramas he sees all around him. 'You see all this real estate up there [indicating the billboard]. You know it's expensive, but of course you want', he told me simply. His fantasies of a particular material future are intimately entangled with the visual culture of digital architectural design that enters the marketing machine of property development and circulates throughout Nairobi.

The types of anticipatory actions provoked by Vision 2030 are not always so positive. Previous urban renewal projects in Nairobi have been far from transparent, and claims of land-grabbing, corporate intrigue, elite capture and removal of sitting tenants have been rife (see Rigon, 2014). Given such precedents, residents fear Eastlands renewal may mean exclusion and eviction, and are setting in motion other forms of action. Hassan has lived in Kaloleni all his life. He has raised his own sons, now in their twenties, in the estate, but he now fears for their future. He plans to pre-empt the renewal project by moving out of Kaloleni:

> …So even our worries are there 'cause when they bring these houses down, they'll build modern houses…we won't get and we cannot afford. This Vision what-what. So even our children are thinking 'so, we move. We move now or we wait and we cannot afford'. You know, cost is rampant in this Nairobi. Up, up, up. So we say better [to] plan now.

In Hassan's plans to move his family from the estate, we see how an uncertain future inserts itself into the present and compels new types of actions. Vision 2030—even if it remains immaterial—creates new 'economies of anticipation' as local people recalibrate their aspirations and try to predict what horizons will remain open to them (Elliott, 2016, p. 512).

Hassan is far from alone in trying to live towards an uncertain future. In May 2014 near the railway line that runs through Eastlands, I met two men constructing a corrugated iron lean-to; an extension to a small, timeworn house. When I asked what the structure was for, one of the men stopped hammering and looked up. 'This is Vision 2030!' he laughed. 'We have waited so long for investment in this place, but still it is not coming'. He explained that his house is overcrowded—his children have to sleep on the floor. 'So now we can't wait any longer, that is why we are doing it', he continued. 'We are doing our own urban renewal!'. Rather than seeking to preempt Vision 2030, as Hassan intends, these residents are trying to surmount the gap between the plan and its implementation by taking it on for themselves. The future as imagined in schemes like Vision 2030 is not thirteen years away, but understood as available—up for grabs—in the present.

8. There's Nothing We Shall Get!

Though the spectacular imagery of Vision 2030 represents a desirable future, for many Kaloleni residents this enthusiasm is tempered by their fears of exclusion from such schemes. The gap between the material present and the future envisaged in digital renderings can feel impossible to overcome. Many interviewees caveated their endorsement of the billboard with doubts about the practicalities: how could such a project be built without displacing sitting tenants? Would the apartments be for rent or for sale? For how much? Wasn't it likely that current residents would never benefit?

In their discussions about the billboard, residents often simultaneously evoked fantasies about what the vision might bring, and fears about what it might take away. Boniface said, 'I for one would like to get a bigger house. This billboard, yes, it can be good. I would like to get a

house that gives me a big living room'. But he also added 'Let me tell you for a fact, when things become practical, a lot of guys who have money will be the ones benefitting from this'. Monica was fairly typical when she said, 'I'm on the side of change. If they can take us to a modern system it can be good', and then qualified this with doubts about the implementation:

> …if those who are going to do it are genuine people, if they are transparent, [if] they are trustworthy is when it will be ok. In Kenya there's a lot of corruption. You can't say it will be good. It might have some problems with maybe those who are going to build houses, the tenders…those who are going to get tenders and how the tenders will be, you know, will be given. You never know.

Such ambivalence also tinted Maggie's comments as she summed up the shades of local opinion:

> Some of us are happy because we might get these modern houses and it will be good…some people say we don't know. Even if they are to be built, they have to allocate [properly]…Some of us are even saying no [to the billboard]. Maybe those houses when they'll be built, maybe it might go to the big people, and we'll be left with nothing. Peasants, there's nothing we shall get!

As Kaloleni residents described their fears of exclusion, that the future would be 'for the big people' and not for the likes of them, they expressed frustration at being left behind, where they felt that time seemed to stand still, or even to go backwards. This was apparent in the views of Dolly, another local resident. Dolly's council house is very worn, the furniture tired and tatty, the walls engrained with dust and grubby finger marks. The old concrete floor is bare and no repairs have been undertaken for many years. Dolly expressed her frustration about life in Nairobi, of the failures of its governance and of waiting for things that never come:

> We are left behind. We used to have water, [today] there's no water. The roads—you see how they are. We used to have footpaths, they are no longer there. These houses are just like [a] museum anyway. But people are still living in them!

In her assessment, a museum is not a positive comparison: the implication is that the houses are static, stuck in place and time, while the city moves on around them. 'They say we are going to Vision 2030, but we are going back', she concluded.

How could residents feel so invested in the 2030 visions whilst concurrently also deeply suspicious that they will never benefit from its promises? In their work on infrastructural projects in Peru, Harvey and Knox take up the notion of enchantment to understand how such schemes retain their lustre and promise 'even in the face of specific circumstances in which they are acknowledged as having failed to deliver' (2012, p. 523). Following Bennett (2001), they take enchantment not as superstition or belief in the supernatural, but as a 'visceral, affective form of relating to that which is sidelined or cast out of formalised, rationalised descriptions of material and social phenomena' (Harvey & Knox, 2012, p. 523). The billboard image was enchanting because the future it seemed to promise offered the possibility of transcending existing social and material arrangements. But it was also precisely this promise that made it dubious in the eyes of many residents. One interviewee, a man in his forties named Duncan, expressed this clearly when he told me, 'No one can be for that image', explaining that because it was so enticing, because the apartments looked so expensive and exclusive, 'definitely they will be out of our league'. This is a future indefinitely out of reach. Even as residents seek to anticipate the future, they simultaneously describe a sense of temporal inertia, of living in an endless present.

9. Conclusion

The experiences of ordinary Nairobi residents do not match up with the panoramas and new beginnings envisaged by Vision 2030 and its promises of 'achieving middle income status' (Government of Kenya, 2007, p. 3). Residents' anxieties about being excluded from such visions show how the material conditions of their living and dwelling seem to make the fantasy of Vision 2030 both more alluring and more out of reach. Rather than experiencing the steady progress of developmental time, where one thing comes predictably after another, I have suggested that many in Eastlands feel themselves to experience a dissonant coexistence of temporalities, where multiple temporal experiences are felt concurrently. This dissonance is deeply influenced by the seductive power of Vision 2030's visual culture: the image trail that circulates in the city is not immaterial, rather it is part of the 'stuff' of the city, entangled in the reconfiguration of urban spaces and urban lives (Bunnell & Das, 2010, p. 282).

In the particular terrain of Eastlands in Nairobi, where Vision 2030 is reorienting temporalities and aspirations, I have shown how fantasies of an enclaved 'world city', though they might seem far removed from Nairobi's current disintegrating materialities, nevertheless have become enmeshed in the everyday lives of ordinary citizens. This has important implications for scholarly approaches to the current spate of spectacular masterplanning. Rather than dismissing spectacular simulations or cookie-cutter urban replication, it enables instead a more open-ended approach that attends to ways that seductive imaging and utopian language can have tangible effects.

As critics of Vision 2030, Kaloleni residents cast themselves in the role of catchers-up on a road where the destination seems to be slipping further and further away.

Or, as Dolly tells it, 'we are left behind', living in a museum where time stands still. And yet, the enchanting digital vistas give the impression that the future has arrived already. Living among the dream images of Vision 2030 has set in motion new types of actions, as people plan alternative futures or take up new construction practices, seeking to remake the city in ways that go beyond De Boeck's 'architecture of words'. The spatial and temporal gap between the dream of Vision 2030 and its implementation has left room for anticipatory actions that try to make the future more knowable. In so doing, residents in Eastlands seek to upset the exclusivity of a dazzling, capsular future Nairobi. But at the same time this gap can feel vast, even insurmountable, as their own experiences have bitterly revealed. Even as they work to make it present, the seductions of Vision 2030 are entwined with exclusionary forces that keep them at arm's length. The future-perfect city remains an exclusive mirage always just out of reach.

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Conflict of Interests

The author declares no conflict of interests.

References

Abram, S., & Weszkalnys, G. (2013). *Elusive promises: Planning in the contemporary World*. New York: Berghahn Books.

Anderson, D. M. (2001). Corruption at city hall: African housing and urban development in colonial Nairobi. *Azania: Archaeological Research in Africa*, *36–37*(1), 138–154.

Bennett, J. (2001). *The enchantment of modern life: Attachments, crossings, and ethics*. Princeton, NJ: Princeton University Press.

Brosius, C. (2010). *India's middle class: New forms of urban leisure, consumption and prosperity*. New Delhi and Abingdon: Routledge.

Bunnell, T., & Das, D. (2010). Urban pulse—A geography of serial seduction: Urban policy transfer from Kuala Lumpur to Hyderabad. *Urban Geography*, *31*(3), 277–284.

De Boeck, F. (2012). Spectral Kinshasa: Building the city through an architecture of words. In T. Edensor & M. Jayne (Eds.), *Urban theory beyond the West* (pp. 311–328). London: Routledge.

De Cauter, L. (2004). *The capsular civilization: On the city in the age of fear*. Rotterdam: NAI Publishers.

Elliott, H. (2016). Planning, property and plots at the gateway to Kenya's "new frontier." *Journal of Eastern African Studies*, *10*(3), 511–529.

Elliott, H., & Smith, C. (2015). *Towards an anthropology of the "not-yet": Development planning, temporality and the future. Panel at the ASA15 Conference, University of Exeter, UK.*

Government of Kenya. (2007). *Kenya Vision 2030: The popular version*. Nairobi, Kenya: Ministry of State for Planning.

Government of Kenya. (2008). *Nairobi Metro 2030: A World class African metropolis*. Nairobi, Kenya: Ministry of Nairobi Metropolitan Development.

Grant, B. (2014). The edifice complex: Architecture and the political life of surplus in the new Baku. *Public Culture*, *26*(3 74), 501–528.

Harvey, P., & Knox, H. (2012). The enchantments of infrastructure. *Mobilities*, *7*(4), 521–536.

Huyssen, A. (2003). *Present pasts: Urban palimpsests and the politics of memory*. Stanford, CA: Stanford University Press.

Jansson, A., & Lagerkvist, A. (2009). The future gaze: City panoramas as politico-emotive geographies. *Journal of Visual Culture*, *8*(1), 25–53.

Kamau, J. (2016, March 13). Greed, deceit and a web of underhand deals: The sad story of Tatu City. *Daily Nation*. Retrieved from http://www.nation.co.ke/news/The-sad-story-of-Tatu-City-/1056-3114978-format-xhtml-146oank/index.html

Kenya Vision2030. (n.d.). About Vision2030. Retrieved from http://www.vision2030.go.ke/index.php/about-vision2030/

Klopp, J. M. (2011). Towards a political economy of transportation policy and practice in Nairobi. *Urban Forum*, *23*(1), 1–21.

Konza Techno City. (n.d.). *Konza: The vision*. Retrieved from http://www.konzacity.go.ke/the-vision/

Kracauer, S. (1995). *History: The last things before the last*. Princeton, NJ: Markus Wiener Publishing Inc.

Lagerkvist, A. (2007). Gazing at Pudong—"With a drink in your hand": Time travel, mediation, and multisensuous immersion in the future city of Shanghai. *The Senses and Society*, *2*(2), 155–172.

Linehan, D. (2007). Re-ordering the urban archipelago: Kenya Vision 2030, street trade and the battle for Nairobi city centre. *Aurora Geography Journal*, *1*, 21–37.

Manji, A. (2015). Bulldozers, homes and highways: Nairobi and the right to the city. *Review of African Political Economy*, *42*(1), 1–19.

McKinsey. (2003). *Vision Mumbai: Transforming Mumbai into a world-class city*. Mumbai, India: Bombay First. Retrieved from http://www.visionmumbai.org/aboutusdocs/McKinseyReport.pdf

Moser, S. (2015). New cities: Old wine in new bottles? *Dialogues in Human Geography*, *5*(1), 31–35.

Murray, M. J. (2015). "City doubles": Re-urbanism in Africa. In F. Miraftab, D. Wilson, & K. Salo (Eds.), *Cities*

and inequalities in a global and neoliberal World (pp. 92–109). Routledge.

Myers, G. A. (2014). A World-class city-region? Envisioning the Nairobi of 2030. *American Behavioral Scientist*, *59*(3), 1–19.

Nzuma, V. (2014, April 7). Ranching society vows to resist bid for Konza City land. *Standard Digital News*. Retrieved from https://www.standardmedia.co.ke/article/2000108827/ranching-society-vows-to-resist-bid-for-konza-city-land

Pelkmans, M. (2006). *Defending the border: Identity, religion, and modernity in the Republic of Georgia*. Ithaca, NY: Cornell University Press.

Rigon, A. (2014). Building local governance: Participation and elite capture in slum-upgrading in Kenya. *Development and Change*, *45*(2), 257–283.

Roy, A. (2011). Urbanisms, worlding practices and the theory of planning. *Planning Theory*, *10*(1), 6–15.

Sassen, S. (1991). *The global city: New York, London, Tokyo*. Princeton University Press.

Smith, C. (2015). "They are just terrorists": Constructing security claims in Nairobi. *Etnofoor*, *27*(2), 133–155.

Smith, C. (2016). *Present pasts, uncertain futures: Materiality and time in a Nairobi housing estate* (Unpublished PhD Thesis). UCL, London.

Tatu City. (n.d.). *Tatu City: Live, work, play*. Retrieved from http://www.tatucity.com/project-details/plans/

Thornton White, L. W., Silberman, L., & Anderson, P. R. (1948). *Nairobi: Master plan for a colonial capital: A report prepared for the Municipal Council of Nairobi*. London: H.M. Stationery Office.

Waitatu, N. (2013, November 19). Nairobi's Eastlands set for facelift with plan to build 80,000 houses. *Standard Digital News*.

Wanga, J. (2014, May 14). In comes Chinese money, out go Eastlands estates. *Nairobi News*, pp. 4–5.

Watson, V. (2013). African urban fantasies: Dreams or nightmares? *Environment and Urbanization*, *26*(1), 215–231.

White, L. (1990). *The comforts of home: Prostitution in colonial Nairobi*. Chicago, IL: University of Chicago Press.

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Article

Planning in the Face of Power. Experiencing Power Dimensions in a Visioning Process in the West Bank and the Gaza Strip

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Abstract
This article reflects on dimensions of power that occurred in visioning workshops with different stakeholder in the West Bank and in the Gaza Strip. The overall argument developed in the article is that the visioning process—especially signs of spatial and institutional dimensions of power—occurred in both cases in a rather similar way, even though the conditions for planning and visioning are significantly different in the West Bank and in the Gaza Strip. The visioning process illustrated that planning indeed shows signs of mediating space and power. Those power struggles are deeply rooted in the Palestinian planning history, the long-standing separation between the Gaza Strip and the West Bank and the protracted conflict between Israel and Palestine. Experiencing oneself the 'dark side of planning' makes clear that planning is not benign and that planning can be a powerful tool for either progressive, pluralistic practices or oppressive ones, as means of regulation and control.

Keywords
conflict; dark side of planning; mobility; Palestine; power; spatial planning

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1. Introduction to Planning in the Palestinian Context

How does planning work in cities and regions that are contested and conditioned by harsh power asymmetries, occupation (West Bank) or under siege (Gaza strip)? Our reflection on a capacity building and planning project in the Occupied Palestine Territories (West Bank and Gaza) illustrates in a very straightforward way that planning is a highly socio-political activity, strongly related and interlinked with the socio-political environment in which the planning system operates (Rokem & Allegra, 2016). In the 1990s, Coon (1990, 1992) and Altrock (1998) provided a comprehensive standard reference on the West Bank planning system, which Coon coins as 'planning under occupation'. The occupation has a significant impact on the planning regime, which we will see later, but the situation there is highly different than in Gaza, which is still under siege. From that perspective, the oPt (occupied Palestinian territories) might be a so-called extreme case (Flyvbjerg, 2006), or extreme arena, for the relation of power and space that is mediated by planning (Yiftachel, 2010). In such arenas, politics and the political agenda, such as security or housing matters (Chiodelli, 2012; Hague, 2016; Shmueli, 2005) are translated into plans, policies and institutional designs and communicated. The relation between power and politics has been

debated in the planning theory, examining planning as a means of regulation, control and subjection of minorities or ethnic groups, which Flyvberg (1996) characterizes as the 'dark side' of planning (e.g. Flyvbjerg, 1996; Flyvbjerg & Richardson, 2002; Forester, 1990; Hillier, 2002; Huxley, 1994; Marcuse, 1976). Yiftachel (1998) describes four main dimensions of power relations and control: (1) spatial (territorial), (2) institutional dimension (power relations in decision making and procedures), (3) the resulting socio-economic dimension and (4) the cultural dimension. Planners are not decoupled from the field of power. They are neither neutral nor exclusively technical experts (Rokem & Allegra, 2016), but are actors in this arena practising coalition building, networking, lobbying and political steering (Wagenaar, 2004). The authors also stress the ambiguity, complexity and discrepancy of the institutional decision making process (Hague, 2016; World Bank, 2008). While the official institutions recognise the political dimension of planning and decision making (in terms of Israeli settlements), the reasoning for disapproval of outline plans for Palestinian communities remain purely technocratic (Hague, 2016).

The past and present conflicts between Israelis and Palestinians have created a situation in which the planning and the entire governance system itself is contested (e.g. Coon, 1992; Yiftachel, 2010) and plays an instrumental role in reinforcing the social division and structural processes of discrimination in the population based on the ethnic origin (e.g. Reuveny, 2003; Salamanca, Qato, Rabie, & Samour, 2012; Yiftachel, 1998, 2010). These conflicts and constraints become most evident in the fields of urban, spatial and transportation planning, especially around housing and settlement policies and practices (Altrock, 1998; Shalbak, 2013). Almost 75% of the Palestinian population lives in the urban regions of Gaza and the West Bank (Gaza/Hebron/Jerusalem/Ramallah/Bethlehem). High population densities with an average of 778 persons/km^2 in the West Bank and 5,000 persons/km^2 in Gaza City are the outcome, peaking at 8,700 persons/km^2, which is comparable to London (see Figure 1).

The urbanization gets amplified by rural-urban migration, better job opportunities (e.g. Nikisic, Nasser Eddin, & Cali, 2014) and a lesser impairment of daily practices due to mobility restrictions (e.g. El-Atrash, 2016). Scarcity of building land, limited means for mobilising building land complemented by presumed trends towards real estate bubbles (Palestine Economic Policy Research Institute—MAS, 2012) lead to a so-called housing crisis (Palestinian Central Bureau of Statistics [PCBS], 2007, 2015a, 2015b), stressing the little number of affordable houses available. Razeq (2015) reports an average amount of 1,450$ per month necessary to afford good quality housing for a family in Gaza. The number can be contrasted with a 40% poverty rate, the highest unemployment rate in the world and 70% of the work-

Figure 1. Khan Yunis in the south of the Gaza Strip. Destroyed or ruined buildings are a common impression in the dense urban pattern.

ing cohort in Gaza being employed in the private sector, earning an average monthly wage of 174$ per person (World Bank, 2015). The discussed responses to housing crises in Gaza include active land management policies, high density solutions, the support of self-organised repair and building activities, land-saving building patterns and price caps for building land as well as reorganised apartment floor plans (e.g. Asfour, 2012). In the West Bank, limited building land resulted in informality (e.g. Alfasi, 2014; Chiodelli, 2012) and construction of buildings without permits, as a result of which they are constantly threatened by demolition and removal (Office for the Coordination of Humanitarian Affairs oPt [OCHA oPt], 2015a). Different studies are exploring the opportunity of polycentric development (Affouneh, 2014) and possible locations for new suburban centres (AbuSada & Thawaba, 2011) in the metropolitan region Ramallah-Jerusalem. Complementary debates are revolving around micro-scale planning action and the value of insurgent planning (e.g. Porter et al., 2013), community based approaches (e.g. Ibrahim & Domgjoni, 2015; Jabareen & Carmon, 2010) and micro socio-spatial practices challenging the spatial logics laid down by the official institutional framework (Gazit & Latham, 2014). The commonality of those debates is rooted in the general conditions and the planning systems of the two parts of the territory—Gaza strip and the West Bank.

1.1. Aim and Method

The aim of this article is to examine and illustrate how spatial and institutional dimensions of power (Yiftachel, 1998) occurred in the planning process of an international design workshop. The study is based on a research-through- design approach (Frayling, 1993; Godin, 1993; Stappers, 2007), building on the main assumption that the act of designing has the potential to create insights, skills and knowledge of wicked problems (Rittel, 1972; Rittel & Webber, 1973). Invited by UN-Habitat and UNDP, two teams of international planners (ISOCARP) were invited to visioning workshops. The aim of those workshops was to reflect with local stakeholders and actors on current challenges and practices and formulate visions for the time of full Palestinian sovereignty including open borders and free movement. The workshops were set up as a mix of different methods, featuring interviews, focus groups, field trips and group discussions with local stakeholders (e.g. municipalities, planning departments, Women's Affair Technical Committee), planning professionals, NGOs (e.g. IPCC, Save Youth Future Society), academia (e.g. An-Najah University, Bard College) and public administration (e.g. Ministry of Local Government, PNSP, Ministry of Transportation). The developed visions are not considered to be future conformance-oriented goals but a means to instigate further discussions and reflections on possible action. The results of the workshops are available in three reports (ISOCARP, 2015a, 2015b, 2016).

The structure of the paper is as follows: In section 2 we introduce the current planning issues in the Gaza Strip and the West Bank that were addressed in the workshop and contextualise them. In section 3 we zoom in on the topic of mobility and transportation and illustrate signs of power dimensions that occurred in the design process. In section 4 we conclude that planning is not benign and that power dimensions are extending to planning practises.

2. Planning in the West Bank and Gaza Strip

The situation in the West Bank and in Gaza can be described as a protracted crisis with a declining humanitarian situation (European Commission, 2016), due to the prolonged Israeli occupation, the blockage of the Gaza strip for a decade and the recurring infringement of international law by e.g. settlement activities in the West Bank. In the West Bank vulnerabilities are rooting in occupation policies and military orders (e.g. Coon, 1992; El-Atrash, 2016; OCHA oPt, 2015a), settler violence (e.g. Eiran & Krause, 2016; Hanauer, 1995) and extension of settlements (e.g. Salamanca et al., 2012), increased number of demolition and increased restrictions on movement. In 2016 a 60% increase of demolitions and confiscations of Palestinian property and homes, compared to 2015 has been reported (European Commission, 2016). Between 1988 and 2016, 16,087 demolition orders have been issued: thereof 3,344 have been executed, 209 files closed, 9,138 are still in process, 2,909 are on hold due to legal processes and 487 are ready for execution at any given moment (OCHA oPt, 2015b, 2016). Thus, 300,000 people in area C (West Bank total population 2.86 millions) can be considered in constant risk of displacement.

2.1. West Bank

The division of the West Bank into the areas A, B and C origins in the 1995 Interim Agreement between the PLO and the Israeli Government. Area A delineates the major pre-existing Palestinian urban agglomerations (ca. 18% WB) and is under full Palestinian jurisdiction and civil control (see Figure 2). Area B are the peri-urban areas surrounding the urban cores of area A or small towns (21% WB). Area B is under Palestinian civil- and Israeli security control. The 'remaining' 61% of the West Bank are Area C, which is controlled and governed by the Israeli Civil Administration (ICA)—including all civic matters, such as health or education. This division is also mirrored in the planning system: in areas A and B Palestinian administration is responsible for planning and development issues, while in Area C planning is controlled by ICA, which still strongly focuses on military interests and territorial expansion (see Coon, 1992; UN Habitat, 2015). This division has resulted in an artificial land scarcity because Area C is virtually not available and disposable for the Palestinian communities. Thus, 61% of the West Bank are inhabited by only 6% of the 2,649,000 population

Figure 2. Area A delineates the major pre-existing Palestinian urban agglomerations, such as Ramallah, and is under full Palestinian jurisdiction and civil control.

(additional 628,000 Israeli settlers) since outline plans, the provision with technical infrastructure (e.g. roads, water), issuing of building permits (including refurbishment or upgrading) are executed and controlled by the Israeli administration. Different authors and various UN agencies are reporting on the arbitrary, ambiguous decisions in issuing such permits. OCHA (OCHA oPt, 2015a, 2015b) reports that between 2010 and 2014 only 1.5% of submitted applications were approved. More recently Hague (Hague, 2016) reported that although local zoning and outline plans match the international technical standards, only three of them were approved and the rest denied based on the alleged technical deficiency. As a result, informal building activities are taking place, additionally enhanced by the artificial land scarcity and arbitrary practices (see also Hague, Crookston, Wegener, Platt, & Gladki, 2016).

2.2. Gaza Strip

In the Gaza Strip (356 km^2), between Gaza City in the North and Khan Yunis (see Figure 1) in the South, a metropolitan area trends along the Mediterranean Coast (41 km). Entering the 10th year of the 'Gaza blockage', communities are struggling to cope with the complexities of a hostile environment under siege, causing deteriorating socio-economic conditions, confinement of citizens to the Gaza strip (restricted access, movement and exit of citizens and other civics, controlled by Israeli administration), limited trade of goods such as building material required for reconstruction and housing. The last major conflict in 2014 caused approximately 100,000 internally displaced people, 16,000 destroyed housing units (see Figure 3) which are beyond repair (Norwegian Refugee Council, 2015) as well as severe damage to the water and sanitation infrastructure (United Nations Information System on the Question of Palestine [UNISPAL], 2014). The planning and housing situation in the Gaza Strip is severely affected by the past and on-going conflict between Israelis and Palestinians. Reports confirm that whereas the supply of building material became easier, the housing demands are still not met (PCBS, 2015b). Thus, the density in the metropolitan area along the coast is expected to increase further due to population growth and the confinement to the area. Hence, two million people (PCBS, 2015a) that are living in the Gaza Strip are facing daily challenges concerning fragile housing situation, reconstruction, job provision, environmental degradation and the so-called 'SUGI energy-food-water-nexus' (see also Asfour, 2012; Koek, Arafat, & Clutterbuck, 2015). Still, most of the land remains unregistered resulting in a clandestine land-market and informal transactions. Planning itself is embedded on municipal level, but comprehensive strategies such as legally approved housing policies are still lacking (see also Asfour, 2017).

Figure 3. Demolition of housing suburbs in the Gaza Strip.

2.3. Institutional Framework

Spatial and urban planning in Palestine stems back to the early 19th century and is a unique assemblage of planning approaches, laws and regulations from different periods and administrations. A comprehensive analysis on the history and difficulties of the Palestinian planning system and its implications on the Palestinian spatial and territorial development are provided by e.g. Coon (1992), Altrock (1998), Shalbak (2013) and El-Atrash (2016). The legal framework governing planning, land tenure and administration goes back to the Ottoman period (1850–1917). During this time, first statuary road and building regulations were implemented. Under the British mandate (1917–1948), town planning was enforced in the British fashion but remained limited to urban areas, such as Jaffa, Haifa, Nablus or Gaza. A hierarchical planning system (central and local level for construction, building permits, roads, etc.) was implemented and later complemented by regional and local plans. After the end of the British mandate, when Jordan annexed the West Bank and Gaza was placed under Egyptian administration, the British planning system and structural plans remained in force. In this time period, land registration was introduced (see also Koek et al., 2015). However, most of the land remained unregistered since land owners tried to avoid registration costs and land taxation (Koek et al., 2015) resulting in problems regarding land-tenure, land management and informal housing markets in Gaza, which is commented by an interview partner: "The land ownership system that exists in Gaza is a rather complicated system and it affects future planning" (N. A.). For the West Bank unregistered land is under constant threat of Israeli confiscation, but also attaining building permits is impossible without official land-titles. Israeli occupation (1967) brought a great number of military orders, carried out by the ICA, which superimposed a military governance system over regular civil law (e.g. Coon, 1992; El-Atrash, 2016). However, shortcomings and ill adaptions of the current planning systems are reported:

> The second element is related to the packages of laws & byelaws related to urban issues like planning law, building regulation & byelaws, stipulation of private land and laws. This legal package inherited from long ago is unsuitable to deal with the actual problems that our cities currently face. When these laws were elaborated and adopted 50–60 years ago, the dimension of socio-economic development was not taken into consideration and it was related just to land use and transportation network. (H. A.)

3. Power Dimensions Occurring in the Workshops and Discussions

One important matter that was addressed in both workshops was the issue of mobility, the future development of urban centres and their connection. In the West Bank workshop, the debates illustrated the impediments and disruptions of daily practices due to the separation wall (see Figure 4), security measures, checkpoints and roadblocks. Additionally, the infrastructure networks are segregated systems: Palestinians are restricted to certain roads and have restricted access to roads in Area C (see Figure 5). One example is the Highway 443 connecting Tel Aviv with Jerusalem, cutting into the West Bank: Palestinians without permits to work or travel inside Israel are not allowed, several Palestinian communities need to take excessive detours to reach Ramallah because of the blocked highway.

The second main design narrative was to conceptualise Ramallah, Jerusalem and Bethlehem as a metropolitan region with complementary qualities and functions. These two topics are strongly interlinked: private transport is cluttering and congesting the cities, dominating the public space and streets. The connections between the cities are organised by a mix of buses, minibuses and shared taxis that have to cross Area C and are thus exposed to mobility restrictions. The importance of developing more sustainable mobility solutions on the regional and urban scale was addressed by different workshop participants:

> For sure, I mean the road system is the system that is forming now the backbone and will still form the backbone of the transport system to my better understanding. Of course, more should go towards the transit system, for example, the bus rapid transit system, other kinds of mass transit because this will make efficient use. This should be accompanied with policies to restrict the ownership of the vehicles, the automobiles, so on and so forth. This is one of the major developments that we should take into account to develop the roads not specifically only the physical structure of the road but also the kind or the type or the mode of the transportation. We should invest more in the rapid transit or the mass transit or the public transportation. Now beside this, I think there must be also the development of the rail but in a wise manner. I mean rail is very expensive; topography is not very much suitable. You have two kinds of rail—rail for the close communities—urban centres where there is very high demand, then you have the light rail, metro or any other kind of urban rail system. (S. E.)

The proposals developed during the workshop focused on two scales: (a) regional scale, connecting the cities of the metropolitan region in a North-South direction,

Figure 4. Separation wall cutting through the Palestinian landscape.

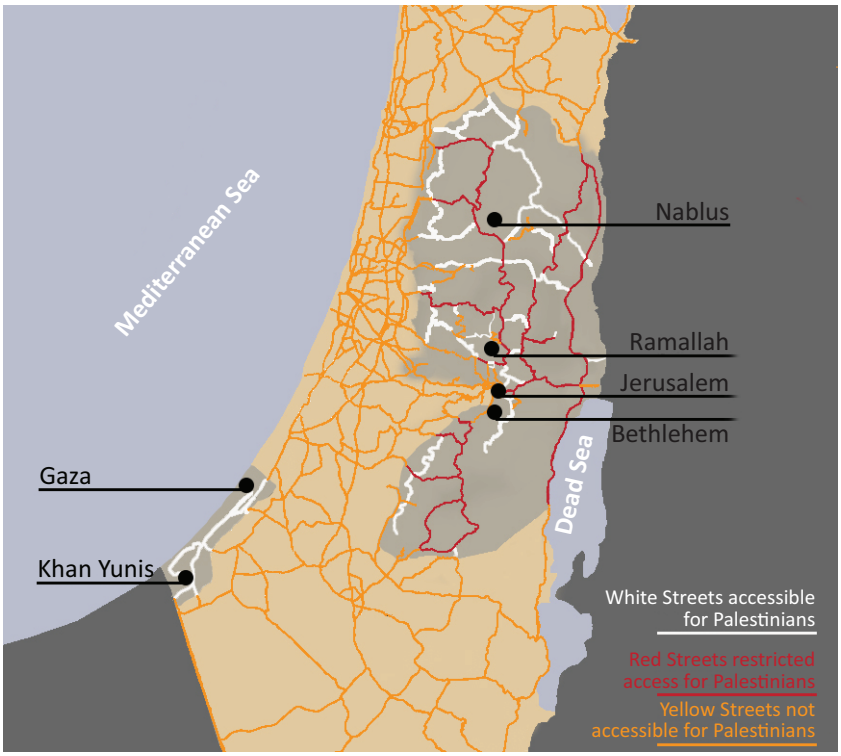

Figure 5. The segregated road-network exacerbates the daily life and practices of the Palestinian population (illustration by authors, based on data from visualisingpalestine.com and ISOCARP, 2015a).

and subsequently considering the future train stations as possible development nuclei on urban scale (b). On the regional scale, a light rail system connecting the major urban centres Ramallah, Jerusalem and Bethlehem was proposed. At the train stations, the local mobility systems are interlinked. Those main routes were outlined as possible areas to increase densities to accommodate the housing demand and connect the different communities and neighbourhoods, which are now rather isolated due to the hilly landscape (see Figure 6).

Another strong debate revolved around the importance of an airport in the West Bank, which was strongly advocated by local planning professionals, representatives of administration and academics:

> (...) other modes are needed like the sea, air for connecting Palestine with rest of the world, connecting Gaza Strip with the West Bank in addition to the corridor that is being suggested. We also need to connect people by air between West Bank and Gaza. (S. E.)

> Also, something to connect the future state of Palestine with international and regional dimension as to enlarge and redevelop the area of Gaza Airport and to have another regional airport in the West Bank. The latter to be as commercial airport (...) (H. A.)

Yasser Arafat airport, located close to Rafah at the Egyptian border, was built based on the agreements set in the Oslo Accords. It was bombed in 2001 during the al-Aqsa Intifada, and the runway was destroyed in 2002 (see Figure 7). From a strictly technical perspective, the claim for two airports would likely seem elusive, with Tel Aviv and Amman in reach and the design context of free movement and open borders. However, the strong opinions on the importance of airports in the Gaza Strip and West Bank and connecting 'the people by air between West Bank and Gaza' are owed to the limited freedom of movement within the Palestine territories and the general difficulties and chicaneries for Palestinian at Tel Aviv Airport to leave and return to the country, given they even reach the airport due to frequent road closures. Those mobility impediments make the means of regulation and control evident and can be interpreted as a reaction to the perceived and de-facto non-sovereignty of a community and individuals to make meaningful decisions about their mobility and spatial practices (Flyvbjerg & Richardson, 2002; Yiftachel, 1998).

Also at the Gaza workshop, mobility and mobility impediment were among the core topics. In the Gaza strip, the urban areas are stringed along the coastal zone with two major centres Gaza (North) and Khan Yunis and Rafah in the South. The current mobility patterns are characterised by individual car traffic and a not well-functioning minibus system that is connecting different localities along the coast. The Gaza blockage and limited amount of resources also instigated a strong discussion on future options of mobility and mobility practices. In the case of Gaza, a link to Jerusalem and further to Cairo via an expressway and railway along the eastern border was developed. The location was chosen because it was either still undeveloped or was cleared by the Israeli as

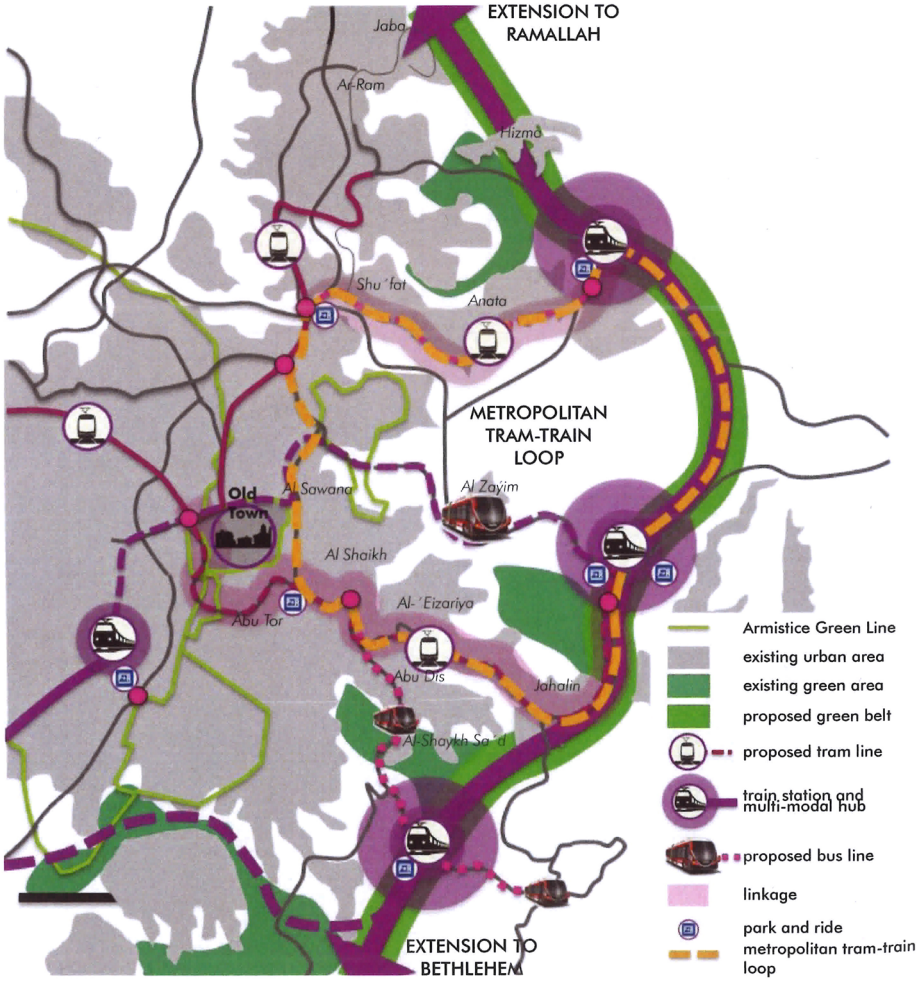

Figure 6. Vision for the metropolitan region Ramallah, Jerusalem and Bethlehem integrating sustainable mobility and urban development (Goethals, 2016).

a consequence of the disengagement in 2005. The historic train path, connecting Gaza with Cairo, still exists, but it is rather underdeveloped and therefore unsuitable for hosting the train track of the strong integration in the built-up area. The stations in Khan Yunis and Gaza are considered as mobility hubs interlinking with the public transport system and to the two seaports. The port in Gaza is seen as logistic centre towards Israel and the one in South as a fishing port. The mobility system is complemented by a biking network located on the former train path. Advocating a resource saving mobility alternative and providing space was considered adequate for the Gaza Strip due to its flat landform (other than in the West Bank).

For the West Bank, particularly strong debates occur on the topic of locating a train line around Jerusalem, especially considering the spatial-political discussions on the Israeli E1 (East1) zone. E1 is a synonym for an Israeli development plan including 15,000 residential homes (12 km^2) located within the Palestinian territories in the East of Jerusalem. The plan is contested because there is the threat of increasingly bisecting the West Bank and exacerbating the linkages between East Jerusalem from the rest of the West Bank (see also Hakala, 2012). Even though a very schematic and general vision was developed, several variations and adaptions were necessary to achieve a somewhat politically agreeable version:

> Gaza, for example, I look at the proposed railway direction—it is a logical location, but it feels wrong—because it's near to the border with Israel. But I also know, in the end, it's 6 km—it's going to be either in the east or in the middle, as it was in the past. Or Jerusalem, I do not totally agree with the proposed path of the railway, I prefer a ring road for now, but I think it can be implemented in about ten years. Maybe I do not believe in all the proposed concepts, it's mainly a different perspective. (T. B.)

The discussions demonstrate that spatial debates trigger political debates and reveal power structures. Discussing the track of a railway line or an expressway is less a technical debate. It is rather a debate on the meaning of this line for political negotiation processes and an expression of powerlessness of the Palestinian community to improve their livelihoods via planning. Limited hous-

Figure 7. Destroyed Yasser Arafat International Airport at the southern border in the Gaza Strip.

ing opportunities, restricted mobility options, separation walls, containment into a certain area, road blocks, informal housing, demolition of houses and the destruction of spatial structures all indicate the spatial dimension of power and control in the West Bank and in the Gaza Strip (Yiftachel, 1998). As for the institutional dimension of power, we can see that with the lack of land-titles, the institutional framework for Area C is inhibiting Palestinian authorities from implementing plans and policies and creating a statutory relationship between the authorities and citizens (Forester, 1993). The lack of planning authority in Area C restricts all spatial initiatives and development plans and also exacerbates the mobility developments that are actually envisaged. Further, it prevents spatial practices of individuals, by rejecting individual applications for building permits. An interview partner commented on this power dimension:

> You know what is really bothering me—when you are at a conference and you sit down with the planners—they consider our case most as 'post-conflict'. I ask then, what does that mean post-conflict? We are not in 'post-conflict'—we are under occupation. It's a difference of thinking in planning—if you want to plan it's not the same. (T. D.)

In the self-governed Areas A and B but also in Gaza, reported institutional ill-adaptations are witnesses of current and historic institutional power struggles, rooting in the various design implements by foreign administrations and occupants.

4. Concluding Remarks

As for the relation between power, politics and planning, the West Bank and Gaza are showing similarities. However, we argue that reflecting on such different extreme cases can shed some light on how planning practices and experiences are related with power struggles. The current planning practices are deeply rooted in the long-standing separation of the Gaza Strip and the West Bank. Policies, plans and the planning debate are pervaded by political meaning and subtext, expressing the struggles for recognition and sovereignty to develop plans and implement them. We learned that the power dimensions (Yiftachel, 1998) are extending into the design process itself, so that even plain actions like drawing a line on a conceptual sketch turn into a signifier of power relations and political meaning. We indeed experienced the effects of the "dark side of planning", how planning exercises power in an institutional and spatial environment and create realities on the ground that are impacting and in this case significantly restricting everyday life and social and cultural practices. The example shows that urban, regional and mobility planning practises can be progressive, pluralistic or oppressive and it appears there is a certain naivety and blindness towards the latter, mistakenly believing that planning is per se a positive agent of change. We argue that a critical attitude on actual institutional practises and the structural role that planners play in planning regimes is crucial for working in such contexts. "Should planner speak up?" was the uncomfortable question Cliff Hague (Hague, 2016) asked

Figure 8. Separation Wall in the West Bank.

the academic community and different planning associations, reflecting on repressive institutional planning practises in the West Bank. 'The philosophers have only interpreted the world in various ways. The point is, however, that planning changes it'—Marx would perhaps answer.

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Conflict of Interests

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References

AbuSada, J., & Thawaba, S. (2011). Multi criteria analysis for locating sustainable suburban centers: A case study from Ramallah Governorate, Palestine. *Cities*, *28*(5), 381–393. doi:10.1016/j.cities.2011.05.001

Affouneh, N. (2014). Polycentricity as a spatial model for regional development. The case of Ramallah. In *Rural areas: Exploring challenges and opportunities for their conservation and development* (pp. 176–220). Birzeit: Birzeit University & Austrian Development Cooperation.

Alfasi, N. (2014). Doomed to informality: Familial versus modern planning in Arab towns in Israel. *Planning Theory & Practice*, *15*(2), 170–186. doi:10.1080/14649357.2014.903291

Altrock, U. (1998). *Stadtplanung in Israel und Palästina. Der Friedensprozeß als Neubeginn?* (Arbeitsheft). Berlin: Technische Universität Berlin.

Asfour, O. S. (2012). Towards an effective strategy to cope with housing land scarcity in the Gaza Strip as a sustainable development priority. *Habitat International*, *36*(2), 295–303. doi:10.1016/j.habitatint.2011.10.005

Asfour, O. S. (2017). The role of land planning policies in supporting housing affordability: The case of the Gaza Strip. *Land Use Policy*, *62*, 40–48. doi:10.1016/j.landusepol.2016.12.018

Chiodelli, F. (2012). Planning illegality: The roots of unauthorised housing in Arab East Jerusalem. *Cities*, *29*(2), 99–106. doi:10.1016/j.cities.2011.07.008

Coon, A. (1990). Plans in the West Bank. *GeoJournal*, *21*(4), 363–373.

Coon, A. (1992). *Town planning under military occupation*. Aldershot: Dartmouth Publishing.

