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Ecological infrastructure in a critical-historical perspective: From engineering 'social' territory to encoding 'natural' topography

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Abstract

The tandem of infrastructure and landscape ecology is increasingly presented as the design strategy *par excellence* to address the risk society. Staged in explicit contrast to engineering as discipline disrupting natural balance, discourses endorsed by landscape and ecological urbanism propagate a new and improved 'post-carbon' and 'post-Euclidian' infrastructure. The broad objective of the article is to examine the accuracy of this claim of moving infrastructure from the realm of engineering to urbanism, and appraise the proclaimed methodological shift from determining top-down logics to bottom-up argumentation. In the first part, the recent design culture and techniques are analysed in relation to historical sociotechnical concepts and methods that deal with infrastructure, programmatic uncertainty and environmental control. More specifically, current design approaches are studied against the background of early nineteenth-century urban interventions that aspired to curb impending epidemics and social crises in the emerging metropolis. In the second part of the paper, historical analysis is exchanged for a theoretical reflection about the relation between analysis – basically the measuring of the land (topography) – and project – or the organization and control of the terrain (territory). The article concludes with an active projection, in order to explore new perspectives for recent developments in urban design and call for a fundamental reappraisal of how our design attitudes and techniques should be integrated with the political and social context.

Keywords

technonature, risk society, ecological urbanism, landscape ecology, post-political

Urbanism (re)discovering infrastructure

The prominence of infrastructure as guiding principle for urbanization is again the object of vibrant debate in academic and professional circles. Infrastructure is being increasingly identified as both the cause and remedy of diffuse, unbridled urbanization and the

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socio-ecological problems that go along with it (Monstadt, 2009). Initially, scholars in such analytical disciplines as transport history, STS and political geography (e.g. Dupuy, 1991; Harvey, 1996; Kaika and Swyngedouw, 2000; Offner, 1994; Picon, 1992; Tarr and Dupuy, 1988) addressed the crucial role of social and technical networks for planning urbanization processes. Lately, design oriented disciplines are proposing infrastructure as backbone for structuring urban development over large surfaces. Contrary to the dichotomy between the prominence of networked infrastructure in urbanization processes and its disciplinary absence as the "'Cinderella" of contemporary urban studies and urbanism', noted by Graham and Marvin (2001: 18), infrastructure has clearly re-emerged today in both theory and practice as the linchpin of disciplinary re-orientations in urbanism, (landscape) architecture and planning. In an effort to curb the late twentieth-century crisis of urban design, failing to respond to the exponential growth and upwelling hybridity of the urban condition, urbanism has re-examined its design context and turned to infrastructure to render the discipline operational again. Rhizome networks, corridors, green belts, waterfronts, and intermodal hubs, or transit-oriented development, are seen as structuring devices capable to re-conceptualize the contemporary city, which is defined in terms like *métapolis, weak metropolis, hyperville*, *città diffusa*, *generic city*, or *Zwischenstadt*, referring to its rural–urban hybridity, horizontal urbanization, neoliberal economic regimes and rising environmental concerns (see Ascher, 1995; Branzi, 2010; Corboz, 2000; Indovina, 1990; Koolhaas, 1995a; Sieverts, 1997). As common denominator of discourses breaking with functionalist, top-down planning and, more pragmatically, as one of the last resorts allowing public authorities to give structure to haphazard settlement, infrastructure has emerged as not only the glue holding disperse urbanization together, but as the object around which new visions about urbanization can be assembled in order to formulate novel grounds for the discipline (Bélanger, 2012). In contrast to post-war deterministic approaches, Pierre Bélanger states: '(i)n the wake of over-planning, over-regulation and over-engineering of the past century', future design has to be oriented towards 'the re-coupling, re-configuration, and re-calibration of these processes', through, 'the re-design of infrastructure' (Bélanger, 2013: 24–25).

Intended as an alternative to object-fixated modern(ist) design and traditional urban form failing to intervene successfully in the dynamic and complex urban metabolism, North American-born new *-isms* like *landscape urbanism* and (its progression in) *ecological urbanism* shift the focus from architecture to landscape as the organizer of space (see Hagan, 2015; Thompson, 2012).[1] In contrast to design principles like (b)order, stability and control, landscape is understood as a continuous horizontal field of inter-relationships in which organic models of open-endedness, flexibility, adaptation and self-regulation thrive (Reed and Lister, 2014; Waldheim, 2006). Landscape and ecological urbanism particularly foreground the alliance between landscape ecology and infrastructure design, as it is believed to produce complex adaptive systems able to both integrate and materialize myriad interactions between the 'social' and 'natural'[2] realm, and this over extensive spatial and temporal scales. More specifically, ecological infrastructure design explores fresh paths for the discipline by conceiving resilient technonatural frameworks bolstering both urban development and fragile ecological processes within a context of environmental threats and rapid urbanization. Recent literature in ecological urbanism shows that design strategies are increasingly merging technological infrastructural function with natural ecological structures – that is *designing bio-physical processes as infrastructure system* as well as *designing infrastructure/city systems as biological metabolisms/metaphors* – to address the risks related to the imminent ecological crisis, accelerating planetary urbanization and the vicissitudes of worldwide investment

within a complex urban condition (see Bélanger, 2013; Hagan, 2015; Reed and Lister, 2014; Mostafavi and Doherty, 2010). Standardized engineered connectors – e.g. roads, rails and sewers – meant to uphold the (unsustainable) demands of urban life, are supplemented or replaced by their antidote: blue and green corridors are viewed as the major structuring elements of urbanization, and are determined by underlying structures of topography, hydrology and vegetation (Mossop, 2006). In the field of political ecology too, the capacity of ecological networks in facilitating the growth and transformation of urban (infra)structures has been foregrounded. Infrastructure's potential to play a mediating role between nature and city has been recognized, and contributed to a more fundamental analysis of the socio-ecological sustainability of the urban environment as a whole (e.g. Gandy, 2004, 2008a; Graham and Marvin, 2001; Heynen, 2006; Heynen et al., 2006; Kaika, 2005; Monstadt, 2009; Swyngedouw, 2004). In addition, the emphasis on the social construction of nature ties in with literature on the post-political and the de-politicization of the problem of climate change, in which urban interventions are supposed to follow *only* from technical deliberations and considerations, thus excluding those groups and concerns that cannot be easily dealt with through techno-managerial procedures (e.g. Metzger et al., 2015; Swyngedouw, 2010; Wilson and Swyngedouw, 2014). In contrast to political ecology, however, focusing on social justice concerns and uneven socio-ecological relations caused by the so-called 'balanced' and 'a-political' technonatures, the entanglement between nature and technology in the current new design -isms postulates, amongst others, that proficiently designed ecological infrastructure can act as a comprehensive integrator of space. Infrastructure is believed to generate an inclusive assemblage, a landscape for the general 'public good'. In contrast to the adaption of the idea of 'Public Work', the reorientation of infrastructure from concrete and steel to soil and vegetation mobilizes a new expert, explicitly opposing the approach of the conventional post-war civil engineer. In urban design, infrastructure engineering is portrayed as a discipline imposing standardized models of practicality and efficiency, regardless of the context, and consequently as a domain that has contributed to the disruption of natural balance causing a proliferation of natural disasters (see Bélanger, 2012; Reed and Lister, 2014). Instead of belonging to the rationale of the engineer, the new and improved 'post-Euclidian' and 'post-carbon' infrastructure design is guided by what Kirchhoff et al. (2013) describe as the new 'super-science' of landscape ecology geared at bridging the divides between the natural and social sciences and the humanities. Landscape is conceived as a co-evolutionary, self-organizing unity of social systems and their specific ambient ecological system (5). Kirchhoff et al. (2013) argue that this concept can be traced back to J.-G. Herder's theory of cultural development (ca 1800), which is 'directed against the Enlightenment concept of human individuality and ideals of emancipation from tradition and nature, formal governance and universalism'. In this organicist perspective on landscape, co-adaptive interactions between human societies and their specific natural environment lead to 'unique, spatially and functionally integrated unities of land and people' (Kirchhoff et al., 2013: 9). In current design, this concept of landscape, as inclusive socio-ecological system both encoded and sustained by the transformative power of self-organizing processes and reciprocal interactions, is becoming the universal assumption. In the rhetoric of the new -isms, a socio-ecological integrative approach is given a central role: bottom-up processes take prevalence over top-down planning; topological relations over Euclidean zones; life cycles over linear progress; and internal systems over external choices.