Eiran, E., & Krause, P. (2016). Old (Molotov) cocktails in new bottles? "Price-tag" and settler violence in Israel and the West Bank. *Terrorism and Political Violence*, *6553*(July), 1–21. doi:10.1080/09546553.2016.1194271

El-Atrash, A. (2016). Implications of the segregation wall on the two-state solution. *Journal of Borderlands Studies*, *31*(3), 365–380. doi:10.1080/08865655.2016.1174594

European Commission. (2016). *Humanitarian aid and civil protection Palestine*. Brussels. Retrieved from http://ec.europa.eu/echo/files/aid/countries/factsheets/palestine_en.pdf

Flyvbjerg, B. (1996). The dark side of planning: Rationality and "relationality." In S. J. Mandelbaum, L. Mazza, & R. W. Burchell (Eds.), *Explorations in planning theory* (pp. 383–397). New Brunswick: Rutgers University Press.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, *12*(2), 219–245. doi:10.1177/1077800405284363

Flyvbjerg, B., & Richardson, T. (2002). Planning and Foucault. In search of the dark side of planning theory. In P. Allmendinger & M. Tewdwr-Jones (Eds.), *Planning futures: New directions for planning theory* (Vol. 7, pp. 44–63). London & New York: Routledge. doi:10.1177/1473095208090432

Forester, J. (1988). *Planning in the face of power*. Berkeley, CA:University of California Press.

Forester, J. (1993). *Critical theory, public policy, and planning practice*. Albany, NY: SUNY Press.

Frayling, C. (1993). Research in art and design. *Royal College of Art Research Papers*, *1*(1), 1–6.

Gazit, N., & Latham, R. (2014). Spatial alternatives and counter-sovereignties in Israel/Palestine. *International Political Sociology*, *8*(1), 63–81. doi:10.1111/ips.12040

Godin, D., & Zahedi, M. (2014). Aspects of research through design: A literature review. *Proceedings of DRS*, 1667–1680.

Goethals, S. (2016). A progressive path to accessibility. *PLAN*, *3*, 31–36. The Hague: ISOCARP.

Hague, C. (2016). Planning practice in the West Bank: Should planners speak up? *Planning Theory & Practice*, *17*(1), 161–165. doi:10.1017/CBO9781107415324.004

Hague, C., Crookston, M., Wegener, M., Platt, C., & Gladki, J. (2016). *Why planning needs to change in the occupied West Bank*. UN-HABITAT oPT. Retrieved from https://unhabitat.org/spatial-planning-in-area-c-of-the-israeli-occupied-west-bank-of-the-palestinian-territory/

Hakala, P. (2012). *Removing Bedouins from Jerusalem's outskirts, jeopardising the two-state solution* (Quick policy insight). Luxembourg: European Parliament.

Hanauer, L. S. (1995). The path to redemption: Fundamentalist Judaism, territory and Jewish settler violence in the West Bank. *Studies of Conflict and Terrorism*, *18*(245–270).

Hillier, J. (2002). *Shadows of power: An allegory of prudence in land-use planning*. London: Routledge.

Huxley, M. (1994). Planning as a framework of power: Utilitarian reform, enlightenment logic and the control of urban space. In S. Ferber, C. Healy, & C. McAuliffe (Eds.), *Beasts of suburbia: Reinterpreting cultures in Australian suburbs* (pp. 148–169). Carlton, VIC: Melbourne University Press.

Ibrahim, A. (2015). Placemaking in the West Bank in Area C. *PLAN*, *1*, 59–62.

ISOCARP. (2015a). Spatial visioning reflections. The heartland of the West Bank. *PLAN*, *1*. The Hague: ISOCARP.

ISOCARP. (2015b). Spatial visioning reflections. Gaza Coast. *PLAN*, *2*. The Hague: ISOCARP.

ISOCARP. (2016). Spatial visioning reflections. Palestine. *PLAN*, *3*. The Hague: ISOCARP.

Jabareen, Y., & Carmon, N. (2010). Community of trust: A socio-cultural approach for community planning and the case of Gaza. *Habitat International*, *34*(4), 446–453. doi:10.1016/j.habitatint.2009.12.005

Koek, E., Arafat, J., & Clutterbuck, M. (2015). *Rebuilding from the rubble: Post-conflict land tenure challenges and opportunities in the Gaza Strip*. Paper presented at the 2015 World Bank Conference on Land and Poverty.

Marcuse, H. (1976). Professional ethics and beyond: Values in planning. *Journal of the American Institute of Planners*, *42*, 264–294.

Palestine Economic Policy Research Institute—MAS. (2012). *The construction sector in the Palestinian territory: Is there real estate bubble?* Ramallah: MAS.

Nikisic, O., Nasser Eddin, N., & Cali, M. (2014). *West Bank and Gaza—Area C and the future of the Palestinian economy*. Washington D.C.: International Bank for Reconstruction and Development / The World Bank. http://doi.org/10.1596/978-1-4648-0193-8

Norwegian Refugee Council. (2015). *Rental rights and responsibilities in Gaza* (Gaza Housing, Land and Property Rights Series, Fact Sheet 7). Oslo: Norwegian Refugee Council.

Office for the Coordination of Humanitarian Affairs oPt. (2015a). Under threat. Demolition orders in Area C of the West Bank (Vol. 972). East Jerusalem: OCHA oPt.

Office for the Coordination of Humanitarian Affairs oPt. (2015b). *Humanitarian response plan*. East Jerusalem: OCHA oPt.

Office for the Coordination of Humanitarian Affairs oPt. (2016). Israeli demolition orders against Palestinian structures in Area C, 1988–2016. East Jerusalem: OCHA oPt. Retrieved from http://data.ochaopt.org/demolitions/index.aspx?id=311650

Palestinian Central Bureau of Statistics. (2007). *A statistical report about land use statistics in the Palestinian Territory*. Ramallah: PCBS.

Palestinian Central Bureau of Statistics. (2015a). *Palestine in figures 2014*. Ramallah: PCBS.

Palestinian Central Bureau of Statistics. (2015b). *Statistical yearbook of Palestine*. Ramallah: PCBS.

Porter, L., Martí-Costa, M., Torvà, M. D., Cohen-Bar, E., Ronel, A., Rogers, D., . . . de Hoop, H. (2013). Finding hope in unpromising times: Stories of progressive planning alternatives for a world in crisis. *Planning Theory & Practice*, *14*(4), 529. doi:10.1080/14649357.2013.853470

Razeq, O. A. (2015). *Housing market in Palestine: Supply and demand and prices*. Ramallah: MAS.

Reuveny, R. (2003). Fundamentalist colonialism: The geopolitics of Israeli-Palestinian conflict. *Political Geography*, *22*(4), 347–380. doi:10.1016/S0962-6298(02)00114-2

Rittel, H. (1973). The state of the art in design methodology. *Design Research and Methods*, *7*(2), 143–147.

Rittel, H., & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169.

Rokem, J., & Allegra, M. (2016). Planning in turbulent times: Exploring planners' agency in Jerusalem. *International Journal of Urban and Regional Research*, *40*(3), 640–657. doi:10.1111/1468-2427.12379

Salamanca, O. J., Qato, M., Rabie, K., & Samour, S. (2012). Past is present: Settler colonialism in Palestine. *Settler Colonial Studies*, *2*(1), 1–8. doi:10.1080/2201473X.2012.10648823

Shalbak, M. (2013). *Mauern: Konsequenzen aus künstlichen Trennungen in städtischen und regionalen Agglomerationen. Israelische Trennungsstrategien und ihre Folgen für Raumentwicklung in den palästinensichen Gebieten*. Karlsruhe: Karlsruhe Institute of Technology.

Shmueli, D. F. (2005). Is Israel ready for participatory planning? Expectations and obstacles. *Planning Theory & Practice*, *6*(4), 485–514. doi:10.1080/14649350500349656

Stappers, P. J. (2007). Doing design as a part of doing research. In R. Michel (Ed.), *Design research now: Essays and selected projects* (pp. 81–91). Basel: Birkhäuser.

UN Habitat. (2015). *'One UN' approach to spatial planning in "Area C" of the occupied West Bank*. Ramallah: UN-Habitat Palestine.

United Nations Information System on the Question of Palestine [UNISPAL]. (2014). *Gaza water disaster: Damages to water infrastructure*.

Wagenaar, H. (2004). "Knowing" the rules: Administrative work as practice. *Public Administration Review*, *64*(6), 643–665. doi:10.1111/j.1540-6210.2004.00412.x

World Bank. (2008). *West Bank and Gaza—The economic effects of restricted access to land in the West Bank*. Washington, DC: World Bank Group.

World Bank. (2015). *Economic monitoring report to the ad hoc liaison committee*. Washington, DC: World Bank Group.

Yiftachel, O. (1998). Planning and social control: Exploring the dark side. *Journal of Planning Literature*, *12*(4), 395–406.

Yiftachel, O. (2010). From Sharon to Sharon: Spatial planning and separation regime in Israel/Palestine. *Hagar*, *10*(1), 71.

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Article

The Architecture of the Metacity: Land Use Change, Patch Dynamics and Urban Form in Chiang Mai, Thailand

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Abstract
This essay analyzes the spatial and temporal dynamics which have emerged from the rapid development of Chiang Mai, Thailand over the last four decades. Modern urbanization since the 1980s in the previously remote Chiang Mai-Lamphun Valley has coincided with digital and financial globalization, neo-liberal governance, and the articulation of a new geological era of the Anthropocene based on evidence of human induced climate change. This time frame serves as a lens to theorize the architecture of the "metacity", a new urban form and new form of urban practice responding to the demands of global digital financial networks and neo-liberal trade policies, but grounded in the ecology and life worlds of particular localities. The metacity appears in Chiang Mai within the interstices of a particularly fragmented rural/urban mix within a self-organized rather than plan-controlled built environment. The entire valley has been the site of intensive inhabitation for centuries, and recently urbanized, yet is spatially heterogeneous, extensive and patchy rather than ordered, bounded and uniform. The resulting landscape is marked by a disjunction between a feudal wet-rice cultivation land tenure structure overlaid with a market-based typology of urban real estate products with little enforcement of land use controls. The essay begins with theorizing the form of the metacity, continues with a description of the Chiang Mai case study, and concludes with a general assessment of the need to create a new form of metacity urban practice. A metacity design practice would re-conceptualize urban theories and forms by inking architectural and ecological thinking with inclusive social practices, enhanced by new digitally-enhanced urban imaginaries and new representational tools of mapping, modeling and design.

Keywords
Chiang Mai; Desakota; land use change; landscape ecology; metacity; Thailand; urban design; urban/rural mix

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1. Introduction: Metacity Theory

Over the last four decades, the digitalization of global finance and the deregulation of world trade preceded the recent exponential development of a dense and volatile cloud of social media, communication and information. While 19th century industrialization produced the spatial logic of the modern metropolis and American post-war hegemony produced the late 20th century oil-based megalopolis, the digitally networked 21st century will produce a new form of meta-urbanism. Metacity theory follows the distribution logic of metacommunity and

metapopulation theories in ecology (Pickett, 2015), and is difficult to disentangle from pre-digital urban forms and inherited urban images. The metacity is both virtual and actual, concentrated in the hyper centers of global capital, but also widely distributed in new hybrid mixtures in the urbanizing countryside. While information and prosperity has been broadly dispersed through this new decentralization, it has also resulted in the hyper-concentration of inside knowledge and wealth among the "1%" (Picketty, 2014). The metacity appears within the shells of the fragmented 20th century metropolis, as well as in new 21st century conurbations sprawling across formerly rural and wild territories. This essay employs the theoretical framework of the metacity, a term recently introduced in urban design and ecology discourse (McGrath & Pickett, 2011; McGrath & Shane, 2012), in order to develop methods to decipher the architectural form, social equity as well as ecological performance of Chiang Mai, Thailand. The metacity framework serves as a basis for a call for an urban practive of ecologically and socially activist design, linking a new digitally enhanced urban imaginary with the actual reality of contemporary urban life.

1.1. Contradictory Urban Theories

The urban century has arrived at the very moment that the definitions and meanings of the terms city, metropolis and territory have been exhausted. The architecture of the city (Rossi, 1982) and collage city (Rowe & Koetter, 1978) recognized the slow evolution of the traditional European city as a singular artifact with localized typological and morphological structures. Furthermore, they imagined a new role for architects, not merely the as designers of buildings *in* the city, but as specialists in the form *of* the city. The European metropolis evolved to a collision of fragments between the traditional city accommodated the new scales and technologies masked in grand architectural imagery (Shane 2008). More recently, the figure of the metropolitan architect was revived as a retroactive manifesto, exploiting the technologies of the industrial age to empower the architect to artificially simulate nature as urbanism is subsumed within the big architecture of New York's skyscrapers, theme parks such as Coney Island and corporate complexes such as Rockefeller Center (Koolhaas, 1978).

The structure of the American road based city has also been theorized, starting with Venturi, Scott Brown and Isenour's *Learning from Las Vegas* (1967) and Banham's four ecologies of Los Angeles (1972), continued with the work of Gandalsonas (1999) and Pope (1996). In the post-war car-based city, the architect was relegated to the corporate campus, museum or elite residence, while landscape and advertisement branders were the design firms more in tune with this new urban form. Banham uses the word ecology metaphorically to designate the various geographies and social groupings of the sprawling American city. Ecology is also often used as a metaphor in urban sociology, where the megacity and slum theory became a new focus in urban studies (Rao, 2006). Here architects are often seen as in the way of the desires of residents. Chance, informality and event is celebrated in Tschumi's analysis of Manhattan (1983) and Atelier Bow Wow's Tokyo (Tukamoto, Kuroda, & Kaizima, 2001), updating the architect's role as cultural interpreter of the city.

All these authors describe radically different yet singular theories of urbanism, much like the story of the blind men and the elephant. They all describe only one idea of urbanism, one kind of city, and one prescribed method and role for the architect. Metacity theory does not place itself in opposition to this sample of urban theories, but instead is introduced as a theory of theories (McGrath, 2012). Metacity theory promotes a radically inclusive assemblage of ideas about the traditional city, the fragmented metropolis, the sprawling megalopolis and the imploding megacity through new communication, information and automation technologies and a new role for the architect/urban designer as the mediator, translator and negotiator between various urban actors. The metacity practitioner confronts disruptive urban change emerging directly from the demands of financial volatility, social uncertainty and unevenness, spatial disjunctions and cultural fragmentation played out in lived landscapes.

The historical city evolved through a slow process of aggregation, adaptation; the metropolis employed architecture as a cultural façade for a massive civil engineering project; and the megalopolis prioritized highway construction to seed a self-organizing logic of speculative development equipped with graphic designed wayfinding within a green veil of landscape design (McGrath & Shane, 2012). The metacity instead inverts the uniformity of the traditional city, the power logic of the modern metropolis and the social isolation of the megalopolis recognizing that urban creativity, invention and change is best when self-determined and socially produced.

Metacity theory was born from an exhaustion of singular urban models of urban form, recognizing the rise of activism in civil rights and environmentalism, and the emergence of new sensing, communication and imaging technologies. "Meta" implies that which exists above and beyond the traditionally defined city and territory, but also above and beyond current professional practice. If the metropolis was the result of a colonial world system, the megalopolis and megacity were created in the Cold War order following its collapse. The metacity emerges in the multipolar world of late global capital aided by new information and communication technology, which allow for new forms of both concentration and dispersal across a planet that has reached is capacity to accommodate human activities. Meta urbanization is unbounded, at once urban and rural, center and periphery. Contemporary theories of disturbance ecology give us an understanding of the environment neither in balance nor equilibrium, but in a constant state of flux. The

ecology of the metacity should be understood within a complex adaptive system in disequilibrium, and the social actors of the city are seen as integral actors shaping nature (Pickett, 2015).

An archaeology of the metacity follows a trajectory of the shifts in urban design practice in relation to new forms of subjectivity, representation and social activism (McGrath & Pickett, 2015). In New York City and London in the 1980s, the metacity first appeared through 'damage control' by local activist designers, often blind to larger logic and global impact that the introduction of electronic trading on Wall Street and the City, and the Thatcher/Reagan policies of deregulation of markets and trade. In August 1991, the worldwide web was launched, opening up the use of the internet beyond military, government and academic users. The introduction by NTT DoCoMo in Tokyo of the first smart phones to achieve mass adoption in a country, in 1999, Ima Hima (are you free now?) enabled customers to locate themselves and others within the vast chaos of the megacity, and to text simultaneously with a group of friends. Civil engineering and metropolitan architects produced the form of Haussmann's Paris, but the social space of contemporary Tokyo produced text messaging.

1.2. The 21st Century

The 21st century began with an attack on New York's World Trade Center, physical symbols of global financial speculation and trade. Globalization became thought of as a threat as well as an opportunity, resulting in the widespread deployment of a web enhanced security and surveillance network. Facebook was founded in 2004 and the iPhone was introduced in 2007, just before the enormous shock of the worse financial crisis in the U.S.A. since the Great Depression. This current decade began with Occupy Wall Street, one of many protests organized via widely dispersed on-line social activism. This decade is ending in a period of revanchist political retreat from the open progressive promise of digital and financial globalization. The project of the metacity seeks to uncover the urban spatial practice under capitalism in Picketty's 21st century. Flash mobs, occupation protests, scandal, fake news, and self-promotion are spatial practices both actual and virtual, and call for architects and designers to take a political position.

Three end-of-the-20th century prophets of the metacity are Henri Lefebvre (1991) Terrance McGee (1996) and Paul Krugman (1996). Lefebvre's triad of social practice, representations of space and representational space is increasingly converging in the metacity where the mobile phone, GPS, satellites, the Internet and the cloud intertwine. Hand held digital communication and information technology stored and distributed through the cloud has made more a volatile landscape of occupations, adaptations and appropriations. The possibilities of new forms of computer generated representations of space have proliferated and come to dominate the architecture profession since the 1990s have often not been met by actual new forms of representational space. Hyperreal renderings are commonplace, but new ways of seeing are more elusive (McGrath, 2008). In Lefebvre's terms, mediated representation has made more volatile the disjunction between social practice, the spaces of representation and the representation of space.

Evidence has been recently revealed about the unevenness of recent urbanization, yet hundreds of millions in Asia have left poor subsistence peasant livelihoods and have entered middle class through the globalized urban economy in the last four decades (Figure 1). If the two-stroke motorcycle was the key technology in what McGee has called the rural/urban mix of *Desakota*, mobile communication and information technology has produced a much more heterogeneous, volatile diffuse rural/urban mix, not as a transitional state of an expanding metacity, but as a new urban form. The motorcycle and the cell phone are powerful tools that give access to job markets and economies ending the isolation of rural villages, now often juxtaposed next to new peri-urban real estate developments. Arguably, much of the urbanization of the 21st century has already proliferated and will continue to spread within the wet rice cultivation areas of South, East and Southeast Asia.

The neoliberal city itself was recognized as self-organizing in space and time at various hierarchically nested scales. Self-organized, atomistic interactions among individual agents can spontaneously generate largescale order. Small differences in initial conditions can have large effects on long-run outcomes through discontinuous change where small quantitative changes in the underlying factors that drive location will sometimes produce large, qualitative changes in behavior (Krugman, 1996). Morphological fragments based on a market-based typology of urban real estate products constitutes the production of the speculative city, sprawling along with the universal recipe of development: road and highway construction.

The technological shifts that have produced our new urbanized global society have just begun to unfold. The next decades will see further applications of artificial intelligence, autonomous vehicles, giant data cloud farms, and ubiquitous drones and robotics replacing millions of jobs. A metacity practice would begin with the integration of Lefebvre' production of space, McGee's *Desakota* and Krugman's self-organization in space. New media and communications systems, both close-up and remote, provide tools for the architecture of the metacity to be engaged by a wider range of actors than the current client based system of the metropolitan architect or the corporate landscape of the megalopolis. Representation takes on a new role of persuasion by altering cognitive images of the city, rather than in articulating specialized units of construction (McGrath & Shane, 2007). Digital representations have brought analytical tools to any smart phone as well as provided a bridge for

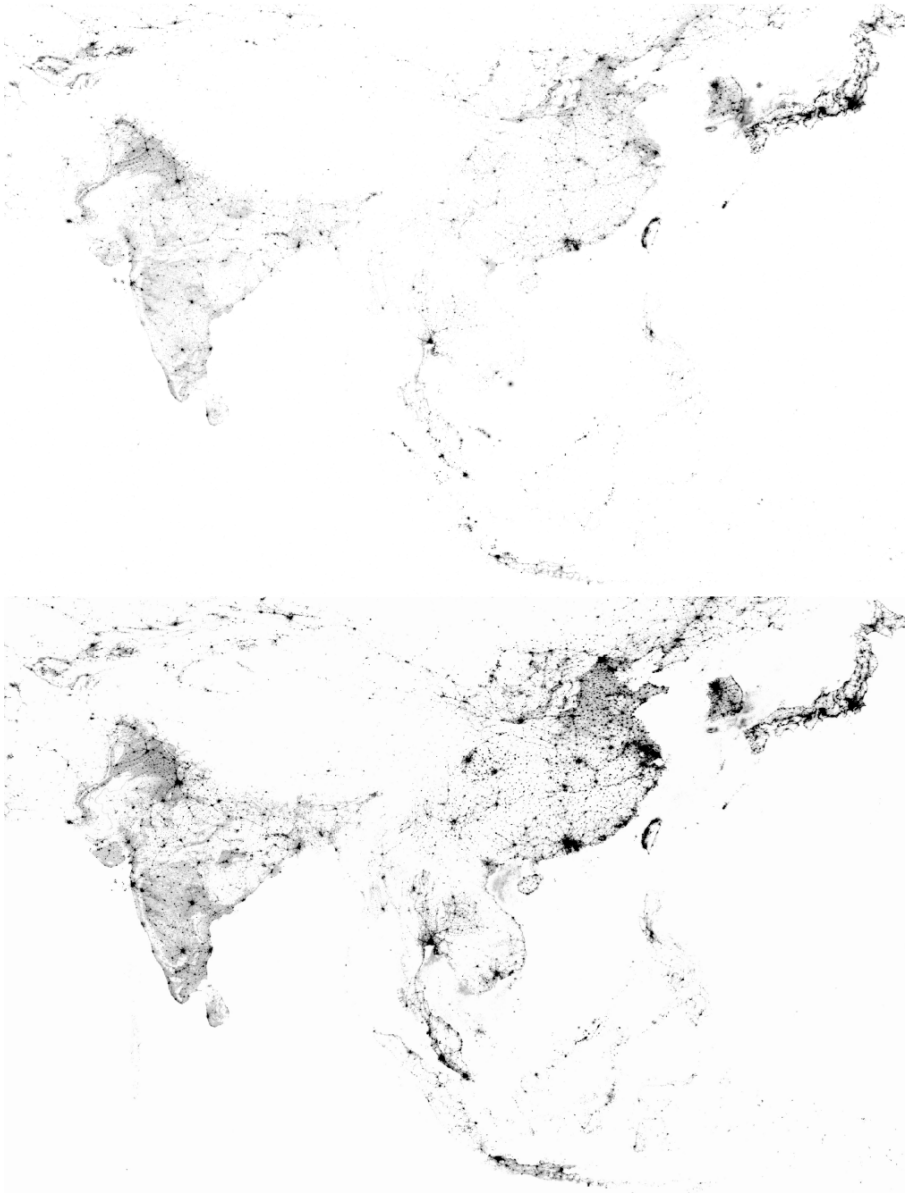

Figure 1. Comparison of nighttime satellite imagery, 1992–2013 indicates the extent of urbanization in South, Southeast and East Asia over two decades. Data courtesy: Marc Imhoff of NASA GSFC and Christopher Elvidge of NOAA NGDC.

transdisciplinary research between architecture, social science and ecology. Drones and sensors provide farmers smart technologies to monitor irrigation, crop growth and pests.

1.3. The Ecology of the Metacity

The very metabolism of urbanization needs to be fundamentally transformed to insure to the survival of life on this planet and equitable access to its limited resources. The distribution logic of metacommunity and metapolulation theories in ecology provide a way forward for a metacity design project and practice (Pickett, Cadenasso, & McGrath, 2013). Pickett has called the metacity a spatially extensive, system of cities, suburbs and exurbs, structured as dynamic mosaics of patches, in which flows, distant connections, historical contingencies, and the disturbances act in spatially explicit ways (2012). The metacity is a patch dynamic system where differentiation is produced at various spatial and time scales. "Meta" in ecology refers to a system of systems, nested and dynamic, and the metacity requires a multi-scalar understanding. Local internal dynamics leads to larger system flux as flows between patches vary across boundaries and scales. The metacity approach is inclusive of the designed as well as the vacant and abandoned including conserved or derelict agriculture and wilderness. It disrupts the myth of escape from responsibility for the consequences of metabolic decisions such as off-site periphery from which to gather natural resources and dispose of waste (Pickett, 2012, p. 480).

For Pickett, a nested mosaic understanding begins with a recognition of urban patches as bounded volumes or spaces whose characteristics differ from adjacent ar-

eas. Mosaics can be understood as simultaneously parts of larger patches and are made up of smaller patches. Patch mosaics are preeminently about spatial heterogeneity, adaptation, change and connection. Dynamism results from the flows of materials, energy, organisms, and information, but is also socially driven. The physical history of any city reflects adaptive social ecological process over time and an understanding of history is crucial to understanding the architecture of the metacity. A dynamic patch approach promotes adaptation resulting from both feedbacks and from larger contextual factors, such as climate, human and biotic migrations, and shifting economic investments can promote inclusion by design. Adaptation is multiscalar, consisting of nested mosaics that extend from households to regions. Patches are key to understanding social and ecological heterogeneity, but places these patches, at whatever scale, in some larger, spatial mosaic context. Patch mosaics invoke an *ethos* of inclusivity, recognizing the joint natural and cultural features of urban systems within spatially extensive dynamic systems in which flows, distant connections, historical contingencies and the disturbances of innovation and crisis act in spatially explicit ways (Pickett, 2012).

The Urban Design Working Group as part of the Baltimore Ecosystem Study has experimented with an interdisciplinary metacity design practice by creating design scenarios for neighborhoods across a regional watershed (McGrath & Pickett, 2011). Solutions to regional ecological problems are based on the degree of cooperation or independence neighbors seek. Some scenarios provide ideas for individuals to alter their own property, while others demand taxes or bonds to transform public right of ways. Most interesting are solutions that provide neighbor to neighbor cooperation—around shared backyards, adjacent driveways, or common water, agricultural or forest resources. Private, public or shared solutions can be enacted differently across political jurisdictions in order to address larger issues such as exporting nitrogen downstream, but also flood or drought risk scenarios. The metacity design approach links neighborhood choices with bio-regional issues.

The next section of this paper elaborates on the architecture of the metacity through a multi-scalar spatial and temporal analysis of one in-depth case study. Chiang Mai, Thailand, a previously remote, inland mid-size city with a deep and rich history, which has experienced rapid growth coinciding with the four-decade time frame of the emergence of the metacity. A modern leisure, tourist, retirement, agricultural, craft and design economy comprises a dynamic landscape of diverse patches. The specifics of a case study will aid in conceptualizing a future metacity practice based on a layering and recombination of all theories of urban form in order to establish a methodological description of a system of systems. Old false dichotomies between rural and urban, center and periphery will be dropped. Borrowed from Western industrial development paradigms, urbanization now often arrives through intensive road, energy and water infrastructure. A metacity practice would trigger adaptive strategies employing tomorrow's rather than yesterday's infrastructures based on self-reliance, environmental responsibility and social cooperation.

2. Chiang Mai Case Study

2.1. Geology, Climate and Early Settlement

When the India plate collided with the Eurasian continent 90 million years, its subduction produced the Himalaya Mountains and Tibetan Plateau. The collision created the headwaters of Asia's great Yellow, Yangtze, Red, Mekong, Irrawaddy and Ganges/Brahmaputra rivers, and the sustenance for Asia's wet rice cultivating civilizations (Figure 2; Marshall, 2016). The impact of this enormous continental collision elongates Southeast Asia southeastward and induces a counter-clockwise rotation (Rhodes, Pereza, Lamjuanb, & Kosuwanb, 2003). The Irrawaddy and Red River faults bracket a large territory of mountains and valleys of upland Southeast Asia, providing the homeland of the Tai linguistic groups within this rugged terrain forming the frontier between northern Burma, Laos, Southwest China and Thailand. The Ping and Uttaradit Faults funnel a tributary river system comprised of the Ping, Wang, Yom and Nan and their tributaries, the headwaters for the Chao Phraya, Thailand's "River of Kings".

Northern Thailand's highlands and fertile river valleys comprises a distinct human ecology: the hideaway for the anarchic upland tribal groups who practiced what James Scott (2009) has called "the art of not being governed", and the Lanna people who settled the fertile basin areas of fan terraces and lowland alluvial plains of the Ping, Wang, Yom and Nan River Valleys. Ancient records indicate that a communal irrigation system for rice cultivation called *muang* (canal) *fai* (weir) has been operating for more than 1,000 years (Surarerks, 2006). In the *muang fai* system, villagers work collectively to build enormous weirs across the main rivers at the start of the rainy season, diverting water to major irrigation canals several kilometers long, which, in turn feed village based tributaries. The tops of the bamboo and mud weirs wash away once the paddies fill. The *muang fai* system relies on organized village labor collectives to construct the green infrastructure to capture monsoon rainwater and use the natural gravitational flow of the river to fill their individual rice paddies. The territory still bears clearly visible traces consisting the small landholdings, village networks along with this complex weir, canal and paddy system (Cohen & Pearson, 1998).

India's cultural influence gave rise to a mandala tributary political system across Southeast Asia that allowed for both large-scale irrigation, road infrastructure and royal city building, while allowing local autonomy in village and inter-village water management. The Dharma Raja was a god of the water, forest and soil; a spiritual leader mediating between heaven and earth. Un-

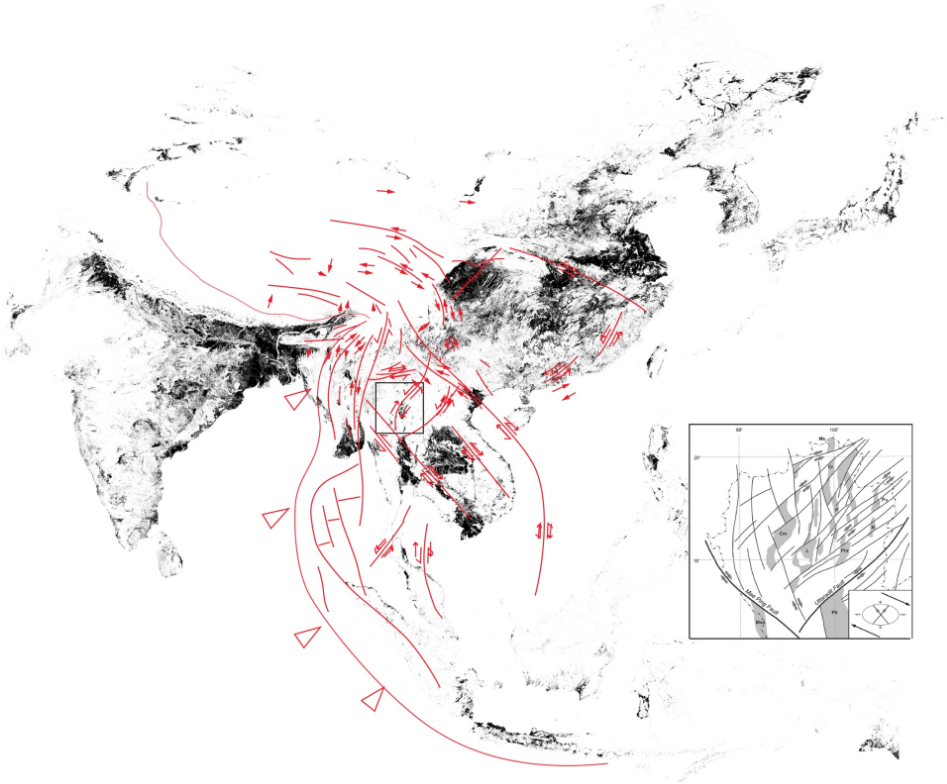

Figure 2. Overlay of tectonic activity created by the subduction of the India under the Eurasian plate in red with areas of rice cultivation in black. Asia Rice map: Andrew Nelson, Murali Krishna Gumma. A map of lowland rice extent in the major rice growing countries of Asia. 2015, 37p. IRRI, Los Banos, Philippines. Inset map of northern Thailand showing the model of Polachan et al. (1991). Shading marks the location of the major basins of northern Thailand within the funnel created by the Ping and Uttaradit Faults.

like the Chinese imperial system, the mandala network produced remarkable differentiation between kingdoms (Coedes, 1966). Phya Mangrai, Lord of the Lanna Kingdom of Northern Thailand, founded his new capital of Chiang Mai in 1296 as a node within this network. Lanna means one million (*lan*) rice fields (*na*), and Mangrai located his capital in the foothills of Doi Suthep to the west for its capacity to guarantee large quantities of water for wet rice cultivation in the lower basin flood plain as well as avoiding flooding (Figure 3). His new royal and religious capital maintained an identity as a distinct sovereign kingdom by providing tribute to the kings in Siam and Burma while commanding lesser kingdoms across the Lanna region (Winichakul, 1994). Mangrai formalized the existing village based *muang fai* territorial network through issuing the irrigation law known as "Mangrai Sart" or "Winitchai Mangrai". Mangrai's dynasty continued through 1558, when the Kingdom was defeated by Burma. In 1775 Chiang Mai came under control of the King of Siam (Surarerks, 2006).

The Mandala urban form of royal city centers and lesser peripheral centers constituted a tributary ecology as well as a political system for the Lanna region. The system was challenged by colonial demands for metropolitan political system with national borders and legal rights for foreign traders (Winichakul, 1994). Facing the British in Burma and Malaysia and the French in Laos, Cambodia and Vietnam, the Siamese and later Thai state transformed from tributary to a semi-colonial control over the Lanna Kingdom at the turn of the 20th century. To counteract British influence, Siam's King Rama V connected Chiang Mai to Bangkok with a rail line in 1923, a huge financial investment. Most economic development in Siam/Thailand was focused on the primate city of Bangkok with its rice producing and industrial periphery, leaving the Chiang Mai relatively unchanged until the last decades of the turn of the 21st century.

2.2. State Modernization and Ethnographic Studies

Thailand benefitted economically from its Cold War alliance with the U.S. during the American War in Southeast Asia, and since the 1970s it became the site of offshoring of Japan's automobile and electronics industries. From the mid 1980s to the mid 1990s, Thailand was the world's fastest growing economy, before the Asian economic crisis of 1997 and China's subsequent domination of global export manufacturing (Pongpaichit & Baker, 1998). By the 1980s, national policy began to begin some development to the secondary cities of the

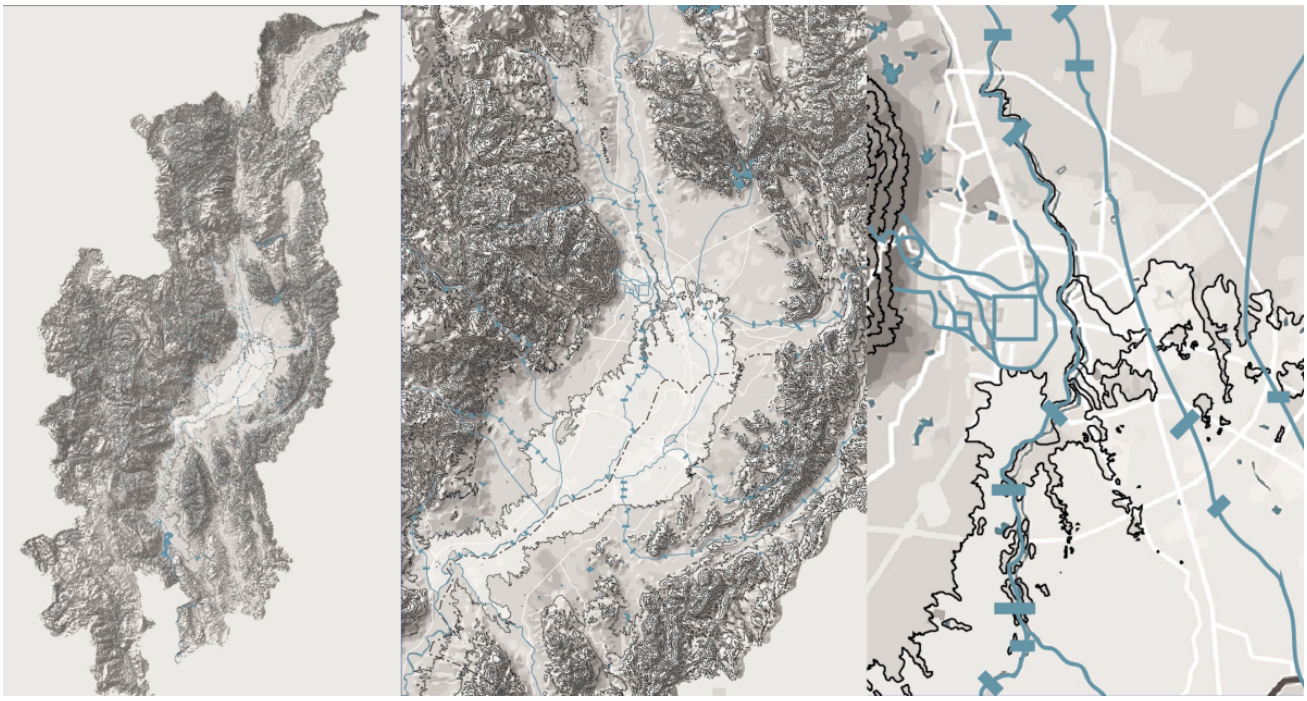

Figure 3. Three scales of the Chiang Mai-Lamphun Valley, a stomach-shaped valley with the royal moated city of Chiang Mai situated at a slightly higher table at the foothills of Mount Suteph, overlooking a lower flood plain southeast of the city. The water supply from the mountain to the old city is redrawn from the research of Surapon Dumrikul. Also shown are the major rivers and community managed weirs documented by P. T. Cohen and R. E. Pearson.

kingdom. Due to the Asian economic crisis of 1997, however, Thailand's GDP shrank from 182 to 112 billion dollars. The economy recovered in 2000 with a 5% growth through 2007. But deep division about the nature of that recovery has led to continual political unrest, military coups in 2006 and 2014, and current growth most recently under 2%.

Some of the most valuable information regarding the recent urban transition of the Chiang Mai region is found in village anthropological studies conducted since the 1950s. Ethnographies reveal both the ancient *muang fai* communal farming labor exchange system, and since the 1980s, the impact of modern irrigation and farming technologies, access to labor markets and urbanization. Long term comparison of ethnographic studies present not just the traditional social ecological methods of settlement, but also the transformation of the landscape during contact with colonialism and capitalism. Historical records and important longitudinal comparisons of ethnographies include Peter Cohen's field work from 1967 to 1969 and follow-up research in 1978 and Shigeharu Tanabe's field work in 1974 through 1975 in Mae Rim, 15 km north and upstream of the city (Tanabe, 1994). Konrad Kingshill (1991) studied a village south and downstream near Saraphi first in 1957 followed by Jack and Sulamith Heins Potter field work in the same village downstream from 1971 to 1972 (Potter J., 1976; Potter S. H., 1980). Tanabe's study of a village in Mae Rim documents village networks as social system employing "practical ecology". Both Tanabe and Jack Potter provide remarkable drawings, diagrams and tables documenting village based, comparative, and multi-village irrigation networks that provide a baseline to evaluate current household and farm structure and management (Figure 4).

Anan Ganjanapan in his field work from 1980 to 1981 first recorded the transformation of the village society due to contacts with modern state Royal Irrigation Department projects (Ganjanapan, 1984). Historian Vanpen Surarerks (2006) provides both the archival evidence of the long history of the communal irrigation system, as well as the introduction of the People's Irrigation Act of 1939, when the ancient *muang fai* system is recognized by the Royal Irrigation Department. Mark Andrew Ritchie's field work in the same village as Tanabe from 1990 to 1991 at the beginning of intensive urbanization and modernizations by the state and a new real estate market. Local adaptations play out as villagers' response to contact with Chiang Mai's developing labor and land markets (Ritchie, 1996).

The Ministry of Interior began the first formal planning regulation according to the Town and Country Planning Act in Thailand in 1952 in response to rapid economic growth and the need for urban development control in Bangkok. The modern era of land use planning started following an agreement for technical assistance from the American government that provided scholarships for Thai planners to study and train in the U.S. and they applied knowledge in American land use planning system (Roachanakanan, 2014). American land use planning is based on dividing and classifying blocks and plots

Figure 4. *Muang* (canal) *fai* (weir) on the Kuang River inside Chiang Mai's outer ring road. The weir in the center of the image creates a retention pond at a higher level that supplies the canal on the left of the frame, which in turn gravity-feeds the rice paddies in the upper left of the frame. The cultivated rice paddies on the left are on the east side of the Kuang River within the agricultural protection zone, however the ring road is just out of the frame to the left. The unmaintained paddy on the right is within the low-density housing zone west of the river. Drone imagery Santipab Sonboom, October 2016.

of land into different category according to their different functions was not formalized in a land use map in Chiang Mai until 1984.

Sanay Yarnasarn (1985) attended Columbia University on a government scholarship in the 1980s, where he was introduced to three theoretical city models from North American urban geography: concentric zoning, radiating sectors, and multiple nuclei satellites, through which he attempted to analyze the existing land-use pattern as a basis to project the future urban growth of Chiang Mai city following standard practice in North America. Despite the Western conceptions embedded in these models, tools and plans, Chiang Mai's urban-agricultural hybrid mix resisted all these rigid and abstract classifications. The introduction of Western planning strategies, technology and methods fed by central government investments in modernization, led to the inevitable adaptation of Chiang Mai to Western ideas and patterns (Figure 5; McGrath, Barcelloni Corte, & Sangawongse, 2012).

2.3. Mapping Rapid Urbanization

The Ministry of Transportation and the Department of Rural Roads are two Bangkok-based bureaucracies set to determine Chiang Mai's urban future. A flurry of highway building projects followed Thailand's economic boom, and has accelerated the extended urbanization of Chiang Mai. The financial crisis of 1997 divides this road infrastructure development into two periods in Chiang Mai, with the construction of superhighway and radial road widening before crash producing some rural property development including exclusive golf course communities as well as more modest extensions of villages and towns. The post-crash 21st century city has seen the development of a ring road system and the proliferation of mass market gated communities and new commercial centers. The uneven development of Chiang Mai can be seen as the result of a boom and bust cycle in Thailand, which has lifted the majority out of poverty but has further concentrated wealth.

A team from the Faculty of Social Science at Chiang Mai University and the Chiang Mai Royal Irrigation Office (Region 6) acquired Landsat Thematic Mapper (TM) data and Enhanced Thematic Mapper (ETM Plus) data at 30m resolution for 1989, 2000, 2006 and 2009 in order to come to grips with documenting Chiang Mai's rapid urbanization. Data was organized by the supervised classification (Jensen & Im, 2007) into seven land use types as shown in Table 1. Land use data was one input into a computer model covering the area within the comprehensive boundary to capture the urban growth pattern and to predict future land use change through 2030. Evidence revealed a significant increase of urban area during the study period (from 10.6% in 1989 to 18.27% in 2009). Five different types of growth were modeled: diffusion, breed (city center expansion), spread (expension

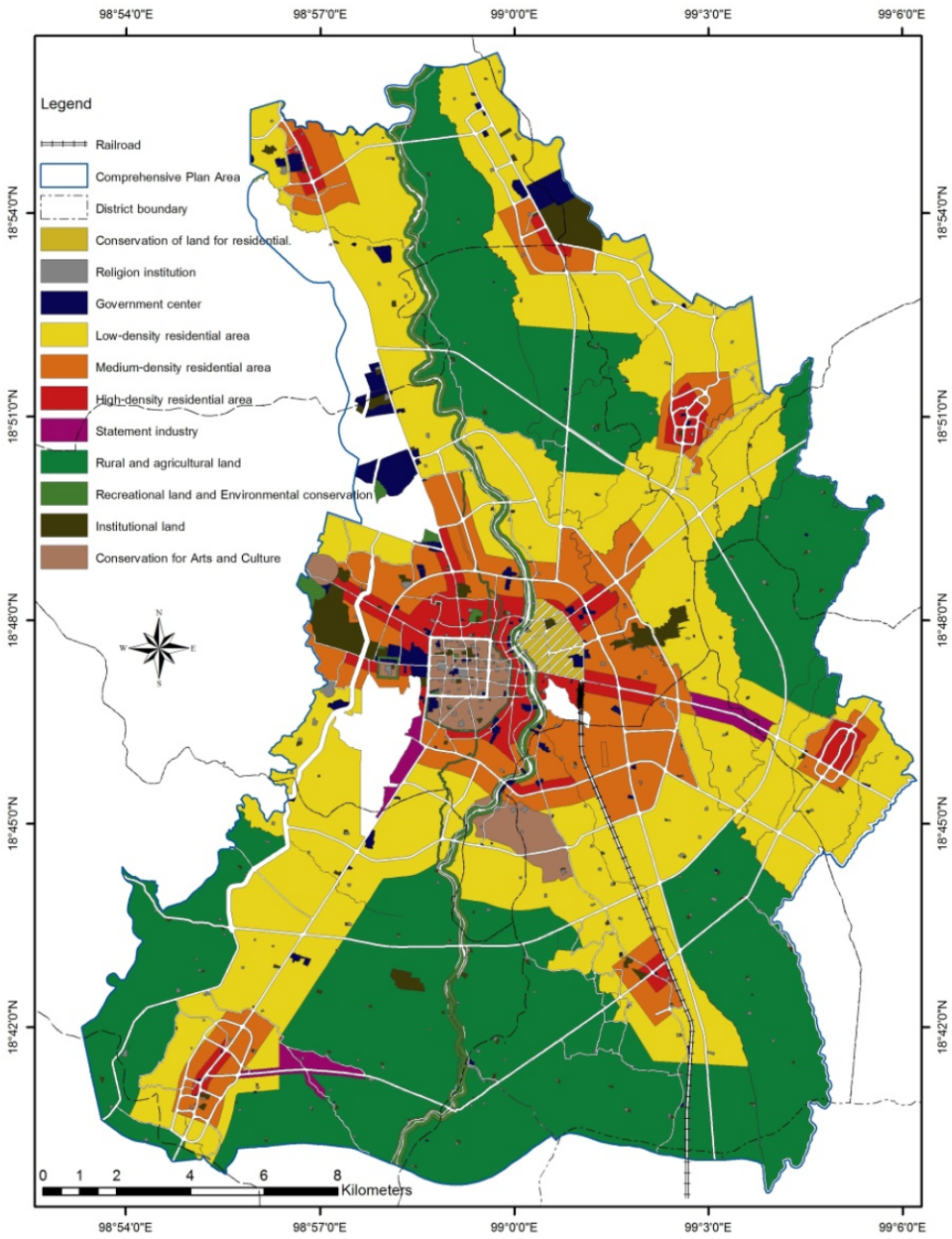

Figure 5. Eleven land use zones in the 3rd revision of the Chiang Mai Comprehensive Plan. The outer ring road passes through wedges of agricultural conservation zones, yet is triggering uncontrolled development. Six older town centers are planned for higher density development along radial roads, but most high density residential and commercial spaces are emerging at the intersections of the superhighway and ring roads and the radial roads producing unplanned centers. Adapted from Department of Public Works and Town & Country Planning (2010).

from center and sub-centers), slope, and road based. The model predicted a significant increase in proportion of urban area primarily from city center breed and road based development, within the comprehensive planning boundary in five year intervals from 2010 to 2030 with an increase in urban land from 38% to 80% (Figure 6; Sangawongse, Sengers, & Raven, 2012).

But actual urbanization has exhibited all growth types in the SLEUTH model, as evidence of dispersed and sub-center growth is evident from both on the ground and drone surveys, as well as from remote sensing analysis. The valley has seen a great reduction in rice paddy land use over the twenty-year period from 1989 to 2009, first as orchard cultivation replaced rice farming in the 1980s, and after the 1980s, an acceleration of urbanization. The current balance in the comprehensive planning area between forest, orchard, paddy and urban land uses suggests the possibility of seeding a more dispersed and mixed urban/rural development in the future, as opposed to the current road and expanding center models (Table 1 and Figure 7).

Further work on land use change analysis in the Comprehensive Plan boundary was conducted by Sangawongse and Vittaya (2015). This analysis updated the

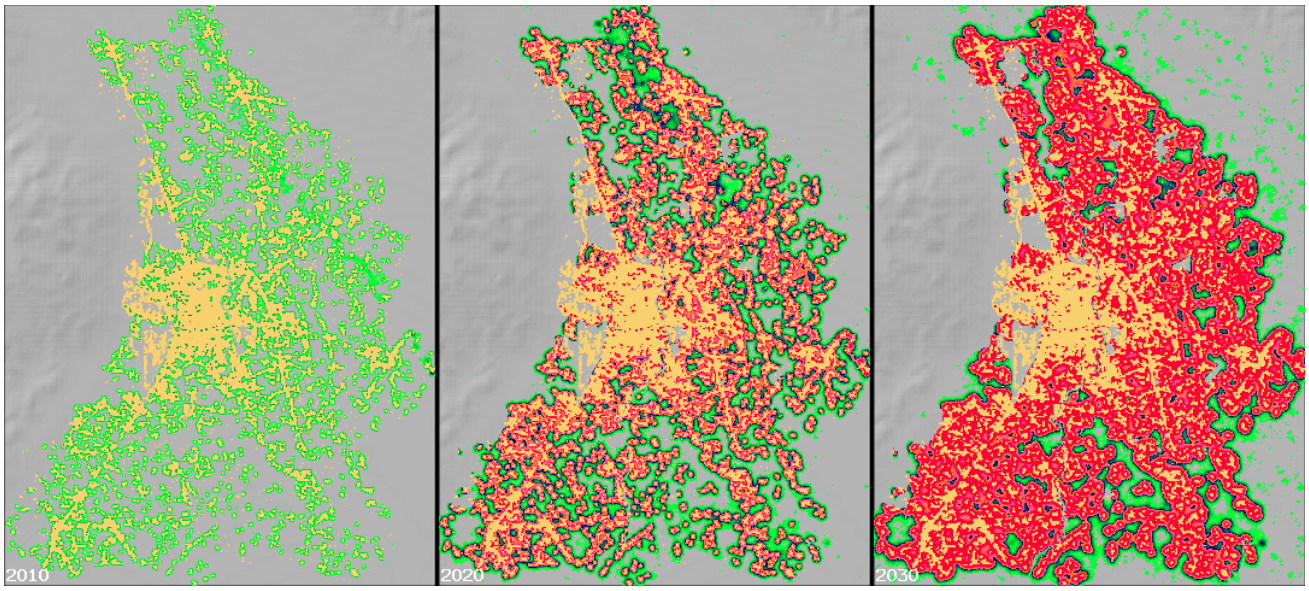

Figure 6. SLEUTH growth model was developed from cellular automaton (CA) model, which can be used for mapping urban growth and land use dynamics. Left, 2010 urbanized area, middle 2020 projection and right 2030. Without any policy shift, the model predicts 80% urbanized comprehensive planning area by 2030 (Sangawongse, Kowsuvon, & Sasom, 2011).

Table 1. Land Use Change in Chiang Mai Comprehensive Plan boundary. From a paddy dominated region to one in which patches of forests, orchards, rice paddies and urban land use interact (Sangawongse et al., 2011).

	Area 1989		Area 2000		Area 2009	
Land Use Type	Km^2	%	Km^2	%	Km^2	%
Urban	73.24	10.60	83.49	12.09	126.32	18.27
Paddy Field	283.46	41.01	201.58	29.19	131.32	18.99
Orchard	123.04	17.80	172.15	24.93	169.62	24.53
Forest	124.91	18.07	155.67	22.54	171.92	24.86
Water Body	4.12	0.60	2.69	0.39	28.21	4.08
Other	73.36	10.61	74.31	10.76	62.88	9.09
Bare Land	9.09	1.32	0.7	0.10	1.24	0.18

number of new buildings within the Comprehensive Plan boundary up to 2013 using the ortho-aerial photographs of Chiang Mai acquired from the Royal Thai Survey Department in 2013. Changes between 2000 (base year) and 2013 were classified according to eleven land uses in the Comprehensive Plan boundary. Results showed that built-up areas of urban land use categories have increased mostly in low density residential class with 33% increase in number of buildings and 37.5% in total area (Table 2). Most significantly, this research revealed that 20% of growth since 2000 has crossed the land use boundaries within the plan with many subdivisions built within the agricultural zone. Development has also leapfrogged over the comprehensive boundary itself. Meanwhile large areas zoned for residential use remain active farming areas. The entire plain is subject today to an extremely complex condition of urban dispersal, which is strongly changing the ecological and economic mix of the region. As a result of the construction of new roads and urban facilities, a new diffuse and mixed city (McGrath, 2012) is being created.

While the comprehensive plan aims to preserve wedges of agricultural land between the main radial streets, gated housing enclaves are being constructed along both radial and ring roads. The logic of the comprehensive land use plan does not sync with the infrastructural capacities of the irrigation and road systems. A major branch of the Mae Kuang system is used as a border between urban and agricultural land uses, ignoring the fact that it is best suited for agricultural land. The outer ring road crosses large swaths of agricultural preservation zones, while it disrupts the gravity fed irrigation system and promotes development of gated communities. Land use boundaries are not enforced, but bureaucratic boundaries between ministries and between scalar jurisdictions prevent synthetic urban/rural planning and design integration and cooperation.

Clearly the controlled planning strategy promoted by the Ministry of the Interior does not match the reality on the ground in Chiang Mai. A metacity project needs to provide the basis for a new conception of the city and more innovative planning strategies based less

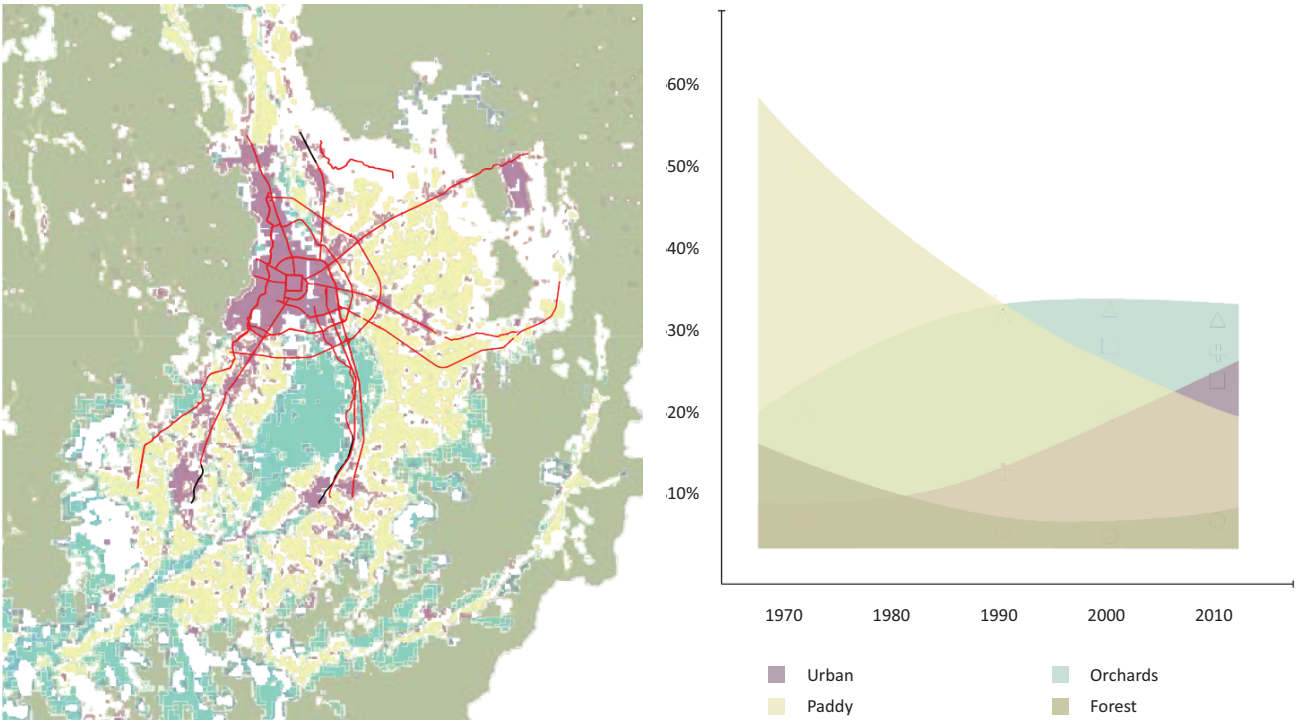

Figure 7. Chiang Mai/Lamphun Valley showing the major land cover types. The graph indicates Sangawongse's land use documentation of the comprehensive planning boundary. A rice paddy and forested dominated region has recently evolved to one where there is a balance between urban area, orchard, paddy and forest patches. Agricultural map underlay adapted from M. Ekasingh, Chiang Mai University Multiple Cropping Center.

Table 2. Land Use Changes in the Comprehensive Plan Boundary by Zones between 2000–2015. Data reveals that 20% of recent building construction within the comprehensive boundary area has been in agricultural preservation zone. (Sangawongse & Vittaya, 2015).

	Buildings (2000)		**Buildings (2015)**		**Change in no. of buildings**		**Total Area change**	
Land Use Code/Classes	Number (Thousands of Units)	Area (sq. km.)	Number (Thousands of Units)	Area (sq. km.)	Number (Thousands of Units)	Percent	Area (sq. km.)	Percent
1. Conservation residential use	2.00	0.39	2.20	0.60	0.20	1.66	0.21	1.08
2. Low density residential zone	4.76	6.99	8.71	14.23	3.95	33.01	7.24	37.51
3. Medium density residential zone	2.52	4.66	3.46	6.70	0.94	7.85	2.04	10.55
4. High density residential zone	12.39	0.31	15	4.09	2.17	18.10	3.78	19.57
5. Specific Industrial zone	1.63	0.44	2	0.61	0.34	2.84	0.18	0.91
6. Rural & Agricultural zone	3.60	3.68	5.2	7.53	1.64	13.67	3.85	19.94
7. Open space for recreation & maintaining environmental quality	4.88	0.08	5.5	1.07	0.65	5.46	0.99	5.11
8. Educational land use	1.90	0.85	2.4	1.18	0.47	3.91	0.33	1.72
9. Preservation of cultural identity	9.13	1.66	10	2.05	1.18	9.81	0.39	2.02
10. Religious institutions	2.37	0.47	2.6	0.61	0.28	2.31	0.14	0.75
11. Government Institutions and public utilities	2.89	0.78	3.1	0.94	0.17	1.39	0.16	0.84
Total	48.07	20.31	60.05	39.61	11.98	100.00	19.30	100.00

on hypothetical models, and with more analysis understanding of the discrepancy between the comprehensive land use plan which designates agricultural preservation wedges, and ring road construction through those supposed preservation zones. With the rise of Edge Cities in the U.S. in the 1980s, economics developed spatial models for the self-organization in space along lines (strips or ribbon developments) and rings, punctuated in time by waves of development (Krugman, 1996). These models perfectly describe the two phases of the last four decades of development in Chiang Mai, which coincide with the development of a radial and ring road system. The geographic data looking at land use change from 1989 to 2009 shows the current balance between forest, orchards, rice paddies and urban land use, while the second data set demonstrates the effect of radial and ring sprawl.

3. Conclusion: Study Areas for a Metacity Project

3.1. Current Urban Reality on the Ground

Two extensive surveys of study areas in close detail have been conducted, first in the orchard dominated area south of the city, studied in 2012 (Barcelloni Corte, 2014), and current field work by McGrath east of the city center. The area around Saraphi, downstream of the old city center of Chiang Mai, is the best irrigated land in the region, and farmers have profited from switching to *longan* and other fruit orchards in the early 1980s with government support (Figure 7). Barcelloni describes the traditional settlement area as consisting of diverse patches, often separate from each other physically, functionally, economically and in terms of age, but imbued with great flexibility, easily modifiable, adaptable to the changing needs of the different subjects they come under. Alongside the minute mixture of functions in small urban centers sit market streets, where homes and shops, mechanics, and small factories cohabit side-by-side, within a cultivated area that has come to be dominated by commercial orchard farming.

Large plots of *longan* trees stretch in between villages, tucked in areas removed from recent highway construction and their attended gated communities. Agricultural, industrial and residential uses are not separate but work, trade, services and leisure coexist within a complex urban/rural matrix. Spaces of everyday living appear like complex tesserae within a great territorial mosaic of extended villages, religious buildings and spaces, factories and industrial warehouses, as well as small and medium centers, inside a common territorial frame. The research offered an analysis of the site as an example of "horizontal urbanism" that integrates the rich mixture of flexible housing patterns, combined residential/work environments, with emerging forms of commercial concentration and public life (Barcelloni, 2014).

San Phu Loei, a town in Doi Saket District 15 km. east of Chiang Mai, is within the Chiang Mai Comprehensive Plan boundary. Here the new outer ring road intertwines with the Mae Kuang River, feeding a landscape dominated by wet rice paddy cultivation. Bisecting this intertwining river and highway is the narrow, old San Kamphaeng Road, the "handicraft highway" developed for bus coach tourism in the 1980s (Cohen, 1995). Erik Cohen identifies two types of craft-ribbons: the simple localized ribbon, emerging along roads in and adjoining a craft producing community, and the complex ramified ribbon which emerges between such a community and a major urban tourist center. Ban Tawai wood carving village south of the city center and the Bo Sang bamboo and mulberry paper umbrella making to the east are examples of the former, while Hang Dong to the south and San Kaphaeng Road to the east are examples of the latter (Figure 8).

These older radial roads not only fostered new craft industries to serve bus coach tourism, but also facilitated the development of a first phase of housing subdivisions before the financial crisis of 1997, when much speculative real estate development fell into bankruptcy. As a result, radial roads from the city center connect to multiple incomplete and partially vacant subdivisions located between villages, rice paddies and new gated communities. Large tracks of rice paddy and vacant land are preserved within the super blocks created when the new ring roads crossed the older radials at the end of the 20th century. The urban low density yellow zone of the comprehensive plan contains many productive rice fields and orchards, while patches of new property developments proliferate within the agricultural preservation zone. Illogically, the Kuang River forms the border between yellow residential and green agricultural zones, when it is the main conduit for paddy irrigation and the life line of a rich agricultural zone within the outer ring road. (Figure 9). Both study areas share common opportunities and challenges to the current urban plan: creating a new village compound, fostering new craft economies, and finally designing a new public realm.

3.2. The New Village Compound

In both sites, village compound houses are structured to accommodate intergenerational matrilocal extended families (Potter, J. 1976; Potter, S.H. 1980) confront a new landscape of gated subdivisions filled with identical detached houses on small plots built for an imagined nuclear family consumer. Ethnographic studies conducted over several decades reveal how the compound house accommodated an open relation between interior and exterior spaces and evolves through simple additions of extended family dwellings, work spaces and outdoor living areas and kitchens. These compounds create tree shaded microclimates, and now increasingly include small business enterprises and small dormitories. The expanded compound now often provides the only affordable housing for migrant laborers and spaces for small cottage industries serving the urban economy.

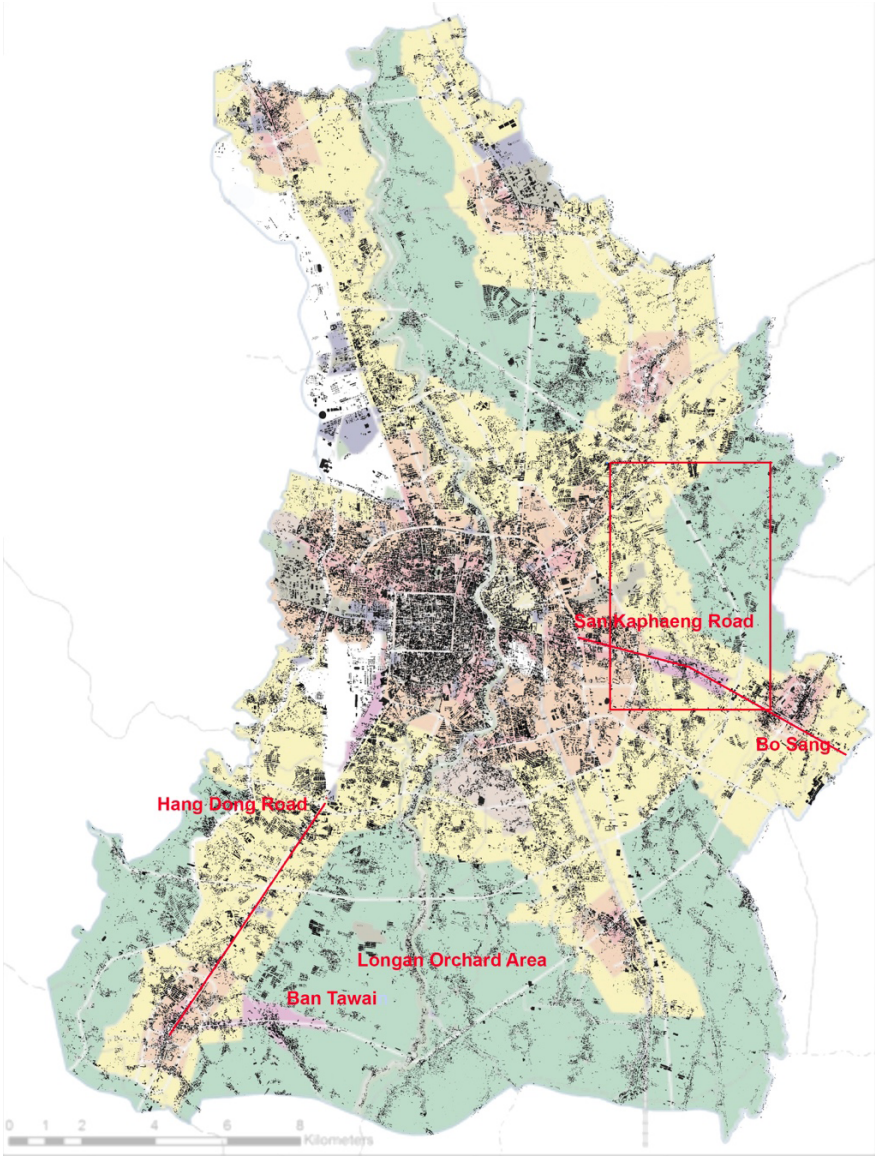

Figure 8. Figure/Ground drawing of Chiang Mai overlaid on the comprehensive plan area showing the highway induced sprawl overlaying with the existing village/water/paddy structure of the land. Both growing villages and new gated enclaves proliferate within the agricultural preservation zone (green on this map). The inset area outlined in red is the study area illustrated in Figure 9.

In contrast with ring road gated developments, these small-scale initiatives exploit existing resources to produce a pattern that densified and adapted the village with simple modifications. Slight road extensions at villages create new house zones separate from the large gated subdivisions along the new ring and widened arterial highways. The pattern of change in the residential grain of the villages spread across the valley can be detected easily in the time series of Google Maps since 1984. Before the economic crisis of 1997, a first phase of interventions associated with local actors consisted of compound and village densification and extensions through street building and land plotting. A second, post-crisis phase, features more homogeneous interventions, completed built out with limited house types of consistent design developed by large Bangkok-based firms equipped with mortgage plans catering mostly to a non-resident market (Figure 10).

The new real estate enclaves are highly inflexible and ill-suited to the climate, familial needs or even cooking habits of locals. The social value of flexibility confronts the real estate worth of ensuring a safe investment. The new gated enclaves feature a limited pallet of material and layout choices, highly manicured open spaces raised on land fill and fenced behind large concrete walls above surrounding farms. Gated and protected, they guarantee safety and privacy, but at the same time are isolated from the existing natural resources and social infrastructure. The selling point for the house is the view of surrounding rice fields and mountains, but there is little support for the farmers or the communal irrigation infrastructure which maintains that landscape.

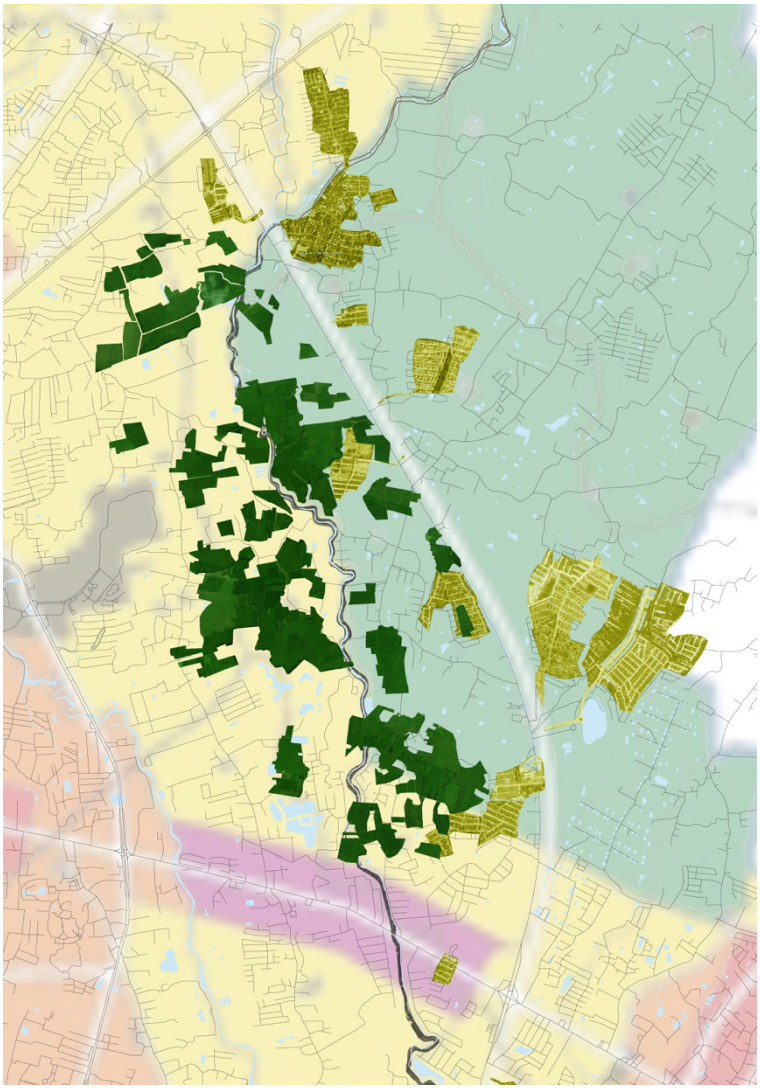

Figure 9. Study area showing the Mae Kuang River and adjacent rice paddies on the left in green and the outer ring road and new gated subdivisions in yellow on the right, overlain on the comprehensive plan zones: yellow is low density housing, green is agricultural preservation and the purple manufacturing ribbon is along San Kaphaeng Road, the "handicraft highway". Collage from Google Earth imagery, December 2016.

3.3. New Craft Economies

The handicraft highways serving tourists as well as the food processing industry which accompanied longan cultivation and other market based farming have transformed subsistence farming life to diverse forms of commodified labor. Ethnographers have described the seasonal cycle of rice farming and how villagers in addition to setting up craft production also turn to construction, transportation, tourism and small scale retail to supplement farming income. Single or small groups of industrial sheds are scattered between villages and farm fields. These productive fragments at first sight seem at odds with the agricultural landscape, but a more detailed analysis reveals that villages, farms and small industries are complementary.

Tourism-related craft-producing and marketing establishments took the form of ribbon development for bus coach tourism (Cohen, 1995). However, handicraft was traditionally dispersed within the village and farm compound setting, and many new art, design, food and craft entrepreneurs are seeking out these "rural" locations off the tourist ribbons. Chiang Mai's branch of Thailand Creative and Design Center in bringing new attention to the future of a craft economy tied to global interest in well-designed hand made goods. The co-presence and the mixture of functions between productive, residential and agricultural activities sharing the same services and infrastructure highlights the possible integration of rural and urban types, not as a passing phase as McGee describes in *Desakota* (1996), but aided by social media and GPS navigation as a new form of meta-urbanism. A point cloud of new developments form micro-nodes of a new local production system that has a potential to connect to the search for cultural authenticity and sustainable tourism (Figure 11).

Figure 10. A high wall separates rice paddies and fish ponds from new gated community under construction within the agricultural preservation zone east of the Kuang River. Industrial food processing sheds can be seen in the background. Drone imagery: Santipab Sonboom, October 2016.

Figure 11. Wet rice paddies and secondary irrigation canals just north of the weir in Figure 12, all within the low density residential zone of the comprehensive plan. Wat Tha Thum is to the right. Drone imagery: Santipab Sonboom, October 2016.

3.4. A New Public Realm

While the widening of radial roads triggered linear strip commercial development before the economic crisis of 1997, the completion of three ring roads by end of the 20th century produced a new gated community residential market, as well as multiple new commercial and high density residential zones. Malls and mid-rise con-

dominium projects are built across the street from each other, but no pedestrian connection has yet emerged. A proliferation of bicycle advocacy groups and weekend walking streets has created a new interest for a modern public realm and in a public transit system. However, the majority of the area of the valley is an agricultural territory that is only designed for the car between historical city with its temples, wall and moat, and the amenity-filled forested mountains.

Between and surrounding the new highway sprawl an intricate network of streams, weirs, canals and roads forms an undervalued public infrastructure that could provide public access and participation in agricultural life rather than forming a scenic backdrop for the marketing of new homes. This narrow and winding network induces slow movement of bicycles and pedestrians, but also motorcycles, tractors and the informal public transit of pick-up trucks with two benches and small vans. The small weirs and canals are still collectively maintained by villagers, cleaned and flushed according to the seasonal variations of water levels, and marked by spirit houses and seasonal rituals in sync with the monsoon cycle (Figure 12). These artifacts are nodes in the most important public realm of the Lanna territory, and they hold the possibility of not only connecting the villages, but providing access between new dense nodes and incorporating the recently constructed gated enclaves.

These two public investments, one, the state's large infrastructural systems, and the other, the gradual improvement of the existing pathways and waterways, constitute the overlay of high and slow speed territories. Since these territories do not have a dominant center, a dispersed condition establishes non-hierarchical relationships between their different patterns and speeds. A metacity system whose complementarity and integration, beyond the center-periphery center-center opposition, renders an integrated area where open and agricultural land weaves complex and often complementary patterns and relationships with new developments. The metacity is a layered space evolving towards an increasingly connected mesh where the dispersion of figures creates a dense network of elements providing choice and difference but not leading to the forming of rigid hierarchies.

3.5. Metacity Practice

The last four decades of development in Thailand have occurred within the volatile time frame of economic booms and busts, extreme political shifts between populist and royalist sentiments, and extreme flood and draught cycles. Yet, Chiang Mai remains a high amenity area of ecological and cultural importance with great scenic beauty and increasing tourist, leisure, retirement and second home demand. Comprehensive planning favors the system of the main urban center and the routes crossing the territory connecting to mountain's leisure and recreation amenities. Contemporary design practice

Figure 12. Royal irrigation department people's irrigation project on site of former *muang fai* looking north with Doi Suthep mountain to the west (left of frame). The weir creates a fish hatchery pond upstream and feeds an irrigation canal following the curving road to the left. The large rice field in the background, fed by the upstream pond. The rice field is within the low-density housing zone as it is east of the Kuang River. The land to the west is zoned for agricultural preservation. Drone imagery: Santipab Sonboom, October 2016.

has focused on the design and packaging of new architectural products and the successful conservation of the historical center and the forested hinterland, while the agricultural zone of the flood plain in between has been neglected.

The detailed case study of Chiang Mai can be seen as representing the extensive urbanization practice of national infrastructural and real estate products in rural territories across Asia (Figure 1). Rapid and dense road and real estate development has ignored the diverse cultural, spatial and ecological legacies in the extended, densely inhabited traditional networks of wet rice cultivating societies (Figure 2). 20th century urban building types and design practices progressively stiffen the territorial ecosystem, making it increasingly less flexible and resilient. The micro-communal irrigation networks and cooperative village settlements in Chiang Mai are important elements of the development and self-determination of the regional economy and have not been successfully engaged by governments, architects and urban planners (Ganjanapan & Lebel, 2014). Current urbanization brutalizes the fragile village/rice cultivation/communal irrigation system through modern dam and canal building and highway construction, urban strategies of a top-down metropolitan panning system of the past.

A metacity practice assists the adaptation of the historical territory to the new demands and desires of a modernizing society, but always begins with a careful analysis of the lived reality on the ground. A metacity project models the calculus of the multitude of individual decisions relative to the best mode of dwelling, working, recreating and living by a territory's residents. A metacity practice reflects the lifestyles of inhabitants who, with time, have learned to make good use of the considerable potential of the natural resources of the valley by utilizing the power of labor exchange and social cooperation (Potter J., 1976) and advocates incremental self-determination (Tan-Kim-Yong, 1995).

Conflict of Interests

The authors declare no conflict of interests.

References

Banham, R. (1972). *Los Angeles: The architecture of four ecologies*. New York: Harper & Row.

Barcelloni Corte, M. (2014). *Horizontal urbanism: A comparative exploration of an emergent urban principle from land to water* (Doctoral Dissertation). IUAV, Venice, Italy.

Coedes, G., (1966). *The making of South East Asia*. Berkeley, CA: University of California Press.

Cohen, E. (1995). Touristic craft ribbon development in Thailand. *Tourism management*, *16*(3), 225–235.

Cohen, P. T., & Pearson, R. E. (1998). Communal irrigation, state, and capital in the Chiang Mai Valley (Northern Thailand): twentieth-century transformations. *Journal of Southeast Asian Studies*, *29*(1), 86–110.

Department of Public Works and Town & Country Planning. (2010). *Future land use plan: Scale 1:4000*. Bangkok: Department of Public Works and Town and Country Planning (DPT), Ministry of Interior. [In Thai]

Gandelsonas, M. (1999). *X-urbanism*. New York: Princeton Architectural Press.

Ganjanapan A. (1984). *The partial commercialization of rice production in Northern Thailand* (1900–1981) (Ph.D. Dissertation). Cornell University, Ithaca, USA.

Ganjanapan S., & Lebel L. (2014). Interplay between new basin organisations, pre-existing institutions and emerging environmental networks in the Mae Kuang watershed, Northern Thailand. In *The politics of river basin organisations, coalitions, institutional design choices and consequences*. London: Edward Elgar Publishing.

Jensen, J. R., & Im, J. (2007). Remote sensing change detection in urban environments. In *Geo-spatial technologies in urban environments* (pp. 7–31). Heidelberg: Springer-Verlag.

Krugman, P. (1996). *How the economy organizes itself in space: A survey of new economic geography*. Sante Fe: Sante Fe Institute Working Papers.

Kingshill, K. (1991). *Ku Daeng: Thirty years later*. DeKalb, IL: Northern Illinois University.

Koolhaas, R. (1978) *Delirious New York*. New York: Oxford University Press.

Lefebvre, H. (1992). *The production of space*. New York: Wiley-Blackwell.

Marshall, V. (2017). Designing mega delta interactions. In S. Dong, J. Bandyopadhyay, & S. Chaturvedi (Eds.), *Environmental sustainability from the Himalayas to the oceans: Struggles and innovations in China and India* (pp. 205–238). New York: Springer.

McGee, T. G., (1991). The emergence of Desakota regions in Asia: Expanding a hypothesis. In N. Ginsburg, B. Koppel, & T. G. McGee (Eds.), *The extended metropolis: Settlement transition in Asia* (pp. 3–25). Honolulu: University of Hawaii Press.

McGrath, B. (2008). *Digital modelling for urban design*. London: John Wiley & Sons.

McGrath, B. (2012). *Urban design ecologies*. London: John Wiley & Sons.

McGrath, B., Barcelloni Corte, M., & Sangawongse, S. (2012). *Structuring dynamic growth through inherited urban form: Case study from Chiang Mai, Thailand*. Paper presented at ACSA Conference.

McGrath, B., & Pickett, S. T. A. (2011). The metacity: A conceptual framework for linking ecology and urban design. *Challenges*, *2*(4), 55–72.

McGrath, B., & Pickett, S. T. A. (2015). An archaeology of the metacity cities. In W. Ding, A. Graafland, & A. Lu (Eds.), *Cities in transition: Power, environment, society* (pp. 104–134). Rotterdam: NAI010 Publishers.

McGrath, B., & Shane, D. G. (Eds.). (2007). Sensing the

21st century city: Close-up and remote [Special Issue]. *Architectural Design*, *75*(6).
McGrath, B., & Shane, D. G. (2012). Meteropolis, megalopolis, metacity. In *The Sage handbook of architectural theory* (p. 641). New York: Sage.
Pickett, S. T. A. (2012). The ecology of the city: A perspective from science. In McGrath, B. (Ed.), *Urban Design Ecologies*. London: John Wiley & Sons.
Pickett, S. T. A., Cadenasso, M. L., & McGrath, B. (Eds.). (2013). *Resilience in ecology and urban design: Linking theory and practice for sustainable cities*. New York: Springer.
Picketty, T. (2014). *Capital in the twenty-first century*. Cambridge, MA: Harvard University Press.
Polachan, S., Pradidtan, S., Tongtaow, C., Janmaha, S., Intarawijitr, K., & Sangsuwan, C. (1991). Development of Cenozoic basins in Thailand. *Marine and Petroleum Geology*, *8*(1), 84–97.
Pongpaichit, P., & Baker, C. (1998). *Thailand's boom and bust*. Bangkok: Silkworm Books.
Pope, A. (1996). *Ladders*. New York: Princeton Architectural Press.
Potter, J. (1976). *Thai peasant social structure*. Chicago: University of Chicago Press.
Potter, S. H. (1980). *Family life in a Northern Thai village: A study in the structural significance of women*. Berkeley: University of California Press
Rao, V. (2006). Slum as theory: The South/Asian city and globalization. *International Journal of Urban and Regional Research*, *30*(1), 225–232.
Rhodes, B. P., Pereza, R., Lamjuanb, A., & Kosuwanb, S. (2003). Kinematics and tectonic implications of the Mae Kuang Fault, northern Thailand. *Journal of Asian Earth Sciences*, *24*(1), 79–89.
Ritchie, M. A. (1996). *From peasant farmers to construction workers: The breaking down of the boundaries between agrarian and urban life in Northern Thailand, 1974–1992* (Doctoral Dissertation). Berkeley: University of California at Berkeley.
Roachanakanan, T. (2014). *Articles in Planning Review of town and country planning in Thailand*. Bangkok: Department of Public Works and Town & Country Planning.
Rossi, A. (1982). *The architecture of the city*. Cambridge: MIT Press.
Rowe, C., & Koetter, F. (1978). *Collage city*. Cambridge: MIT Press.
Sangawongse, S., Kowsuvon, N., & Sasom, P. (2011). Assessment of the impacts of urbanization on environmental quality in the Chiang Mai–Lamphun Valley. *Journal of Remote Sensing and GIS Association of Thailand*, *12*(2), 1–14.
Sangawongse, S., Sengers, F., & Raven, R. (2012). The multi-level perspective and the scope for sustainable land use planning in Chiang Mai city. *Environment and Natural Resources*, *10*(2), 21–30.
Sangawongse, S., & Vittaya, R. (2015). Towards a GIS-based urban information systems to plan a smarter Chiang Mai. Nakhara: *Journal of Environmental Design and Planning*, *11*, 1–8.
Scott, J. (2010). *The art of not being governed: An anarchist history of upland Southeast Asia*. New Haven: Yale Universtiy Press.
Shane, D. G. (2008). *Recombinant urbanism*. London: John Wiley & Sons.
Surarerks, V. (2006). Muang fai communities in Northern Thailand: People's experiences and wisdom in irrigation management. *Journal of Developments in Sustainable Agriculture*, *1*, 44–52.
Tanabe, S. (1994). *Ecology and practical technology: Peasant farming systems in Thailand*. Bangkok: White Lotus Press.
Tan-Kim-Yong, U. (1995). *Muang-fai communities are for people: Institutional strength and potentials*. Bangkok: Chulalongkorn Social Research Institute.
Tschumi, B. (1983). *Manhattan transcripts*. London: AA Files.
Tukamoto, Y., Kuroda, Z., & Kaizima, M. (2001). *Made in Tokyo*. Tokyo: Kajima Institute Publishing.
Venturi, R., Scott-Brown, D., & Isenour, D. (1972). *Learning from Las Vegas*. Cambridge: MIT Press.
Winichakul, T. (1997). *Siam mapped: A history of the geo-body of a nation*. Honolulu: University of Hawaii Press.
Yarnasarn, S. (1985). *Land-use patterns and land-use changes in Chiang Mai, Northern Thailand* (Ph.D. Dissertation). Columbia University.

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Article

Getting to Common Ground: A Comparison of Ontario, Canada's Provincial Policy Statement and the Auckland Council Regional Policy Statement with Respect to Indigenous Peoples

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Abstract
Indigenous rights are crucial to contemporary land use planning and policy in settler states. This article comparatively analyzes the manifest and latent content of the 2014 Provincial Policy Statement (PPS) of Ontario, Canada and the 1999 Auckland Council Regional Policy Statement (ACRPS) of Aotearoa New Zealand in order to evaluate their relative capacity to recognize the rights of Indigenous peoples. While the results show that jurisdiction is an impediment to fostering common ground between Indigenous peoples and settler states, the authors conclude that the PPS and the ACRPS serve vital roles in building dialogue and equitable planning outcomes.

Keywords
Aotearoa; Auckland; Canada; comparative policy; Indigenous; land use planning

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1. Introduction

Both Aotearoa New Zealand and Canada are settler states and have common asymmetrical structural policy features that have sought to dominate Indigenous peoples[1] (Hibbard, Lane, & Rasmussen, 2008; Maaka & Fleras, 2005). These structures are largely the result of British colonial planning and settlement that was facilitated through the negotiation of foundational documents between the British Crown and Indigenous peo-

[1] The collective term 'Indigenous' is used throughout this article when speaking to both settler states in order to allow for an international comparison of key regional land use policy statements from two settler states, and to be consistent with the international context in recognizing First Peoples and communities who have unique legal and political relationships stemming from original occupancy and inherent connections to specific lands prior to settler contact. When referring specifically to the Aotearoa New Zealand context, the term 'Maōri' is used to refer to Indigenous peoples. When referring to the Ontario, Canada context, the term 'First Nations' is used. 'Aboriginal peoples', which refers to First Nations, Métis, and Inuit peoples of Canada collectively as identified in Section 35 of the *Constitution Act, 1982* is not used as prevalently because this article emphasises the perspectives of First Nations partners who are involved in this research. The term 'Aboriginal' is only used in certain instances in the article when referring to the Canadian context, the manifest content of the Provincial Policy Statement, and Aboriginal and Treaty rights as recognized and affirmed under Section 35 of the *Constitution Act, 1982*.

ples grounded in co-existence—Aotearoa New Zealand's 1840 Treaty of Waitangi and Canada's Royal Proclamation of 1763. In Canada, the spirit and intent of the Royal Proclamation of 1763 and the subsequent Treaty of Niagara of 1764, especially regarding Indigenous perspectives and interpretations, has not been lost entirely from the public conscience.[2] The struggle, however, remains to insist on the continued relevance and significance of these treaties and reports, rather than disregard, in a process of reconciliation (Borrows, 1997; Royal Commission on Aboriginal Peoples [RCAP], 1996; Truth and Reconciliation Commission of Canada [TRC], 2015). In Aotearoa New Zealand, following the formal reinstatement of the Treaty of Waitangi and the establishment of the Treaty of Waitangi Tribunal in 1975, there has been an increased shift towards the formal recognition of its principles and the foundational idea of two nations and their founding partnership (Ericksen, Berke, Crawford, & Dixon, 2004). While both the Royal Proclamation of 1763 and the Treaty of Waitangi (1840) play significant roles in determining the rights of Indigenous peoples in Canada and Aotearoa respectively, regional policies and plans also deserve close scrutiny regarding the extent to which the settler states formally recognize the rights of Indigenous peoples to lands and resources.