Although such 'ecological view' of planning is in itself not new (e.g. McHarg, 1969), in current disciplinary reorientation the actual focus lies on sophisticated digital design techniques – e.g. scenario-based modelling, pattern recognition, remote sensing, indexing

and diagramming – in order to meet landscape ecology's central ambition of generating complex self-organizing, co-evolutionary systems. These techniques amount to a generous framework of bottom-up processes and biological patterns, often geared to organizing ecosystems as 'green reserves' for a variable (mostly market-driven) program. Or, in the words of Brian McGrath, '(b)ased on smart infrastructure, self-sufficiency and hybrid local models, highly adaptive design patterns take the form of responsive micro patches rather than overarching master plans' (McGrath, 2009: 48). One of the archetypal examples of this parametric urbanism driven by ecology can be found in Groundlab's design for Shenzhen (China). It proposes a relational urban model, in which indexing and diagramming techniques translate environmental, topographical, and geographical parameters into interactive, bottom-up mechanisms, with the river as central ecological corridor weaving urban fabric, open space and (transport) infrastructure together (Castro and Ramirez, 2012) (Figure1). Waldheim (2008) comments that this new generation of projects is not driven by historic precedent or community opinion, but centres on data coming from landscape ecology, generating design proposals that, according to him, are both ecologically literate and economically viable (Waldheim, 2010, 2013). Other examples of design firms/labs, which were 'the first' in grounding their projects in a parametric, systemic ecological approach, inspiring designers and design rhetoric world-wide, include, amongst others: Stoss, James Corner Field Operations, P-REX lab, Opsys, PEG office of landscape + architecture, and Anuradha Mathur & Dilip Da Cunha. In this article, the main focus is on these 'founding' designers and projects, recurrently praised as best practices, and in most cases affiliated with

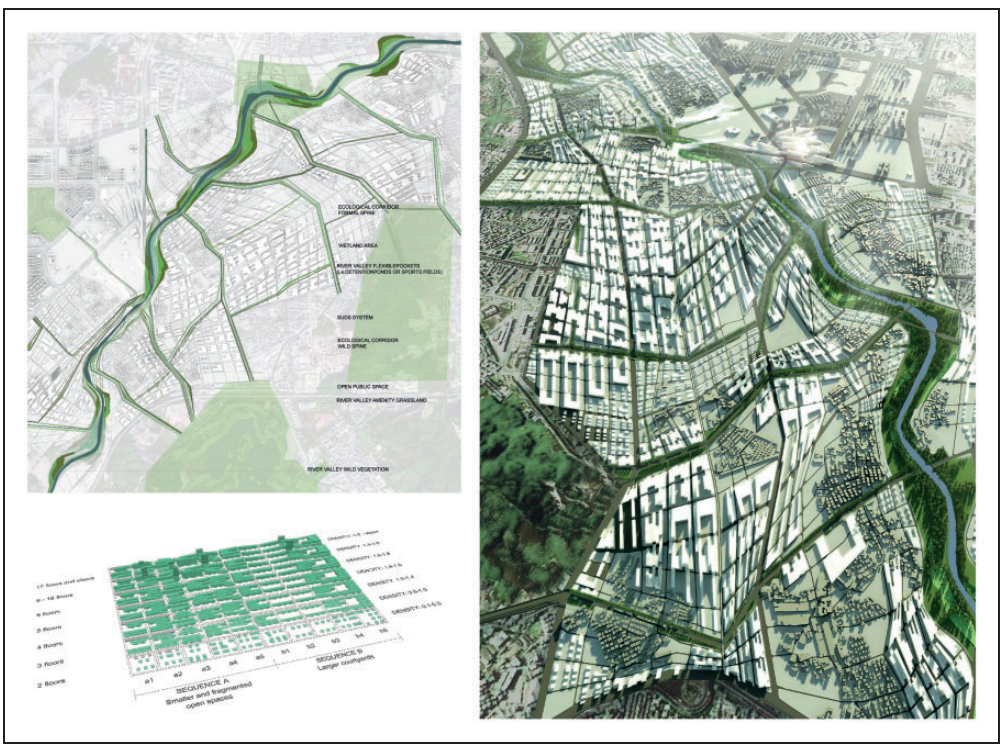

Figure 1. Parametric infrastructure design driven by ecological performance: Deep Ground by Groundlab, Shenzhen (China). Copyright Groundlab.

influential design schools disseminating theory on landscape and ecological urbanism – notably AA School, Harvard University Graduate School of Design, MIT and University of Pennsylvania. Projects and designers combining a focus on ecological infrastructure with concepts of complex adaptive systems and landscape ecology in general are the object of study here; designs using the systemic and ecological *only* as rhetoric are included in the critique by extension.

In an opinion piece for the special issue on city systems of *Architectural Design-AD*, Colin Fournier explains this reliance on the parametric and systemic in infrastructure design as a twofold reaction. In addition to a legitimation against top-down determinism of the modernist and engineer, current design is the product of the commonly held view that city systems are becoming more complex over time and hence need more sophisticated conceptual models and analytical tools to understand and intervene in them (Fournier, 2013). However, according to Fournier, one can critique this turn to sophisticated digital techniques and the grounds they rest upon, as the discourse is reminiscent of earlier models practised by the system engineers for designing cities. In addition, his essay casts a critical eye on 'current' turn to organic *systems* of open-endedness, flexibility and adaptation, away from 'earlier' mechanistic *models* of stability and control (see Reed and Lister, 2014: 25). He argues that the 'new' landscape infrastructure is developing a body of work based on '"all-knowing", quasi-Orwellian operational models[3] that will observe the city and the flows through its interconnected infrastructure systems in order to facilitate their control, rather than a more pluralistic discourse addressing topics other than the systemic and allowing different voices to be expressed' (Fournier, 2013: 128).

Expanding the self-referential character of the current discourse

This essay proposes to look more carefully into this suggested analogy between the new *-isms* and the discourse of engineering, between systemic design and mechanisms control, grounded by Fournier on their comparable ways of intervening in the complex urban metabolism. As such, the aim of the essay is to examine the accuracy of the claim of new discourses to move infrastructure from the realm of engineering to urbanism and appraise the proclaimed methodological shift from determining top-down logics to bottom-up argumentations. These discourses seem to be drawing on similar – though with another degree of sophistication – 'quasi-Orwellian' design techniques to set up supposedly 'self-organizing' processes, while in fact facilitating control, or indeed capitalist development. In the absence of a critical-historical evaluation of current design theory, techniques and practice, the technological and scientific (r)evolution guiding infrastructure design is commonly approached from a deterministic point of view, detached from societal developments and social agendas. It appears as if designs/designers are passively submitted to technological change (Picon, 2010a). In his book *Digital Culture in Architecture*, Picon (2010a: 9) avoids this 'pitfall of narrow technological determinism' through the construction of a historical frame that goes back to the turn of the nineteenth and twentieth centuries. In this way, he succeeds in evaluating current relationship between digital technology in architecture and dominant social, economic and cultural conditions more attentively. Similarly to architecture discourse, urbanism and planning fail to embed design techniques in a wider range of disciplinary concepts relating technology with space and society, or position them in a longer chronology of environmental adaptation, beyond the post-war era. Their protagonists often affirm to start from a 'new beginning', 'against' traditional urban form or react 'against' (post-war) infrastructure engineering. Consequently, one arrives at a rather self-referential and often prolix discourse

(see Kuhn, 1962 on scientific revolutions). In his conceptual analysis of Landscape Urbanism, Thompson (2012) refers for instance to the difficult language accompanying the technologically sophisticated mappings to exemplify this self-referential discourse, which only addresses the inner circle of proponents.

The increasing weight of advanced technological anticipatory/projective knowledge in the production and governance of space, combined with a strong self-legitimizing rhetoric, make it timely, if not urgent, to position landscape and ecological urbanism in a larger historical–geographical reflection on design-founded techniques of calculation and cartography. Tying in with the effort to decode the conceptual language of the 'new' discourses, contained in Thompson's (2012) analysis of *landscape urbanism*, Kirchhoff et al.'s (2013) study of *landscape ecology*; Adams (2014) reflection on ties between nature and urbanization; and Gandy's (2015) review of *urban ecology*, this article intends to examine the recent reorientation of design to landscape/ecological infrastructure in relation to historical ideas and techniques that deal with infrastructure, programmatic uncertainty and environmental threats and control. By doing so, it ambitions to construct a critical distance vis-à-vis the danger of developing a self-referential discourse that would stem from an all too simple legitimation, namely the creation of theory and practice by denouncing the mindset of the directly preceding timeframe. Within the limits of the article, it is not the intention to write a broad conceptual history, but rather to develop an account that mobilises a Foucauldian perspective on the genealogy of relations between knowledge and power, referring to well-defined socio-spatial contexts and practices in history best fit to critically engage with present-day disciplinary developments in urbanism (see Elden, 2013a: 8–10). This lineage to Foucault underpins a close attention to historical specificity, as antidote for reductionism, as well as to the interpretation of technology as 'techne' – that is 'a practical rationality governed by a conscious goal' (Foucault, 1984: 255).[4] Thus, the historical analysis of technology as 'techne', studying the inscribed conscious decisions about economic, demographic and political transformations, is grounded in a critical engagement with present-day urban issues, theory and practice upholding the aura of technological objectivity.

More specifically, the first part of the paper studies the relation between current design approaches and rhetoric on imminent ecological apocalypse against the background of early nineteenth-century urban interventions that aspired to curb the impending epidemics and social crises in the emerging metropolis. As such, this episode is differentiated from the conventional view considering the *longue durée* as a succession of waves in which the previous technical development is supplanted by the next innovation, and where unconscious forces generate likewise societal transformations (Rabinow, 1989). Similar to Gandy's analysis of the emergence of 'the bacteriological city' positioning the relationship between water, the city and processes of capitalist urbanization in a longer history (Gandy, 2006), this paper places current and early nineteenth century turn to ecological infrastructure under one conceptual frame. Positioning today's momentum for (re-)inventing design techniques that are geared towards upholding 'natural' qualities, in a tradition of technological innovation that steers spatial transformation towards an improvement of 'human' ecology, indeed opens up the discourse for critical reflection. This method of historical exploration adds to a 'history of the present' (see Elden, 2013b), of which the intention is not to find 'the origin', but to understand and critically reflect on the current urban condition by studying it as a historian, while the events unfold. It aims to give new historical and theoretical depth to, and insights in, the present discourses in design and planning.

In the second part of the paper, historical analysis changes into theoretical reflection about the relation between the analysis – or the measuring of the land (topography) – and the project – or the organization and control of the terrain (territory). The article concludes with an active projection in order to explore new perspectives for recent developments in urban design, and call for a fundamental reappraisal of how our design attitudes and techniques should be integrated with the political and social context. As such, the aim is to enhance to the profundity of the academic discourse on *landscape urbanism* and *ecological urbanism* and highlight questions that urgently need to be addressed.

The social vis-à-vis the natural

> *It was on the level of knowledge, of a more precise and powerful analysis of milieu, with* conditions de vie *blending biological and social variables, that the cholera epidemic* (1832) *not only provided a clear impetus for change, but opened the way for new scientific discourses, new administrative practices, and new conceptions of social order, and hence ushered in a long period of experimentation with spatial/scientific/social technologies.* (Rabinow, 1989: 15)

Rather than tying in with conventional tools of urbanism, it is argued here that current design modes are related to nineteenth century techniques of calculation and cartography – for instance statistics, layering and categorization – developed within the realms of engineering, medicine, sociology and political economy to plan and govern the environment of, or – more precise – the sanitation systems for, the industrial metropolis. Although these designs focused on infrastructural interventions that are now re-conceptualized, such as embankments, thoroughfares, and extensive water supply and sewer systems, the reformist design context and the socio-ecological goal of the projects are reminiscent of the challenges and aims formulated in the discourses of *landscape* and *ecological urbanism* today. Similar to the current turn to parametric analysis and attended ecological infrastructure design, previous regimes focussing on eco-technology as means of spatial planning responded to a transformation of the socio-economic and political context, with associated ideas about modernization. Especially, the first half of the nineteenth century corresponds, *in abstracto*, to the contemporary design context as it was characterized by a mutually reinforcing combination of, on the one hand, a disciplinary crisis due to the mismatch between permanent architectural form and a rapidly changing reality and, on the other, the anticipation of an imminent environmental crisis. The exponentially growing metropolis with risks of social segregation, high crime rates and the constant threat of cholera outbreaks jeopardized the 'human ecology' of the city. In addition to these dire consequences of the Industrial Revolution, political revolutions had destroyed the urban design tradition of detailed monumental complexes and aesthetically refined landscape assemblages. Accordingly, space could no longer be conceived for elites, by elites, following a static perception that would ensure the perfect solution *hic et nunc*. In the words of Benevolo, designing entailed no longer 'to apply the plausible approximation of an absolutely invariable image to a very slow-moving reality' (Benevolo, 1975: 12). In the immediacy of a changing institutional context, looming environmental threats and an overall dynamic, yet opaque, expanding urban world, it was a pressing necessity to develop a radically different design methodology.