This article proposes that a comparison of the 2014 Provincial Policy Statement (PPS) of Ontario, Canada (Ministry of Municipal Affairs and Housing [MAH], 2014a) and the 1999 Auckland Council Regional Policy Statement (ACRPS) of Aotearoa New Zealand (Auckland Council, 1999), using manifest and latent content analysis of the texts, is warranted in order to evaluate the relative capacity of each policy to recognize the rights of their respective Indigenous peoples, namely, First Nations and Maōri peoples. An international comparison of key regional land use policy statements from two settler states enables a more practical understanding of the strengths and limitations of both policies on the rights of First Peoples. As a research partnership of First Nations in Southern Ontario and academic researchers of non-First Nations cultural backgrounds, the co-authors' work has emerged out of an ongoing interest and need to improve the relationships that exist between First Nation communities and state-based planners as well as to influence state-based planning policies that have historically situated the issues facing Indigenous peoples, especially those who live on reserves in close proximity to cities, as marginal. Following this introduction, a rationale and background to a comparison of the policies is provided, followed by the research methods along with the construction of the theoretical framework used to conduct the manifest and latent content analysis of the policies. The results are then summarized in relation to each policy statement respectively beginning first with findings into the 2014 Provincial Policy Statement and then the 1999 Auckland Council Regional Policy Statement. The subsequent discussion highlights key lessons from the analysis of Ontario's policy and what can be learned from the ACRPS planning context. The article concludes by discussing the implications of this comparative study for planning policy and practice.

1.1. Rationale

Our interest in the PPS as a research partnership stems from our ongoing collective efforts to amend the PPS to better support meaningful municipal-First Nations relationships during its 5-year review and our broader collective interests in making inroads and influencing how planning in Southern Ontario unfolds through systematic and strategic policy changes at the provincial-scale (McLeod, Viswanathan, King, Macbeth, & Whitelaw, 2014). With on-the-ground land use planning and decision-making in Southern Ontario largely directed and guided by The Province through the Planning Act (Government of Ontario, 1990) and PPS, the integration of specific policies concerning Aboriginal peoples in the most recent iteration of the PPS (2014) was recognized as both significant and long overdue (Dorries, 2014; McLeod et al. 2014). Based on the findings of McLeod et al. (2015), the PPS was also recognized as a relatively significant provincial land use and resource management text in its relative capacity at recognizing and supporting First Nations, Aboriginal and treaty rights, and embodying past Crown-First Nations relationships, when assessed along with 336 other provincial land use planning and resource management texts. However, to fully comprehend the strengths and limitations of recent changes to the PPS, we identified an immediate need to move beyond relative assessments of Ontario land use planning and resource management texts, and to carry out a comparison with a similar guiding planning policy statement from another settler state.

Aotearoa New Zealand was chosen to support this endeavour at understanding if recent changes to the PPS where truly significant because it is well recognized that this settler state, in comparison to Canada, is far more advanced in its relationships with Maori peoples at the local government scale (Awatere, Harmsworth, Rolleston, & Pauling, 2013; Participant Three, personal communication, June 13, 2014). Without provinces in Aotearoa New Zealand and following the implementation of the Resource Management Act (RMA) (Ministry for the Environment, 1991), planning authority was primarily devolved to regional and local governments. The ACRPS (1999) was the ideal comparative text with the PPS (2014) as it situates in a similar position within its respective planning hierarchy. As part of a comprehensive study of the effectiveness of Aotearoa New Zealand's new planning regime under the RMA by Ericksen et al.

[2] Indeed, Call to Action #45 of the Truth and Reconciliation Commission's Final Report calls for a (new) Royal Proclamation of Reconciliation that builds on both the Royal Proclamation of 1763 and the Treaty of Niagara 1764 as well as "reaffirm[ing] a nation-to-nation relationship between Aboriginal peoples and the Crown." (TRC, 2015, p. 252)

(2004), the ACRPS ranked third overall out of 16 regional policy statements for Māori interests. During the execution of this comparative analysis between March and September 2014, the subsequent iteration of the ACRPS found in a consolidated draft regional policy statement chapter of the Proposed Auckland Unitary Plan (PAUP) had been released for review (Auckland Council, 2013). However, with uncertainty regarding its final contents, approval, and timeframes for when it would be operational, it was determined that the ACRPS would be the ideal policy statement to assess relative to the PPS.

The rationale for executing a comparison between the PPS (2014) and the ACRPS (1999) was also further strengthened by the nature of the geographical regions, the Auckland Region and Southern Ontario, where the two policy statements largely influence everyday planning decisions of local governments. First, as major regions, both the Auckland Region and Southern Ontario comprise of a large proportion of their respective national populations; the Auckland Region comprising 30% of Aotearoa New Zealand's population and Southern Ontario comprising over 30% of Canada's population (MAH, 2014b; Memon, Davies, & Fookes, 2007). Each region is growing fast and provides core economic functions nationally. Each region is also characterized in many places by similar patterns of low-density sprawl (Gordon & Janzen, 2013; Memon et al., 2007). In terms of governance, both regions during the 1990s faced a series of reforms and amalgamations that resulted in significant reductions of the number of local governments (Memon et al., 2007; Sancton, 2011). Finally, Southern Ontario and the Auckland Region both exist on ancestral lands of Indigenous peoples and planning texts in these regions until recently undervalued Indigenous peoples. Increasingly, Indigenous peoples in each region, parallel to efforts in other regions within settler states, are using land use planning as a form of resurgence, and to their benefit, in order to gain recognition of their rights and inherent connection to the land and their traditional territories (Lane & Hibbard, 2005; Porter & Barry, 2013).

2. Background

First Nation reserves in Ontario, Canada, many located along borders of urban local governments[3], have and continue to be controlled under federal jurisdiction and the restrictive confines of the Indian Act (MAH, 2009; RCAP, 1996). Whereas, the provincial government exercises jurisdiction over off-reserve lands, including traditional territories and lands under specific treaties. The integration of provincial land use policies concerning First Nations peoples in Ontario is both significant and long overdue. The Ontario PPS plays a critical role in planning in the Province of Ontario, Canada and also influences the content of other plans within the province. Yet, if there is a conflict between provincial plans and the PPS, provincial plans take precedent unless otherwise stated (MAH, 2014a). The remaining tiers of Ontario's planning hierarchy consist of regional official plans by upper-tier local governments and official plans by lower or single-tier local governments, and local implementation tools, such as land use bylaws. In theory, strategic direction from the province tiers down to local authorities, but in certain areas of Southern Ontario, lower-tier local governments must account for the PPS, four provincial plans, and higher-tier plans in their day-to-day planning decisions. There have been four versions of the PPS, including the 1994 Comprehensive Set of Policy Statements, the 1996 PPS, the 2005 PPS and the 2014 PPS. The current PPS came into effect in April 2014 and is significantly different than its predecessors with respect to recognition and support of First Nations (Dorries, 2014). It is posited that in order to fully comprehend the strengths and limitations of the PPS in relation to the rights of First Nations, there is a benefit to moving beyond relative assessment of federal policies across nations and to carrying out an international comparison with a regional plan from another settler state.

Since the early 1990s, Aotearoa New Zealand's planning context has been characterized by an approach, in which regional and territorial authorities under the guidance of the Resource Management Act have had a great degree of discretion in developing policies and plans. Under the RMA, each regional council is required to prepare a regional policy statement, which reflects the regional context and identifies significant resource issues and policies to address their management. Consequently, the Auckland Regional Council Policy Statement came into effect in August 1999 to promote the sustainable management of natural and physical resources in the Auckland Region following a period of major decentralization and reform of planning and governance (Auckland Council, 1999). While the RMA is regarded as the highest strategic tier across all regions in Aotearoa New Zealand, the central government[4] is also required to provide additional guidance through national policy statements and New Zealand Coastal Policy Statements. Specific to the Auckland Region's planning context, the ACRPS is situated just below the tier of the RMA and has a significant influence on the content of regional plans, regional coastal plans, and district plans, as lower levels of plans and policies cannot be inconsistent with this regional policy statement (Ericksen et al., 2004). Without a parallel governance hierarchy to accompany the policy hierarchy, local and regional governments are required to act in partnership to ensure that the goals of the statute are being met.

[3] The term 'local government' is intentionally used throughout this article to allow for a comparison between the PPS (2014) and ACRPS (1999). While 'municipal government' is often cited in the Canadian context as a form of local government and referenced throughout the overall land use planning framework in Ontario; the term 'municipal' is not used in Aotearoa New Zealand and is not transferable. Accordingly, we have intentionally avoided using the term 'municipal' and refer to municipalities and municipal governments in the Ontario context as local governments to support this comparison with the Auckland Region.

[4] The equivalent of the central government in Aotearoa New Zealand is the Federal government in Canada.

3. Methods and Framework for Analysis

To assess the 2014 and previous versions of the Ontario PPS and the ACRPS (1999), a literature review, policy document analysis, and four interviews for validation purposes (three with First Nations community representatives and one planning expert in Southern Ontario) were conducted in this research from March to September 2014 to ensure triangulation, internal validity of initial findings and external validity of the analytic framework. The interviews are therefore integrated into several sections of the paper rather than as standalone findings. This research examines both manifest and latent content of policy statements and their associated higher-tier legislation with respect to Indigenous peoples and not their effects or implementation. In turn, the primary method for further inquiry was document analysis (Cope, 2010). The justifications for the use of document analysis draws heavily from Barry and Porter (2011) and Porter and Barry (2013) as the critical examination of planning law and governance in British Columbia, Canada and Victoria, Australia, evident in both articles, highlights the need to analyze statutory planning texts, including legislation, policies, guidelines and regulations to better understand planning's conflicting relationship with Indigenous peoples. It became clear that for this research it was just as important to understand the content of strategic-level policy statements that shape the everyday as it was to understand daily practices and processes that can advance Indigenous peoples' rights, concerns, and knowledge as well as create uneven power relations and starting points for communities.

Yet, analytical frameworks that assist in evaluating and making inferences about provincial and regional policy with respect to Indigenous peoples are relatively limited; this required our research partnership to construct an analytical framework by drawing out specific elements from the literature. To elaborate, the few frameworks that do exist relating to the New Zealand planning context, primarily Berke, Ericksen, Crawford and Dixon (2002) and Ericksen et al. (2004), tend to "simplify Indigenous recognition to a matter of accommodating greater numbers of Indigenous peoples in mainstream decision-making forums" (Barry & Porter, 2011, p. 172). While these authors focused on New Zealand's environmental planning regime under RMA, including analyzing a number of plans and policy statements in great detail along with their successes and failures, the actual questions and criteria that guided their analysis were too RMA-focused, making it difficult to transfer to a comparative study. As a result, with limited studies regarding the content analysis of Crown and local government planning policies in relation to Indigenous peoples and no clear comparative framework for planning policy statements to replicate, the research partnership had to engage in theory development (Yin, 2009). Informed by the ideas of our research partnership and relevant academic literature[5], a four-tiered framework to assess the manifest and latent content of each policy statement document was developed as a part of an iterative process to address this void in the literature. It was further validated through expert interviews.

4. Four-Tiered Framework

The framework implemented in the document analysis of the manifest and latent content of the policy statements consists of four elements: clarity, recognition, willingness and active reconciliation. Each element is guided by questions and indicators that informed the policy analysis of relevant sections of each of the planning texts under scrutiny. Authors that broadly informed the foundations of corresponding elements of the framework are also identified with the corresponding elements of the framework. Grounding the analytical framework in existing literature was done to ensure the implications of this research would link to larger discussions of planning theory and practice. This analytical framework is by no means complete and should be treated as a living document to learn from and build upon.

4.1. Clarity

Starting with clarity, as noted in Table 1, the first element of framework is intended to chart the position of individual policy statements within their respective planning frameworks and evaluate whether they vertically connect to higher-tier legislation and lower-tier plans, such as official plans in Southern Ontario and district plans in the Auckland Region. Drawing from Ericksen et al. (2004) and Berke et al. (2002), who used multiple methods to evaluate how well regional and district plans as well as certain regional policy statements in Aotearoa New Zealand accounted for the mandate of the RMA and key provisions relating to Māori interests and the Treaty, the first question and set of primary indicators (Table 1) were established to analyze what guidance is provided by higher-tier legislation for each policy statement. The second question and set of indicators (Table 1) draws from the concepts of strategic planning and tiering (Healey, 2006; Noble, 2009) and are intended to identify if lower-tier planning authorities have to conform to policy statements through reviewing the terminology in key provisions of the Planning Act (1990) and the RMA (1991).

4.2. Recognition

Recognition, the second element of the framework, is meant to focus the policy analysis on how state-based planning, as mediated through texts, extends horizon-

[5] It is important to note that ideas and concepts of authors listed within individual elements of the framework collectively influenced the development of that element of the framework. For instance, Noble (2009) influenced the research partnership in focusing on tiering and understanding how overarching legislation at the strategic level tiers down to individual policy statements.

Table 1. Key aspects to *Clarity* in reference to the Ontario Provincial Policy Statement and the Auckland Council Regional Policy Statement.

	Primary Indicators	
Question	PPS (Ontario, Canada)	ACRPS (Auckland Region, Aotearoa New Zealand)
Do higher-tier legislation provide a clear mandate on Indigenous issues and rights for the policy statement?	Within the manifest content of the Planning Act (1990) is there reference to: 1. Indigenous peoples (First Nations; Aboriginal peoples; Indian Band; First Nation Council) 2. Aboriginal & treaty rights (section 35 of the Constitution Act, 1982; specific treaties) 3. The Royal Proclamation of 1763	Within the manifest content of the RMA is there reference to: 1. Indigenous peoples (Māori; Indigenous Peoples; Tangata Whenua; Mana Whenua) 2. Treaty of Waitangi
Do lower-tier planning authorities have to conform to the policy statement when making informed land use planning decisions?	Assessment of terminology in section 3 of the Planning Act (1990)	Assessment of terminology in section 59–62 of the RMA

tally outwards to the edges of planning to draw in Indigenous peoples' rights, concerns, claims and knowledge that have historically been overlooked. The first question and set of indicators (Table 2) centre on identifying the highly circumscribed sites of recognition within each policy statement where Indigenous peoples, treaties, rights and traditional territories are brought forward (Barry & Porter, 2011; Porter & Barry, 2013). The second question and set of indicators (Table 2) then examine the latent content of flagged sites of recognition to evaluate whether Indigenous peoples are framed by the discourse of policy statements as just another stakeholder (Healey, 1997) or as equal and active partners with equal footing in the planning process (RCAP, 1996; Borrows, 1997; Maaka & Fleras, 2005; Porter, 2006). Understanding what forms that recognition takes in policy statements gives further insight into how lower-tier planning authorities recognize and engage with Indigenous peoples and more generally, the continued existence of asymmetrical relations between dominant planning frameworks and Indigenous peoples (Hibbard et al., 2008).

4.3. Willingness

Willingness is the third element of the framework, as noted in Table 3. Questions that inform this element and set of indicators (Table 3) are grounded in the work of McLeod et al. (2015), and are intended to identify the degree of willingness of the Crown set out in each policy statement to honour past relations. Still, historically, Indigenous peoples do not enter planning systems on equal terms, and consultation and accommodation policies may not fundamentally change a community's uneven starting point in the planning process (Hibbard et al., 2008). Thus, in certain instances different degrees of willingness within texts may not change the status quo significantly and improve Indigenous peoples' ability to shape local decision-making (Dorries, 2014; Participant Four, personal communication, July 23, 2014).

4.4. Active Reconciliation

Active reconciliation, the final element of the framework is best understood theoretically as multifaceted and embodies a set of temporal connections to the past and future, which together have the potential to enable planning as a system of representation to become unsettled and transformed by acknowledging what has happened in the past, figuring out what is going to be done about it and then following through with action. According to the Truth and Reconciliation Commission of Canada (2015, p. 6), reconciliation means "establishing and maintaining a mutually respectful relationship between Aboriginal and non-Aboriginal peoples in [Canada]. In order for that to happen, there has to be awareness of the past, acknowledgement of the harm that has been inflicted, atonement for the causes, and actions to change behaviour." In Aotearoa, similarly, active reconciliation with respect to the framework is not a passive act that is a means to an end as has been the case in Canada through formal apologies (Fairweather, 2006). Reconciliation has no end state as it is an active and genuine process to change and transform uneven planning relations through first acknowledging planning's past and current role in injustices towards Indigenous peoples. Furthermore, reconciliation acknowledges the limits of planning frameworks that continue to be defined by dominant society, that Indigenous peoples have an inherent right to

Table 2. Key aspects to *Recognition* in reference to the Ontario Provincial Policy Statement and the Auckland Council Regional Policy Statement.

	Primary Indicators	
Question	PPS (Ontario, Canada)	ACRPS (Auckland Region, Aotearoa New Zealand)
What form does recognition of Indigenous peoples, treaties, rights and traditional territories take within the policy statement?	Within the manifest content of policy statement is there reference to: 1. Indigenous peoples (First Nations; Aboriginal Peoples; Indian Band; First Nation Council); 2. Aboriginal & treaty rights (section 35 of the Constitution Act, 1982; specific treaties; Royal Proclamation of 1763) 3. Traditional territories (traditional territories; sites of cultural significance to individual nations) 4. Indigenous language, expressions, and worldviews	Within the manifest content of policy statement is there reference to: 1. Indigenous peoples (Māori; Indigenous peoples; Tangata Whenua; Mana Whenua) 2. Treaties & rights (Treaty of Waitangi) 3. Traditional territories (ancestral lands; ancestral taonga) 4. Indigenous language, expressions, and worldviews
How are Indigenous peoples framed within planning processes based on the textual evidence of the policy statement?	Within the latent content of the policy statement is there reference to: 1. Indigenous peoples as stakeholders in planning processes; or 2. Indigenous peoples as equal and active partners with equal footing in planning processes.	Within the latent content of the policy statement is there reference to: 1. Indigenous peoples as stakeholders in planning processes; or 2. Indigenous peoples as equal and active partners with equal footing in planning processes.

Table 3. Key aspects to *Willingness* in reference to the Ontario Provincial Policy Statement and the Auckland Council Regional Policy Statement.

	Primary Indicators	
Question	PPS (Ontario, Canada)	ACRPS (Auckland Region, Aotearoa New Zealand)
What is the degree of willingness of the Crown set out in each individual policy statement to honour past relations and acknowledge and engage with Indigenous peoples, perspectives and concerns?	Within the manifest and latent content of the policy statement is there reference to: 1. Reference to consultation with respect to Indigenous peoples 2. Reference to accommodation with respect to Indigenous peoples 3. Reference to consent with respect to Indigenous peoples	Within the manifest and latent content of the policy statement is there reference to: 1. Reference to consultation with respect to Indigenous peoples 2. Reference to accommodation with respect to Indigenous peoples 3. Reference to consent with respect to Indigenous peoples

self-determination and that there is an imminent need for effective and sustained equitable relationship building to restore shared territories. While reconciliation is the responsibility of all of society to address denial and make fundamental changes and restitution (Corntassel & Holder, 2008), state-based planning also has a significant role to play in its advancement.

The overarching question and four primary indicators (Table 4) that inform this element of the analytical framework were chosen because they act as points of reference into how prepared governing officials and planning policymakers are in actively challenging and restructuring the status quo of Indigenous peoples-state relations based on the content of planning texts. The four indicators provide insight into what may be missing from current planning policy and collectively draw on Barry and Porter (2011), Borrows (1997), Corntassel and Holder (2008), Hibbard et al. (2008), Maaka and

Table 4. Key aspects to *Active Reconciliation* in Reference to the Ontario Provincial Policy Statement and the Auckland Council Regional Policy Statement.

	Primary Indicators	
Question	PPS (Ontario, Canada)	ACRPS (Auckland Region, Aotearoa New Zealand)
How does the policy statement reconcile both the limitations of state-based planning efforts with respect to Indigenous peoples and the opportunities to support and sustain relationships and mutual understanding amongst Indigenous and non-Indigenous peoples?	Within the manifest and latent content of the policy statement is there reference to: 1. Acknowledgement of planning's involvement in historical and ongoing injustices towards Indigenous peoples, rights and traditional territories 2. Acknowledgement of the current limitations of planning in understanding Indigenous peoples' rights, concerns, claims and knowledge and the need for Indigenous voices and partnerships to actively transform planning 3. Acknowledgement of Indigenous peoples' inherent right to self-determination 4. Acknowledgement of the need for building effective and sustained equitable relationships between the Crown, Indigenous peoples and non-Indigenous communities on common ground and actively following through	Within the manifest and latent content of the policy statement is there reference to: 1. Acknowledgement of planning's involvement in historical and ongoing injustices towards Indigenous peoples, rights and traditional territories 2. Acknowledgement of the current limitations of planning in understanding Indigenous peoples' rights, concerns, claims and knowledge and the need for Indigenous voices and partnerships to actively transform planning 3. Acknowledgement of Indigenous peoples' inherent right to self-determination 4. Acknowledgement of the need for building effective and sustained equitable relationships between the Crown, Indigenous peoples and non-Indigenous communities on common ground and actively following through

Fleras (2005), Porter (2006), Porter (2010), the RCAP (1996), Regan (2010), Sandercock (2004), Turner (2006) and the UN Declaration on the Rights of Indigenous Peoples (United Nations, 2007). Active reconciliation along with the previous three elements, serve to advance discussions about how we can move from the conceptual to actual changes in order to plan differently through mutual understanding and learning between Indigenous and non-Indigenous peoples on common ground.

5. Results

Results are presented in two major parts—the current Ontario PPS (2014) and the ACRPS (1999). Keeping with the context of Indigenous peoples-state relations in Southern Ontario and the Auckland Region, findings from the analytical framework relating to the PPS refer to First Nations, while findings relating to the ACRPS refer to Māori people, iwi, Mana Whenua or Tangata Whenua. Certain terms will be used interchangeably. Prior to the current PPS (2014), the three earlier versions of the Ontario PPS (the 1994 Comprehensive Set of Policy Statements, the 1996 PPS and the 2005 PPS) differed significantly in terms of content and policies, and came into effect under three different provincial governments. Yet, they share one major commonality: there was no clear acknowledgment of First Nations or Aboriginal peoples in general in any of the three planning texts. These earlier iterations and their inability to recognize and support First Nations is significant to document because it provides a baseline of where the PPS has come from, heightening the importance of recent changes to this policy statement.

5.1. The Ontario Provincial Policy Statement

5.1.1. Clarity

The Planning Act (1990) in its most recent amended form does not provide a clear mandate on First Nations issues and rights as distinct communities continue to be framed as 'public bodies'. There is also no mention of section 35 of the Constitution Act, 1982, which protects Aboriginal and treaty rights or a clear connection to the principles of Royal Proclamation of 1763 in this guiding legislation. In terms of conformity, according to subsection 3(5) of the Planning Act (1990), planning authorities, including local governments, a local board, a planning board and provincial ministers 'shall be consistent with' the current PPS when exercising their authority over a planning matter. This subsection requires that all official plans at the local government-scale be in line with the current PPS. However, the PPS is read in conjunction with provincial plans, and if there is a conflict, provincial plans take precedent unless otherwise stated (MAH, 2014a). For example, cer-

tain legislation, such as the Green Energy Act (Government of Ontario, 2009), can also override the current PPS as well as provincial and official plans. Thus, conformity to the PPS through official plans in certain regions of Southern Ontario may not be as straightforward due to overarching and conflicting provincial plans and legislation. This reality highlights the importance of developing new provisions based on First Nations-led amendments in other policies relating to the Southern Ontario context that may overwrite the PPS.

5.1.2. Recognition

In contrast to the void of recognition of the three previous PPS, the current PPS (2014) addresses this element to a certain extent. First, there is direct recognition of First Nations through use of the broad term Aboriginal, which under the Constitution Act, 1982 refers to First Nations, Métis and Inuit collectively. The use of the term Aboriginal in conjunction with peoples and communities occurs in six instances, primarily around discussions and definitions around conserving cultural heritage and archaeological resources. There is also recognition of existing Aboriginal and treaty rights in section 4.0 of the PPS regarding implementation and interpretation as it outlines that the policy statement "shall be implemented in a manner that is consistent with the recognition and affirmation of existing Aboriginal and treaty rights in section 35 of the Constitution Act, 1982" (MAH, 2014a, p. 33). By recognizing existing rights protected under section 35, the policy statement avoids previous uncertainties attached with placing the onus on practitioners to read the PPS in conjunction with overarching federal and provincial policies. This acknowledgement of section 35 in the PPS visibly brings Aboriginal and treaty rights to the forefront of Ontario's planning framework.

The content analysis also highlighted several gaps in recognition. For instance, specific treaties and individual agreements to Ontario between the Crown and First Nations as well as the principles of the Royal Proclamation of 1763 are not recognized. Most noticeably, there is no recognition of the land and traditional territories in the most recent policy statement. It would behoove the Province to recognize traditional territories and bring them to the forefront of planning policies in Ontario because these lands are often at the centre of ongoing First Nations grievances and disputes over continued development on contested territories (Ipperwash Inquiry, 2007; DeVries, 2012; Participant Four, personal communication, July 23, 2014). Dorries (2012) has noted how planners in Canada remain ignorant, if not uninformed, to recognize Aboriginal treaty rights on lands held by the Crown, including reserves, treaty lands, and traditional territories upon which cities are located. Furthermore, without recognition in the policy statement, it cannot be assumed that all non-Indigenous practitioners and local government councils would factor traditional territories into daily decision-making. In particular, there remains a prevalent assumption amongst non-First Nations communities that provincial lands have been honourably settled and that First Nations do not have a continued interest or right to the land, especially in already developed areas (Participant Two, personal communication, June 12, 2014). These types of assumptions, often reproduced in planning policy, counter meaningful opportunities to educate practitioners and the public at large into the significance of differing and equally valid Indigenous perspectives. Lastly, based on the content of the PPS, First Nations continue to be framed as stakeholders in planning processes; this is an enormous problem. By framing First Nations as stakeholders rather than as owners and keepers of the land, the Crown and the government perpetuate the denial of First Nations to their inherent and treaty rights (Turner, 2006). As noted by Porter (2006, p. 389) the term 'stakeholder' when applied to Indigenous people, "fails to appreciate their unique status as original owners of country that was wrested from them by the modern, colonial state" and when reinforced within a framework of inclusion, could simply reinforce paternalistic relationships between the Crown and Indigenous peoples rather than an emancipatory relationship that could support if not uphold Indigenous sovereignty.

5.1.3. Willingness

The importance of consulting First Nations "on planning matters that may affect their rights and interests" as outlined in Part IV's vision statement signals a degree of willingness that was absent from previous policy statements (MAH, 2014a, p. 4). There are also new sections that emphasize consultation through stating that planning authorities 'shall consider' Aboriginal interests in conserving cultural heritage and archaeological resources (section 2.6.5) and 'are encouraged' to coordinate planning matters with Aboriginal communities (section 1.2.2). Despite the use of less firm language in the latter, the integration of these new section represents a step forward for land use planning policy in Ontario. While the word 'accommodate' is not cited in the latest PPS, the direct integration of section 35 of the Constitution Act, 1982 in section 4.3 could be interpreted as a form of accommodation with respect to First Nations. In order to ensure that the implementation of the PPS' policies do not infringe on existing Aboriginal and treaty rights, consultation and in certain instances accommodation would be required. Reference to consent with respect to First Nations remains non-existent in the entire PPS. Nevertheless, consent may already be part of the on-the-ground processes and relations between certain local governments and neighbouring First Nations even if it is absent in the province's minimum standards of the PPS. The duty to consult and accommodate First Nations should be expected of the Province and thereby also anticipated within the PPS. The duty to consult is legally upheld by the Crown, as represented by the Government of Canada and the provinces, as well as by local governments (or

municipalities) by virtue of being a third party to the Crown (Fraser & Viswanathan, 2013).

5.1.4. Active Reconciliation

The four indicators for active reconciliation were either absent or minimally visible in the review of the latent content of the latest PPS. There was no connection made between land use planning policies and historical and ongoing injustices towards First Nations, Aboriginal and treaty rights and traditional territories. A simple reference to the findings of the Ipperwash Inquiry (2007) or the Royal Commission on Aboriginal Peoples (1996) would address this inherent gap in understanding. In terms of an acknowledgement of the limitations of planning, Section 1.2.2 under very liberal interpretations could be construed as recognition of this limit and the need to coordinate with First Nations, but it still gives authority and agency to planning authorities to decide if it should coordinate. There was also no recognition in the PPS of First Nations' inherent right to self-determination. Lastly, the policies relating to First Nations collectively, particularly those focused enhancing dialogue and communication between First Nations and local governments, could be viewed as a necessary step towards more tangible policies regarding building effective and sustained equitable relationships.

5.2. The 1999 Auckland Council Regional Policy Statement

5.2.1. Clarity

The RMA did provide a clear mandate on Māori issues and rights for Auckland Council in preparation of a regional policy statement. First, subsection 6(e), outlines that "the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu and taonga" is a matter of national significance and shall be recognized and provided for by all persons exercising functions and authority under the Act (1991, p. 69). Second, in subsection 7(a), there is recognition of kaitiakitanga and accordingly, plans and policies must 'have regard to' the exercise of guardianship by local Māori people. Third, section 8 identifies that principles of the Treaty 'shall be taken into account'.

In addition to these broad provisions that apply to all decisions and plans under the RMA, there are also policies specific to regional policy statements. Subsection 61(2A) (a) outlines that when a regional council is preparing or altering a regional policy statement they 'must take into account' any relevant iwi planning document if it is brought forward by a recognized iwi authority. Subsection 62(1) (b) then identifies that any regional policy statement 'must state' resource management issues of regional iwi authorities. In terms of conformity, according to subsection 67(3) (c) and 75(3) (c), lower-tier regional plans and district plans 'must give effect' to their respective regional policy statement.

5.2.2. Recognition

There is significant and meaningful recognition of Māori people, the Treaty, rights and ancestral lands in the ACRPS. To begin, the first page of the policy statement starts with Māori proverb in both Māori and English. In section 2.2 regarding the current context of the Auckland Region, there is acknowledgement that the Māori were first occupants of the region and New Zealand. Subsections 2.4.8 and 2.4.9, outlines that in accordance with the RMA that the relationship of Māori with their ancestral lands and resources are matters of national significance and that Tangata Whenua are under significant pressure to protect and manage their ancestral sites and lands. There is also an admission that the Treaty of Waitangi has been undervalued historically in the management of resources in the region within subsection 2.4.9.

The highest frequency of recognition occurs in Chapter 3 as it is entirely dedicated to regional resource issues significant to local Māori people. It lists Māori groups that were consulted for the ACRPS and summarizes key issues, objectives, policies, methods and justifications. Regarding the recognition of the Treaty of Waitangi, Appendix E of the Treaty provides the three accepted versions of the Treaty (English text, Māori text, translation of Māori text) while the principles of the Treaty are referenced in several instances throughout the text. The actual principles are never defined in greater detail beyond these references. With respect to traditional territories, there are clear instances of recognition of ancestral lands and taonga, but they are typically referenced with section 6(e) of the RMA and directly paraphrased from the RMA (1991), which does not account for the context of the Auckland Region. Through referencing both English and Māori terms for Māori people, recognizing (with limitation) the customary authority of Tangata Whenua over resource management, and emphasizing the need to take into account iwi planning documents, the policies found in this planning text move away, to a certain degree, from the traditional stakeholder model to embody a partnership approach. However, there are external limitations to these forms of text-based recognition as planning is still largely dominated by non-Indigenous perspectives and local non-Indigenous councillors who oversee planning may not be "ready to genuinely share power with iwi" (Ericksen et al., 2004, p. 131).

5.2.3. Willingness

The ACRPS emphasizes a relatively strong willingness to honour past relations through integrating consultation and accommodation with respect to Māori people in different policies, methods, reasons and anticipated results. The most apparent examples of a willingness to consult occur in specific policies and methods in Chapter 3. For instance, policy 3.4.7 identifies that the involvement of Tangata Whenua in the development, implementation or review of the ACRPS as well as regional and district

plans "shall be undertaken in ways which…(iv) provide for early and effective consultation" (Auckland Council, 1999, Chapter 3, p. 3). To give effect to this policy, several methods are provided, including the requirement that the Auckland Council through consultation with local Tangata Whenua develop up-to-date consultation guidelines and checklists and ensure a directory of Māori organizations and representatives are available to assist government and third parties with consultations. The Auckland Council and territorial authorities are also required to encourage applicants to consult affected Māori groups prior to submitting resource consents. To ensure the recognition and protection of sacred places, sites and resources, where agreed upon by Tangata Whenua (policy 3.4.2), planning authorities are required to consult in order to identify sites in plans and provide appropriate levels of protection.

Under the framework of the ACRPS, regional and district plans 'will make' provisions to protect "sites and areas of special significance to Tangata Whenua" where such sites are recognized to exist based on Indigenous knowledge, but not identified in conventional planning maps or diagrams (Auckland Council, 1999, Chapter 3, p. 3). This form of accommodation gives agency to Māori people to shape the dominant state-based planning framework without having to conform to it to ensure their claims and knowledge are valid. Policy 3.4.10 further highlights a degree of accommodation by stating that the management of resources 'shall take into account' relevant Treaty claims and customary rights of Māori people. Lastly, in keeping with Policy 3.4.13 to promote the 'practical expression' of kaitiakitanga, the ethic of guardianship, the Auckland Council and territorial authorities must identify opportunities to include iwi authorities in the management of ancestral sites and resources, including the potential to transfer authority and functions. These features of the policy statement together express a willingness to recognize and engage with Indigenous peoples, perspective and concerns. However, in approximately 168 instances of the use of word 'consent' there was no documentation of the term in relation to Māori people. This lack of textual evidence of consent with respect to Māori demonstrates a clear limitation of the policy statement and planning in general in the Auckland Region. It focuses on increasing Indigenous participation without a significant willingness to give Māori people greater authority or autonomy, which limits any opportunity to address the larger uneven structures of planning frameworks.

5.2.4. Active Reconciliation

In contrast to the current PPS (2014) and its predecessors, the ACRPS does engage with certain aspects of active reconciliation. To begin, section 3.2.3 of the ACRPS acknowledges to a certain extent planning's involvement in historical and ongoing injustices towards Māori people and highlights the following factors (Auckland Council, 1999, Chapter 3, p. 3) regarding the impact of the Crown's breach of the Treaty in Auckland, including: "the alienation of land and other resources which were guaranteed to Tangata Whenua; loss of the use and enjoyment of resources as a result of pollutive discharges to ancestral waters; [and] the over-riding of the customary rights and responsibilities over ancestral taonga". Section 3.2.3 of the ACRPS also recognizes how the Crown has "individualised title and granted use rights in respect of taonga (eg., minerals, water, and land) to individuals and organisations" such that, "[t]he Crown receives income as a result of those actions" (Auckland Council, 1999, Chapter 3, p. 3).

There is also acknowledgement of the limitation of planning and the need for Indigenous involvement in planning processes and decision-making the ACRPS. Section 3.2.2 lists five general factors identified by Māori communities that have inhibited the realization of statutory provisions and their full participation in planning processes, including among others a general misunderstanding of Māori values and limited techniques to ensure early and effective engagement in planning processes (Auckland Council, 1999, Chapter 3, p. 3). Overall, the policy statement fared relatively well with respect to these two indicators. However, the ACRPS' approach to active reconciliation becomes progressively vague and limited when the two final indicators are critically taken into consideration. First, recognition of self-determination is not clear or explicit within the latent content of the policy statement. Although there is reference of rangatiratanga, which has become synonymous with the Indigenous right to self-determination, it is defined with the policy statement as "full tribal authority", which can be understood as local Indigenous organizations that have been given certain authorities over the management of resources and delivery of services by the state following New Zealand's major period of decentralization (Auckland Council, 1999, Appendix D, p. 12). This narrow interpretation juxtaposes others that exist (see Maaka & Fleras, 2005). The fourth indicator, an acknowledgement of the need for building effective and sustained equitable relationships, is partially recognized in the latent content of the policy statement through an apparent emphasis on strengthen ties with Māori people and authority in different sections. In particular, policies regarding the potential transfer of authority to Māori organization or iwi authorities could be interpreted as recognition of this need, but this transfer still occurs on planning's own terms and in the face of pressures from dominant non-Indigenous interests. These last two aspects of active reconciliation further illustrate the limits of this policy statement in its own ability to support a fundamental shift towards finding common ground.

6. Discussion

Based on the analysis, the Government of Ontario has made significant advances with respect to recognition and support of First Nations in the most recent PPS. The content of 2014 PPS signals a long-awaited change in ap-

proach towards recognition and support of First Nations' rights and interests in provincial land use planning policy. One of the most significant changes to the PPS has been the integration of First Nations within policies and definitions of conserving cultural heritage and archaeological resources. In particular, the use of 'shall' and stronger language in section 2.6.5 demonstrates that the Province is willing to engage with a critical issue in Southern Ontario for First Nations and ensure that community concerns are part of the planning process. Recognition of section 35 of the Constitution Act, 1982 was also significant because it not only recognizes and reaffirms existing Aboriginal and treaty rights, but it brings them to forefront of local government planning and decision-making, and into the conscience of practitioners (Participant One, personal communication, June 12, 2014).

Developments since the 2014 PPS offer some hope to the way in which government leaders are seeking ways to enhance Ontario's relations with First Nations. In August 2015, the Chiefs of Ontario signed a Political Accord between First Nations and the Government of Ontario (2015) (see http://www.chiefs-of-ontario.org/node/1168, paragraph 5) in order to:

- Promote…bi-lateral relationships between First Nations and Ontario by strengthening and supporting existing processes;
- Establish a process to identify joint priorities;
- Establish mechanisms such as an alternative dispute resolution process to resolve high-level areas of jurisdiction;
- Uphold First Nations inherent right to self-government; and
- Implement and explore First Nations jurisdiction through a piloted initiative.

Furthermore, the federal government announced their interest in resolving disputes between the Province and the First Nations over the lands associated with the 20-year Ipperwash conflict, seeking to return the lands to the Chippewas of Kettle and Stony Point First Nation along with $95 million in reparations (Simpson, 2015).

Yet, in spite of these developments Ontario's current approach is limited and limiting. Taking into account the manifest and latent content of the 2014 PPS and the Planning Act (1990), it is clear that provincial officials are still wrestling with how to recognize and engage with First Nations in planning policy, rather than focusing on actively addressing larger structural issues of clarity in higher-tier legislation and exploring how to integrate forms of active reconciliation in provincial planning policy. The Planning Act (1990), the PPS's overarching legislation, whether intentional or not, continues to advance the notion that First Nations are just another stakeholder and fails to provide a clear mandate on First Nations, Aboriginal and treaty rights and traditional territories (Participant Three, personal communication, June 13, 2014). Read in conjunction with section 3(9)7 of the Ontario Regulation 200/96, which outlines the requirement to give notice of a hearing for a minor variance to the Chief of every First Nation council, if the community's reserve is within one kilometre of the subject land, one could argue that the Planning Act (1990) also advances the assumption that First Nations' lands, interests and rights end at the boundaries of a reserve. Sustained and equitable relations may be a distant and ambitious aim when most local governments, based on the planning mandate provided by the Province, may assume that First Nations' interests exist within the confines of reserve boundaries. For instance, local governments may not be fully aware of the overlap between traditional territories and local government areas. Adding to this, there is still a need to integrate more explicit forms of active reconciliation in Ontario's PPS.

Recommending fundamental changes to the Planning Act (1990) and the Province's planning framework in relation to First Nations are not novel ideas in Ontario. As outlined by the Commission on Planning and Development Reform in Ontario (1993, p. 58), "the Planning Act and other legislation should provide opportunities for municipalities to work together with Aboriginal communities in addressing planning and development questions." Similar concerns over the Province's planning framework were then echoed in the 2007 Report of the Ipperwash Inquiry, as Justice Linden identified that certain conflicts resulting from conventional land use planning and policy could be avoided if "First Nations are actively and meaningfully involved in the planning or development process" (Ipperwash Inquiry, 2007, p. 136). Changes since both of these reports and their recommendations have gradually occurred to a certain extent. For example, the recent changes to the PPS, the reparations to First Nations resulting from the Ipperwash Inquiry, and the Ontario Premier's agreement with the Chiefs of Ontario should all be applauded. Despite these developments, the Province's existing top-down policy-led approach still largely mirrors that of the early 1990s and remains firmly defined by non-Indigenous individuals, interests, and institutions. Relative to the Aotearoa New Zealand planning context, there are further changes required to Ontario's policies, perspectives and approaches.

6.1. What Can Be Learned from the ACRPS and the Aotearoa New Zealand Planning Context?

While the ACRPS represents only one regional policy statement under the RMA and it has inherent limitations regarding implementation similar to other New Zealand regional policy statements (Ericksen et al., 2004), relative to the PPS it is considerably more progressive with respect to recognizing and supporting Indigenous peoples in the planning process. Through addressing clarity, recognition, willingness and to a certain degree active reconciliation, the ACRPS points to several important lessons. A major reason for its relative strength as a policy statements stems from clarity and the impres-

sive mandate on Māori people and rights provided by its higher-tier, the RMA through sections 6(e), 7(a) and 8 (Awatere et al., 2013). In Aotearoa New Zealand, this recognition of Māori in planning legislation can be traced back to major revisions in 1977 to the Town and Country Planning Act (TCPA) with recognition of the relationship between Māori people and culture and their ancestral lands and resources as matter of national significance (Awatere et al., 2013). This shift can be attributed in part to the creation of the Waitangi Tribunal in 1975, a formal mechanism to address historical grievances of Māori people (Awatere et al., 2013). Prior to the 1977, there was no mention of Māori people in the first TCPA of 1926 and slight recognition in the TCPA of 1953, but in "a very detrimental manner [as] it prevented building on land that remained in Māori title" (Kennedy, 2008, p. 7). This slight recognition in 1953 led to the alienation of land and major migrations of Māori into cities, impacting Māori culture negatively (Kennedy, 2008). Thus, relative to Ontario, the Aotearoa New Zealand planning context in general has had a longer evolving and advanced history with respect to the integration of Māori rights and knowledge (Awatere et al., 2013).

Another major lesson from the ACRPS relates to the multiple forms recognition of Indigenous peoples in the policy statement. Not only is there recognition of Māori people through the interchangeable use of English and Māori terms, but there is recognition of rights, the Treaty and ancestral lands. The use of Māori terms, although often a source of contention as complex terms can be simplified or misappropriated through English translation (Awatere et al., 2013), is highly noteworthy because it is a clear instance in policy of Indigenous peoples drawing on their own traditions, cultures and words to define their communities and central government supporting these differing forms of recognition. Likewise recognition of principles of the Treaty in the policy statement that comprise of "partnership; reciprocity; mutual benefit; active protection; and redress" is critical because it forces local authorities to build an awareness of their implications at the local-scale and to act honourably and in good faith with Māori communities and authorities (Kennedy, 2008, p. 8). Direct recognition assists in the development of a greater awareness amongst the public at large of diverging histories and the importance of these differences to fostering and sustaining mutually beneficial treaty relations. While planning tends to be forward-thinking in the management of land and resources, it is vital to understand its colonial past in order to situate the practice in its cultural context (Porter, 2006).

The Auckland Council and its regional policy statement are not perfect, but they are flexible and progressive relative to the PPS. While Māori rights and knowledge have been recognized in planning legislation since the late 1970s in Aotearoa New Zealand, Ontario has only recently begun to directly integrate recognized and affirmed rights under section 35 of the Constitution Act, 1982. The Province has a great responsibility to be innovative in addressing the status quo embedded in its planning policy framework, restoring relationships, and building an equitable planning system that is reflective of all treaty partners.

6.2. Opportunities for Policy Reform in Ontario

Ontario needs to actively reconfigure its planning policy framework in partnership with First Nations to support more just and effective planning practices. Doing so, could enhance awareness of a majority of non-Indigenous planning practitioners who may remain largely unaware of the place-based Indigenous foundations of the land and continued relevance of treaty relations and obligations to the success of the Province. Further changes could also create new opportunities for non-Indigenous communities to learn from and work together with Indigenous treaty partners. The remote approach of the federal government in Aboriginal affairs in Ontario, as seen with the recent announcement of reparations resulting from the 2007 *Ipperwash Inquiry* coupled with the reality that Ontario is home to the largest Indigenous population in the country places, and the recent recommendations of the Truth and Reconciliation Commission of Canada (2015) offer additional significance on this need to act promptly (Ipperwash Inquiry, 2007; Participant Two, personal communication, June 12, 2014).