Traditionally, architecture and urbanism were the disciplines that offered spatial solutions for social problems. Yet, with the breakthrough of new technologies in the nineteenth century, and the danger of epidemics and social revolutions spreading, the nature of the prevailing problems changed. Consequently, spatial interventions were no longer based on

tradition, but entrusted to more rational designers grounding their decisions on new developments in calculation and cartography (Foucault, 1984; Picon, 1992; Rabinow, 1989). They made up a heterogeneous group ranging from engineers, physicians, mathematicians, to criminologists, described by theorists as an assembly of 'specific intellectuals' (Foucault and Gordon, 1980), 'socio-technicians' (Latour, 1996 [1993]) or even 'technocrats' (Rabinow, 1989), if understood as those who directed technicians to operate between technology, space and society. Their projects of urbanism and architecture no longer recycled fixed spatial layouts. Their approach of engineering was no longer based on trial and error. Instead, the fragile times of imminent crisis and accelerating urbanization urged for innovative and operational forms and policies supported by objective and undisputable facts. In order to analyse the intricate relations within the growing complexity of the socio-spatial realm, the early nineteenth-century socio-technician took on more abstract theories and exact methods derived from fields such as mathematics and biology. These provided the opportunity to map and describe the many interrelated aspects of the urban metabolism, as well as to incorporate uncertainty, probability and perpetual progress in conceptualizations and projections. In this way, designing 'involved not so much establishing limits and frontiers, or fixing locations, as, above all and essentially, making, possible, guaranteeing, and ensuring circulation: the circulation of people, merchandise, air, etcetera', Foucault summarizes in his first lecture on 'Security, territory and population' at the *Collège de France* (Foucault and Senellart, 2007 [2004]: 20–29). For example, the corps of engineers of *Ponts et Chaussées* and the *Polytechniciens* were trained to develop overall planning policies that established a multivalent framework in which a series of uncertain elements/events could unfold – a just assemblage in a contingent world (Foucault and Senellart, 2007: 20). Only a scientifically based practice, infused with mechanisms of control, permitted to tackle the problem of causality and address the social (justice) concerns characterizing modern society. In the pre-bacteriological age, the socio-technician set up a pragmatic, yet holistic compromise combining a scientific interdisciplinary approach *avant-la-lettre* – relating domains like medicine, engineering and municipal management – with socio-political agendas simultaneously geared towards poverty, disease and capitalist development to help the metropolis function more effectively and safely (Gandy, 2006). Independent of scale, the project definition included social as well as technical requirements resulting in designs commonly structured around comprehensive infrastructural schemes, facilitating the circulation of air and light as well as the improvement of living conditions and, of course, the control of social behaviour. Designs for urban transport and sanitation infrastructure as well as integrated sanitary reforms for entire city quarters thus emerged out of the explorative entanglement of disciplinary fields and ideologies.

In contrast to the commonly held view that the design of infrastructure was historically determined by problem-solving and guided by autonomous parameters such safety, feasibility and efficiency, independent of an overall urban vision, it appears that dynamic infrastructure frameworks were explicitly conceived to instigate a broader spatial transformation and undertake a specific project of societal modernization (see Graham and Marvin, 2001). In that way, the design of infrastructure and its embedded spatial development models became the object of persistent political attention, aiming for the regulation of (contested) modernization processes (Swyngedouw, 2015, 1999). Picon highlights that French engineers had 'an enduring connection' with social preoccupations. They were even 'somewhat messianic in their approach of technology as well as in their ambition to use it to service society' (Picon, 2007: 198–203). Although the nature of the designs is as diverse as the designers themselves, the sanitation projects of the early

nineteenth century fundamentally share the same objective. Their common denominator lies in their ambition of regenerating society, or better of correcting and perfecting 'human ecology', by means of technical intervention, combining methods of cartography and calculation with works in the name of the public good. In France (e.g. Aisenberg, 1999; Barles, 1999; La Berge, 1992; Gandy, 1999; Picon, 2003; Rabinow, 1989), but also in Belgium (e.g. De Block, 2011; De Block & Polasky, 2011; De Meulder, 2000), Germany (e.g. Evans, 1987), the USA (e.g. Melosi, 2000; Tarr, 1996), Britain (e.g. Koch, 2011), and many other nations (e.g. Baldwin, 2004 [1999]), new methods of data collecting and cartography both inspired and underpinned the infrastructural interventions making the urban 'organism' a healthier and more harmonious environment for the human species (Figure 2). In the rising awareness of 'ecology' as the constant struggle of adaptation between living beings and their *milieu* (Rabinow, 1989), 'organic' interpretations of society were winning ground. They gave rise to techniques mapping causality and plans projecting relations instead of designing fixed spatial layouts of discrete components. Although this approach often resulted in schemes that have contributed to the crisis of the modern city, the fundamental design challenges they responded to are comparable to current briefs of 'ecological urbanism': designers were assigned the task of (re-)structuring or 'correcting' the city to a co-evolutionary, though strongly controlled socio-ecological system.

Especially, the emergence of 'social physics' (e.g. 1835) of the Belgian statistician Adolphe Quetelet or the socio-ecological approach of the Frenchman Louis-René Villermé (e.g. 1828) forms an interesting point of comparison, as their work on statistics was set up as a remedy against the polluted and overcrowded industrial city during the early nineteenth century. While both authors sought for interrelations between the 'bio-physical' and the 'social' realm, their competing interpretations of nature–society interactions shed light on the kind of land-and-people relations that present-day mapping in landscape ecology conveys. While in Quetelet's analysis the 'stable' natural variables dominated over the moral and social characteristics, Villermé's work underlined the prominence of 'variable' social parameters in the urban metabolism. Accordingly, the ultimate aspiration of Quetelet's social physics was to decipher the universal, inevitable natural patterns that ordered the urban mechanism, moving it towards a condition of equilibrium (see Bracke, 2008: 154;

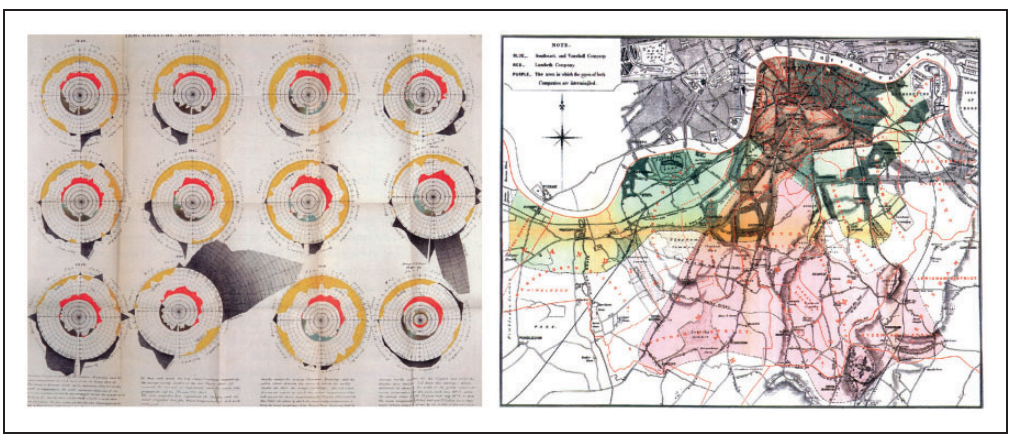

Figure 2. Analysis of the variables of crisis: Left: diagrams relating average mortality and fluctuations in climate /Right: John Snow's map relating water supply systems with relative mortality, translated in dynamic, layered gradients (Source: Koch 2011, p.171 and 183).

Vanpaemel, 2002: 52). This attitude, considering society as being governed by laws of natural evolution, is akin to the ideas circulating in German Naturphilosophie at the time. More specifically, it is reminiscent of Herder's concept on cultural development as naturally guided by co-evolutionary interactions; a theoretical position directed against Enlightenment ideas about the emancipation of nature (Kirchhoff et al., 2013). Villermé adhered to Quetelet's use of quantitative series, but not to his interpretation of the nature–society interactions. On the contrary, the scientific results of Villermé questioned the traditional view assuming that natural causes would ultimately entail a stable state of eternity (La Berge, 1992). In his understanding, socio-economic parameters were the principal determinants of both the urban crisis and its remedy. So, conversely to Quetelet's work producing insights in universal, stable environmental principles governing an equally stable society, Villermé's statistics was geared to connect public health policy to socio-political reform. While Quetelet's social physics internalizes relations between the social and bio-physical, merging analysis with projection, Villermé's approach is a clear illustration of *biopolitique*; a concept coined by Foucault to grasp relations between calculation and the governance of population, emphasizing the (external) political rationality or *dispositif* administering and managing life as well as constructing it as governable (Foucault and Senellart, 2004, 2007; Hinchliffe and Bingham, 2008; Wakefield and Braun, 2014: 5). Although Villermé's intention to prove the statistical redundancy of natural parameters was not broadly followed, the analytical correlation between standard of living and health, with related political technologies ensuring its regulation, pervaded the French sanitation movement and was disseminated internationally. The Belgian socio-technician Edouard Ducpétiaux, for example, grew into a leading reformist by translating statistics into urban, decidedly political, projects (Figure 3).

Reformists scientifically analysed social (e.g. poverty, profession) and natural (e.g. climate, water flows) variables while, at the same time, blending these variables together in spatial projections with the explicit agenda to address the socio-ecological crisis and (partially) change the nature of capital accumulation in the metropolis. Systematic data collection combined with infrastructure-based designs had to produce holistic schemes integrating social aspirations for the working class with remediation of bio-physical forces, through socio-technical fixes. These earlier design modes generally made abstraction of local characteristics to formulate reformed constructs of territorial organization and societal modernization mainly focussing on human ecology, or 'bio-politics' – e.g. mechanisms of controlling and nurturing the masses (Foucault and Senellart, 2007). Today, on the other hand, the engagement with sophisticated techniques deciphering sites in order to uncover and recover local, mostly bio-physical or 'non-human' ecological qualities, seemingly without taking position vis-à-vis current societal/civilization impasse, is developing into a new paradigm (Fournier, 2013; Picon, 2010b). As Cosgrove (2008) states in his essay on environmentalism and imagination: while Cronon (1995) underlined the social construction of nature, today's 'post-environmentalists' seek to theorize how non-human factors co-fabricate the social world. However, in contrast to the analytic scientific approach of 'nature' in urbanism implying objectivity and universality, with a strong focus on bio-physical systems, 'hybrid' or 'post-human' geographers like Whatmore, Braun, Hinchliffe, and Mitchell, or social scientists like Latour emphasize the agency of non-human actors in political life, or the dialectic between the bio-physical and social domain, leading to a multiplicity of socio-natural assemblages (see Braun and Whatmore, 2010; Hinchliffe, 2008; Hinchliffe and Bingham, 2008; Latour, 2004a; Mitchell, 2011; Whatmore, 2002). Landscape ecology, on the other, is reminiscent of Quetelet's pre-occupation with tracing the underlying

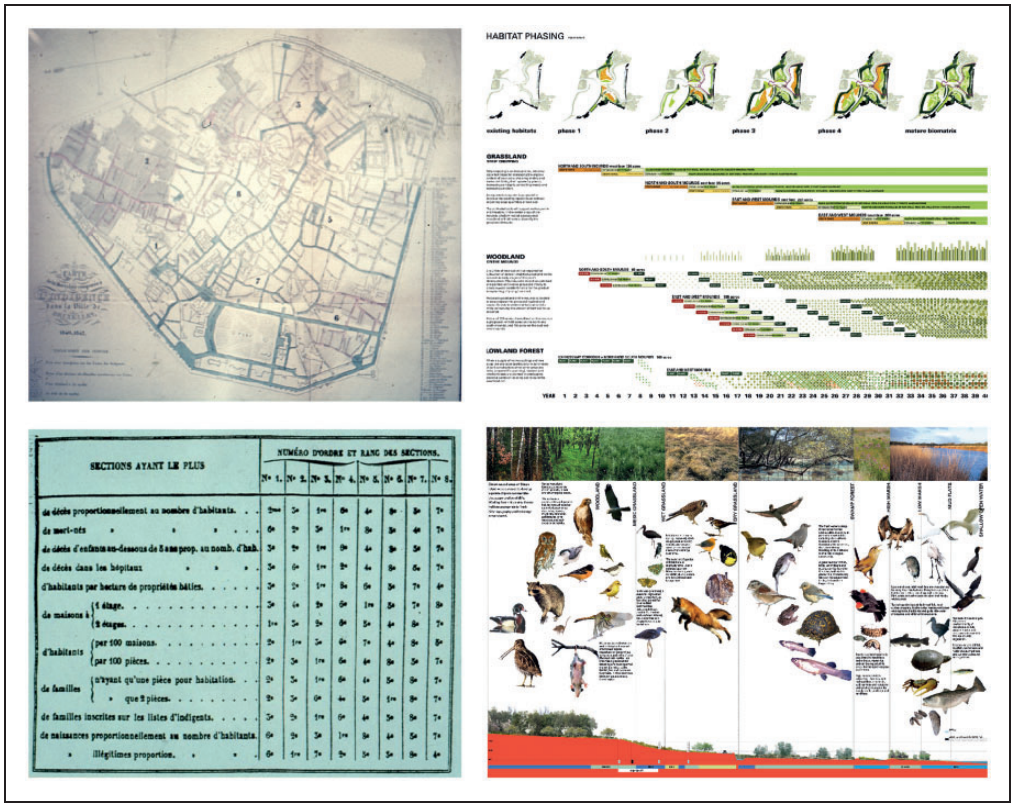

Figure 3. Left. Example of conditions de vie blending social and biological habitat variables: study of Ducpétiaux (1844) of Brussels' human ecology relating variables of mortality with standard of living (housing types, district and density as parameters of poverty). Right: Design of Field Operations for Freshkills Park focused on natural ecology. Top: diversification chart of lifescape's development over time; Bottom: Cultivating new habitats over time. (Left: Ducpétiaux, 1844/Right: *Freshkills Park: Lifescape. Staten Island, New York. Draft Master Plan* (March 2006) www.nyc.gov/freshkillspark; Copyright James Corner Field Operations).

natural patterns of society's evolution and the associated ideas of Naturphilosophie considering the social as a product of an all-encompassing, dominant natural development of systems to a sustainable state of equilibrium. As Gandy explained, the development of new kinds of interdisciplinary insights and sophisticated analytic techniques, with an emphasis on complexity and indeterminacy, yet implicit belief of rationality or universality, risks a renewed philosophical naturalism (Gandy, 2015, 2008b) (Figure 3).