6.3. Policy Recommendations for Planning in Ontario

Based on the findings of this comparative, the following nine (9) recommendations have been proposed to further enhance the current PPS (2014) and planning in Ontario and to assist the Province in getting to common ground; these are by no means a comprehensive set of recommendations and address the elements of clarity, recognition, willingness, and active reconciliation:

6.3.1. Clarity

Recommendation 1: The Province should actively seek out First Nations' involvement to amend the *Planning Act* (1990) to address the lack of a clear and meaningful mandate on First Nations issues and rights, and promote context-specific accords between First Nations and planning authorities where municipalities and traditional territories overlap.

Recommendation 2: The Province should prioritize relationship building by providing joint operational capacity funding to sustain long-term partnerships between First Nations and adjacent municipalities to strengthen mutual understanding and learning.

6.3.2. Recognition

Recommendation 3: The Province in partnership with First Nations should expand recognition in the PPS to

include policies that acknowledge traditional territories and First Nations continued vested interest in lands outside of reserve boundaries.

Recommendation 4: The Province should alter the PPS and other aspects of its larger planning policy hierarchy to recognize First Nations as foundational partners, not just another stakeholder. This can be done by actively exploring in partnership with First Nations, the opportunities to include Indigenous terms, language and knowledge into the PPS to ensure that it reflects the shared foundations of the Province.

Recommendation 5: The Province in partnership with First Nations should provide for and support the protection of cultural heritage and archaeological resources in the PPS that are known to exist, but may be too sensitive to identify and make public through conventional planning means.

6.3.3. Willingness

Recommendation 6: The Province in partnership with First Nations and municipalities should develop specific guidance material for the PPS relating to the need for effective communication and equitable relationship building to address issues of capacities and understanding between municipalities and First Nations. This would be in line with the content and directive provided on guidance material in the PPS.

Recommendation 7: Taking into consideration the findings of the recent *Tsilhqot'in Nation v. British Columbia* (2014) Supreme Court of Canada ruling, the provincial government should be prepared to recognize Aboriginal title and amend the PPS or release additional guidance material to provide clarity on how this may affect planning with respect to consent in certain areas of the province subject to land claims and unceded territories.

6.3.4. Active Reconciliation

Recommendation 8: The Province should actively incorporate all findings of the Ipperwash Inquiry (2007), the RCAP (1996) and ongoing land claims into the PPS in order to directly acknowledge planning's complicity and inherent limitations.

Recommendation 9: The Province in partnership with First Nations should actively educate all Ontarians on past and current injustices, the significance of treaty relations, the shared nature and history of the territory, and the inherent place-based Indigenous foundations of the land that make up the municipalities that Ontarians work, reside and derive benefit from. This would greatly assist in addressing misunderstandings and fractured relations, and enhance the overall impact and reach of new policies in the PPS relating to municipal-First Nations relations.

It is important to reiterate that the PPS has evolved—but Ontario can learn much from the context of Aotearoa New Zealand. As planning practitioners learn from the Calls to Action of the Truth and Reconciliation Commission of Canada (2015), the hope and possibility exist for policy and plans to better reflect a commitment to getting to common ground. This requires non-Indigenous practitioners to realize they are implicated in educating themselves about Indigenous histories of the land and on the land. In turn active reconciliation and planning is not an Indigenous issue, it is everyone's issue and planners need to actively find common ground with First Nations to build more equitable planning futures in Ontario and Canada.

7. Conclusion

The analytical framework and ideas put forth in this article are presented as learning tools for planning practitioners at the local government-scale, who may not be fully aware of the uneven nature of planning frameworks and how ways of knowing are highly-circumscribed with respect to Indigenous peoples. The Government of Ontario has made significant advances relative to previous versions of the PPS with regards to recognizing and supporting First Nations, but relative to the Auckland Region and Aotearoa New Zealand planning context these changes are modest and remain distant from creating spaces of common ground.

With jurisdictional issues and general confusions attributed to the division of Crown responsibilities between the federal and Ontario provincial government, it is easy for some to argue that getting to common ground, similar to reconciliation, is not the responsibility of local governments or local practitioners, as they are not the Crown. However, this narrow and often default legal position ignores the responsibility of all treaty people to acknowledge the inherent Indigenous foundations of the land that make up the communities in which they work, reside and derive benefit. It also overlooks the fundamental fact that getting to common ground requires cultural changes, including a willingness on the part of non-Indigenous people to break with embedded cultural assumptions, understandings, relationships and ways of doing. In turn, this can garner greater public understanding and recognition of Indigenous peoples' continued interest in the land and ensure Indigenous peoples can actively define, on their own terms, a shared planning approach through mutual understanding and mutual learning—not as simply stakeholders, but as partners.

Changing public perspectives will be critical to this process, and planning policies, including the PPS, can serve as a vital and transformative role in building dialogue and ensuring more equitable planning futures in the province. If the Tsilhqot'in Nation v. British Columbia (2014) ruling on Aboriginal title is any indication, modest changes to the status quo embodied in the PPS and other land use and resource management policies are no

longer acceptable. The TRC Calls to Action (2015) and resolutions by planners to *own* reconciliation as both a personal principle and professional principle of practice will only emerge if individuals choose to 'unsettle' the knowledge and practices that they take for granted and struggle to get to common ground with time, resources, accountability and humility.

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Conflict of Interests

The authors declare no conflict of interests.

References

Awatere, S., Harmsworth, G., Rolleston, S., & Pauling, C. (2013). Kaitiakitanga o ngā ngahere pōhatu—Kaitiakitanga of urban settlements. In R. Walker, T. Jojola, & D. Natcher (Eds.), *Reclaiming Indigenous Planning* (pp. 236–259). Montreal & Kingston: McGill-Queen's University Press.

Auckland Council. (1999). *Auckland Council regional policy statement*. Auckland, NZ: Auckland Council. Retrieved from: http://www.aucklandcity.govt.nz/council/documents/regionalplans/aucklandcouncilregionalpolicystatement/ACRPS%20Policy.pdf

Auckland Council. (2013). *The proposed Auckland Unitary Plan*. Auckland, NZ: Auckland Council. Retrieved from: http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/plansstrategies/unitaryplan/Pages/usingtheeplan.aspx

Barry, J. & Porter, L. (2011). Indigenous recognition in state-based planning systems: Understanding textual mediation in the contact zone. *Planning Theory*, *11*(2), 170–187.

Berke, P. R, Ericksen, N. J., Crawford, J., & Dixon, J. (2002). Planning and Indigenous People: Human rights and environmental protection in New Zealand. *Journal of Planning Education and Research*, *22*, 115–134.

Borrows, J. (1997). Wampum at Niagara: The royal proclamation, Canadian legal history and self-government. In M. Asch (Ed.), *Aboriginal and treaty rights in Canada: Essays on law, equality and respect for difference* (pp. 155–172). Vancouver: UBC Press.

Commission on Planning and Development Reform in Ontario. (1993). *New planning for Ontario: Final report*. Toronto: Publications Ontario.

Cope, M. (2010). Coding qualitative data. In I. Hay (Ed.), *Qualitative Research Methods in Human Geography* (pp. 281–294). Oxford: Oxford University Press.

Corntassel, J. & Holder, C. (2008). Who's sorry now? Government apologies, Truth Commissions, and Indigenous self-determination in Australia, Canada, Guatemala, and Peru. *Human Rights Review*, *9*(4), 465–489.

DeVries, L. (2012). *Conflict on Caledonia: Aboriginal land rights and rule of law*. Vancouver: UBC Press.

Dorries, H. (2014). Aboriginal rights brought to the provincial table: Ontario's new Provincial Policy Statement. *Plan Canada*, *54*(2), 42–45.

Dorries, H. J. (2012). *Rejecting the 'false choice': Foregrounding Indigenous sovereignty in planning theory and practice* (Doctoral Dissertation). Department of Geography, University of Toronto, Canada. Retrieved from https://tspace.library.utoronto.ca/bitstream/1807/65468/1/Dorries_Heather_J_201206_PhD_thesis.pdf

Ericksen, N. J., Berke, P. R., Crawford, J. L., & Dixon, J. E. (2004). *Plan-making for sustainability: The New Zealand experience*. Burlington, VT: Ashgate.

Fairweather, J. G. (2006). *A common hunger: Land rights in Canada and South Africa*. Calgary, AB: Calgary University Press.

Fraser, C. M., & Viswanathan, L. (2013). The Crown duty to consult and Ontario Municipal-First Nation relations: Lessons Learned from the Red Hill Valley Parkway Project. *Canadian Journal of Urban Research*, *22*(1), 1–19.

Gordon, D., & Janzen, M. (2013). Suburban nation? Estimating the size of Canada's suburban population. *Journal of Architectural and Planning Research*, *30*(3), 197–220.

Government of Ontario. (1990). *Planning act* (R.S.O. 1990, c. P.13). Toronto: Queen's Printer for Ontario.

Government of Ontario. (2009). *Green energy act* (S.O. 2009, c. 12. Schedule A). Toronto: Queen's Printer for Ontario.

Healey, P. (2006). Relational complexity and the imaginative power of strategic spatial planning. *European Planning Studies*, *14*(4), 525–546.

Healey, P. (1997). *Collaborative planning: Shaping places in fragment societies*. Vancouver: UBC Press.

Hibbard, M., Lane, M. B., & Rasmussen, K. (2008). The split personality of planning: Indigenous Peoples and planning for land and resource management. *Journal of Planning Literature*, *23*(2), 136–151.

Ipperwash Inquiry. (2007). *Report of the Ipperwash Inquiry* (Vol. 2: Policy analysis). Retrieved from http://www.attorneygeneral.jus.gov.on.ca/inquiries/ipperwash/report/vol_2/pdf/E_Vol_2_Full.pdf

Kennedy, N. (2008). *Viewing the World through a wider lens: Māori and Council planning documents. Planning under a cooperative mandate (PUCM)* (Māori Report 6). Hamilton, NZ: International Global Change Institute (IGCI)—University of Waikato.

Lane, M. B., & Hibbard, M. (2005). Doing it for themselves: Transformative planning by Indigenous Peoples. *Journal of Planning Education and Research*, *25*(2), 173–184.

Maaka, R., & Fleras, A. (2005). *The politics of Indigeneity: Challenging the State in Canada and Aotearoa New Zealand*. Dunedin, NZ: University of Otago Press.

McLeod, F., Viswanathan, L., King, C., Macbeth, J., & Whitelaw, G. S. (2014). *2014 Provincial Policy Statement (PPS) at a glance: Changing tides in Ontario Provincial Planning Policy with respect to First Nations interests*. Publisher: Authors.

McLeod, F., Viswanathan, L., Whitelaw, G. S., Macbeth, J., King, C., Alexiuk, E., & McCarthy, D. (2015). Finding common ground: A critical review of land use and resource management policies in Ontario, Canada and their intersection with First Nations. *The International Indigenous Policy Journal*, *6*(1). Retrieved from http://ir.lib.uwo.ca/iipj/vol6/iss1/3

Memon, A., Davies, T. G., & Fookes, T. (2007). Institutional arrangements for metropolitan government and strategic planning in New Zealand. *New Zealand Geographer*, *63*, 43–54.

Ministry for the Environment. (1991). *Resource Management Act (No.69)*. Wellington, New Zealand: Parliamentary Counsel Office. Retrieved from http://www.legislation.govt.nz/act/public/1991/0069/latest/whole.html

Ministry of Municipal Affairs and Housing. (2009). *Municipal-Aboriginal relationships: Case studies*. Toronto: Queen's Printer for Ontario.

Ministry of Municipal Affairs and Housing. (2014a). *2014 Provincial Policy Statement*. Retrieved from http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463

Ministry of Municipal Affairs and Housing. (2014b). *An introduction to the Provincial Policy Statement, 2014: Rural Ontario* (Draft for Discussion—February 2014). Retrieved from http://www.mah.gov.on.ca/AssetFactory.aspx?did=10474

Noble, B. F. (2009). Promising and dismay: The state of strategic environmental assessment systems and practices in Canada. *Environmental Impact Assessment Review*, *29*, 66–75.

Political accord between First Nations and the Government of Ontario. (2015). Retrieved from http://www.chiefs-of-ontario.org/sites/default/files/files/Political%20Accord-FINAL-AUGUST2015.pdf

Porter, L. (2006). Planning in (post)colonial settings: Challenges for theory and practice. *Planning Theory & Practice*, *7*(4), 383–396.

Porter, L. (2010). *Unlearning the colonial cultures of planning*. Burlington: Ashgate.

Porter, L., & Barry, J. (2013). *Planning with Indigenous customary land rights—An Investigation of shifts in planning law and governance in British Columbia, Canada and Victoria, Australia*. Monash University, University of Glasgow, ESRC.

Regan, P. (2010). *Unsettling the settler within: Indian residential schools, truth telling, and reconciliation in Canada*. Vancouver: University of British Columbia Press.

Royal Commission on Aboriginal Peoples. (1996). *Report of the Royal Commission on Aboriginal Peoples. Vol. 1: Looking Forward, looking back*. Ottawa: Ministry of Supply and Services Canada.

Sancton, A. (2011). *Canadian local government: An urban perspective*. Don Mills: Oxford University Press.

Sandercock, L. (2004). Commentary: Indigenous planning and the burden of colonialism. *Planning Theory & Practice*, *5*(1), 118–124.

Simpson, B. (2015, August 15). Ratification vote to start over historic deal next week. *Sarnia Observer*. Retrieved from http://www.theobserver.ca/2015/08/14/ratification-vote-set-to-start-over-historic-deal-next-week

Treaty of Waitangi. (1840). Retrieved from http://www.treatyofwaitangi.maori.nz/

Truth and Reconciliation Commission of Canada. (2015). *Honouring the truth, reconciling for the future: Summary of the final report of the Truth and Reconciliation Commission of Canada*. Ottawa: TRC.

Tsilhqot'in Nation v. British Columbia 2014 SCC 44 (Can.).

Turner, D. (2006). *This is not a peace pipe: Towards a critical Indigenous philosophy*. Toronto: University of Toronto Press.

United Nations. (2007). *Declaration of the Rights of Indigenous Peoples*. Retrieved from http://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage.

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Article

Rethinking Urban Form: Switzerland as a "Horizontal Metropolis"

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Abstract
In light of the rapid population growth forecast for the coming years and the powerful transformations already occurring throughout its whole territory, today's Switzerland stands in urgent need of critical reflection on its urban future. A novel set of concepts and actions is needed in order to produce new visions and operational tools capable of critically reconsidering mainstream debates about Switzerland's future urban growth. On the one hand, national policies and narratives tend de facto towards lending increasing support to a dynamic of "metropolization," which usually leads to stronger territorial hierarchization strategies and processes aiming at a spatial condensation of urban services and functions in specific, selected locations. On the other hand, however, the Swiss territory—with its deep rootedness in federalism and its unique aggregative structure—still embodies key features of what, at different times, has been named a single "Grande Ville," a "dezentralisierte Großstadt," a "Ville-Territoire" or, more recently, "Stadtland Schweiz." The country as a whole is still characterized by extended and layered conditions of inhabitability, where the dispersion of the urban fabric, enmeshed within the agricultural and forested landscape, is articulated through horizontal rather that vertical relationships. This paper offers a novel reflection on how the ongoing metropolization process could be seen as a positive force if a markedly different idea of metropolitan space is introduced—the "Horizontal Metropolis." Its key idea is to distribute and enlarge the benefits which metropolization, if conducted in line with the tradition of decentralization and horizontality, could bring to the Swiss territory and its population. The "Horizontal Metropolis" concept recovers and leverages the various forms of inhabitability and their relation with the infrastructural support. It considers the long-term construction of the Swiss "City-Territory" as a renewable resource, which means reflecting on new life cycles, capitalizing on the urban and territorial embodied energy, and therefore rethinking, without denying it, Switzerland's extensive and diffused fixed capital. This could be a precious resource to accommodate future urban growth and reorient the form it takes, keeping at bay indiscriminate sprawl as well as its currently predominant ideological counterpart, indiscriminate densification and polarization.

Keywords
city-territory; diffused urbanization; growth; Horizontal Metropolis; recycling; Switzerland

Issue
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1. Introduction: Diffused Urbanization, Risks and Opportunities

> *…during the past decades, there were attempts to spell out what seemed new in European territories. It was not the periphery—a phenomenon which had already become evident during the twentieth century—nor was it the peri-urban or the process of suburbanization, which occurred during the first two thirds of the twentieth century. It was not something that was born in the city and, from the city, radiated outward into the territory. The novelty was the 'diffuse city'—something that had its roots in the territory, its inhabitants, and their history.* (Secchi, 2010, original in French)

In the last sixty years, urbanization has evolved dramatically, blurring the city/countryside divide and bringing about vast and complex territorial settlements of previously inconceivable size and population (Brenner, 2014; Burdett, 2008). Accordingly, many neologisms have emerged, clearly reflecting changing boundaries, morphologies and scales of human settlement patterns. Vast portions of the territory located outside historic centers, often in areas previously classified as "rural," have experienced rapid urbanization processes (Buijs, Tan, & Tunas, 2010), which has led certain scholars to think in terms of "planetary urbanization" (Brenner, 2014), taking up in a new guise Henry Lefebvre's hypothesis (Lefebvre, 1970). These processes have been, and still are, generating unprecedented "urbanized landscapes" (Secchi, 2011) characterized by a completely new ratio between built and open space (Brenner, 2009; Indovina, Fregolent, & Savino, 2005), as well as between permeable and impermeable surfaces (McGee, 2009; Viganò, 2013) inside what we now consider a "city." In Switzerland, for example, "open spaces" represent 85.5% of the surface of the territories classified as "agglomerations," against 71.6% of similar spaces located in "urban centers". The increasingly strong influence gained by open spaces within the urban ambit is crucial to the point of acquiring the ability to reshape the very concept of city (Bélanger, 2009; Berger, 2006, 2009).

The relatively recent assumption that some forms of urban dispersion, while entailing certain evident risks for the territory, can also represent a valid substrate for the construction of an innovative project for the city (Allen, 2003; McGee, 1991; Smets, 1986; Viganò, 2013), constitutes the area of research within which this article is developed and the hypothesis thanks to which it will attempt to formulate an ambitious conclusion.

In recent decades, with open space and landscape replacing architecture as the structuring elements of contemporary urbanism (Bélanger, 2009; Berger; 2009; Waldheim, 2006, 2016), the phenomena of urban dispersion have become important occasions to construct a broader vision of the city, capable of going beyond the metropolitan scale and overcoming old binary contrapositions such as center/periphery or town/country. With this shift, a twofold need arose: first, to recognize the limits of architecture's ability to order the city and second, to learn from the complex self-regulating orders already present in the urban fabric (Allen, 1999; Berger, 2009; Cadenasso, Pickett, McGrath, & Marshall, 2013; Pickett, Cadenasso, & McGrath, 2013). This led to the careful observation of often forgotten, hidden or barely perceptible, but ever more influential dynamics, making it possible for elements that had been neglected or overlooked up to now to emerge from the territorial matrix (Tjallingii, 1995; Viganò, 2008). Up until the early 1990s, the descriptive as well as interpretative reading of these territories was ruled by a predominantly urban-centric approach. The urban was seen as "occupying spaces" and provided the benchmark concepts for the critical reflection on guidelines for "valid" design hypotheses. In this picture, the rural dimension was seen as completely swallowed up and displaced by the urban sphere, in a sort of dualistic dialectical imaginary according which "mixed" dispersion tended to be replaced by the polarization between the "dense" urban and the "empty" rural. Despite the fact that numerous and in-depth analyses were being conducted, the prevailing approach remained one of refusal, inurement and inertia as far as the dispersed city was concerned.

Indeed, with the inversion of this trend and the recognition of open space as a structuring element for the city and the territory (Secchi, 1986; Viganò, 1999), the first half of the 1990s witnessed the beginning of a profound reconsideration of the role that "territories of dispersion" (Boeri, Metropolitani, Lanzani, & Marini, 1993; Munarin & Tosi, 2001; Viganò, 2001, 2004) might play, set against the myth of the "compact city"—along with the attempt to posit these territories as the basis for constructing a new urban principle. Several neologisms such as *città diffusa* (Indovina, 1990), *Desakota* (McGee, 1991) or *Zwischenstadt* (Sieverts, 1997) began to emerge and develop as evidence of a new intent to understand these new territorial forms in greater depth, to the point where the term "dispersed urbanization" ceased being a mere oxymoron (Grosjean, 2010). More recent interpretations even go as far as considering these territories of dispersion as forms of spatial, social and natural capital (Viganò, Secchi, & Fabian, 2016). Within a frame of thinking in which the role of open space becomes so crucial as to become structuring, it is not only possible but actually essential to deeply rethink and re-conceptualize "urban form."

However, within the great contemporary thrust towards urbanization, considering urban dispersion as an asset and not just as a mere threat for the construction of a sustainable city does not, by any means, imply that we can neglect the risks pointed out time and again by numerous scholars. The trends towards uncontrolled sealing of soil surfaces, towards the specialization and fragmentation of an originally "rural" or natural area into separate functions, and towards the widespread social marginalization often associated with such a process con-

tinue to feature deeply in the matrix of the dispersed city.

The degree of the changes underway and their potential point towards the need for an ambitious project for the city—a project capable, above all, of strategically using, as a deposit of "embodied energy" (Viganò et al., 2013), resources and tensions already harboured in the urban fabric (Berger, 2009). Our hypothesis is that an heterogeneous and polycentric city, structured upon open spaces and capable of integrating multiple functions, is already under construction. To try and understand it in order to convey its already ongoing development seems paramount. It is to this end that we would like to advance the notion of "Horizontal Metropolis."

1.1. The "Horizontal Metropolis": A Research Hypothesis

The "Horizontal Metropolis" is an oxymoron. Two contrasting terms are juxtaposed in order to conjugate the traditional idea of metropolis—the center of a vast territory, hierarchically organized, dense, vertical, produced by polarization—with the idea of horizontality—a more diffuse, isotropic urban condition, where the borders between center and periphery blur. Beyond the theme of the "peri-urban" or of the "sub-urban," the idea of "Horizontal Metropolis" refers to closely interlinked, copenetrating rural/urban realms, forming a decentralized and multi-polar, but cohesive and self-organizing system of communication, transport and economic activity. It is a layered territorial construction where agriculture and non-agricultural economic activities create an original mix (Viganò, Cavalieri, & Barcelloni Corte, 2016; Viganò, Secchi, & Fabian, 2016).

The *Ville-territoire* connecting Geneva to St. Gallen (Corboz, 1990), the *Città diffusa* of Northern Italy (Indovina, 1990), the *Desakota* in China, Japan, Thailand or Vietnam (McGee, 1991), the *Radiant Periphery* of the fine-grained dispersed settlement pattern in Flanders (Smets, 1986) the *Zwischenstadt* in Germany (Sieverts, 1997): these are only a few of the many examples that can be mobilized to clearly describe the emergence of a completely new urban condition that finds also in Switzerland its specific configuration, "a *Großstadt* in formation," as André Corboz writes in 1990 in *Vers la ville territoire*.

Mainstream trends view figures of urban dispersion mainly as a phenomenon to be highlighted or a problem to be solved. By contrast, the Horizontal Metropolis concept considers them as being beyond the themes of the "peri-urban" and the "sub-urban." They are therefore viewed as an asset for—rather than a limitation on—the construction of a sustainable, innovative urban and territorial project. In fact, in such territories, horizontality of infrastructure, urbanity and relations (among various parts as well as among peers), mixed use, and diffuse accessibility can generate specific habitable and ecologically efficient spaces.

A global and systemic attempt at understanding this specific spatial condition, capable of supplying a general and critical picture of these territorial figures and their particular growth dynamics, has never been fully carried out up to now. Rendered conceptually invisible by the conventional polarized way of thinking between the "dense" urban, the "empty" rural and the "bad" sprawl, they have never been acknowledged as true and proper cities and never been analyzed in comparative and systemic terms. For the same reasons, there is a dearth of strategies and projects capable of enhancing the opportunities offered by these territorial constructions and of addressing their limitations, as well as of carrying over practices across different but comparable case studies. The concept of "Horizontal Metropolis" is rooted in the perceived necessity of building a new awareness in order to observe and actively interact with these new forms of urbanization.

Beyond the construction of an interpretative concept, the "Horizontal Metropolis" is a research hypothesis that explores the possibility of designing a fully-fledged, specific project for the "City-Territory". The aim is to investigate and propose strategies that capitalize on the "City-Territory"'s already existing, and all too often overlooked, signature strengths—strategies to reinforce horizontal social and ecological relations in spaces in which imposed polarization and hierarchization processes are, on the contrary, weakening horizontal networks and disconnecting/marginalizing territories and populations. "City-Territories" are spaces that no longer have a clear "outside," so that they form a de facto urban ecosystem—a multipolar, non-hierarchical, mixed whole compelled to offer proof of its sustainability as an integrated system. They are spaces evidencing an urban condition characterized by non-arbitrary extension and by the existence of lastingly diffuse infrastructural supports, leading to distinctive forms of order and coexistence that differ significantly from the hierarchical one.

The "Horizontal Metropolis" concept is meant to give visibility, meaning and legitimacy to those numerous spaces in which metropolitan characteristics exist along with horizontality of infrastructure, urbanity and relations among the different parts as among peers. The hypothesis is that this horizontality, while generating a specific habitable space, can serve as the support for an innovative urban and territorial project. Today the "City-Territory," operates both as natural and spatial capital and as an agent of transformation; it is a both a support and a locus of potentiality (Viganò 2013; Viganò, Secchi, & Fabian, 2016).

Working on the "Horizontal Metropolis" as a specific spatial condition, as a vision and a hypothesis, requires reshaping the imagination of the architect and urbanist, removing it from orthodox and academic ways of thinking, away from a blind "either/or" pragmatism and from theories that cling to a handful of simplified, overriding images. In the effort to reimagine and reconstruct a different design approach, the specific characteristics of the "Horizontal Metropolis" can play an important role, revealing new territorial representations while acting as a mainstay for conceptual shifts.

2. The Case of Urban Switzerland

Nowadays, more and more research efforts are engaged in deconstructing deeply rooted assumptions in order to move closer to actual urban complexity. This article presents one of them and utilizes the "Horizontal Metropolis" concept to suggest a conceptual shift in order to overcome traditional perspectives that consider the compact city as the only "correct" form of urbanity. It will be used here as a lever to begin re-conceptualizing Switzerland's contemporary urban landscape.

2.1. Switzerland's Contemporary and Future Issues Related to Urbanization

In light of the rapid demographic growth forecast for the coming years (rising to a potential 10 million by 2050) and the deep transformations already occurring throughout its whole territory, today's Switzerland stands in urgent need of critical reflection on what its urban future might look like.

Settlement areas, especially those in the region between the Alps and the Jura mountains—the so-called "Plateau"—have been growing steadily over the last century and are now accelerating their growth at a rapid pace (see Figure 1). There is an intense ongoing discussion, at all levels of the country's administration, on the necessity of a "sustainable urban development" model. This inevitably opens up a broader debate on how this growth could or should be accommodated. At the moment, national policies and narratives tend to support and emphasize "metropolization dynamics" (Bassand, 2004) and, therefore, territorial hierarchization strategies and processes that aim for the spatial condensation of urban services and functions in specific, selected locations. The Swiss Confederation's increasingly strong measures clearly point in this direction, as the recent revision, in 2013, of the LAT (*Loi sur l'aménagement du territoire*) testifies. There is a trend towards drastically concentrating urban expansion through "densification strategies" such as, for example, the introduction of the "urban perimeter" concept with the associated creation of incentives for the use of unbuilt plots within the perimeter area. In the same vein, large-scale infrastructural projects involving big national investments with the aim of "shortening the distances" between national and international main urban nodes—such as the Gotthard Base Tunnel opened in 2016 or the Ceneri Tunnel expected to open in 2019—highlight the strong "selective" character of actual national territorial strategies.

In this framework, Switzerland appears to be set to put into force a gradual stiffening of its planning prescriptions and territorial strategies, in order to steer its landscape increasingly towards the concentration of its urban formations—with the danger of gradually diverting attention from "the rest of the territory" and producing territorial as well as socioeconomic marginality. The risk is that by adopting a mainstream conception of what its urban future and its growth model ought to be, Switzerland might gradually neglect and fail to maintain and renew the impressive infrastructural capital, as well as the associated natural and spatial capital, that has made its urban patterns so conducive to an unpolarized, polycentric, territorially egalitarian way of life. A novel set of concepts and actions is therefore needed in order to produce visions and operational tools capable of addressing future urban challenges, of overcoming paradoxes related to the current urban condition, and of critically reconsidering mainstream debates about Switzerland's future urban growth.

Figure 1. Urban Switzerland in 2014: built (white). Source: *Horizontal Metropolis, a radical project*, Venice Architecture Biennale 2016, Atlases.

2.2. Switzerland's Legacy of "Decentralized Centralization"

Switzerland was already described in the 18th century by Jean-Jacques Rousseau as a "big city divided into thirteen districts, some of which bridge valleys, others on slopes, others that straddle mountains" (Rousseau, 1763). Bolstered by a deeply rooted federalism and a unique aggregative structure, the country still nowadays represents an exemplary case of a "City-Territory" (Walter, 1994). Its decentralized distribution of power, in correlation with its tight intermeshing of urban and rural and the decentralization of its industrial production are all factors explaining why, since the dawn of Swiss national planning in the early 1930s, the term "city" was used to describe the country as a whole (Hildebrand, 2006).

Already in 1933, Armin Meili, who would later become first president of the Swiss Land Planning Association (founded in 1943), formulated the guiding principle of Switzerland as that of a *dezentralisierte Großstadt Mitteleuropas*, a "decentralized Central European metropolis" (Meili, 1933)—a principle which was to receive a lot of recognition in the years that followed. Meili had in mind a specifically "Swiss metropolitan development" where satellite towns, incorporating rural areas, were to be linked into "belts" (like "strings of beads") stretching across the whole country. Meili aspired to a decentralized Swiss Metropolis, made up of small and medium-sized cities capable of economic performance/competition and correlated with functional rural areas. "Politically, the aim of a widespread infrastructure made available to the entire territory was thus directly related to an equivalent economic development of mountains and peripheral regions" (Hildebrand, 2006). Over more than ten years and through a number of publications, he sketched a dynamics of decentralized metropolization capable of achieving an "extensive merging of the city and rural areas" (Meili, 1933) and to create a "close bond between the land and its residents" (Meili, 1941) which could cover an autonomously large portion of their own food requirements. The image of a "Swiss metropolitan zone stretching loosely from St Gallen to Geneva" (Meili, 1941) and offering the great advantage of making partial self-sufficiency possible, started to gradually gain credibility among planners, especially in a context of economic crisis and impending world war.

Without denying the economic and cultural significance of major cities, Meili argued that beyond a certain optimum dimension, disadvantages for excessively large cities were predominant. However, over and beyond this posture, Meili, like many others, clearly understood the fundamental importance of ensuring a "balance" within Switzerland's settlement structure, crucial also to maintaining the country's multilingual and multicultural structure (Hildebrand, 2006). The Confederation's spatial planning was influenced for decades by what we might call a notion of decentralized centralization, capable of envisaging a vast decentralized metropolis closely knit spatially and functionally, where the desired functions of a city cohered with the country's territorial and political specificities. This lasted up to the mid-1980s, when urban centers and conurbations began to globally capture the general political attention.

2.3. The Emergence of "Metropolization"-Related Dynamics

With the economic recovery and the strong push towards the metropolization of the territory (Bassand, Joye, & Schuler, 1988; Leresche, Joye, & Bassand, 1995), the Swiss national vision for a "decentralized centralization" began to fade, gradually being considered less and less adequate to the times and less and less achievable. Already in the early 1990s, the dynamic of "metropolization" worried its observers through the manner in which it was proceeding "without synergies with the region in a context of desertification and destruction of the hinterland" (Leresche & Bassand, 1991). Within the metropolitan fabric, a "twofold process was unfolding: while the metropolis supported innovation becoming a genuine pole of cumulative development, it generated the growth of social inequality and phenomena of exclusion" (Leresche & Bassand, 1991)—thus gradually coming into contradiction with a deep and long-entrenched territorial balance. With the revision of the Federal Constitution in 1999, which assigned a new role to the cities, and the associated development of the agglomeration policy, this process acquired more and more political weight, inaugurating a completely new era in planning (Leresche & Bassand, 1994; Schuler & Bassand, 1985).

Despite such a shift, the image of the "country as a city" that takes advantage of its territory as a whole persisted in the descriptions of several scholars, such as André Corboz who described Switzerland as "a Großstadt in formation" (Corboz, 1990), where "the inhabitants, regardless of where they live, have an urban mentality" (Corboz, 1990). Although increasingly remote from actually prevailing institutional positions, Corboz's interpretation of urbanity garnered a widespread and lasting attention that continues to this day. Franz Oswald, for example, defined the mix of city and countryside with the term New Urbanity (Oswald & Schüller, 2003). Angelus Eisinger and Michel Schneider, through the neologism Stadtland Schweiz—"Swiss city-countryside"—described the Swiss habitat as a new spatial and multifunctional entity—a collage of urban, suburban and rural elements which, together, form a polynuclear condensation zone (Eisinger & Schneider, 2005). Kees Christiaanse considered the picturesque rural landscape endemic to the city (Christiaanse, 2005).

However, despite this general and widespread understanding of the profound complexity and specificity characterizing the Swiss territory, an increasingly hierarchized interpretation of its urban landscape leading to the reinforcement of the "metropolization" dynamics (Bassand, 2004; Leresche et al., 1995) gradually took

hold, developed and gained consensus, especially at the level of the political and administrative institutions. For instance, the large-scale research project *Switzerland, an urban portrait* (Diener, Herzog, Meili, de Meuron, & Schmid, 2005) clearly takes issue with, and distances itself from, a global and fine-grained attention to the diffuse horizontalities of the country's territory. Instead, in the name of the "wealth of the whole organism," it expresses a preference for selecting, differentiating and hierarchizing its different parts with a view to its future development. It argues in favor of rearranging the country's political geography through five clearly distinct urbanization types—metropolitan regions, city networks, quiet zones, alpine resorts and alpine fallow lands—in the interest of "strengthening and completing processes already underway" (Diener et al., 2005). In this perception of the country, metropolitan areas—while widely supported by the recreational and rural territories—represent the very core of the interpretation, while the fallow lands remain as an un-integrated "void" at the periphery—both figuratively and literally—of "urban" Switzerland, thought to be functionally necessary but in fact performing no synergetic function within a larger whole. In such a view, the idea of the territory as a comprehensive, plural life-world traversed by multifunctional and multimedial diversity, seems largely abandoned.

2.4. The Possibility of a Counter-Image

This seems very problematic to us. In the extensive fieldwork activity we are conducting for this research, we have traced the transformations left on the ground—in settlements, landscapes and soils—by selective and increasingly exclusive policies. Meanwhile, the ongoing debates we are observing keep registering the difficulty in actually implementing densification in already built and already relatively dense areas. Accordingly, the "Horizontal Metropolis" hypothesis investigates the possibility of a cohesive project rooted in the already available richness of City-Territories' existing patterns of "decentralized centralization" (See Figure 2). We believe this is all the more timely and relevant because, despite the recent thrust of national policies towards supporting and emphasizing territorial hierarchization processes, the legacy of visions and models developed for over a century around the idea of territorial decentralization and of a "comprehensive use of the territory" is still very spatially visible all across the Swiss territory. This heritage seems to us to represent a very precious resource to face the country's future urban challenges if we are to avoid, or at least mitigate, the dismemberments, disruptions and exclusionary dynamics that are likely to come with the currently prevailing centralizing and polarizing view.

In order to develop a new body of research capable of opening up a debate that, otherwise, risks being weakened into insignificance by a culturally and politically hegemonic project of unmitigated metropolization, we believe it is necessary and urgent to articulate a counter-project. We would like to label that counter-project: "*From growth to development: Space as capital.*" By "growth" we mean the now conventional ideology that, out of a legitimate fear of indiscriminate urban sprawl, demographic increases need to be met with urban concentration and densification (with the associated dualism of rural and urban, built and open, etc.) in order to avoid territorial diffusion and the mixing-up of infrastructural, natural and cultural capital. In the conventional "growth" view, types of capital have to be kept separate in order to maximize the growth of each of them. By "development," on the contrary, we mean a settlement pattern which, while respecting the need to avoid arbitrary sprawl, views human, natural and social health and well-being as anchored in balanced and mixed qualitative evolution, with an intermeshing and interweaving of functions and modes of occupation on territories and with "isotropy" (the similar availability of micro- and macro-infrastructures in all spatial directions) and "fractality" (the similar availability of possibilities for living well at various geographical scales) as the key notions ruling the philosophy of design (Arnsperger, 2016).

The Swiss "City-Territory", as a whole, could then be read as a renewable resource, where recycling and reinvestment would reverse the idea that urbanization means mainly a process of waste. The Swiss "Horizontal Metropolis" could be considered as a new spatial-socio-ecological design issue, to be addressed starting from a careful reading and re-interpretation of the resources already present on the territory (see Figure 3). The Swiss "City-Territory", which historically was extensively inhabited all the way from the valleys to the "Plateau," is in fact characterized by a vast, qualitative and diffused support system for "urban life," made of fine-grained infrastructures and high-quality built capital. One telling example is the country's vast and capillary—we could say territorial—educational system, made up of schools and universities of different scales and kinds, put in place over more than a century with a view to fostering an "extensively educated society."

2.5. Approaching a Case Study: The West of Lausanne—Reframing the Periphery

In order to flesh out and operationalize the "Horizontal Metropolis" concept and to show its contribution to a new urban design approach, concrete design-oriented proposals, concrete "spaces" on which action is possible, need to be identified and rethought. The case of the West of Lausanne will be briefly outlined here to begin a confrontation with concrete territorial themes and to identify a first set of operational tools. Located in the extensive Swiss "City-Territory" and conceived as a periphery now gaining its autonomy, the West of Lausanne represents a good example for exploring the "Horizontal Metropolis" concept in the Swiss context.

For over a century, the West of Lausanne was the industrial periphery of a middle-size city; today, it is wit-

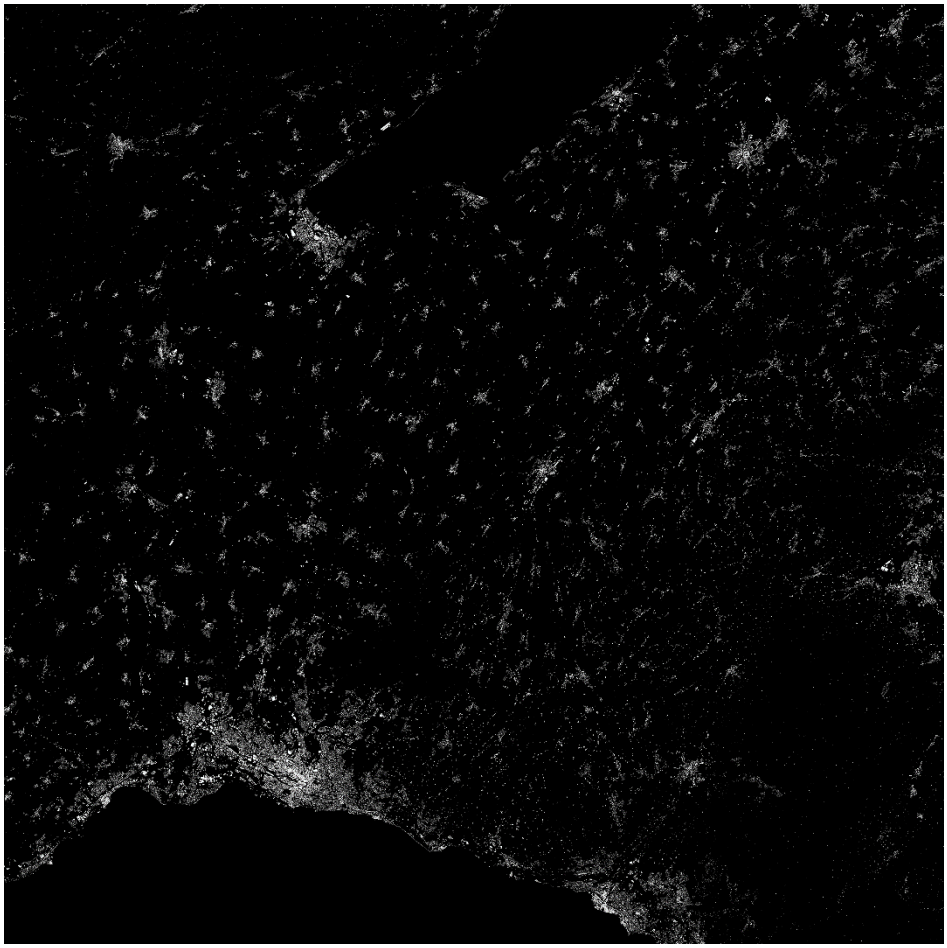

Figure 2. Canton of Vaud (2014), portion. 50x50 km: urban morphology: built (white). Source: *Horizontal Metropolis, a radical project*, Venice Architecture Biennale 2016, Atlases.

nessing an important transformation process which is likely to strongly modify its spatial and social character. The fundamental question, as in many other places in Europe, concerns the future of the industrial activities and the risk of overestimating the role of the tertiary economy. The urban "fabric," made up of villages, dormitory areas, rapidly transforming industries and vast agricultural plots, is extremely fragmented and heterogeneous. Transportation lines such as railways and highways running East-West interrupt already weak ecological networks (mainly watercourses and forests) which, on the contrary, run North-South. The West of Lausanne also contains the vast campus of two big universities dedicated to research and education, a space/economy that is becoming increasingly strategic for the Lausanne area.

In the attempt to re-frame this territory through the lens of the "Horizontal Metropolis" concept and to imagine and construct new design approaches, three strategies can be identified: spatial recycling, reduction of individual car- and truck-based mobility, and capitalization on embedded ecological rationalities. These strategies work through, respectively, the territory's "embodied energy," aiming at reworking the existing urban "stock" and at envisioning new life-cycles for abandoned and underused spaces; the idea of a more coherent and efficient public transport system, capable of inducing a significant decrease in car-based mobility; and the restoration of ecological continuities along water networks, where forests and reclaimed soils could evolve into a territorial park.

For each of these strategies a set of operational tools can be identified:

Spatial Recycling—Within the large existing industrial surfaces, which are already partly being reworked and where abandonment is fragmented and discontinuous, the ongoing incremental recycling of the West of Lausanne's space by small and medium-sized enterprises demonstrates the limits of contemporary *tabula rasa* strategies. In this domain, our first design explorations show that a firm commitment to maintaining production and manufacturing does not necessarily go against the strategy of upgrading the site's qualities: patches that are mixed in terms of land use can draw advantages from existing agricultural plots, and isolated dwellings can be reinforced by new ones. Through minute work on the permeability of the—mainly industrial—spaces and on the reestablishment of connectivity, even old industrial zones bound by infrastructural barriers can become spaces to live well in, with high-quality public standards. New continuities can be imagined connecting the indus-

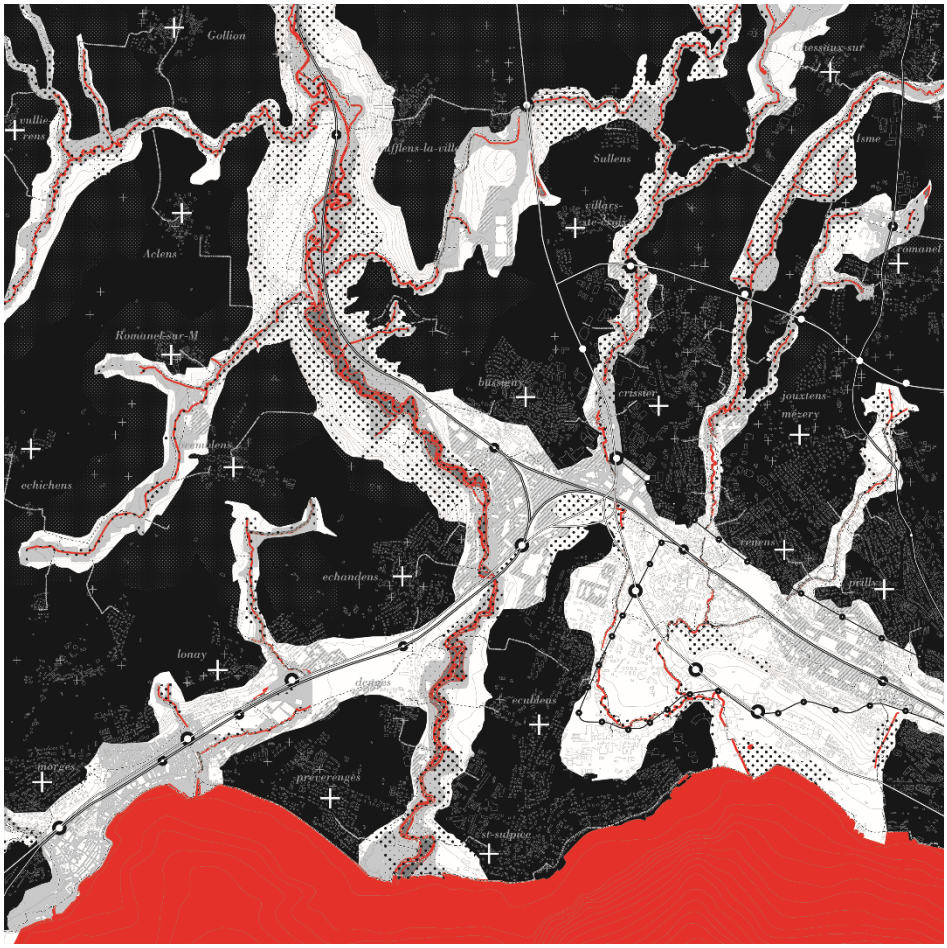

Figure 3. "The *espace rivière* as territorial park." West Lausanne Area, 10x10 km: water (red); *espace rivière* (white); room for water (grey); forest (dotted black); productive and logistic plots (lines hatch); agriculture (dotted white); railways, tramways and bus transportation system (line and black lines); villages (white crosses); built (light grey outlined). Source: EPFL Superstudio Students, fall 2014 and *Horizontal Metropolis, a radical project*, Venice Architecture Biennale 2016, Atlases.

trial, fractured and entrenched spaces to the villages, the agricultural areas and the city around them (see Figure 4). Strategic urban axes can be rethought and redesigned by exploiting, for instance, the construction of new planned tramway tracks and via the recycling of large commercial containers (see Figure 4). Small public spaces, scattered throughout the existing fabric, can take advantage and thrive on the natural patches that persist within them. Communal roofs that cover different buildings, as well as second skins, can have the dual function of producing energy and of making the new "urban fabrics" more comfortable. New urban agriculture and urban parks can be harnessed to built structures that get recycled and adapted to new energy standards.

Reduction of Individual Car- and Truck-Based Mobility (Towards a No-Car Scenario)—To reduce the level of resource and energy consumption, it is fundamental to rediscuss the current role of highways and railways. Accordingly, we need to investigate the spatial impact of a transition from a system based on freight trucks to a rail-based system. In the West of Lausanne it would possible to repurpose the existing highway, which literally cuts the area in two halves, as a BRT (Bus Rapid Transit) and to integrate it within a territory from which it has been almost completely disconnected except as a purveyor of external traffic flows entering or leaving the area. Along the highway new bus stops could allow the requalification of the leftover spaces facing the street, creating new public spaces at the back of the existing industrial and logistic facilities. A system of elevators could enable the highway to be reached by soft mobility and to be connected with the territorial park (see below). The large truck warehouses could be turned into public facilities and the train stations would constitute new poles of attraction, strongly connected to the new bus stations and the soft mobility network/recreational system.

A more efficient public transport system could also improve the connections between the villages to the north and the larger agglomerations to the south, close to the main infrastructures. In the marginal areas, near the stations, there is the potential for improving the typological mix, adding services and exploiting the proximity to agriculture.

Figure 4. "Reestablishment of territorial connectivity." West Lausanne Area: creation of new continuities between forested areas and industrial spaces. Insertion of new strategic urban axes and repurposing of the existing highway (integrated within the territory). Source: *Horizontal Metropolis, a Radical Project*, Venice Architecture Biennale 2016, Atlases.

Capitalization on Embedded Ecological Rationalities—Reversing the logic which, for decades, has built and structured this territory, water networks and "open soils" could become the starting point of a deep overhaul of the West of Lausanne's spatial structure. On the one hand the watercourses could, if managed, reshaped and transformed over time, represent new north-south continuities, both in terms of ecological coherence and of public space (see Figure 3). On the other hand, a renewed, more conscious relationship to soils, which are often trivialized, ignored, and even scorned in urban planning processes, could help mend the way urbanized territories are looked at and judged. If considered as a complex, integrated and integrating system characterized by a broad functional diversity, if taken into consideration not only as a surface (in a quantitative perspective) but also in a qualitative, three-dimensional perspective, well-managed soils could in fact help build sound valorization, compensation and climate change mitigation tools in an area that has inherited a rather negative socio-ecological reputation from its industrial past.

The *espace rivière* could become a territorial park establishing new continuities throughout the territory (see Figure 3). Along the watercourses, an enlarged forest system could surround the water basins for water catchment, so that the runoff from the road infrastructure could be collected via permeable pavements and treated. In the fields alongside the river, phytoremediation could prevent and mitigate problems of pollution—an issue that is of particular acuity for the West of Lausanne. The forest could represent a new unifying and connecting "buffer" between the currently segregated natural and urban environments—especially as historically, part of the West of Lausanne's stock of environmental capital was in fact located in close proximity to industrial activities—and could therefore become the device through which to identify, envision and grow new ecological pockets intermeshed with the urban fabric.

3. Conclusion: On the Necessity of a New Research Agenda

The case of the West of Lausanne is only one of the many urban conditions which can be rethought as part of the Swiss Horizontal Metropolis. These explorations show that we are in urgent need of an alternative set of concepts and actions to produce visions and operational tools to deal with future urban challenges—concepts and actions capable of overcoming the paradoxes and contradictions of the current urban condition and of critically reformulating and recasting mainstream debates around the future of urban growth. In the specific case

of the future of urban Switzerland to 2050 and beyond, visions, planning and design tools need to be articulated, starting from the investigation of concrete case studies and hypotheses and with an ability to cope with local-global instability, unbalance and uncertainty—in other words, to generate territorial resilience. To transform present risks into future opportunities, old dualistic ways of thinking are no longer called for. We need a new interpretation of the inhabitability of the Swiss territory, in relation to the infrastructural support system and the issue of social inclusion. We require a deeper understanding of the Swiss "City-Territory" as a renewable resource, by reflecting on new life cycles and capitalizing on the urban and territorial "embodied energy."

To this end, we have suggested and defended here the idea of "Horizontal Metropolis," which stands opposed to both indiscriminate sprawl and equally indiscriminate densification and concentration. Through the lens of the "Horizontal Metropolis," the exploratory case of the West of Lausanne was shown to suggest first possibilities for alternative and novel ways—based, in the case of Switzerland, of deeper inherited historical and ecological wisdom—of redesigning our cities and territories for the future.

Conflict of Interests

The authors declare no conflict of interests.

References

Allen, S. (1999). *Points+ lines: diagrams and projects for the city*. New York: Princeton Architectural Press.

Allen, A. (2003). Environmental planning and management of the peri-urban interface: perspectives on an emerging field. *Environment and Urbanization*, *15*(1), 135–148.

Arnsperger, C. (2016). Fractality—Isotropy—Perma-circularity: Richard Register, Paola Viganò and the new foundations of settlement design. *Perma-Circular Horizons*. Retrieved from http://arnsperger-perma-circular.com/2016/10/19/fractality-isotropy-perma-circularity-richard-register-paola-vigano-and-the-new-foundations-of-settlement-design

Bassand, M. (2004). *La métropolisation de la Suisse*. Lausanne: Presses polytechniques et universitaires romandes.

Bassand, M., Joye, D., & Schuler, M. (1988). *Les enjeux de l'urbanisation: Agglomerationsprobleme in der Schweiz*. Bern: Lang.

Bélanger, P. (2009). Landscape as infrastructure. *Landscape Journal*, *28*(1), 79–95.

Berger, A. (2007). *Drosscape: Wasting land urban America*. New York: Princeton Architectural Press.

Berger, A. (2009). *Systemic design can change the world*. Amsterdam: Sun Architecture.

Boeri, S., Metropolitani, A. I., Lanzani, A., & Marini, E. (1993). *Il territorio che cambia: ambienti, paesaggi e immagini della regione milanese*. Milano: Abitare Segesta.

Brenner, N. (2009). Restructuring, rescaling and the urban question. *Critical Planning*, *16*(4), 61–79.

Brenner, N. (Ed.). (2014). *Implosions/explosions: Towards a study of planetary urbanization*. Berlin: Jovis.

Buijs, S., Tan, W., & Tunas, D. (Eds.). (2010). *Megacities: Exploring a sustainable future*. Rotterdam: 010 Publishers.

Burdett, R. (2008). *The endless city*. London: Phaidon Press.

Cadenasso, M. L., Pickett, S. T. A., McGrath, B., & Marshall, V. (2013). Ecological heterogeneity in urban ecosystems: Reconceptualized land cover models as a bridge to urban design. In S. T. A. Pickett, M. L. Cadenasso, & B. McGrath (Eds.), *Resilience in ecology and urban design* (pp. 107–129). Springer Netherlands.

Christiaanse, K. (2005). Zwischen Metropolis und Arkadien: Ein Blick von aussen auf Zurich. *Archithese*, *35*(6), 32.

Corboz, A. (1990). Vers la ville-territoire. In *Sonderdruck aus Ergänzungen Ergebnisse der wissenschaftlichen Tagung anlässlich der Einweihung des Ergänzungsbaus der Hochschule St. Gallen* (pp. 631–635). Bern und Stuttgart: Verlag Paul Haupt.

Diener, R., Herzog, J., Meili, M., de Meuron, P., & Schmid, C. (2005). *La Suisse: Portrait urbain*. Basel: Birkhäuser.

Eisinger, A., & Schneider, M. (Eds.). (2005). *Stadtland Schweiz: Untersuchungen und Fallstudien zur räumlichen Struktur und Entwicklung in der Schweiz*. Berlin: Walter de Gruyter.

Grosjean, B. (2010). *Urbanisation sans urbanisme: Une histoire de la" ville diffuse"*. Wavre: Mardaga.

Hildebrand, S. (2006). Urbane Schweiz. UrbanistischeKonzepte für die Schweiz von 1930 bis heute. In K. Borgmann, M. Bruhn, S. Kuhrau, M. Schalenberg (Eds.), *Das Ende der Urbanisierung? Wandelnde Perspektiven auf die Stadt, ihre Geschichte und Erforschung* (pp. 69–84). Berlin: Humboldt-Universität zu Berlin. Retrieved from http://edoc.hu-berlin.de/e_histfor/8

Indovina, F. (1990). La città diffusa. In F. Indovina et al. (Eds.), *La città diffusa* (pp. 19–43). Venice: Daest.

Indovina, F., Fregolent, L., & Savino, M. (2005). *L'esplosione della città: Barcelona, Bologna, Donostia-Bayonne, Genova, Lisbona, Madrid, Marsiglia, Milano, Montpellier, Napoli, Porto, Valencia, Veneto centrale*. Bologne: Compositori.

Lefebvre, H. (1970). *La révolution urbaine*. Paris: Gallimard.

Leresche, J.-P., & Bassand, M. (1991). *Métropole lémanique: Une nouvelle dynamique urbaine* (Rapport de recherche). Lausanne: IREC, Institut de Recherche sur l'Environnement Construit, Département d'Architecture—EPFL.

Leresche, J.-P., & Bassand, M. (1994). *Les faces cachées de l'urbain*. Bern: Peter Lang.

Leresche, J.-P., Joye, D., & Bassand, M. (1995). *Métropolisations: Interdépendances mondiales et implications lémaniques*. Genève: Georg.

McGee, T. G., (1991). The emergence of desakota regions in Asia: Expanding a hypothesis. In N. Ginsburg, B. Koppel, & T. G. McGee (Eds.), *The extended metropolis: Settlement transition in Asia* (pp. 3–25). Honolulu: University of Hawaii Press.

McGee, T. (2009). *The spatiality of urbanization: The policy challenges of mega-urban and Desakota Regions of Southeast Asia* (UNU-IAS Working paper no. 161). Yokohama: United Nations University-Institute for Advance Studies.

Meili, A. (1933). Allgemeines über Landesplanung. *Die Autostrasse*, *2*, 17–21.

Meili, A. (1941, July 16). Landesplanung in der Schweiz. *Neue Zürcher Zeitung*.

Munarin, S., & Tosi, M. C. (2002). *Tracce di città: esplorazioni di un territorio abitato: L'area veneta*. Milano: FrancoAngeli.

Oswald, F., & Schüller, N. (Eds.). (2003). *Neue Urbanität—Das Verschmelzen von Stadt und Landschaft*. Zürich: gta-Verlag.

Pickett, S. T. A., Cadenasso, M. L., & McGrath, B. (Eds.). (2013). *Resilience in ecology and urban design: Linking theory and practice for sustainable cities*. New York: Springer.

Rousseau, J.-J., (1763). Lettre à M. le Maréchal de Luxembourg, Môtiers, le 20 janvier 1763. In J.-M. Tremblay (Ed.), *Lettres (1728–1778)*. Retrieved from http://classiques.uqac.ca/classiques/Rousseau_jj/lettres_1728_1778/rousseau_lettres.pdf

Schuler, M., & Bassand, M. (1985). *La Suisse, une métropole mondiale?* (Rapport de recherche 1985-001). Lausanne: Institut de Recherche sur l'Environnement Construit—EPFL.

Secchi, B. (1986). Progetto di suolo. *Casabella*, *520*(1986), 19–23.

Secchi, B. (2010). Préface. In B. Grosjean, *Urbanisation sans urbanisme: Une histoire de la" ville diffuse"*. Wavre: Mardaga.

Secchi, B. (2011). La nuova questione urbana: Ambiente, mobilità e disuguaglianze sociali. *Crios*, *1*, 83–92.

Sieverts, T. (1997). *Zwischenstadt: Zwischen Ort und Welt, Raum und Zeit, Stadt und Land*. Wiesbaden: Vieweg+Teubner Verlag.

Smets, M. (1986). La Belgique ou la banlieue radieuse. In *Paysage d'architectures 1886–1986* (pp. 33–35). Brussels: Fondation de l'Architecture.

Tjallingii, S. (1995). The water system in the city: Summary of discussions. In H. van Engen, D. Kampe, & S. Tjallingii (Eds.), *HYDROPOLIS: the role of water in urban planning*. Leiden: Backhuys Publishers.

Viganò, P. (1999). *La città elementare*. Milano: Skira.

Viganò, P. (2001). *Territories of a new modernity*. Electa: Napoli

Viganò, P. (Ed.). (2004). *New territories*. Roma: Officina.

Viganò, P. (2008). Water and Asphalt. The project of Isotropy in the metropolitan region of Venice. *Architectural Design*, *78*(1), 34–39.

Viganò, P. (2013). The Horizontal Metropolis and Gloeden's diagrams. Two parallel stories. *OASE Journal of Architecture*, *89*, 94–103.

Viganò, P., Secchi, B., Cavalieri, C., Fabian, L., Giannotti, E., Calò, A., . . . Bonifacio, V. (2013). *Energie et recyclage* (EPFL-REPORT-215347). Paris: Ministère de la culture et de la communication, Bureau de la recherche architecturale, urbaine et paysagère.

Viganò, P., Secchi, B., & Fabian, L. (Eds.). (2016). *Water and asphalt. The project of isotropy*. Zürich: Park Design.

Waldheim, C. (2006). *The landscape urbanism reader*. New York: Princeton Architectural Press.

Waldheim, C. (2016). *Landscape as urbanism: A general theory*. Princeton: Princeton University Press.

Walter, F. (1994). *La Suisse urbaine, 1750–1950*. Carouge-Genève: Zoe.

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Commentary

Visualizing Conflict: Possibilities for Urban Research

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Abstract
The *Center for Spatial Research* (CSR) is undertaking a multiyear project investigating what we have termed *Conflict Urbanism*. The term designates not simply the conflicts that take place in cities, but also conflict as a structuring principle of cities intrinsically, as a way of inhabiting and creating urban space. The increasing urbanization of warfare and the policing and surveillance of everyday life are examples of the term (Graham, 2010; Misselwitz & Rieniets, 2006; Weizman, 2014), but conflict is not limited to war and violence. Cities are not only destroyed but also built through conflict. They have long been arenas of friction, difference, and dissidence, and their irreducibly conflictual character manifests itself in everything from neighborhood borders, to differences of opinion and status, to ordinary encounters on the street. One major way in which CSR undertakes research is through interrogating the world of 'big data.' This includes analyzing newly accessible troves of 'urban data,' working to open up new areas of research and inquiry, as well as focusing on data literacy as an essential part of communicating with these new forms of urban information. In what follows we discuss two projects currently under way at CSR that use mapping and data visualization to explore and analyze *Conflict Urbanism* in two different contexts: the city of Aleppo, and the nation of Colombia.

Keywords
conflict; data; data visualization; GIS; interactive; mapping; urbanism

Issue
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1. Visualizing to Understand Complexity in Colombia

At first glance it is extremely difficult to grasp the scope of the Colombian conflict: it spans more than 50 years and covers most of the country's territory, it even crosses its borders into neighboring Ecuador, Venezuela, Peru and Brazil; it includes multiple actors, both from the right and from the left, who at times fought against and at times profited from the illegal drug business; it has been shaped and re-shaped by a multiplicity of political and socio-economic forces, and has generated millions of victims of displacement, homicide, massacres and sexual violence. More recent developments include a long and controversial demobilization process by the right-wing paramilitary groups, and the current peace process with the left-wing guerrillas of the FARC, which have polarized the country. The most recent peace accord has been in the making for more than four years and produced an agreement that was signed by the government and the FARC and then rejected by the Colombian people through a referendum, only to be modified and approved again by members of the Colombian legislative body.

As part of this ongoing peace process the Unidad para la Atención y Reparación Integral a las Víctimas, an agency within the Colombian Government, has been dedicated to assembling a database of victims of the conflict: the Registro Único de Víctimas. This massive dataset reflects the stories of nearly eight million Colombian cit-

izens, who volunteered information in hopes of someday receiving reparations. It is doubtful that the dataset is complete, but it is still a remarkable repository of information about who has been impacted by the conflict, the kinds of crimes committed at different points in time, and where people have been displaced to and from.

This project uses techniques of mapping and data visualization to understand spatial and temporal patterns of the conflict as well as the limits and gaps embedded in the data. How has the conflict impacted urban development in Colombia? Do particular types of crime form spatial concentrations? How have internally displaced people moved throughout the country? Have cities of all sizes had to bear the burden of massive influxes of displaced people equally? Are there spikes that expose bias in the data collection? Through an iterative process the project has used spatial analysis and visualization to address these questions and prompt others for further research to build a nuanced understanding of the conflict.

Figure 1, for example, shows internally displaced people in Colombia, from 1985 to 2015. The thickness of the lines represents the number of people who were displaced—the thinnest lines represent fifty people and the thickest more than 10,000. The color within each

Figure 1. Map of Internally Displaced People 1985–2015.

line represents direction of movement—the white ends of the line represent origins of displacement and the orange destination[1]. The map shows well known facts about the conflict: the large numbers of people who were displaced from small towns and moved to large cities, like Bogotá, Medellín or Cali; it also shows the more than 20,000 people that were displaced before, during and after the most infamous massacres of the conflict: the attack on Bojayá by the FARC, or the repeated massacres around La Gabarra by the paramilitaries; it also reveals that the areas surrounding Medellín and Turbo saw more than half a million departures and arrivals. However, the map also highlights other aspects of the conflict that are not that well known or understood: it makes clear that municipalities like Florencia, Popayán or Pasto in the southwest received almost 300,000 displaced people; that over 15,000 people have been forcibly displaced from Buenaventura to Cali and, almost 50,000, from Buenaventura to Bogotá; and that all the main cities along the Atlantic coast have served as destinations for more than 350,000 displaced people. It even shows how remote and sparsely populated municipalities like Leticia in the south or Puerto Inírida in the east have also suffered displacement.

The map powerfully reveals how the conflict has enveloped the whole country in a deep and intricate web of displacement and violence. While this visualization conveys the complexities of the war as a whole, it does not show the stories of individual displacement events or speak to the number of displacements that have occurred from the country side to the cities or within small and medium-sized municipalities.

A second type of visualization, in the form of a video animation (Figure 2), begins to reveal these finer grain histories captured by the Registro Único de Víctimas: this video uses a simple particle system to illustrate every single displacement in the dataset from 1985 to 2015.[2] The advantage of showing this information in video form is that it allows us to display a rather complex dataset in a single diagram while still conveying a sense of dynamism that a static graph cannot produce. The animation shows how in the late 1980s and early 1990s displacement was mostly confined to the regions around Medellín and Urabá, and how starting in the late 1990s there was not just an increase in the number of displaced people but an expansion of forced displacement to the rest of the country. By the mid 2000s the visualization clearly shows how the whole country is covered in forced displacement and the south-west of the country has also become a center for this type of violence.

In addition, this type of visualization allows us to zoom into specific moments and places in the conflict while still providing relevant contextual information through text annotations. For example, we can see the exact moment in which the FARC attacked Mitú displacing more than 1,000 of its inhabitants, killing almost 150 and kidnapping more than 100 people; or the permanent flow of displacement that has been going on from Buenaventura to Cali and Bogotá since 2013.

2. A Multilayered Approach to Detecting Urban Damage: Aleppo, Syria

The city of Aleppo fell to Syrian government forces and their allies in December 2016. Hundreds of thousands of Syrians have been killed or injured, and an estimated nine million people displaced. Aleppo has suffered extensive physical damage – to its symbolic center, the Citadel; its surrounding heritage sites, which mark ancient empires, diverse religions, and multiple cultures and trade

Figure 2. Screenshots of animation (zoomed out and in).

[1] View and interactive version of this map at http://c4sr.columbia.edu/conflict-urbanism-colombia.
[2] This animation can be viewed at http://c4sr.columbia.edu/conflict-urbanism-colombia.

routes; and to its eastern and southern neighborhoods. The destruction of the city's cultural and urban history, as well as its cultural memory and identity, appears to be an intentional result of military operations, and not merely a byproduct of them.

The focus of this work has been on the city of Aleppo, on urban damage, and on how the city became an integral part of the infrastructure of conflict. We have created an archive and a resource, which we hope will become useful in the years to come, as a framework for documenting crimes of war, as well as for speculating about how Aleppo might be rebuilt.

Unlike the work on Colombia, much of the focus on Aleppo has revolved around how to create spatial datasets where they did not previously exist. To facilitate our work we created an interactive map of the city of Aleppo, which combines layers of high-resolution satellite images together with data gathered by UNITAR-UNOSAT (the United Nations Institute for Training and Research Operational Satellite Applications Programme), to show the historic city, and damages incurred to it, from 2012 to the present.

We followed this map with a series of case studies released over the course of 2016 in which we use the map, together with other data sources to examine specific moments in the war. This article focuses on the methods of observation and monitoring that the project has used to examine small-scale and city wide patterns of damage during the war: on the one hand the project uses the view from a distance with high and low-resolution satellites; and on the other it has archived thousands of on-the-ground videos captured by citizen-journalists and uploaded to YouTube. Using the logic of a typical geographic information system (GIS) map, the *Conflict Urbanism: Aleppo* project overlaps these different sources of material as layers for two purposes: first, to provide evidence about the physical destruction of the city, and second, to prototype different methods of observing and monitoring urban warfare from a safe distance.

The interactive map (Figure 3) assembles an archive of high resolution satellite images and allows users to navigate the city of Aleppo by neighborhood.[3] Each pixel in these images captures just fifty centimeters on the earth's surface—the highest resolution available to civilians until recently. The branch of the UN dedicated to satellite research, UNITAR-UNOSAT, trains and assigns teams of people to manually examine images like these to identify and record sites damaged by bombs in war zones. The map allows users to view the data produced by UNITAR-UNOSAT about Aleppo and compare it to high resolution satellite images where this damage is visible from four days throughout the war.

Although we tend to take it for granted today, the high-resolution satellite technology and imagery that we make use of here, seen in Figure 4, was only declassified and made generally available a decade and a half ago

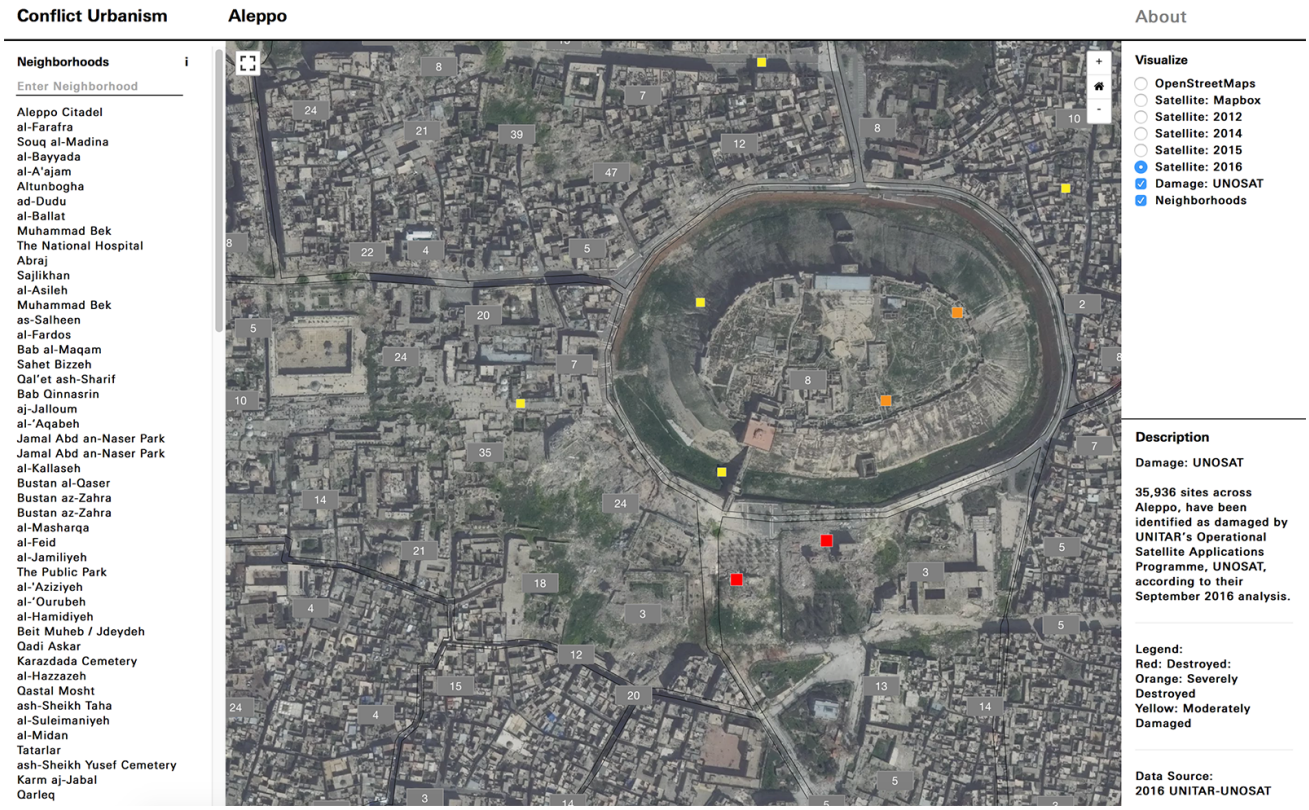

Figure 3. Interactive map of Aleppo that allows users to browse by neighborhood. Satellite images from World View II © Digital Globe 2015 & 2016.

[3] View the interactive map at http://c4sr.columbia.edu/conflict-urbanism-aleppo/map/index.html.

Figure 4. Two satellite images of Aleppo's Citadel and surrounding neighborhoods on March 23, 2016 (left) and September 3, 2015 (right). Yellow squares indicate damaged sites identified by the United Nations in May 2015. Additional unmarked damaged sites are also visible. Satellite images from World View II © Digital Globe 2015 & 2016.

(Cosgrove & Fox, 2010; Kurgan, 2013). And while images become available for purchase by the public once they are captured, they are still expensive, costing between $14 and $18 per square kilometer.

Because of the cost of high resolution satellite images and the time required to analyze them manually, looking for damaged sites, UNITAR-UNOSAT has only collected data at four dates over the 5 years of war. Although their data is thorough, it was not updated on a regular basis, and, we saw a need to track urban damage more frequently than is possible using expensive and proprietary high resolution satellite images. In a collaboration with a remote sensing scientist the project took on an experimental approach to using low resolution, and free, images captured by the Landsat satellite to detect change in Aleppo every two weeks.[4] This analysis has resulted in a dataset, created algorithmically, which can help identify areas over specific time periods that have been severely destroyed in the city. This approach measures changes in the brightness of pixels in the Landsat satellite images between two successive images. The result is messy and riddled with ambiguity (Figure 5), but has nonetheless led to new insights about the locations and rhythm of destruction in the city.

In order to ground-truth the results of this experimental approach, we did two things: first we overlaid the Landsat pixels (shown in yellow in Figure 6) onto high resolution satellite images from the same time frame; second we cross-checked it with YouTube videos, from the same date. In many cases the method was successful and revealed that the analysis of low resolution satellite images had been able to identify many areas of damage to large buildings and infrastructure.

YouTube has become one of the largest sources (and archives) of information about events on the ground in Syria: since January 2012 over a million videos of the conflict have been uploaded, with hundreds of millions of views to date. This independently reported footage has created a new powerful archive, but opens up crucial questions of credibility, verification, and bias. As with all data, every video comes to us bearing the traces of the situation and intentions that motivated its production. This does not disqualify it—quite to the contrary—but it does demand that we approach everything critically and

[4] Jamon Van Den Hoek, "Remote Sensing Urban Damage" in Conflict Urbanism Aleppo. http://c4sr.columbia.edu/conflict-urbanism-aleppo/remote-sensing.html.

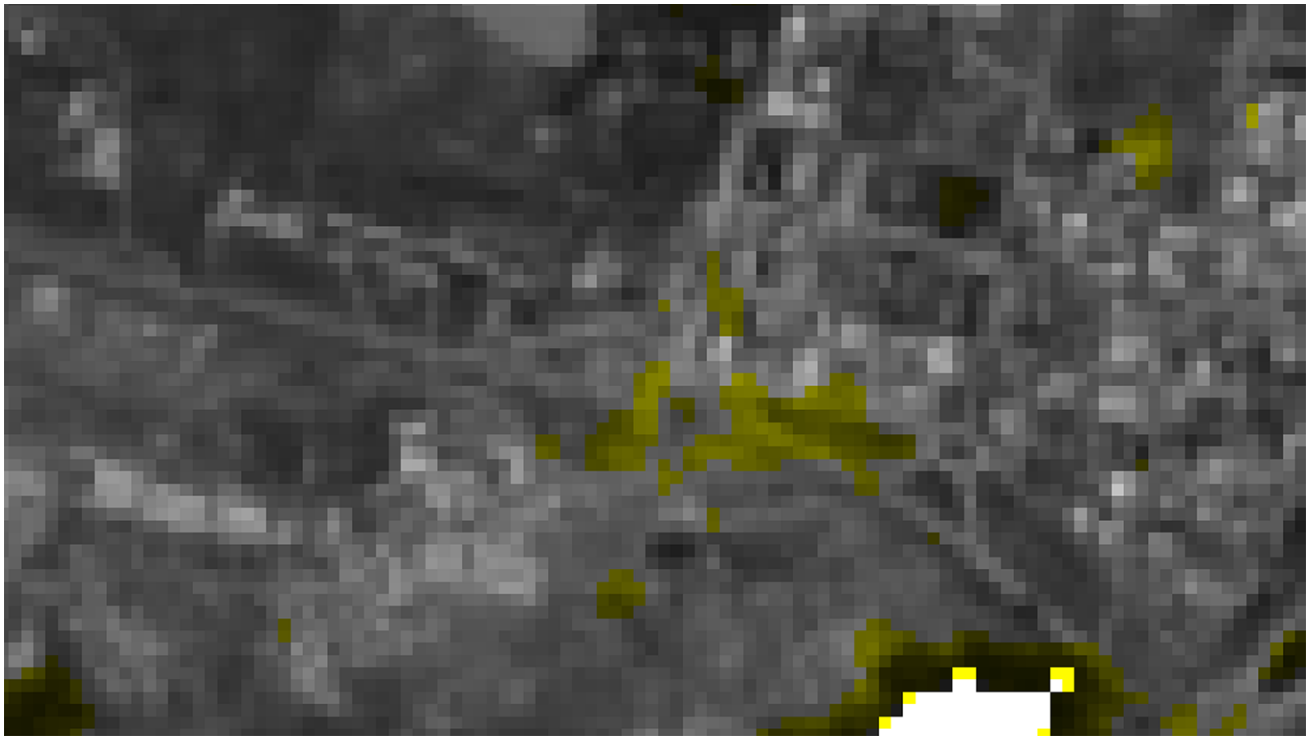

Figure 5. Landsat Image of Castello road on June 10, 2016 with areas of 'significant' pixel value change highlighted. Significant pixel change detection algorithm developed by Jamon Van Den Hoek.

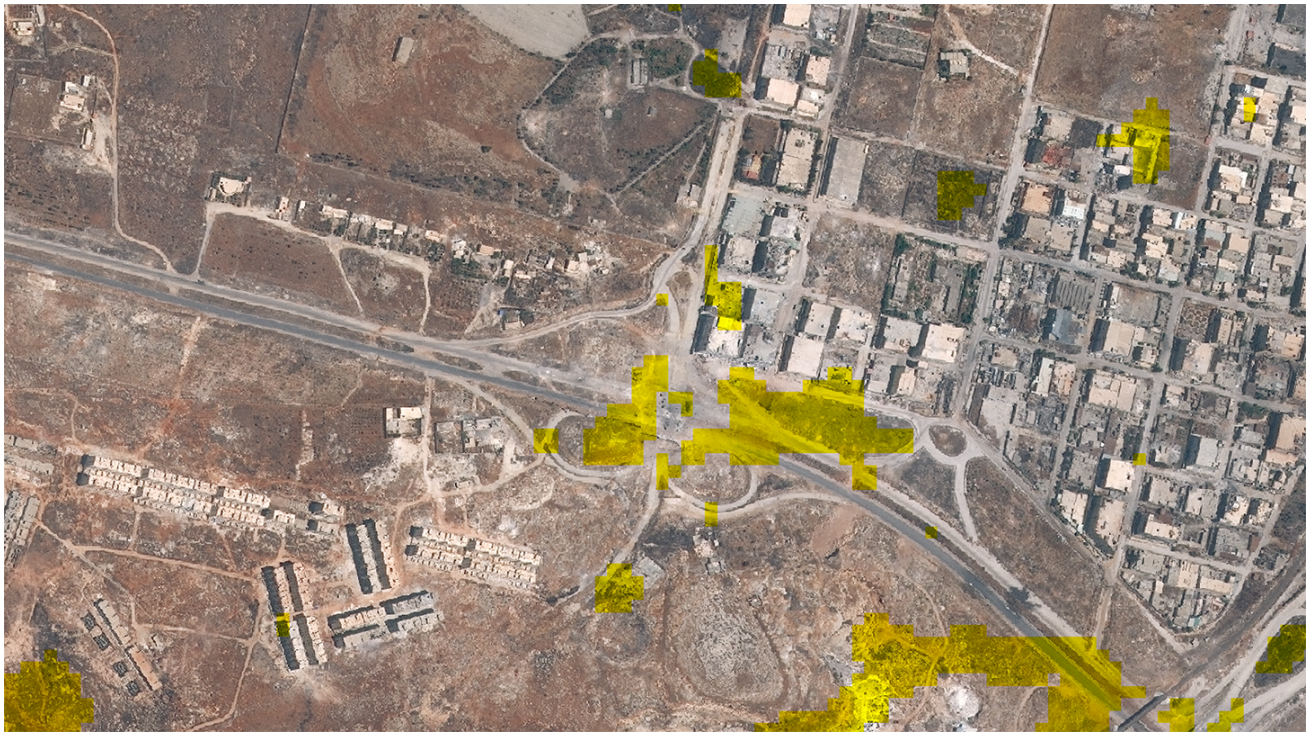

Figure 6. High resolution satellite image from June 11, 2016 (one day after the second Landsat image was taken) which shows major damage to Castello Road overpass as well as buildings in the surrounding area. Satellite images from World View II © Digital Globe 2015 & 2016. Significant pixel change detection algorithm developed by Jamon Van Den Hoek.

carefully. The videos can be a key source to verify the location and date of events: major news agencies have come to rely on YouTube as a primary source for their reporting, and human rights organizations often cite videos as part of their advocacy and documentation efforts.

YouTube is not an inherently spatial data source. However, citizen journalists uploading these videos often included the names of the neighborhoods or landmarks depicted in their footage in the video titles. Because of this widespread naming convention, CSR was

able to geolocate and map YouTube videos posted by three of the most highly cited channels posting videos about the conflict in Aleppo. This spatialized archive (Figure 7) has already assisted CSR research about Aleppo, and will hopefully help to further the use of YouTube videos in investigations about the war.

Through a multilayered approach the project uses these three modes of seeing Aleppo—triangulating between these different sources—to reveal astonishing city-wide and hyper-local patterns in the war. At the city scale: the high-resolution view and the data produced from it by UNITAR-UNOSAT shows that the vast majority of the damage was experienced by neighborhoods in the eastern and southern portions of Aleppo which were besieged by the Assad Regime during the fall of 2016. Narrative accounts through news reporting confirms this and these are also the areas of the city which have the most damage documented through YouTube videos. Together these sources of evidence show that this portion of the city was systematically bombed and shelled for the duration of the war. At the hyper local scale: a block of flattened buildings, a highway overpass dotted with massive holes caused by bombs, attacks on an access road which carried life critical supplies to rebel held areas of the city, and collapsed structures amidst dense residential neighborhoods are among the individual events we have been able to uncover by cross referencing these three different modes of seeing in Aleppo.

Our case studies show that the use of high and low resolution satellite imagery, in combination with YouTube videos recorded by citizen journalists in Aleppo, provide a means of navigating the city in the midst of ongoing war.[5] Each of these three sources of data offers a different kind of information about the city, and each has a different set of limitations. Our aim is that our research will productively highlight, rather than obscure these limitations.

3. Visualizing Conflict: Possibilities for Urban Research

The *Conflict Urbanism* projects in Colombia and Aleppo exemplify two challenges of analysis and visualization often critical for urban research. In Aleppo, through satellite imagery and YouTube videos we created data for anal-

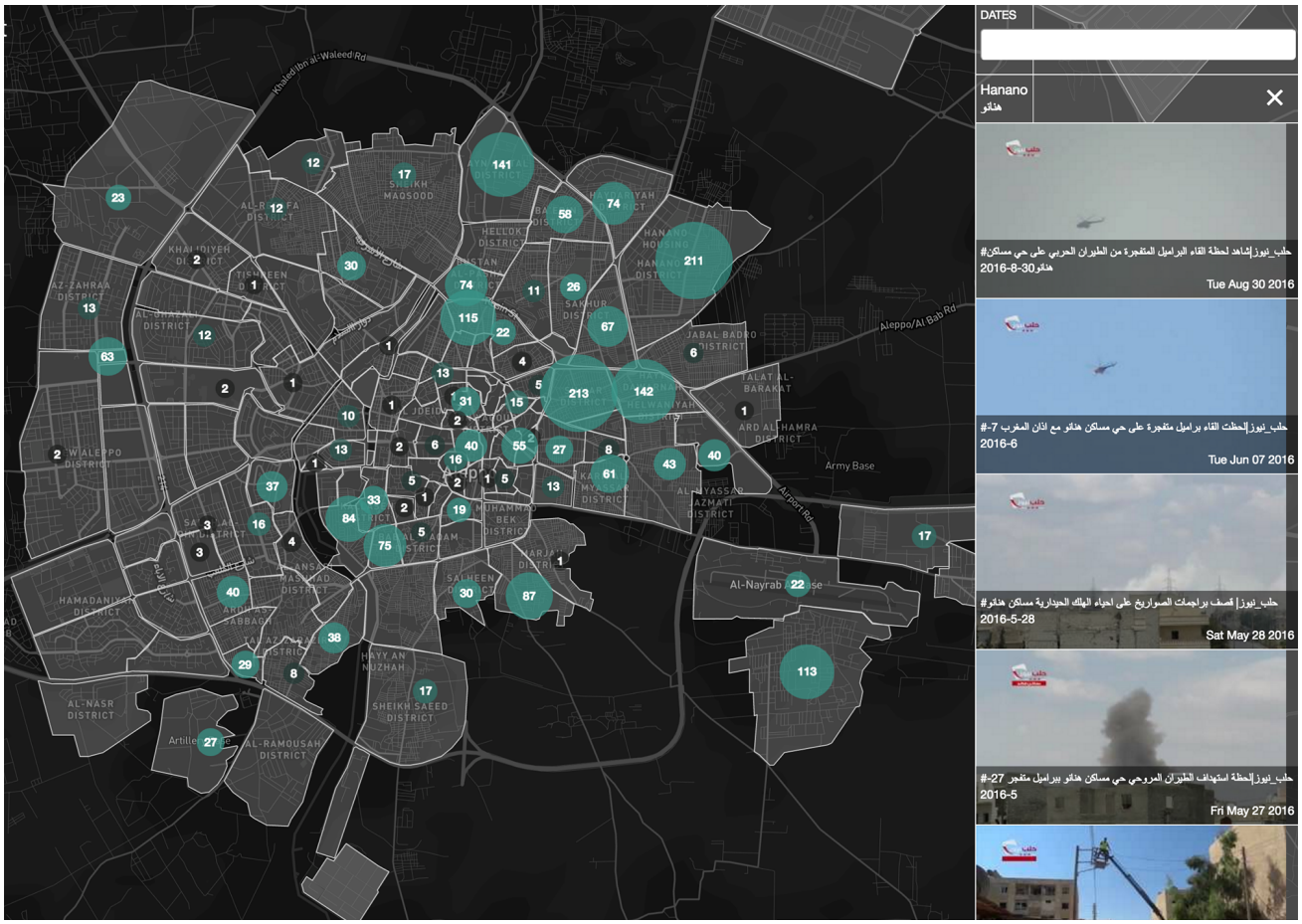

Figure 7. Interactive map with videos from three of the most highly cited YouTube channels geolocated to neighborhoods in Aleppo.

[5] View from Above, *Conflict Urbanism: Aleppo*. http://c4sr.columbia.edu/conflict-urbanism-aleppo/view-from-above.html.

ysis which did not previously exist. Even in the era of 'big data' many of the most pressing urban issues are often those for which there is little or no recorded information. Experimental approaches such as the ones used in the Aleppo project can produce new tools that allow unconventional sources of information to become sources for research. In contrast, the work on Colombia was aided by the presence of a large but incomplete dataset. Resisting the temptation to present a comprehensive narrative with incomplete data, the project examines this one dataset very thoroughly, documenting its strengths as well as its limitations and using it as a lens to show the intricate pathways that people take in the midst of conflict. Both projects strive to responsibly produce and work with multiple new forms of data, specially data about the urban dynamics of conflict.

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Conflict of Interests

The authors declare no conflict of interests.

References

Cosgrove, D., & Fox, W. L. (2010). *Photography and flight*. Reaktion Books.

Graham, S. (2010). *Cities under siege: The new military urbanism*. New York: Verso.

Kurgan, L. (2013). *Close up at a distance: Mapping, technology, and politics*. Brooklyn, NY: Zone Books.

Misselwitz, P., & Rieniets, T. (Eds.). (2006). *City of collision: Jerusalem and the principles of conflict urbanism*. Basel: Birkhäuser.

Weizman, E. (2014). Introduction: Forensis. In Forensic Architecture, A. Franke, E. Weizman, & Haus der Kulturen der Welt (Eds.), *Forensis: The architecture of public truth* (pp. 9–32). Berlin: Sternberg Press.