When conceptually comparing early nineteenth-century urban design to current historical momentum, many parallels can be drawn with regard to ideas and methods. In both stages, the underlying goal is to establish dynamic interactions between society and nature in order to curb crisis as well as to accommodate uncertainty within the context of rapid urbanization. In addition, a similar rise of the 'objective' expert with his/her 'innovative' and precise design techniques can be discerned when faced with incumbent threats. Today, however, the role of the nineteenth-century socio-technician is (re)claimed by the urban designer and more, or other, forms of life are incorporated into the construction of socio-nature with a focus shifting from 'human' to 'natural' ecology. Socio-nature is generally stripped down to a biological perspective, assuming that a just and sustainable

social structure will emerge from the enhancement of natural formation processes. Although landscape ecology has striking similarities with nineteenth-century sanitation in regard to the *analysis* and the comprehension of bottom-up systems that stem from it, on the level of the urban *project*, a clear difference is taking shape when comparing the socio-spatial construction of ecological infrastructure. The earlier strong ties between politicians and socio-technicians, both explicitly formulating top-down constructs of technological innovation, territorial organization and societal modernization, seem to be replaced by a focus on, and accumulation of, local interventions generated by, what seem like, more complex design techniques. The analysis, or the measuring of the land (topography) becomes the project, seemingly without taking position on the way to organize, or control, the terrain (territory). Consequently, the political-technological dimension of space – or the notion of territory defined by Stuart Elden as a political technology comprising techniques for measuring land and controlling terrain (Elden, 2010: 799; see also Hannah, 2000) – has become ambiguous in current design theory and practice. While many designs contain abundant and detailed descriptions of relations between bio-physical characteristics and the locus, these plans include little to no explicit information or prospect about overall developments of space and society. The politics, or choices about biopolitics in relation to geopolitics, population in relation to territory, are evacuated by the techniques merging analysis with project. In *critical* mapping, the resulting natural or self-evident character of maps calls for a 'real critical historical analysis' looking into the 'relation between calculation as a territorial strategy and the production of space' (Crampton, 2011: 95–96).

Territory vis-à-vis topography

> *What are the political forces at work in the new fields explored by designers today?*
> *A temptation could be to see no political force at work at all, but processes of emergence that are not related to actors in the traditional sense. The risk would then be to return to a magical world animated by forces that escape human characterisation, a magical but also mythical world in which tales replace arguments.* (Picon, 2010b: 99)

Picon's essay 'What has happened to territory?' explores the eroded relation between the meanings of territory and landscape (Picon, 2010b). In contrast to the indeterminate political position of today's ecological infrastructure, throughout history, infrastructure has been the principal tool to integrate, control and organize space and society. Infrastructure projects used to be connected to administrative action and the construction of territory, based on concepts relating the circulation of people and goods to an ideal of social mobility (De Block and Polasky, 2011; De Block, 2014; Desportes and Picon, 1997; Picon, 2010b: 95). Due to Enlightenment ideas emancipating man from environment or nature, infrastructure could be designed from the 'outside', approaching the territory as a project. The making of the territory was mastered and policed by public authorities with a 'panoptic-like overview', enabled by developments in cartography and survey methods (De Block, 2011; Picon, 2010b: 97–99). *Cuius carta, eius regio*, as Sloterdijk notes, or *whose map, his realm*, and indeed territory (Sloterdijk, 2013 [2005]: 103).

As a reaction against this earlier top-down, reductionist and authoritarian practices in engineering and planning, design today focuses on internal systemic mapping un/re-covering the emergent relations within 'nature':

> *In making visible what is otherwise hidden and inaccessible, maps provide a working table for identifying and reworking polyvalent conditions; their analogous-abstract surfaces enable the*

> *accumulation, organization and restructuring of the various strata that comprise an ever-emerging* milieu[5]. *[…]*
> *[M]apping differs from 'planning' in that it entails searching, finding and unfolding complex and latent forces in the existing* milieu *rather than imposing a more-or-less idealized project from on high*. (Corner, 1999: 225–228)

Critical mapping and (hybrid) geography too question traditional techniques that approach territory as a closed container in which Euclidian space is the static backdrop for top-down design (Whatmore, 2002: 6); as a geometric space in which power is extended over fixed distances (Allen, 2009: 199). Inspired by Deleuze and Guattari, these fields consider territory as a process of de- and re-territorialization, approaching it by hybrid, processual mapping practices emphasizing heterogeneity, topology and context-dependencies, thus unsettling closed–open, local–global and inside–outside divides. However, as Whatmore warns, '(the) spatial vernacular of such geographies… (is) not to ignore the potent affects of territorializations of various kinds, just the reverse. It is a prerequisite for attending more closely to the labours of division that (re-)iterate their performance and the host of sociomaterial practices – such as property, sovereignity and identity – in which they inhere' (Whatmore, 2002: 6). In landscape and ecological urbanism, however, the focus on the increasing complexity of interdependencies does not lead to a questioning of divides and processes of territorialization, but, conversely, to a collapse between territory and landscape, between outside and inside, between analysis and project (Picon, 2010b: 98). The processual understanding in critical mapping revealing context-dependencies, assemblages of choices and decisions, values and judgements (Kitchin and Dodge, 2007; Kitchin et al., 2013) does not inspire mapping in design.

Without a critical reflex, mapping 'ever-emerging' natural systems, as *pars pro toto* for a relational socio-ecological approach, blurs distinctions between building and ground, territory and topography. Designers unlock existing patterns 'naturally' inscribed on site (Adams, 2014), resulting in 'harmonious' continuous fields and processes, instead of conceiving heterogeneous territories and urbanization (Figure 4). With no 'outside' from which to design, the fading distance between the individual autonomy of the designer and the emergent environment he/she is uncovering, forecloses the potential of the first causing the latter to change. Societal development is implicitly considered as 'naturally guided, by non-deterministic co-evolutionary and co-adaptive interactions' with the land (Kirchhoff et al., 2013: 9), and the notion of territory as a political process is lost. Instead of governing the territory from the outside by imposing structures and ideas about the future, surfaces are simultaneously analysed and designed parametrically by enhancing or extrapolating existing patterns, processes and trends. Utopian thinking makes way for endless modification and adaptation (Baeten, 2002; Timms et al., 2014). The analysis or the map is the project, geared to facilitate bottom-up self-organization, as Martin Prominiski concludes his article on 'Designing landscapes as evolutionary systems' (Prominiski, 2006). Fournier compares this parametrical, evolutionary approach with Jorge Luis Borges' parable 'The map and the territory' in which the complexity and the scale of the map merge with reality, and finally become it, thus warning for the fact that 'we will have to accept that its internal logic will gradually escape our understanding… We will have to accept that we are out of control… Once the city-system and its model become fully sentient, we will enter… the Greek myth of Prometheus steeling fire from the Gods' (Fournier, 2013: 129–131) (Figure 5).

Although there still are urbanists and architects who incline to a (social) 'engineering' attitude and choose to design from the *outside* by superimposing structures in order to instigate clear territorial and societal transformation, the attitude of carefully deriving

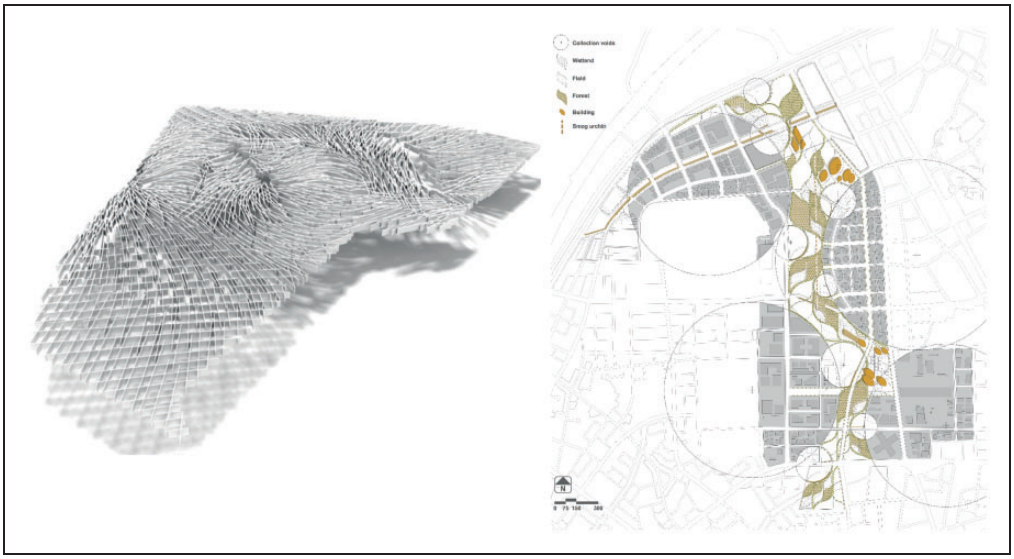

Figure 4. Design patterns for Taichung Gateway Park International Competition (Taiwan) of PEG office of landscape+architecture. The leaf and circle figures are used to organize the site's circulation, program, and hydrology. Copyright PEG office of landscape + architecture.

biophysical landscape structures from the *inside* of the site is winning ground. Both approaches create a framework to facilitate uncertain programmatic evolution. *In se,* they rely on similar design techniques, but they are almost contradictory in their design beliefs. Analysing today's obsession with 'design' in relation to the ecological crisis, Bruno Latour states that there were and still are two great narratives: one of emancipation, detachment, modernization, progress, founding, colonizing and mastery, responding to an engineering attitude; and the other, completely different, of attachment, precaution, entanglement, dependence, sustaining, nurturing and caring, which could be categorized under what he defines as 'design' (Latour, 2009b: 2). According to Latour, design implies humility, an attentiveness to detail and a skill associated to arts and crafts (Latour, 2009b: 3). It is defined by an absence of the heroic, or, as Picon states: deciphering the context, making sense of information in order to formulate a contextual and ecological strategy is the new heroism (Picon, 2010). Although this attentiveness to detail is undoubtedly laudable and productive, it is not unproblematic in a time when we are faced with a fundamental societal impasse in which, in the words of historian of technology Rosalind Williams, we have 'to imagine the retooling of economic and material systems for sustainability (cyclical processes) when for so long they have been built on assumptions of growth (linear processes)' (Williams, 2013: 343). In contrast to the infrastructure projects and discourse of, for example, Koolhaas advocating to take 'insane risks' (Koolhaas, 1995b: 969), or the discourse of planning and political geography warning that we might be wasting a crisis (e.g. Oosterlynck and Gonzalez, 2013), mapping is doing what no revolution has ever contemplated, namely the remaking of ecological systems, of life on earth, by operating exactly opposite to revolutionary attitudes. Instead of a political project steering territorial intervention, carefulness and precaution is the *Leitmotiv* – 'redesigning everything from chairs to climates' (Latour, 2009b). In the

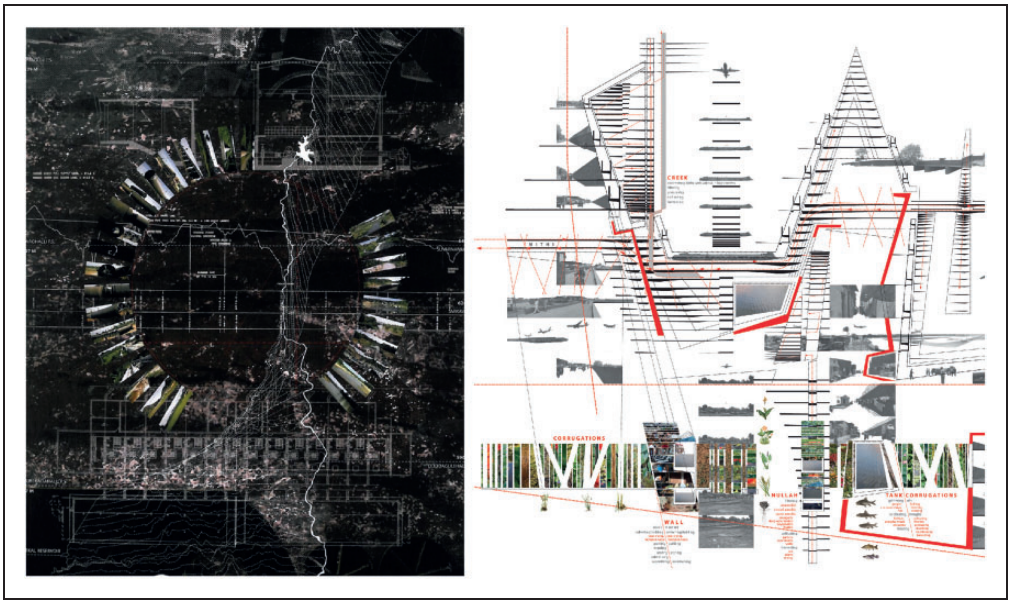

Figure 5. Examples of complex mappings by Mathur & da Cunha. Copyright Mathur & da Cunha. (Source: Left: Mathur and da Cunha (2006) /Right: Mathur and da Cunha (2009)).

light of what is currently at stake, namely our welfare, and more fundamentally, the earth, Latour states:

> *It is as though we had to combine the engineering tradition with the precautionary principle; it is as though we had to imagine Prometheus stealing fire from heaven in a cautious way! . . . We have to be radically careful, or carefully radical . . . What an odd time we live through.* (Latour, 2009b: 3–5)

A projective conclusion: moving beyond the post-political and post-critical

Some may argue that we have arrived at this 'carefully radical' attitude with the launch of *ecological urbanism*. In its aftermath, ecological infrastructure projects, in which the careful ecological is the leading principle, are being studied and implemented worldwide, giving proof of a radical – i.e. large-scale, reiterated and universally applicable – physical intervention. Precautionary environmental features such as 'biodiversity', 'resilience', 'CO2 emissions', 'bird habitat' and 'bioremediation' are central in the 'careful' design of our future. Strikingly complex and precise digital mapping techniques, seemingly regardless of size and cultural context, derive sustainable frameworks from the site as convincing and legitimizing rationale for the –radical – transformation of large areas. A clear differentiation can be noticed, however, if the question is posed in its political rather than its physical sense. In fact, one can argue that discourses such as *landscape urbanism* or *ecological urbanism* – while being radical with regard to their biophysical topographical interventions – are conservative with regard to socio-economic territorial change.

While early nineteenth-century ecological infrastructure projects were largely determined by socio-political aspirations, in contemporary theory and practice, 'grand ideas' about

society with related spatial ideologies are lacking, or at least less explicit. Infrastructure design used to be associated with the 'exterior' action of a technology-driven territorial intervention in a socio-natural environment, aspiring a well-defined modernization project. Today, the shift of infrastructure from engineering to urbanism, from the urbanization of nature to the naturalization of the urban, with related (post-)environmentalism has internalized interactions between technology, society and nature. Urbanization moves from a political project to a preconditioned geographical background over which natural processes play. Nature moves from resource to goal, urbanization from project to resource. Territorial strategies of extracting urbanization from nature are inverted to Nature itself being derived from urbanization. While infrastructure used to be designed to overcome nature in order to ensure urbanization and indeed the circulation and governance of population, ecological infrastructure today is geared at the mobilization of nature into calculated corridors and networks, overgrowing the urban context (Adams, 2014). Although current rhetoric formulates an urbanism 'against' engineering, one could state it is even closer to what is narrowly defined as technocratic, problem-solving engineering projects – interventions with only an internal logic, without considering the broader context – than early technonatural projects dealing with environmental crisis at the dawn of industrialization. Design is ending up being what it rejects.