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Article

Scenario Analysis of Alternative Land Development Patterns for the Leipzig-Halle Region: Implications for Transport-Land-Use Sustainability

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Abstract
The objective of this paper is to present alternative land development scenarios for the sustainability impact assessment of transport-land-use relationship in the Leipzig-Halle Region. Using the MOLAND Model that was applied to a declining urban region for the first time, two different land-use scenarios were developed representing a baseline dispersed development and an alternative *compact* development case. The assessment of land-use-transport relationships is carried out incorporating the use of social, economic and environmental indicators. The impacts and indicators were specified and evaluated subject to a quantitative and qualitative assessment. The findings imply that a compact development scenario is preferable over dispersed development scenario in terms of potential quantitative data on the benefits to the environment and society. In contrast, dispersed development in the baseline case indicates the costs of such development exceed the benefits. The results of this type of scenario analysis provide an objective evidence basis in policy evaluation and decisions regarding future urban developments. This research was developed from several scenarios created with the key stakeholders of the Leipzig-Halle Region from research originally conducted as part of the PLUREL Project in 2012 and updated in 2016. It aims at contributing to literature by providing a sustainability assessment framework for rapid rail infrastructure provision that incorporates socio-economic and environmental impact assessment of alternative future urban form scenarios into the analysis. In addition, due to MOLAND features, it provides the opportunity for the sustainability impact assessment of different forms of urban development linked with transport infrastructure provision in the Region and compare the findings with other case study areas in Europe and internationally.

Keywords
land-use model; land-use policy; scenario analysis; transport indicators; transport-land-use sustainability

Issue
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1. Introduction

The rapid growth of peri-urban areas in many of the metropolitan centres in Europe has resulted in dispersed or scattered type of developments in contrast to the historical forms of more compact structures. The outward expansion of metropolitan areas observed both in economically strong regions and weakening core areas in Europe has been recognised as costly in social, economic and environmental terms (Girardet, 2015; Haghshenas & Vaziri, 2012). Traffic congestion, automobile dependence, air pollution, social segregation, degradation of

scarce land resources and decreasing quality of life are often cited as some of the most important problems faced by many of the large urban metropolitan centres (United Nations Human Settlements Programme [UN-Habitat], 2013). To address some of these problems, policies such as sustainable urban development and growth management have become central both in planning theory and practice.

EU policy has for decades advocated the principles of a compact city approach to sustainable urban management as advanced in the European Spatial Development Perspective (European Commission [EC], 1999) and more recently in the New Urban Agenda adopted by the United Nations (2016). The UN promotes a specific goal to make cities and human settlements inclusive, safe, resilient and sustainable. This international policy aspiration is to promote urban consolidation and intensification and avoid the negative externalities of dispersed or sprawl type patterns of development and the resulting associated car dependency. The lack of integration of transport and land-use planning makes the realisation of such goals severely problematic and the debate continues as to whether land-use policies in isolation can be effective in influencing development and transport use patterns.

In line with such urban policy discussions, urban research also suggests that compact city is preferred to more dispersed patterns in terms of sustainable spatial development and transportation efficiency (Burton, 2013). The reason is related to the reduction in travel demand and travel time since most work and non-work activities are closely located in the compact form (Bertaud, 2004; Nelson, Dawkins, & Sanchez, 2007). It is also argued that compact form can support public transport services better than dispersed form since population densities in the former case are high enough to provide efficiency in different modes of public transportation (K. Williams, 2005). Alternatively, other studies question the sustainability of compact form (Breheny, 2001; Westerink et al., 2013) and suggesting that decentralised or polycentric urban development solutions would be more efficient in terms of transport patterns. One reason for this enhanced efficiency cited in research is that multi-centred cities can provide significant transport benefits by locating residences close to employment centres (Simmonds & Coombe, 2013; K. Williams, Burton, & Jenks, 2000).

Existing planning practice provides examples of policies to achieve integrated land-use through dispersion of facilities over residential areas to achieve mixed development and pedestrian-oriented transportation (van Eck, Burghouwt, & Dijst, 2005). Alternative strategies promoted include transit-oriented development (Jones & Ley, 2016), containment policies (Hortas-Rico, 2015), and polycentric urban areas (Broitman & Czamanski, 2015) which focus on various modes of transportation to support development along or near the existing public transportation axis. Both theory and planning practice suggest that accessibility to various services is an important aspect in sustainable development which could be achieved by provision of high quality and efficient transport systems.

The literature shows that the relationship between land-use and transportation is complicated since different factors such as historic urban structure, density and city size are commonly in effect in determining the transportation demand, which in turn will affect the spatial structure, density and size of the urban area (Kenworthy & Laube, 1999). There are key theories in the literature to represent this complex relationship: the theories of urban location and urban structure are among these, which are primarily based on economic and spatial modelling of the interdependence between land rents and transportation costs. Classic theories rooted in urban economics suggest that the choice of urban location depends not only on the characteristics of economic agents and urban space, but also on the accessibility considerations (see Alonso, 1964; Mills, 1967; Muth, 1969 and others). The dynamic relationship between locational accessibility and transportation systems leads us to conclude that sustainability of the urban form and efficient transport provision are two closely interlinked subjects. In this regard, sustainability implies an urban form in which different modes of transportation are available as an alternative to private car—resulting in fewer trips—and shorter trip lengths are emphasised through the integration of land-use and transportation systems. The sustainability of a transportation system is identified as a system that provides 'access to people, places, goods and services in an environmentally responsible, socially acceptable, and economically viable manner' (Organisation for Economic Co-operation and Development [OECD], 2002).

The importance of increased travel impacts related to urban growth and transport relationships, such as traffic congestion, air/water pollution, social segregation, and urban sprawl is increasingly evident (European Environment Agency [EEA], 2006). This makes it vital to understand and encourage sustainable forms of urban development linked with provision of efficient transport services (Litman, 2016). However, urban growth no longer persists as a continuous development path in many European cities and regions (Turok & Mykhnenko, 2007). Another aspect of development path is the urban shrinkage that is spreading extensively in Europe's old industrial regions (e.g. Northern England) and large areas of post-socialist countries in Eastern Europe (D. Haase, A. Haase, Kabisch, Kabisch, & Rink, 2012) as well as older industrial regions in the USA. Turok and Mykhnenko also noted that, in the early 2000s, Europe had experienced an increasing number of declining cities compared to the number of growing regions. Therefore, shrinkage has become a challenging issue not only for urban policy makers and planners but also researchers aiming at understanding and coping with the causes and impacts of urban restructuring and shrinkage on economic and social welfare.

For many cities, this presents a new and uncertain development paradigm where growth, restructuring and

now potential decline must be considered and a growth only context has to be replaced. In particular, from 2008 to 2016, the impacts of cyclical surges and corrections in property prices have been a feature of many international economies and were pronounced as the global financial crisis evolved (B. Williams & Nedovic-Budic, 2016). Cities and regions in several European states—notably Spain and Ireland—were severely affected by market corrections and development. Property market collapses occurred with significant levels of unfinished and abandoned developments (B. Williams, 2014). Therefore, strategies for urban futures are sometimes required to react to new, often sudden, unexpected and unforeseen economic change. This means that flexibility in alternative planning scenarios and options chosen becomes ever more necessary.

It is accepted that a managed polycentric model may present a further alternative option and this was not covered in this research as one of the options for the chosen region. The research findings are limited to analysis of the compact and dispersed urban form options which were actively considered at research workshops with stakeholders. However, a similar methodology or approach can be adopted in future research to investigate managed polycentric and other alternative planning policy options.

An analysis of the literature on urban form-transportation relationship has shown that existing case studies in Europe were predominantly conducted in economically growing regions whereas the studies on post-socialist countries which had been characterised as declining regions are relatively scarce (Westerink et al., 2013). This study aims to fill this gap by focusing on a case study of Leipzig-Halle Region for the sustainability impact assessment of transport-land-use relationship through application of scenario analysis approach. For the sustainability impact assessment of transportation systems in cities and regions, there are various methods in the literature that consist of performance indicators, accessibility measures, commuting efficiency analysis, modal choice modelling, cost-benefit analysis, and socio-economic and environmental impact analysis. Existing evaluation methodologies such as socio-economic and environmental impact assessments tend to be static and do not consider costs (or benefits) of alternative forms of urban development linked with provision of public (rapid rail) transport infrastructure. Therefore, the current paper aims at contributing to literature by providing a sustainability assessment framework for rapid rail infrastructure provision that incorporates socio-economic and environmental impact assessment of alternative future urban form scenarios into the analysis. The potential land development scenarios of this study were originally developed from the MOLAND (Monitoring Land-Use/Cover Dynamics) Model applications as part of the PLUREL[1] Project for evaluating the impacts of different policies and programmes on urban development considering sustainability in urban form and peri-urban-rural relationships (Ustaoglu, Williams, & Petrov, 2012). MOLAND, for the first time, was applied to a region that had experienced a shrinkage process. This provides an opportunity for the sustainability impact assessment of different forms of urban development linked with transport infrastructure provision in the Region and comparing the findings with other case study areas in Europe and internationally.

Section 2 provides a brief overview of the case study region. Then, in section 3, based on usage of the MOLAND Model, two scenarios for the Leipzig-Halle Region are described. This is followed by the methodology for the scenario-based impact assessment of transport-land-use relationship for the case study of Leipzig-Halle Region. The results are presented and discussed in section 4, which leads to the final conclusions in section 5.

2. The Case Study of Leipzig-Halle Region

Located in the federal states of Saxony and Saxony-Anhalt, Leipzig, together with the city of Halle, constitutes a polycentric urban area in eastern Germany (Figure 1). The entire region has a total population of around 1 million people, with 567,846 living in the city of Leipzig and its adjacent municipalities in December 2015, and the rest living in the Halle (Stadt Leipzig, accessed 2016).

The Region's two main urban cores, Leipzig and Halle, belong to two different federal states and are governed by various administrative bodies. These two urban core areas constitute a complete functional region and have been serving as main centres of commerce and trade since the 19th century. There are functional relations between Leipzig and Halle varying from commuting, leisure and business activities. The Region was part of the German Democratic Republic (GDR) until 1989. Following the German re-unification of 1990, the economy of the region suffered a decline (Berkner, 2000): unemployment reached 20% in the mid-1990s and the area experienced a rapid decline in population within only 10 years time (Leipzig's population declined 12% while Halle lost 20% of population), which is linked with the economic crisis (Rink, Haase, Grossmann, Couch, & Cocks, 2012). The Region exhibits a complex pattern of urban development considering existence of simultaneous peri-urban growth and shrinkage processes in different areas. The reasons of the shrinkage process are mainly related to three factors: a considerable level of out migration to Western Germany just after re-unification; a massive movement from inner core city to peri-urban areas resulting in sprawl; and a decrease in birth rates and growth in death rates (Schwarz, Bauer, & Haase, 2011).

Leipzig's population began to stabilise from 2000 onwards, considering there has been a net positive migration in the last few years in Leipzig, following the resur-

[1] Peri-Urban Land Use Relationships-Strategies and Sustainability Assessment Tools for Urban-Rural Linkages, Integrated Project of the EU 6th Framework Programme, Contract No. 036921.

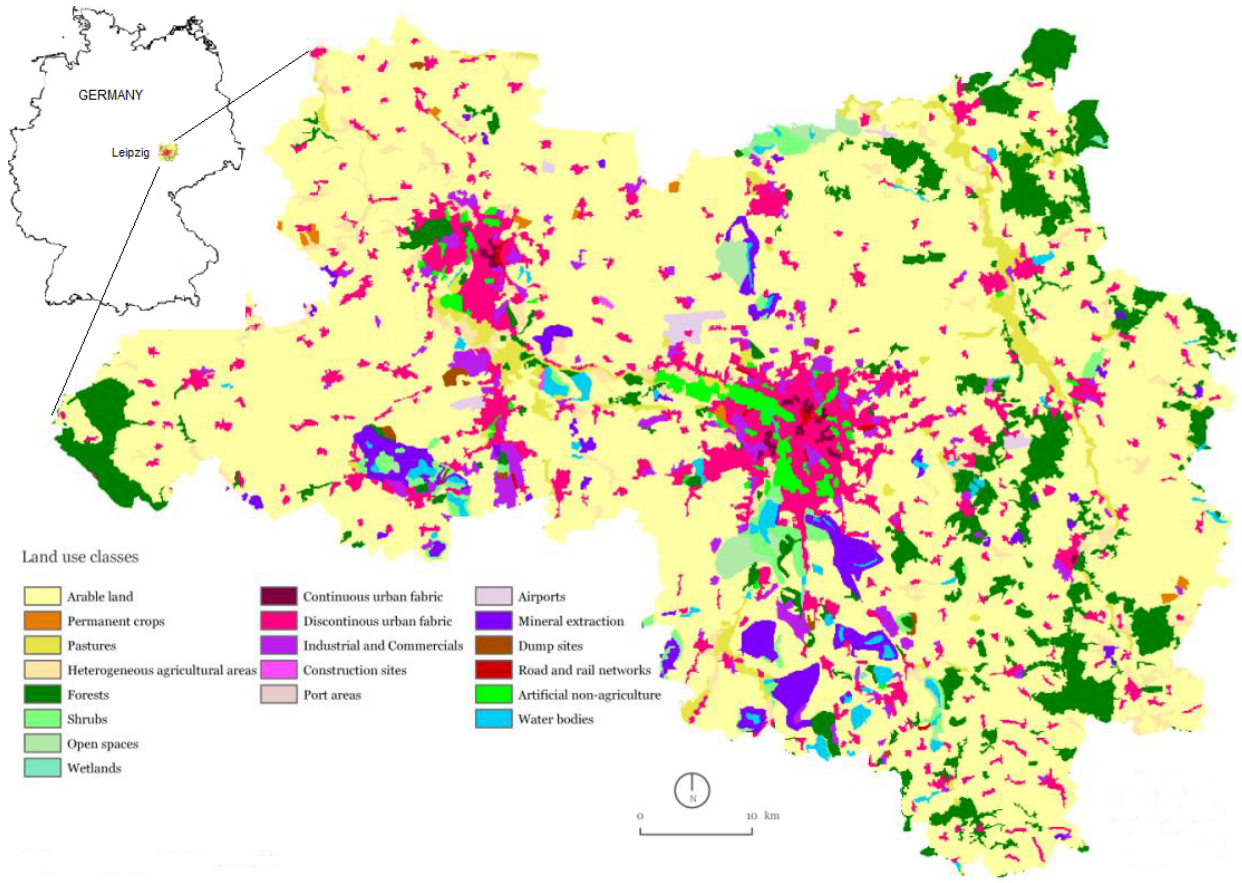

Figure 1. Land-use of Leipzig-Halle Region, 2000.

gence of the inner city started in 1999 (Schwarz et al., 2011). The population increase started on the late 1990s (493,000 in 2001) and reached around 525,000 inhabitants early 2011 (Großmann, Arndt, Haase, Rink, & Steinfuhrer, 2015). The major reason behind the population growth is the in-migration, primarily from Saxony and the other eastern German federal countries. The suburbanisation process has come to a halt as formerly suburbanised areas have started to lose population to the inner city. This implies a phase of re-urbanisation in Leipzig emphasised through regaining of population in the inner-city districts that are experiencing rejuvenation and diversification of socio-demographical structure (A. Haase et al., 2010). Leipzig has been supported through considerable amount of public funds since 1990, which have mobilised private investment to the city and returned Leipzig into an attractive place for services, industrial and cultural facilities (Rink et al., 2012). Associated with the economic growth started on the 2000s, the sprawl-type pattern of development of residential and commercial uses has increased considerably along the Leipzig-Halle axis (D. Haase, Schwarz, Strohbach, Kroll, & Seppelt, 2012). Following the dispersal of residential and commercial development initially started in early 1990s, the ongoing loss of productive agricultural areas, natural landscape and corresponding ecosystem services is critically observable.

Cities such as Leipzig and other previously industrial regions have been identified as having stabilised their populations and have seen a return to modest growth of some thousand people per year following major economic restructuring. Florentin (2010) identified the key themes in the city planning strategy for Leipzig as: first, preserving the architectural heritage, next the creation of green spaces and open spaces to replace dilapidated housing estates, and finally support for the creation of a micro-scale hierarchy of centres. In practice, these strategies were regarded as partially implemented and activated via city marketing campaigns, as the city and planners often lacked the financial and legal tools to fully implement them in pursuit of urban regeneration.

3. Methodology

In the frame of support to the implementation of government plans and policies in the Leipzig-Halle Region, this study develops a methodology for the transportation impact assessment of different land-use scenarios. From planners' or policy makers' view, urban planning and management pose the problem of dealing with complex systems in which social, economic and geographical factors are interrelated. Understanding the processes that cause these systems to change where activities, land-uses and spatial interactions will change—because

of the growth potential of the system and the policy interventions—is crucial in developing effective policies (Lavalle et al., 2004). MOLAND and ASTRA-EC are the two modelling approaches integrated in this study to assist planners, policy makers and stakeholders to analyse different spatial policies and the associated spatial configurations. MOLAND consists of dynamic spatial models that operate at various spatial levels. ASTRA-EC is a four-stage transportation model that analyses Trans European Network-Transport (TEN-T) projects, and has wide area coverage in Europe. From this integrated modelling approach, the sustainability impact assessment of transportation-land-use relationship in the Leipzig-Halle Region is carried out through application of different land-use and transport-related indicators. An essential aspect of the methodology is the dynamic and cyclical interrelation between scientists, policymakers and stakeholders, supporting discussion at all stages, being adapted for territorial analysis and improved iteratively (Figure 2). This methodology of dynamic interrelation can be applied to different cities and regions at different spatial scales with an aim of supporting stakeholders and policymakers in future policy strategies.

The growth processes observed in different cities and regions often display similar characteristics; therefore geographical spaces in cities can be fundamentally similar (Batty, 2008). However, socio-economic systems that develop in cities show heterogeneities at all spatial levels and are shaped by interaction processes taking place at different geographical scales. At various geographical scales, the differences due to city-specific boundary conditions (i.e. topography and physical characteristics, geometry of transportation network, and local planning) determine the observed differences amongst cities. CA-based models aim at representing geographical systems that have heterogeneities at all levels of detail. For instance, CA-based models such as MOLAND incorporate interaction processes at the macro level which are beyond the cellular space of the modelled system. They also incorporate micro level attributes that represent non-homogeneous dynamic nature of the geographical space (Lavalle et al., 2004). A key element of MOLAND is the use of suitability maps which represent the capacity of a cell to support a specific activity or land-use. The suitability maps are generated in a geographical information system (GIS) and include factors such as: elevation, slope, soil, agricultural capacity, exposure to pollutants and hazards (Hagen-Zanker & Lajoie, 2008). The MOLAND model uses suitability maps to accurately reproduce the local characteristics of an area without excluding the general context (Petrov, Lavalle, & Kasanko, 2009). The customisation of these maps, together with the fine-tuning of other parameters, allows specific drivers to be explored. For example, using the physical suitability component of MOLAND, the outputs of a climatology model will be used for assessing future climate changes, floods, etc.

In the first step of this study, a scenario analysis approach—focusing on dispersed or more compact development cases, linked with major investments of the transportation system in the Leipzig-Halle Region—is undertaken through application of a land-use modelling approach. In the next step, a scenario-based impact assessment of transportation-land-use relationship is undertaken focusing on a number of key selected impacts and indicators representing sustainability of urban form and transportation.

3.1. The MOLAND Model

The MOLAND model is applied for the first time to a region which had experienced a reducing population or shrinkage process. This will provide an opportunity for an

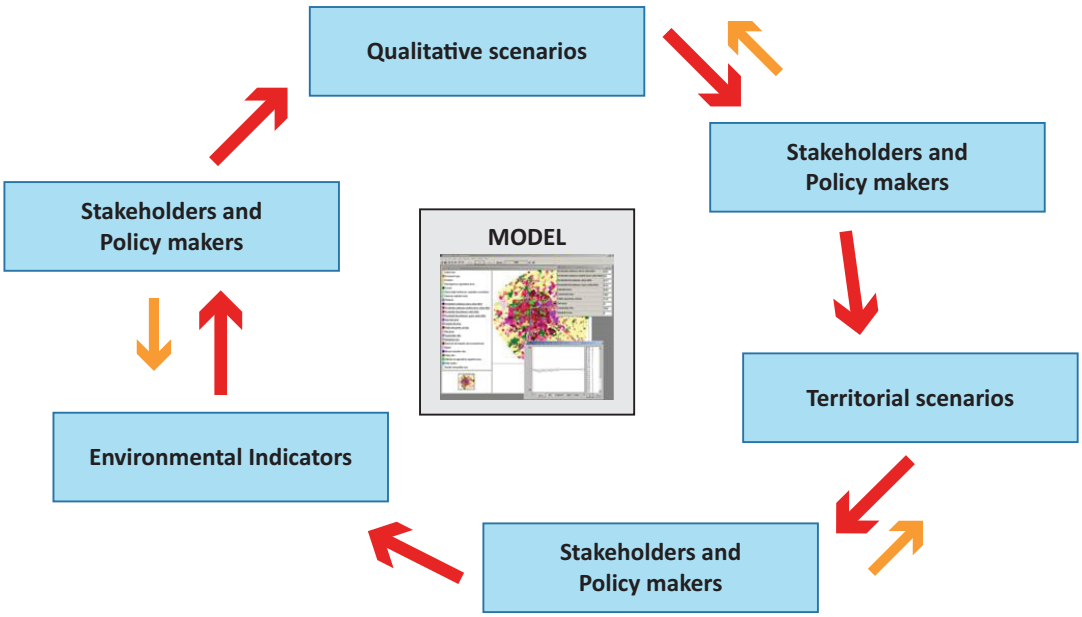

Figure 2. The model and the interrelation between stakeholders and policy makers.

in-depth analysis regarding application of MOLAND with an increased flexibility in a variety of cities and regions. MOLAND is based on a spatial dynamics bottom-up approach and can be defined as a CA-based model (Barredo, Demicheli, Lavalle, Kasanko, & McCormick, 2004). It is an improved version of the CA first developed by White, Engelen and Uljee (1997) and has achieved robustness through successful applications to more than 70,000 km^2 in European Regions and beyond (e.g. Dublin Metropolitan Area covering about one third of Ireland; city of Lagos, in Nigeria; Pordenone province, in Italy; Dresden-Prague transport corridor; Algarve Region; Madrid; Istanbul, etc.; Petrov et. al, 2009). It has been applied in European cities, regions and beyond for urban development, regional development, transport corridors and adaptation to climate change-driven hazards. It is not the objective of this paper to give a detailed description of the model. However, we include a short overview of its characteristics. A more detailed technical description of the model can be seen in Barredo, Kasanko, McCormick and Lavalle (2003) and Barredo et al. (2004).

MOLAND integrates spatial aspects of land-use patterns with socio-economic (including transport plans), institutional and environmental features of territorial development. Also, it allows a high level of flexibility in representing the economic sectors, population development and environmental drivers, supporting very diverse sets of scenarios and planning measures (EEA, 2006). MOLAND simulates land-use dynamics and is calibrated with historical land-use information. The Model also includes a transport module[2] (Barredo et al., 2003, 2004). The inputs and outputs of the MOLAND Model can be seen in Table 1. The spatio-temporal characteristics of the MOLAND output are presented in Table 2 (Shahumyan, Williams, Petrov, & Foley, 2014).

The MOLAND Model has two key components, including regional and urban land-use sub-models. The model includes an extensive data set obtained from CORINE Land Cover (CLC) data and utilises both macro- and micro-type parameters. Macro-level data such as GDP and population growth are inputs for the regional sub-model, also affecting the urban land-use sub-model

Table 1. Summary of the MOLAND Model: inputs and outputs.

Model Input and Parameterization	**Description**
Land-use map	Corine Land Cover (CLC) maps showing the historical land-use/cover
Accessibility	Accessibility of a cell to the transport network
Zoning Status (policy)	Master plans, zoning plans (designated areas for agriculture, housing, industry, commerce, recreation etc., protected areas, historical sites, natural sites and reserves, land ownership)
Suitability	DEM (slope, aspect), soil quality and geomorphology, natural hazards (floods, landslides etc.), air, noise, water, soil pollution, agricultural capacity, subsidies etc.
Socio-economic Data	Population, income, production, employment etc.
Model Output	
Projected land-use/cover digital maps	Land-use/cover characteristics Changes in urban land-use Distribution of urban activities

Table 2. Spatio-temporal extent and resolution of the model output.

Parameter	**Description**
Spatial Extent/Country Coverage	Large Urban Zone (LUZ) NUTS-2 (Region)
Spatial Resolution	100 × 100 m or higher
Temporal Extent	Yearly time step; Projections for 10, 20, 50 years
Temporal Frequency	Yearly

[2] The MOLAND transport model is based on a classical four-step transportation model, which requires transport zone maps of the region as well as data on transport flows between those zones. The MOLAND transport model is a dynamic model where the land-use model serves as an input to the transportation model, and in turn the transportation model influences the land-use model by means of a local accessibility term. The number of people and jobs per zone are used to calculate production and attraction of each transport zone. Based on these travel demands and inter-zonal transportation costs, trips are assigned to the transport network. Transportation costs are represented as an aggregate measure of distance, travel time and other transport costs. These costs are incorporated in the regional model as interregional distances affect the distribution of land-use functions across the regions. At the local level, the potential for certain land-uses is determined by their local accessibility i.e. the distance to the transport network (for details, see Research Institute for Knowledge Systems [RIKS], 2007).

that is run through a CA model. Since the data incorporated in the Model come from a disaggregated data set, the micro-model parameters (i.e. neighbourhood effects, accessibility, suitability, zoning, population, employment indicators) can be utilised to explain the micro-level spatial issues, which diverge the model from those incorporating aggregate data sets and rely on large geographic districts (see Barredo et al., 2003).

However, the CLC data is not a prerequisite for the application of the MOLAND Model. For example, for the Lagos case study, MOLAND made use of high-resolution satellite imagery, aerial photographs and other ancillary data. The minimum mapping unit is 1 hectare (100×100m) and the land-use datasets comprise forty land-use classes. The detailed methodology for the GIS database production to be used in MOLAND model is provided in EEA (2002).

The main variable of the model is the land-use (raster) map, and the state of every cell is its land-use class (e.g. residential, industrial and commercial, forest, agricultural). The development of each land-use class is defined by four factors:

1. Physical Suitability, represented by one map per land-use class, describing the degree to which the cell fits to support a particular land-use function and the associated economic or residential activities;
2. Zoning, represented also by one map per land-use class for different planning periods and the associated economic or residential activities;
3. Accessibility, represented by one map per land-use class determining the direction to which the particular land-use function and associated economic or residential activities can respond to the cell's needs for transportation and mobility given the underlying transportation system;
4. Dynamic impact of land-uses in the area, determined by so-called 'transition rules' or weighting parameters which specify the interaction between neighboring land-use types (the attraction or rejection of a cell and its immediate surroundings: 196 cell neighborhood). The transition rules change each cell to the state for which it has the highest potential; each cell will receive a weight according to its state and distance from the central cell, beginning with the highest ranked cell and proceeding downwards. However, it is subject to one constraint: the number of cells for a land-use at a given time must be equal to the total number of cells demanded for that land-use, at that time (Barredo & Demicheli, 2003).

The consequences of trends, shocks and policy interventions over a long period of time are visualised by means of dynamic year-by-year land-use maps as well as spatially explicit socio-economic and environmental indicators represented at high spatial resolution. In relation to capturing the elements from descriptive scenarios and how they are translated into in the model, expanded explanations are given in the 'Ingesting narrative storylines in the model' section and Appendix A of Petrov et al. (2009).

Regarding Leipzig-Halle Region, these maps were generated in a GIS environment, including factors such as: elevation, slope, aspect, soil type and existing land-use. In MOLAND, the suitability values are expressed on a scale of 0 (completely unsuitable) to 10 (highly suitable), and were computed for all the land-uses (residence, industry, commerce, services, agriculture, forest, semi-natural vegetation, ports, etc.) that are simulated in the Model. For instance, cells that are adjacent to water bodies are highly suitable for port related uses, and are assigned with the highest suitability values (values greater than 9). The land-uses adapted from CLC data comprise nineteen land-use classes that were divided in three groups (see Table 3): vacant features (areas where expansion can happen), active functions (the most dynamic areas that can determine urban growth) and fixed features (where land-use change is constrained) (Lavalle et al., 2009).

MOLAND simulates zoning with binary options, i.e. 0 is assigned to a cell that is permitted for development while 1 is assigned to those where it is not. Zoning specifies whether a cell may or may not be developed for a specific land-use function during the simulation time period. The zoning maps were developed from master plans and zoning plans that have been produced by local governments in the Leipzig-Halle Region. Land-use development policy is steered by the designation of land-use

Table 3. Land-use classes for Leipzig-Halle Region.

Vacant features	Active functions	Fixed features
Arable land	Continuous urban fabric	Airports
Permanent crops	Discontinuous urban fabric	Mineral extraction sites
Pastures	Industrial and commercial	Dump sites
Heterogeneous agricultural areas	Construction sites	Water bodies
Forests	Port areas	Artificial non-agricultural sites
Shrubs		Road and rail networks
Open spaces		
Wetlands		

objectives specific to land within the planning authorities' jurisdiction.

In addition to suitability and zoning, accessibility to transportation networks is a key input in the MOLAND Model. The existing road and rail networks in the Leipzig-Halle Region were used to create accessibility maps to represent the relative importance of access to the transportation networks for different land-uses in the model.

The methodological approach used for simulating land-use changes in Leipzig-Halle Region can be summarised (Figure 3) with the following steps (Lavalle et al., 2009):

1. Definition of scenarios by local stakeholders;
2. Compilation of input data (land-use maps for 1990 and 2000, transport network, zoning and suitability maps, socio-economic data such as GDP and population);
3. Calibration of the MOLAND (for the 1990–2000 period);
4. Running the MOLAND model under different scenarios;
5. Production of outputs (land-use maps and statistics);
6. Running the ASTRA-EC Model to develop accessibility related indicators from the transport model;
7. Evaluation of the results.

3.2. Scenarios for the Leipzig-Halle Region

A number of scenarios were developed with the key stakeholders of the Leipzig-Halle Region, in line with the work conducted as part of the PLUREL Project between 2009 and 2012. It followed the building scenario methodology described in Petrov et al. (2009). This work has been reviewed and updated in 2016 to be considered and evaluated in the current paper. Within the framework of the current study, two likely scenarios are considered that incorporate a dispersed and a more compact development pattern in the Region linked with transport infrastructure investments. In this respect, the transportation-land-use relationship in Leipzig will be evaluated considering a *hyper-tech* scenario (H-TS) and a *transport* scenario (TS), each developed with the assistance of the MOLAND Model. The main driver of the two scenarios is transport accessibility linked with the public transportation network, which influences development patterns (dispersed or compact) of the area. In the H-TS of dispersed development hyper-tech sectors are strongly encouraged, while in the TS of more compact development transport logistics, rapid development of tourism, manufacturing and services sectors are strongly supported. In the latter scenario it can be followed that due to better transport linkage there is significant improvement in travel time and number of accidents as well as a tendency of increasing areas of agricul-

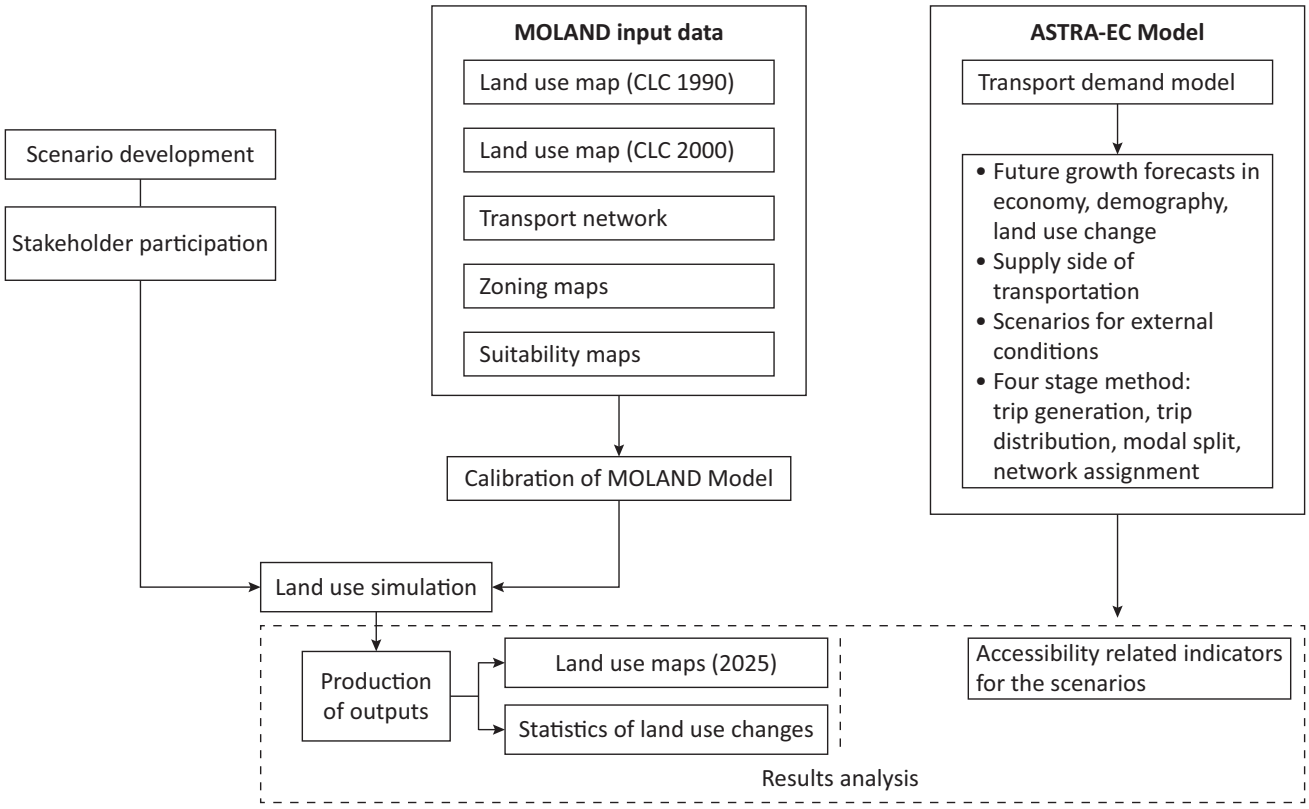

Figure 3. Land-use and transport modelling methodology. Adapted from Fermi, Fiorello, Krail and Schade (2014) and Lavalle et al. (2009).

tural and green land (and decreasing discontinuous urban fabric area). Further details of the assumptions and results related to each scenario are shown in Tables 4 and 6, and briefly explained in the following sections.

3.2.1. Scenario 1: Hyper-Tech Scenario

This scenario is characterised by prioritising and facilitating a development leading to rapid technology advance and consequent growth in the economy with investment in transportation and infrastructure improvements. New industrial and commercial growth takes place in the entire area with this growth directed to Halle and other towns located south from Leipzig (Figure 4). This increase in growth has mainly an impact on arable land, pastures and heterogeneous agricultural areas. In 2025, these changes are reflected by the land-use patterns due to considerable changes in industrial and commercial areas and construction sites (increases of 98% and 195%, respectively; Figure 5). This increase in urban fabric has resulted in a more than 20% reduction in the heterogeneous agricultural areas and pastures, and a 1.5% reduction in arable land.

The most important feature of this scenario is the insufficient provision of rapid rail or other transit infrastructures, which is linked with urban growth in the form of dispersed settlements. The failure to provide adequate transport investment can have a double effect on development patterns. First, new developments will be located in areas with existing weak infrastructure in a dispersed manner and second, this development will lead to increased levels of poor transport accessibility. There are minor improvements in the national roads and provision of links and extensions to the motorways and airport. Rapid rail investments will not take place or will be performed in the long-term. The absence of these investments in the short-term, passive management of urban development and low environmental protection in this scenario all contribute to dispersed urban development.

3.2.2. Scenario 2: Transport Scenario

In this scenario, it is presumed that land-use changes are constrained by high energy prices. Despite the demographic and economic growth (Table 4), the allocation of economic activities is influenced by inherent costs of energy. Population increase due to in-migration of young people contributes to the expansion of residential areas, leading to a densification of the urban fabric. Demolished residential areas will be replaced by new residential uses and other land-uses, which leads to an expansion of the existing urban area (Figure 6). The replacement of brownfield sites with new land-uses will contribute to a compact urban form since these sites are mainly located in the inner-city areas. New clusters of discontinuous urban areas locate close to industrial and commercial areas,

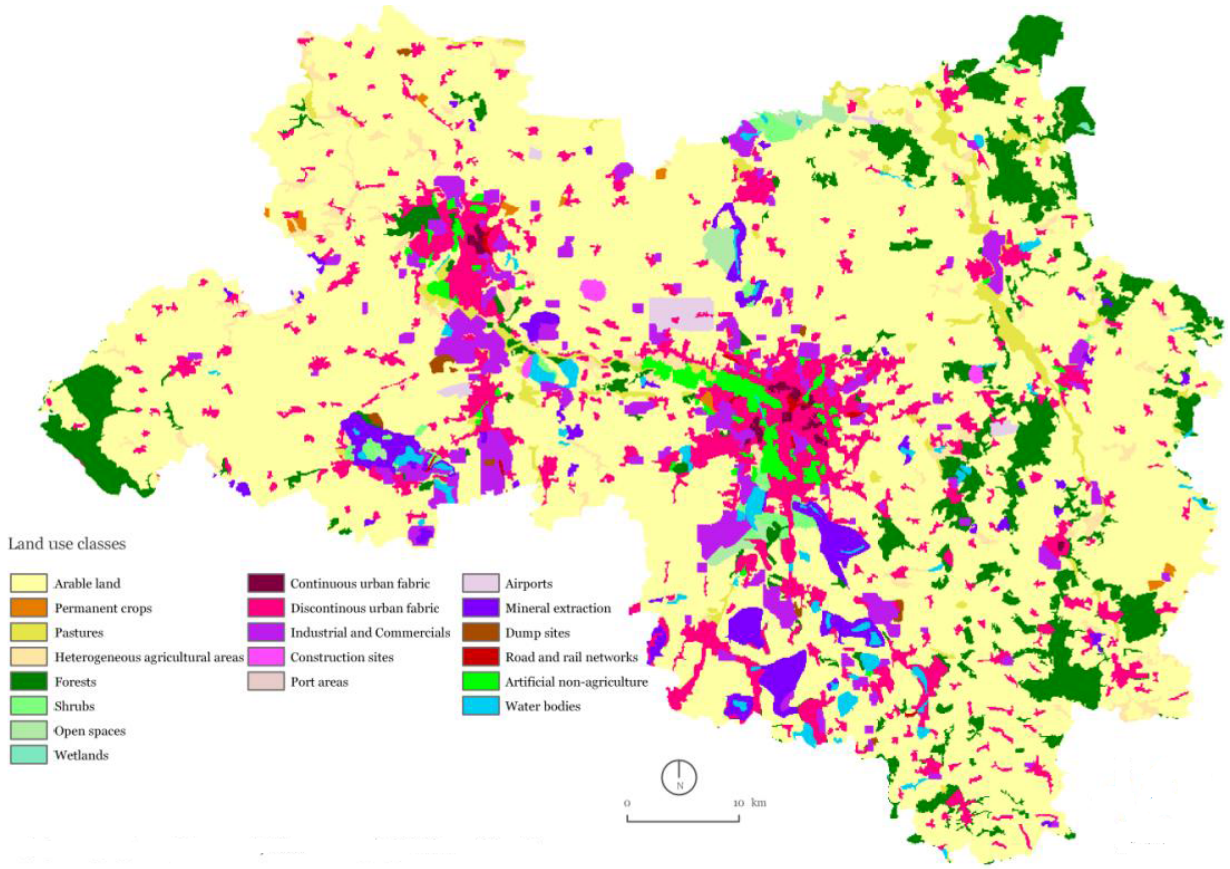

Figure 4. Leipzig 2025: Hyper-Tech Scenario.

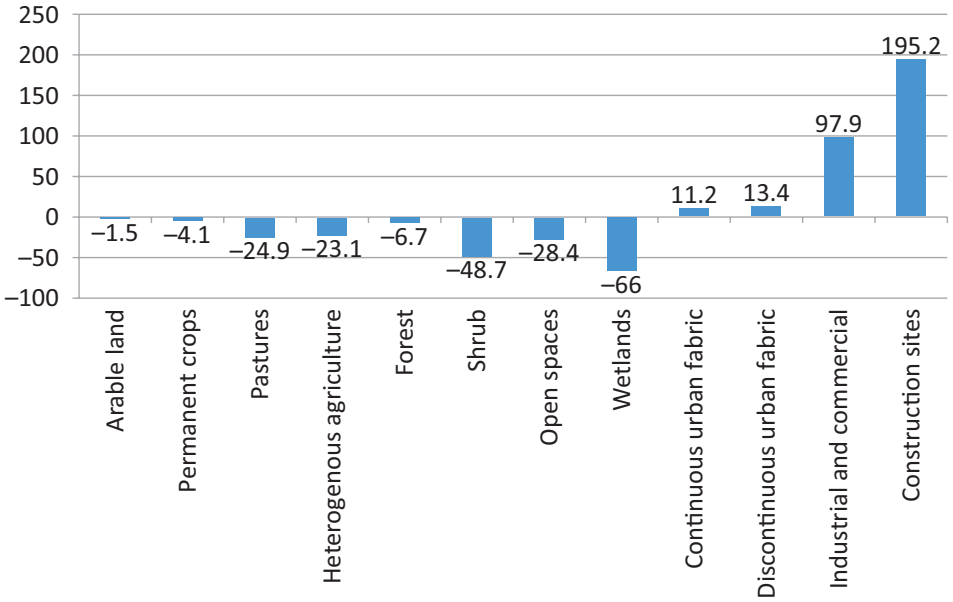

Figure 5. Percentage change of land-use classes in Hyper-Tech Scenario (2000–2025).

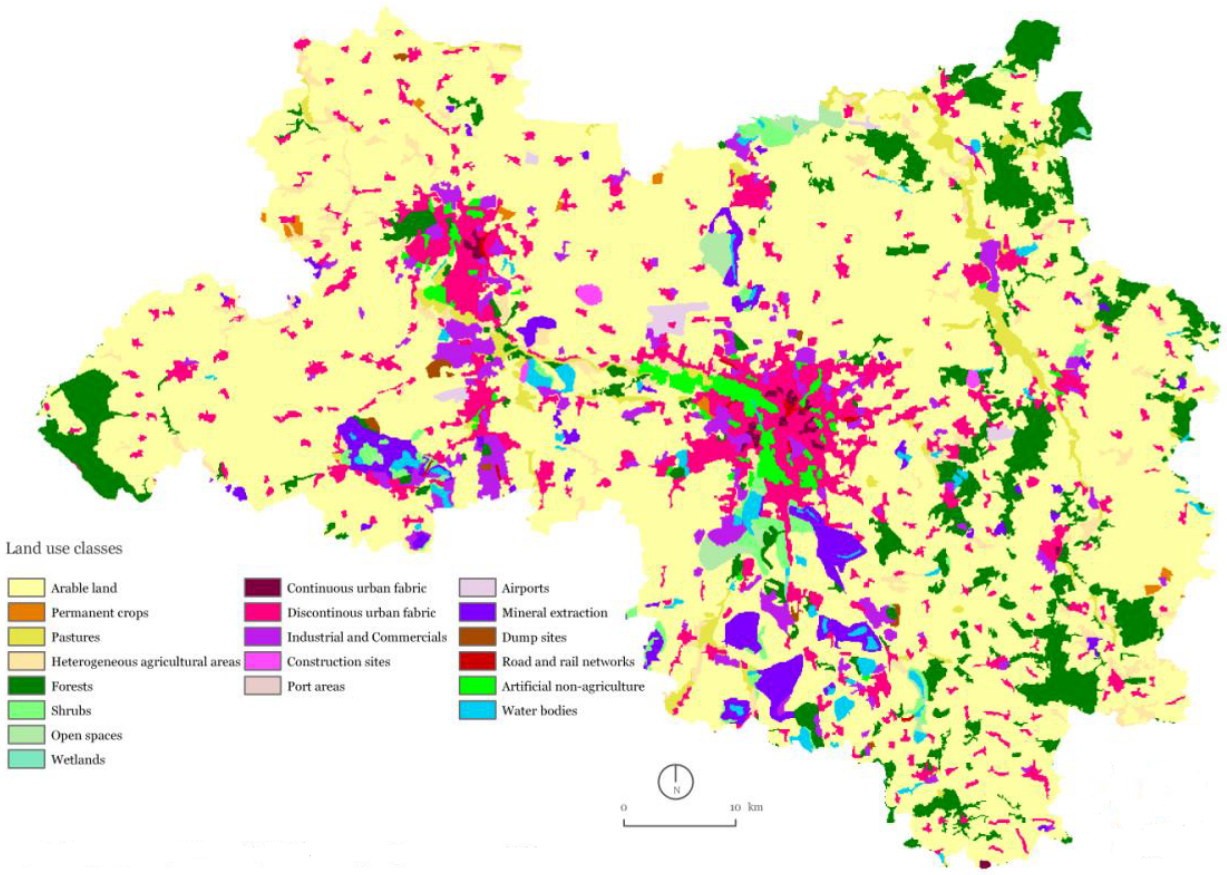

Figure 6. Leipzig 2025: Transport Scenario.

which would contribute to a reduction in commuting distances. In 2025, tourism, service and manufacturing sectors will have an impact on land-use dynamics, making industrial and commercial areas and construction sites grow by 68% and 208%, respectively (Figure 7). Due to the compact pattern of urban development in this scenario, reductions in pastures (17%), heterogeneous agricultural areas (10.8%) and arable land (0.6%) are lower compared to those in the H-TS (Figure 7). Among key transportation investments, there are fast railways to Munich, Berlin and Erfurt, which will serve public transportation from areas surrounding the Leipzig-Halle Re-

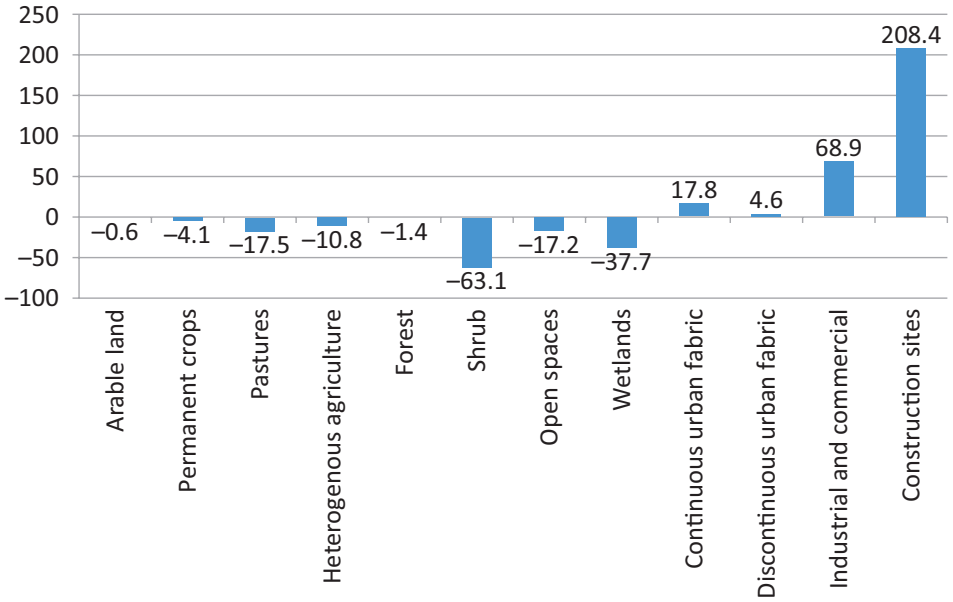

Figure 7. Percentage change of land-use classes in Transport Scenario (2000–2025).

gion. Therefore, mixed-use development could be more intense both in the inner city and along the transport corridors considering that mixed-use developments are supported by both planning policy and required transportation networks. This implies that the inner city of Leipzig will attract more population from the suburban areas and countryside thanks to the increasing investments in brownfield sites adjacent to the inner city.

These two scenarios show that transport accessibility has a stronger impact on land development patterns (i.e. dispersed or compact development) compared to the impact of economic trends. And, despite the strong investment in high-tech sectors in H-TS, this scenario leads to dispersed development due to poor transport accessibility.

3.3. Evaluation Methodology: Impact Assessment of Transport-Land-Use Relationship in the Leipzig-Halle Region

There are both direct and indirect effects of transportation provision on the land development processes. Directly, it determines the land devoted to transport facilities (such as roads, rail tracks, parking areas); while indirectly, it affects accessibility and development costs of various locations (Iacono, Levinson, & El-Geneidy, 2008; Litman, 2016). It is well documented in planning literature that automobile-oriented planning policies tend to increase urban sprawl by improving accessibility to urban fringe locations and by increasing the amount of land required for development. By contrast, policies supporting public transportation and pedestrian activities encourage more compact and mixed developments (Litman, 2016; Simmonds & Coombe, 2013). It has been argued that rapid rail systems can play a critical role in overcoming problems posed by dispersed or sprawl type development patterns, especially when transport infrastructure investments are associated with supportive policies and land development plans (Litman, 2016; May, 2013). Among the competing transit technologies such as rapid rail, light rail, and express bus, these alternative options can provide high quality service in terms of reliability, speed, safety, reduced travel time and—with a greater probability—act as a substitute for private car usage. As a consequence, rapid rail systems have become a preferred policy approach to avoid road congestion and other detrimental effects of urban sprawl (Higgins, Ferguson, & Kanaroglou, 2014; May, 2013). This constructs a framework for the current study focusing on sustainability impact assessment of high-speed rail provisions on land-use, in line with the tendency of compact development in TS presented in Table 4.

A wide variety of studies deal with the evaluation of transportation impacts on land-use, land development and environment (Bohman & Nilsson, 2016; Dröes & Rietveld, 2015), on certain externalities (i.e. accessibility, adjacent property values, etc.) and performed detailed analysis related to this area (Karou & Hull, 2014; Zondag, de Bok, Geurs, & Molenwijk, 2015 among others). However, there are few studies incorporating all of the possible externalities into their analysis. International literature on the inclusion of different impacts in evaluation process and transport appraisal methods in use for different countries can be found in Bristow and Nellthorp (2000) or Odgaard, Kelly and Laird (2005). Litman (2016) points out some of the weaknesses of current project evaluations and suggests using a more comprehensive approach for evaluating land-use impacts of transportation provisions. The literature shares a number of common impacts and indicators that are more or less similar to each other despite the existence of differences in their policy evaluation goals and appraisal method-

Table 4. Characteristics of urban development scenarios in the Leipzig-Halle Region.

	Hyper-Tech Scenario (H-TS)	Transport Scenario (TS)
Population	Population growth: • Rapid increase of young population • Increased fertility rates	Population growth: • In-migration of young population
Economic Trends	• Rapid increase in GDP • Invest *more* in: high tech sectors (electronics, computers, pharmaceuticals) • More research institutes are encouraged in science and research • Tourism and service sectors as current trends • Agriculture is of minor importance	Rapid increase in GDP • The industrial activity is strongly reinforced as well as tourism, manufacturing and service sectors strongly encouraged (e.g. public services, health care, accommodation, food and beverage, entertainment) • More employment in science and research • Agriculture also here is of minor importance
Spatial Development/ Planning	• New industrial developments occur between Leipzig-Halle axis and other towns • New residential developments are encouraged in the polycentric urban form	• Increases in infrastructure construction (e.g. demolished houses inside of the city replaced by new housing, sports and recreational activities) • Existing old buildings are preserved or demolished leading to perforation
Transport	• New transport investment (e.g. improvement of national roads and better links to the motorways; airport extensions)	• Low investment in transportation due to high fuel costs and environmental concerns • Investment in local rapid transit systems • Investment in fast railways to Munich, Berlin and Erfurt (ICE)
Overall Trends	• Rapid technology advance-economic growth • Low environmental protection • Passive management leading to peri-urbanisation and 'metro-polisation' of rural area	• Economic growth • Moderate environmental intervention • High energy prices affect transport costs limiting commuting distances

ologies. Given the literature, the main steps in the evaluation of transportation-land-use relationship are summarised in Table 5.

It is obvious from Table 5 that transportation provision has significant impacts on land-use, and as empirical evidence has shown, it is not so easy to quantify in detail most of these impacts. Some of the impacts and indicators can be represented in monetary values, while others can be expressed in a more qualitative or quantitative way. Here, an important issue to consider is the correlation among various indicators, such as the positive correlation between land-use accessibility and land values, or the negative correlation between air pollution exposure and area property values. Considering the correlation effects, impacts and indicators should be kept as orthogonal as possible to prevent double counting problems in the transport policy evaluations.

The impacts of high-speed rail investments on land development in the Leipzig-Halle Region will be evaluated through the selection of related indicators considering four main types:

1. **Direct Impacts of Transport Provision on Land-Use:** costs and capital investments of transport infrastructure constitute a significant part in project evaluations, and therefore, they are incorporated in all transport evaluation studies (European Commission, 2008; Odgaard et al., 2005). Further impact of transport investment is on the total amount of green land used for transport facilities. The problem is related to the depletion of green areas on or around newly provided transportation axis.
2. **Impacts on Development Patterns:** compact developments are more likely to be associated with lesser consumption of green land of high natural and agricultural value compared to more dispersed developments (Wheeler, 2013). This is related to a requirement of less space for transport and urban facilities as such facilities are closely located in the compact form. Dispersed development needs to provide public services to the low-density population, with reflected increases in infrastructure and public service costs (Litman, 2016). Álvarez, Prieto and Zofio (2014) have shown that municipal costs of residential public service provision of water distribution, sewage collection and cleansing of wastewater increase considerably with dispersed development.
3. **Impacts on Land-Use Accessibility:** transport infrastructure investments contribute to economic

Table 5. Impacts of transportation provision on land-use and suggested indicators for the current study. QT: quantitative assessment, QL: qualitative assessment. Adapted from Litman (2016).

Transport provision results in*	Physical Effects*	Impacts*	Suggested Indicators for the Current Study
Direct changes in land-use	Amount of land devoted for transportation facilities	1. Green space preservation 2. Transportation facility land values 3. Development costs/capital investments 4. Adjacent property values	*Changes in:* • *Development costs/capital investments of transportation infrastructure (QT)* • *Total green area used for transport facilities (QT)*
Changes in development patterns	Location, density and compactness of development	5. Green space preservation 6. Public service costs	*Changes in:* • *Total green area (QT; QL)* • *Costs of providing public services (QL)*
Changes in land-use accessibility and transport diversity	Dispersion of common destinations, and quality of travel options	7. Changes in per capita vehicle travel 8. Area property values 9. Socio-economic benefits a. Affordability (housing) b. Affordability (transport) c. Social Inclusion d. Socio-economic growth 10. Land-use/transportation accessibility 11. Transport network effects	*Changes in:* • *Travel time on proposed rail system (QT)* • *Passenger vehicle kms (car, train, air, slow modes of transport) (QT)* • *Number of passengers (car, train, air, slow modes of transport) (QT)* • *Accident costs (QT)* • *Traffic congestion (QL)* • *Transport diversity/integration (QL)* • *Land-use-transport accessibility (QT)*
Changes in travel activity	Per capita motor vehicle ownership and use	12. Consumer transport costs 13. Accidents 14. Energy and environmental impacts a. Energy consumption b. Air/noise pollution exposure c. Climate change d. Water resources e. Landscape and heritage f. Ecological impacts g. Vibration h. Waste disposal	*Changes in:* • *Climate change emissions (CO_2) (QT)* • *Noise pollution (QL)* • *Water pollution (QL)* • *Vibration (QL)* • *Ecological impacts (QL)* • *Accessibility to heritage sites and landscape (QL)*

growth by expanding the stock of capital, increasing labour productivity and therefore ensuring more efficient production (Pereira & Andraz, 2013). The general argument in the literature is that the benefits from transport improvements are mainly represented in travel cost savings, which result from improvements in the efficiency of the transportation system. Travel cost savings include the savings in travel times, vehicle operation costs and costs of accidents, reduction in traffic congestion, etc. (Litman, 2016). Savings in travel time capture economic growth effects—stemming from travel time savings of labour and traffic congestion effects—reflecting the ease of travelling with a considerable shift from private car use to rail-transit based transportation. This also includes accessibility changes in land-use—indicating savings in various travel costs and the resultant easiness of access—reflecting the shift from dispersed developments to more compact urban form (Simmonds & Coombe, 2013). Concerning travel time, two different indicators are suggested in the current study: an indicator of travelling time on the proposed rail system, and an indicator of potential passenger accessibility for different modes of transport (i.e. car, train, air).

Regarding accident costs, it is widely accepted that public modes of transport have lower accident rates than private car trips (Litman, 2000, 2016). Among the alternative public transport modes, high-speed rail systems can be considered as the most reliable ones due to the low likelihood of fatal accident occurrence. Therefore, a shift from car-based transportation to rail-based systems can contribute to considerable savings in (fatal, serious injury and minor injury) accident costs. Accident cost savings can also be considered as socio-economic benefits which contribute to social and economic well-being by reducing injury and fatality rates and the resultant losses in labour force.

Vehicle operating cost savings are associated with user benefits indicating the shift of travel from private car to public transit such as local rapid transit systems and high-speed rail. At the very least, the shift from private car to rail-based systems saves fuel and oil, which can be considered to have important impacts on energy consumption and environment pollution levels (May, 2013). In addition, there are costs of depreciation, insurance and parking which are associated with increasing car use which lead to increases in repair and maintenance costs, reductions in vehicle resale value, increases in parking and traffic costs, etc. (Litman, 2000, 2016). Concerning vehicle operating costs, an indicator of total vehicle kilometres per year for different modes of transport (i.e. car, rail, air and slow modes) will be evaluated.

4. **Impacts on Travel Activity:** related to energy and environmental factors, we can state that dramatic change in the climate system is resulting from the human-induced emissions i.e. greenhouse gas emissions (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Although transportation is not the only contributor to the rising levels of GHG, it is the fastest rising contributor to the problem (European Commission, 2007). Dramatic increase in private vehicle ownership—which is also encouraged by the provision of large-scale urban motorways—has led to air and noise pollution and increasing amounts of transport-related energy consumption. Although there are examples of counter arguments, the general research has been in favour of compact urban form in comparison to the more dispersed urban developments largely on the grounds of transportation energy savings (Breheny, 1995; May, 2013). In addition, energy and environmental impacts i.e. air/noise pollution exposure, vibration, climate change emissions (greenhouse gas emissions), water pollution, ecological impacts, landscape and heritage are all important for the impact assessment of transportation infrastructure investments.

3.4. Transport Related Indicators

In this study, the transportation-related indicators refer to: CO_2 emissions, total passenger kilometres, total number of passengers, and potential passenger accessibility by different modes of transport. They were obtained from the future simulations of the ASTRA-EC Model that has been developed as part of the ASSIST project of the European Commission of the 7th Framework Programme[3]. The details of the ASTRA-EC Model are provided in Fermi et al. (2014). The Model was first simulated for the baseline scenario where there is investment on Trans European Network-Transport (TEN-T) projects comprising the Leipzig/Halle-Erfurt high-speed rail section. It is important to note that all these projects had already been approved by the EC, and therefore the baseline scenario considers all the TEN-T projects by keeping constant all other parameters related to economy, society, environment and transportation (see Fermi et al., 2014). The Model was also simulated for the alternative scenario where there is *accelerated* investment on TEN-T projects, improvements in frequency and reliability of bus and train services, introduction of urban road user charges related to limited entrance of road transport vehicles to urban areas, charging of heavy-duty vehicles for the use of the motorway, new vehicle taxations based on CO_2 emissions and restrictive limits of CO_2 and other emissions on new vehicle purchasing. In the alternative scenario, there are settings of parameters to ensure transport system reliability and environmental protection. The accelerated construction of TEN-T projects, in particular rail investments, will improve accessibility of the urban locations, and can support mixed-use developments when associated with supportive land-use plans and policies. Therefore, estimates from the alternative scenario are linked to the TS of compact development and estimates from the baseline scenario are considered for the H-TS of dispersed development as provided in Table 4.

4. Findings

To evaluate the sustainability of transport-land-use relationships in the Leipzig-Halle Region, the selected impacts and indicators in Table 5 are subject to quantitative and qualitative assessment regarding dispersed and compact development scenarios (Table 4). The indicators that are subject to quantitative assessment are given in Table 6. For example, the table shows that there are costs of new transport infrastructure provisions of more than 2 billion euros in the TS. Among the new rail investment projects concerning the Leipzig/Halle-Erfurt line, there is a 2-km railway tunnel connecting Leipzig Main and Leipzig Bavarian stations, aiming at improving

[3] ASTRA-EC Model is developed in Vensim, which is also linked with other existing tools developed by the EC (i.e. TRANS-TOOLS and POLES models). The model covers the time period from 1995 till 2050, and covers all EU27 member states plus Norway and Switzerland. The population module of the Model simulates demographic development for the European countries covered in the model, comprising information on age structure, gender, household type and income group. The population module provides valuable information to the transport module considering that the differentiation of population according to the specific attributes allow different mobility patterns and elasticity to be considered in the Model. The economic module consists of inputs such as interactions between economic sectors, demand-supply interactions and employment. The transport module consists of classical 4-step transportation model both for passenger and freight transport. The model adjusts the estimation of trip generation, distribution and modal split phases on the basis of parameters differentiated by demand segments. The vehicle fleet module simulates the development of stock of road vehicles in terms of size and composition. The common structure for road vehicles is characterised by a feedback between annual new vehicle purchases, the number of vehicles in the stock, the scrapping of vehicles per year and a generated demand regulating the change of vehicle fleets (for details see Fermi et al., 2014).

functional integration of the two core cities. Although Leipzig and Halle are well connected to each other by means of road and rail transportation, the functional integration of the two cities is poor given that there is relatively less traffic congestion between the two cities even in the rush hours (see European Metropolitan Network Institute [EMI], 2012). The new tunnel improves 'the accessibility of Leipzig by rail and provides better connections between Leipzig and Halle with Chemnitz and Zwickau' (EMI, 2012, p. 12). In Table 6, we also note that total land area required for new rail construction is 370 hectares covering the catchment area of the new rail along the Leipzig/Halle-Erfurt corridor. There will be lost 160 hectares of green land along the catchment area (expanded from Leipzig/Halle to the city of Erfurt) that are required for the construction of the new rail track.

From Table 6, H-TS of dispersed development shows an increase in total area of discontinuous urban fabric compared to the observed in TS, which would result in higher public service provision costs in the case of the former scenario. Compact development in TS is associated with larger total areas of green land than those in H-TS, implying more protection of highly valued agricultural land and natural areas in the case of TS. Total area of open spaces is also higher in TS, implying the benefits of less space consumption of urban facilities in the compact form, supporting the preservation of green land and open spaces.

We note that there are considerable travel time savings on the proposed rail lines, which is important for the German Government aim to achieve considerable shifts from road and air transport to the newly constructed rail system. Travel time savings on the rail network will induce shifts particularly from private modes of transport, achieving travel time savings on the road network. The results show that the total number of passengers and passenger kilometres of private vehicle transportation is higher in the H-TS of dispersed development compared to TS. By contrast, these parameters show lower values regarding train, air and slow modes of transportation in the H-TS compared to those obtained for compact development cases in TS. Larger private vehicle kilometres in the dispersed development scenario are associated with higher costs of vehicle operations and environmental pollution compared to the lower estimates in the compact development scenario. In fact, the dispersed development scenario is characterised by higher CO_2 emissions, higher road-based traffic accidents, lower passenger accessibility to public transport services, and lower number of passengers using slow modes of transport such as walking and cycling (Table 6). These findings suggest the sustainability of transportation-land-use relationship is more evident in the transport scenario given that compact development is more efficient when the socio-economic and environmental impacts are considered.

Considering the difficulties involved in quantifying all the impacts and indicators specified in Table 5, a qualitative assessment framework is provided for the selected impacts, as these cannot be quantified based on data accessibility issues. The details of qualitative assessments focusing on transport-related impacts, land development and environmental impacts are explained in Table 7. It is important to note that the qualitative evaluation framework presented in the table is subjective and it can be used to complement the outcomes of quantitative assessments. Therefore, we suggest that future studies should focus on developing new data sources and research primarily on the quantification of environmental and transport-related indicators that were not quantified in the current study.

5. Conclusion

This paper examined the sustainability implications of transportation and land-use relationship through focusing on the key linkages and impacts of transportation infrastructure investments on land development trends in the Leipzig-Halle Region. Innovative aspects of this study are that the expected cost of infrastructure investment options can be compared with detailed quantitative data on some of the expected environmental and social variations in impacts which can be expected in alternative scenarios. This includes impacts on land-use, passenger numbers, travel costs and the impact on the environment by CO_2 emissions.

From the quantitative and qualitative assessments of impacts and indicators on social, economic and environmental considerations, our findings provide evidence-based assessments of compact urban structures and concentrated development patterns with data supporting conclusions that compact scenarios of urban development will prove more efficient in terms of the sustainability impacts on urban form and transport use patterns. Unlike the compact development case, dispersed or sprawled development as in the case of H-TS is costlier over the long term, regarding the negative impacts on the environment and social welfare. Transport-related benefits of compact urban development could be achieved through the application of policies and plans supporting sustainability of transportation and land-use relationships in the compact urban form. The identification and prioritisation of two evidence-based land development scenarios in our research and impact assessment processes can be used as a policy support tool in discussions of alternative development and investment decisions such as compact and dispersed developments in Leipzig-Halle and other case study areas.

Leipzig is an example of a post-socialist city, which had experienced a shrinkage process in 1990s and followed by modest population growth in the last two decades. As the MOLAND Model was successfully applied to a declining region for the first time, this provides the opportunity for the cross-comparison of the presented methodology and research findings regarding the transport impact assessment of compact and dispersed development scenarios with other case study re-

Table 6. Quantitative assessment of selected indicators for the dispersed and compact development scenarios in the Leipzig-Halle Region. Dissavings are shown in parentheses with a negative sign. By slow modes of transportation, we refer to walking and cycling.

Indicator	Scenario 1 (H-TS)	Scenario 2 (TS)	Savings (Dissavings) in Scenario 2 vs. Scenario 1	Explanation
Direct Impacts of Transport Investment				
Investment costs of new line Erfurt-Leipzig/Halle (million Euros)	0	2,310	(–)	Source: Federal Ministry of Transport, Building and Housing, 2003.
Investment costs of upgrading Leipzig-Dresden line (million Euros)	929.1	929.1	0	
Investment costs of upgrading Karlsruhe-Stuttgart-Nuremberg-Leipzig/Dresden line (million Euros)	1,499	1,499	0	
Total land area along Leipzig/Halle-Erfurt corridor required for newly provided transport infrastructure (Ha)	0	370	(–)	The total area required for new rail line is 370 hectares, of which 160 hectares is for the rail track along the Leipzig/Halle-Erfurt corridor (Schubert & Kniestedt, 1994).
Impacts on Development Patterns				
Total area of discontinuous urban fabric (km^2)	411.2	377.4	+	These are the results from scenario runs of the MOLAND Model for the year 2025 (Lavalle et al., 2009)
Total area of agricultural land (km^2)	3,517	5,193	+	
Total area of semi-natural vegetation and wetlands (km^2)	38.02	78.05	+	
Total area of open spaces (km^2)	27.8	43.2	+	
Impacts on Land-Use Accessibility and Transport Diversity				
Travel time on proposed rail section (Leipzig-Erfurt line) (min.)	72	44	+	Source: DB Netze (2015)
Travel time on proposed rail section (Halle-Erfurt line) (min.)	77	34	+	
Travel time on proposed rail section (Berlin-Halle-Erfurt-Frankfurt line) (min.)	297	233	+	
Number of fatality accidents/year (car)	91.24	76.25	+	These numbers were calculated from forecasts of fatality and injury accidents in Germany developed in TEN-STAC project, representing the forecasted numbers of accidents in the Leipzig Region in 2020 (see TEN-STAC, 2004)
Number of injury accidents/year (car)	5,639.8	4,713.3	+	

Table 6. Quantitative assessment of selected indicators for the dispersed and compact development scenarios in the Leipzig-Halle Region. Dissavings are shown in parentheses with a negative sign. By slow modes of transportation, we refer to walking and cycling. (Cont.)

Indicator	Scenario 1 (H-TS)	Scenario 2 (TS)	Savings (Dissavings) in Scenario 2 vs. Scenario 1	Explanation
Impacts on Land-Use Accessibility and Transport Diversity				
Potential passenger accessibility (car)	7,989	4,661	+	These are the transport indicators developed from the transport module of the ASTRA-EC Model runs for the year 2025 for the TEN-T (Trans-European Network-Transport) infrastructure investments as part of the ASSIST project of the EC. The indicators represent the regional values (NUTS 2 regional value for Leipzig) in the cases of baseline dispersed development and compact development scenarios (see ASSIST, 2011)
Potential passenger accessibility (train)	1,955.9	2,032	+	
Potential passenger accessibility (air)	1,907.3	2,215.2	+	
Total passenger kms (mil.)/year (car)	12,533	10,474	+	
Total passenger kms (mil.)/year (train)	1,999.5	3,937.5	+	
Total passenger kms (mil.)/year (air)	643.2	1,113.5	+	
Total passenger kms (mil.)/year (slow modes)	1,191.5	1,296.6	+	
Total number of passengers (mil.)/year (car)	629.7	551.5	+	
Total number of passengers (mil.)/year (train)	140.8	166.9	+	
Total number of passengers (mil.)/year (air)	0.95	2.03	+	
Total number of passengers/ (mil.) year (slow modes)	438.1	476.7	+	
Impacts on Travel Activity				
CO_2 emissions (mil. kg/year)	1,492.9	1,212.5	+	

Table 7. Qualitative assessment of selected impacts and indicators for the Leipzig-Halle Region.

Impacts	Evaluation Criteria	Details	Expected Impact of New Rail Investment in Leipzig-Halle Region
Landscape & environment	Environmental Risk Assessment (ERA) and Habitats Directive Assessment (HDA)	Among the alternative route options, the selected route of Leipzig-Halle-Erfurt line has the lowest land-take and has lower or equal environmental impacts compared to other route options (Feldwisch, Drescher, Flügel, & Lies, 2007). There are new constructions of viaducts, tunnels and bridges on the selected rail line. The required environmental assessments and legal actions were carried out for the construction of engineering structures including particularly the longest bridge of Germany. There are environmental issues to be considered are the Habitats Directive, the zone being a bird sanctuary and a drinking water protection zone grade III, and the Saale-Elster viaduct crossing the floodplains of Saale and White Elster. The line towards Leipzig follows a course of no major structures. Measures were taken to reduce interference with the ecosystem.	No significant impact due to mitigation measures

Table 7. Qualitative assessment of selected impacts and indicators for the Leipzig-Halle Region. (Cont.)

Impacts	Evaluation Criteria	Details	Expected Impact of New Rail Investment in Leipzig-Halle Region
Heritage sites	New rail increases accessibility to the heritage sites and leads to discovery of new heritage sites during construction works	Following archaeological excavations in the construction zone in the Querfurt area, artifacts and remains from the Bronze age and finds of more than 7500 years were uncovered. The most important pieces are exhibited in the museum in Halle. The rail connects to the other historical sites and new findings on the route southern to Erfurt.	Positive impact
Ecological impacts	New rail transport infrastructure and operation impacts on flora, fauna and their habitat	Flora and fauna were subject to examination prior to the rail construction works in order to prevent disturbance to the ecosystem services. This includes re-homing of sand lizards and bats in previously prepared replacement habitat during construction works. They will be returned to their original habitats after the end of construction work. Along the newly constructed rail corridor, conservation measures have been introduced to compensate for damage or replacement of lost values (new hedges and trees will be planted, mountain pastures will be nurtured etc.).	No significant impact due to mitigation measures and compensation of the ecosystem services of negatively influenced areas (following construction work) in other locations
Noise	New and existing transport system has impact on the environment through generation of noise pollution	Considering the expected shifts from road to rail transportation, there will be reduction in the number of road vehicles. This will induce reduction in the noise levels stemming from road transportation. There are tunnels and other structures constructed for the use of new high-speed rail. These structures are constructed with the systems allowing the most modern noise protection. There are walls, soundproof windows and barriers to reduce noise pollution for the residents.	Reduction in noise pollution
Vibration	The increase in train speeds, axle loads and traffic volumes on current train lines lead to increases in vibration to which the surroundings are subjected.	The effects of sound and vibrations were analysed along the newly constructed rail line (Leipzig/Halle-Erfurt line)	Adverse effects may exist during the construction works along the catchment of rail line
Water	Pollution associated with transport facilities and vehicle use	In order to prevent water pollution during rail construction and operation, various measures have been introduced including: drainage systems for all the tracks and points affected; two new rail water retention ponds be provided; modifications of existing drains and ditches to the new track; all the water collected will be soaked to the construction site.	No significant impact due to mitigation measures
Transportation diversity & integration	New rail provides an alternative option to air and road transportation and integrates to the existing transport system	Leipzig-Halle-Erfurt line connects Berlin to Nurnberg and also connects to other cities from Erfurt (to Frankfurt), Berlin (to Hamburg) and Nurnberg (to Munchen and Verona). Erfurt, Halle and Leipzig junctions are the central interchange stations of the region. The connection of the city of Halle, Leipzig/Halle Airport, the Leipzig Trade Fair and the freight centres in Erfurt and Leipzig were considered. The line is important for the European rail connection as it is part of the Line 1 of Trans-European Transport Networks (TEN-T) from Sicily to Scandinavia (TEN-STAC, 2004).	Positive impact

gions. This will assist policy formulation, decision making and reviews concerning the transport infrastructure investment policies and decisions in regions both in Europe and internationally.

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Conflict of Interests

The authors declare no conflict of interests.

References

Alonso, W. (1964). *Location and land use: Toward a general theory of land rent*. Cambridge, MA: Harvard University Press.

Álvarez, I. C., Prieto, A. M., & Zofio, J. L. (2014). Cost efficiency, urban patterns and population density when providing public infrastructure: A stochastic frontier approach. *European Planning Studies*, *22*(6), 1235–1258.

ASSIST. (2011). *The design of the ASTRA-EC Model* (ASSIST deliverable D4.1). Karlsruhe, Germany: Fraunhofer-ISI. Retrieved from http://assist-project.eu/assist-project-en/content/ deliverables.php

Barredo, J. I., Demicheli, L. (2003). Urban sustainability in developing countries' megacities: Modeling and predicting future urban growth in Lagos. *Cities*, *20*(5), 297–310.

Barredo, J. I., Demicheli, L., Lavalle, C., Kasanko, M., & McCormick, N. (2004). Modelling future urban scenarios in developing countries: An application case study in Lagos, Nigeria. *Environment and Planning B*, *31*(1), 65–84.

Barredo, J. I., Kasanko, M., McCormick, N., & Lavalle, C. (2003). Modelling dynamic spatial processes: Simulation of future scenarios through cellular automata. *Landscape and Urban Planning*, *64*(3), 145–160.

Batty, M. (2008). The size, scale and shape of cities. *Science*, *319*(5864), 769–771.

Berkner, A. (2000). The lignite industry and the reclamation of land–developments in the Rhenish, Central German and Lusatian mining areas since 1989. In A. Mayr & W. Taubmann (Eds.), *Germany ten years after reunification*. Leipzig: Institut für Länderkunde.

Bertaud, A. (2004). *The spatial organization of cities: Deliberate outcome or unforeseen consequence?* (Working Paper 2004-01). Berkeley: Institute of Urban and Regional Development, University of California.

Bohman, H., & Nilsson, D. (2016). The impact of regional commuter trains on property values: price segments and income. *Journal of Transport Geography*, *56*, 102–109.

Breheny, M. (1995). Compact cities and transport energy consumption. *Transactions of the Institute of British Geographers*, *20*(1), 81–101.

Breheny, M. (2001). Densities and sustainable cities: The UK experience. In M. Eschenique & A. Saint (Eds.), *Cities for the new millennium*. London: Spon Press.

Bristow, A. L., & Nellthorp, J. (2000). Transport project appraisal in the European Union. *Transport Policy*, *7*(1), 51–60.

Broitman, D., & Czamanski, D. (2015). Burst and avalanches: the dynamics of polycentric urban evolution. *Environment and Planning B*, *42*(1), 58–75.

Burton, E. (2013). The potential of the compact city for promoting social equity. In K. Williams, E. Burton, & M. Jenks (Eds.), *Achieving sustainable urban form*. London: Spon Press.

DB Netze. (2015). *Strecken Prospekt Neubaustrecke Erfurt-Leipzig/Halle*. Retrieved from http://fahrweg.dbnetze.com/file/fahrweg-de/2394134/9Pz20C66xS_Pxtk1IcEk8XzeTvE/9837564/data/2015_33_Streckenprospekt.pdf

Dröes, M. I., & Rietveld, P. (2015). Rail-based public transport and urban spatial structure: The interplay between network design, congestion and urban form. *Transportation Research Part B: Methodological*, *81*(2), 421–439.

European Commission (1999). *European spatial development perspective: Towards balanced and sustainable development of the territory of the EU*. Luxembourg: Office for Official Publications of the European Communities.

European Commission. (2007). *Green paper—Towards a new culture for urban mobility*. Brussels: European Commission.

European Commission. (2008). *Guide to cost benefit analysis of investment projects*. Luxembourg: Office for Official Publications of the European Communities.

European Environment Agency. (2002). *Towards an urban atlas: Assessment of spatial data on 25 European cities and urban areas* (Environmental Issue Report 30). Copenhagen: European Environment Agency.

European Environment Agency. (2006). *Urban sprawl in Europe: The ignored challenge* (EEA Report No: 10/2006). Luxembourg: Office for Official Publications of the European Communities.

European Metropolitan Network Institute. (2012). *Case study Metropolregion Mitteldeutschland*. The Hague: EMI.

Federal Ministry of Transport, Building and Housing. (2003) *Federal transport infrastructure plan*. Berlin: Federal Ministry of Transport, Building and Housing. Retrieved from http://www.bmvi.de/SharedDocs/EN/Documents/federal-transport-infrastructure-plan-2003.pdf?__blob=publicationFile

Feldwisch, W., Drescher, O., Flügel, M., & Lies, S. (2007). Die Planung der Neu-und Ausbaustrecke

Nürnberg-Erfurt-Leipzig/Halle. *Eisenbahntechnische Rundschau*, *56*(9), 494–500.

Fermi, F., Fiorello, D., Krail, M., & Schade, W. (2014). *Description of the ASTRA-EC model and of the user interface* (ASSIST deliverable D4.2). Karlsruhe, Germany: Fraunhofer-ISI.

Florentin, D. (2010). The 'perforated city:' Leipzig's model of urban shrinkage management. *Berkeley Planning Journal*, *23*(1), 83–95.

Girardet, H. (2015). *Creating regenerative cities*. Abingdon, UK: Routledge.

Großmann, K., Arndt, T., Haase, A., Rink, D., & Steinfuhrer, A. (2015). The influence of housing oversupply on residential segregation: Exploring the post-socialist city of Leipzig. *Urban Geography*, *36*(4), 550–577.

Haase, A., Kabisch, S., Steinführer, A., Bouzarovski, S., Hall, R., & Ogden, P. E. (2010). Emergent spaces of reurbanisation: Exploring the demographic dimension of inner-city residential change in a European setting. *Population, Space and Place*, *16*(5), 443–463.

Haase, D., Haase, A., Kabisch, N., Kabisch, S., & Rink, D. (2012). Actors and factors in land-use simulation: the challenge of urban shrinkage. *Environmental Modelling & Software*, *35*, 92–103.

Haase, D., Schwarz, N., Strohbach, M., Kroll, F., & Seppelt, R. (2012). Synergies, trade-offs, and losses of ecosystem services in urban regions: An integrated multiscale framework applied to the Leipzig-Halle region, Germany. *Ecology and Society*, *17*(3), 22.

Hagen-Zanker, A., & Lajoie, G. (2008). Neutral models of landscape change as benchmarks in the assessment of model performance. *Landscape and Urban Planning*, *86*(3), 284–296.

Haghshenas, H., & Vaziri, M. (2012). Urban sustainable transportation indicators for global comparison. *Ecological Indicators*, *15*(1), 115–121.

Higgins, C., Ferguson, M., & Kanaroglou, P. (2014). Light rail and land use change: Rail transit's role in reshaping and revitalising cities. *Journal of Public Transportation*, *17*(2), 93–112.

Hortas-Rico, M. (2015). Sprawl, blight, and the role of urban containment policies: Evidence from US cities. *Journal of Regional Science*, *55*(2), 298–323.

Iacono, M., Levinson, D., & El-Geneidy, A. (2008). Models of transportation and land use change: A guide to the territory. *Journal of Planning Literature*, *22*(4), 232–340.

Jones, C. E., & Ley, D. (2016). Transit-oriented development and gentrification along Metro Vancouver's low-income SkyTrain corridor. *The Canadian Geographer*, *60*(1), 9–22.

Karou, S. & Hull, A. (2014). Accessibility modelling: Predicting the impact of planned transport infrastructure on accessibility patterns in Edinburgh, UK. *Journal of Transport Geography*, *35*, 1–11.

Kenworthy, J. R., & Laube, F. B. (1999). Patterns of automobile dependence in cities: An international overview of key physical and economic dimensions with some implications for urban policy. *Transportation Research Part A: Policy and Practice*, *33*(7), 691–723.

Lavalle, C., Barredo, J. I., McCormick, N., Engelen, G., White, R., & Uljee, I. (2004). *The MOLAND model for urban and regional growth forecast: A tool for the definition of sustainable development paths*. Ispra, Italy: EC-Joint Research Centre.

Lavalle C., Gomes C. R., Mubareka S., & Escobar, F. (2009). *Procedures and protocols to upscale results from high-resolution spatially explicit development scenarios* (PLUREL: D2.4.2). Brussels: EC-6th Framework Programme.

Litman, T. (2000). *Evaluating public transport benefits and costs*. Victoria, BC: Victoria Transport Policy Institute. Retrieved from http://www.vtpi.org/tranben.pdf

Litman, T. (2016). *Evaluating transportation land use impacts*. Victoria, BC: Victoria Transport Policy Institute. Retrieved from http://www.vtpi.org.landuse.pdf

May, A. D. (2013). Urban transport and sustainability: The key challenges. *International Journal of Sustainable Transportation*, *7*, 170–185.

Mills, E. S. (1967). An aggregative model of resource allocation in a metropolitan area. *The American Economic Review*, *57*(2), 197–210.

Muth, R. (1969). *Cities and housing*. Chicago: The University of Chicago Press.

Nelson, A. C., Dawkins, C. J., & Sanchez, T. W. (2007). *The social impacts of urban containment*. Aldershot: Ashgate.

Odgaard, T., Kelly, C., & Laird, J. (2005). *Current practice in project appraisal in Europe: Analysis of country reports* (HEATCO D:1). Retrieved from http://heatco.ier.uni-stuttgart.de/hd1final.pdf

Organisation for Economic Co-operation and Development. (2002). *Impact of transport infrastructure investment on regional development*. Paris: OECD.

Pereira, A. M., & Andraz, J. M. (2013). On the economic effects of public infrastructure investment: A survey of the international evidence. *Journal of Economic Development*, *38*(4), 1–37.

Petrov, L., Lavalle, C., & Kasanko, M. (2009). Urban land use scenarios for a tourist region in Europe: Applying the MOLAND Model to Algarve, Portugal. *Landscape and Urban Planning*, *92*, 10–23.

Research Institute for Knowledge Systems. (2007). *MOLAND transport model* (Final Report of Contract 382463 FISC). Netherlands: RIKS.

Rink, D., Haase, A., Grossmann, K., Couch, C., & Cocks, M. (2012). From long-term shrinkage to re-growth? A comparative study of urban development trajectories of Liverpool and Leipzig. *Built Environment*, *38*(2), 162–178.

Schubert, T., & Kniestedt, F. (1994). Erste weichen gestellt: Eisenbahn-neubautrasse Erfurt-Leipzig/Halle. *Baukultur*, *3*, 20–24.

Schwarz, N., Bauer, A., & Haase, D. (2011). Assessing climate impacts of planning policies-an estimation for the urban region of Leipzig (Germany). *Environmental Impact Assessment Review*, *31*, 97–111.

Shahumyan, H., Williams, B., Petrov, L., & Foley, W. (2014). Regional development scenario evaluation through land use modelling and opportunity mapping. *Land*, *3*(3), 1180–1213.

Simmonds, D., & Coombe, D. (2013). The transport implications of alternative urban forms. In K. Williams, E. Burton, & M. Jenks (Eds.), *Achieving sustainable urban form*. London: Spon Press.

Stadt Leipzig (2016). *Population pyramid Leipzig 2015*. Leipzig: Office of Statistic and Election of the City of Leipzig. Retrieved from http://english.leipzig.de/services-and-administration/leipzig-in-figures/population

TEN-STAC. (2004). *Traffic, bottlenecks and environmental analysis on 25 corridors* (Project No. 14159000/R20040194, D 6: Part I).

Turok, I., & Mykhnenko, V. (2007). The trajectories of European cities, 1960–2005. *Cities*, *24*(2), 165–182.

United Nations. (2016). *New urban agenda* (Resolution adopted by the General Assembly on 23 December 2016). New York: United Nations General Assembly. Retrieved from http://habitat3.org/wp-content/uploads/New-Urban-Agenda-GA-Adopted-68th-Plenary-N1646655-E.pdf

United Nations Human Settlements Programme. (2013). *The state of the World's cities 2012/2013: Prosperity of cities*. New York: Earthscan.

Ustaoglu, E., Williams, B., & Petrov, L. (2012). Developing a CBA methodology for the scenario-based land-use impact assessment of proposed rail investments in the Leipzig Region. In M. Campagna, A. De Montis, F. Isola, S. Lai, C. Pira, & C. Zoppi (Eds.), *Planning support tools: Policy analysis, implementation and evaluation. Proceedings of the Seventh International Conference on Informatics and Urban and Regional Planning INPUT2012*. Milano: FrancoAngeli.

van Eck, J. R., Burghouwt, G., & Dijst, M. (2005). Lifestyles, spatial configurations and quality of life in daily travel: An explorative simulation study. *Journal of Transport Geography*, *13*(2), 123–134.

Westerink, J., Haase, D., Bauer, A., Ravetz, J., Jarrige, F., & Aalbers, C. B. (2013). Dealing with sustainability trade-offs of the compact city in peri-urban planning across European City Regions. *European Planning Studies*, *21*(4), 473–497.

Wheeler, S. M. (2013). *Planning for sustainability: Creating livable, equitable and ecological communities*. New York: Routledge.

White, R., Engelen, G., & Uljee, I. (1997). The use of constrained cellular automata for high-resolution modelling of urban land-use dynamics. *Environment and Planning B*, *24*, 323–343.

Williams, B. (2014). Bailing out the banks: The role of the National Asset Management Agency (NAMA). In A. MacLaran & S. Kelly (Eds.), *Neoliberal urban policy and the transformation of the city*. Basingstoke: Palgrave Macmillan.

Williams, B., & Nedovic-Budic, Z. (2016). The real estate bubble in Ireland: Policy context and responses. *Urban Research & Practice*, *9*(2), 204–218.

Williams, K. (2005). Spatial planning, urban form and sustainable transport: An introduction. In K. Williams (Ed.), *Spatial planning, urban form and sustainable transport*. Hampshire: Ashgate.

Williams, K., Burton, E., & Jenks, M. (2000). Achieving the compact city through intensification: an acceptable option?. In M. Jenks, E. Burton, & K. Williams (Eds.), *The compact city—A sustainable urban form?* London: Spon Press.

Zondag, B., de Bok, M., Geurs, K. T., & Molenwijk, E. (2015). Accessibility modelling and evaluation: The TIGRIS XL land-use and transport interaction model for the Netherlands. *Computers, Environment and Urban Systems*, *49*, 115–125.

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