In the complex, sophisticated self-organizing and evolutionary topographies drawn out by contemporary designers, political forces at work are obscure and structural ideas about social innovation are literally and figuratively displaced. Thompson notes that 'one of the ironies of the 'battle of the urbanisms' is that New Urbanism and Landscape Urbanism are both uncritical of capitalist urbanization and suspicious of governmental intervention' (Thompson, 2012: 16). The central position of the technique focussing on (pseudo-)scientific rationales rather than socio-economic problems/aspirations thus instigates a transition to a populist stance within urbanism, happily associating with the post-political condition. 'In post-politics, political contradictions are reduced to policy problems to be managed by experts and legitimated through participatory processes in which the scope of possible outcomes is narrowly defined in advance', Wilson and Swyngedouw (2014: 6) summarize. Indeed, the mobilization of expert knowledge, complex sophisticated technical practices, and the focus on managing local, mainly biophysical, parameters, instead of social priorities, efficiently function together to reduce controversy and reach stakeholder consensus, thus circumventing political disagreement (Žižek, 1999). Similarly to the technology-driven eco-city, which still remains largely on paper (Harris and Moore, 2015), widely implemented sustainable infrastructural design sustains a post-political and post-democratic urban system as well as a post-utopian and post-critical discourse in urbanism. Political choice and a progressive ideological position are foreclosed in the name of broad consensus and stability (Metzger et al., 2015), i.e. the preservation of existing bio-physical life and more so, the safeguarding of capitalist life:

> *An extraordinary techno-managerial apparatus is under way, ranging from new eco-technologies of a variety of kinds to unruly complex managerial and institutional configurations, with a view to producing a socio-ecological fix to make sure nothing really changes. Stabilizing the climate seems to be a condition for capitalist life as we know it to continue.* (Swyngedouw, 2010: 222)

In addition to the unjust effects of these (socio-)ecological fixes, probably doing more harm than giving way to unbridled patterns of urbanization (Harris and Moore, 2015; Swyngedouw, 2010), one can fundamentally question the 'sophistication' and 'truth' of the techno-managerial apparatus, in this case landscape ecology. Besides the dubious

ability of the super-science and its techniques to merge exact sciences with the social sciences and the humanities (Fournier, 2013; Gandy, 2008b; Kirchhoff et al., 2013) in order to detect, enhance and govern self-organizing, co-evolutionary socio-ecological systems, the prominence of the technique and scientific motives paradoxically instigates a shift in (design) culture from rational arguments to myths naturalizing societal and individual justifications, views and hopes (Essebo and Baeten, 2012). Also, Williams concludes that current discourse about ecological crisis is more about a choice of myth rather than scientific questions. She discerns three scenarios for the construction of myth: upward to salvation corresponding to the culture of progress and modernization; round and round in cycles, corresponding to a state of eternity incorporated in the idea of sustainability; and finally, downward to destruction, in which the end of time is integrated into the present. In today's crisis-laden future without end and without hope of redemption (Wakefield and Braun, 2014), in the idea of a constantly rolling apocalypse forever, in which time is perceived as an endless extension of the present (Agamben, 2011), crisis is no longer imminent though, but immanent. It gets to be an existential anxiety demanding urgent and immediate action (Swyngedouw, 2010: 216; Williams, 2013: 343–345). The myth of sustainability and resilience appears to be the only dispositif to preserve and protect life, to maintain the patterns of present structures and the merely possible (Raco, 2015; Wakefield and Braun, 2014). Today, designers have inscribed themselves in this millennianist discourse, of a present to protect and preserve, as well as added the first myth of 'progress' to the cooking pot. They are producing an instant fix, cleverly combining Williams' three scenarios: ecological infrastructure holds the promise of postponing apocalypse by enabling life cycles, while facilitating *economic* progress through capital accumulation guaranteed by the creation of socio-ecological, self-organizing surfaces. The myth of a sustainable future has tied together ecology and economy in a widely accepted, illogic bond where sustainability is a source of growth that inverts the idea of 'Limits to Growth'. As a consequence, the myth of sustainability as justification for continuous economic accumulation takes precedence over imagineering other socio-spatial systems. Mitigation and adaption, precaution and preparedness, or 'dystopian avoidance' of an apocalypse rather than utopian confrontation, are the logics legitimizing action (Anderson, 2010; Timms et al., 2014). Within these plans and processes, where immediate and distant time as well as local and global spaces are converging, the political disappears from the equation.

Instead of addressing socio-ecological conditions merely with 'careful' sophisticated techniques remedying local ecological problems while avoiding or confirming socio-political and economic issues, it is argued here that design should also pay attention to radically reconceptualizing the relation between man and environment by bringing in the notion of territory as political technology. In order to do so, design urgently needs to extend its interdisciplinary ambition beyond the natural sciences and tie in with critical discourses such as political ecology and critical mapping, as well as the socio-political focus of engineering and STS. Let us recall Koolhaas' contribution to the launch of Ecological Urbanism at the GSD Harvard, appealing for technological interventions with a clear and explicit socio-, even geo-, political ambition: 'we need to step out of this amalgamation of good intentions and branding and move in a political direction and a direction of engineering' (Koolhaas, 2010: 70). Instead of finding legitimation in a position 'against' engineering, a disciplinary recalibration to a broader, and more historically sensitive, understanding of engineering taking position as 'the most basic act in making the city', in 'encoding civilizations on their territory' (Koolhaas, 1995b), needs to push urban design beyond the post-political and post-critical. As an alternative, Koolhaas proposes a design mode for landscape/ecological infrastructure that ties in with engineering and its

fundamentally territorial outlook. The North Sea Master Plan of OMA serves as an example of this ecological urbanism driven by a socio-technical rationale as it envisions a cooperative supra-national infrastructure development of renewable energy, beyond competing national and/or private claims (OMA, 2010) (Figure 6). The design ambitions address the core of global environmental issues, instead of scratching the surface. It compares with Buckminster Fuller's radical and simple schemes combining nature and society, beyond local 'greenwashing' of the urban tissue. In fact, such large-scale schemes of sharing resources tie in with a long tradition of transnational cooperation between engineers, setting up transnational infrastructure networks. The recently published edited volume *Cosmopolitan commons: Sharing resources and risks across borders* (Disco and Kranakis, 2013) studies some of these internationally engineered systems in history, organized to protect both humans and nature. The socio-technical cosmopolitan common is approached as a new kind of moral economy that, if designed and governed appropriately, could direct the individual to the collective and thus be an essential building block of social and environmental sustainability and, indeed, justice (Disco and Kranakis, 2013).

The socio-technical common, or socio-ecological common more specifically, is a promising concept to explore further as it connects the technical, or ecological, with an ideological socio-political ambition. However, we must be cautious not to be tempted into earlier political technologies constructing territories of infrastructure networks interconnecting people, leading to 'universal peace', presupposing tolerance and an already existing common sphere (Stengers, 2011). Instead, this is an invitation to research ways to connect the idea of the socio-ecological common with the concept of cosmopolitics (Latour, 2004b; Stengers, 2011). Flattening consensus and myth should be replaced by explicit choice, conflict and an ideological position combining careful environmental

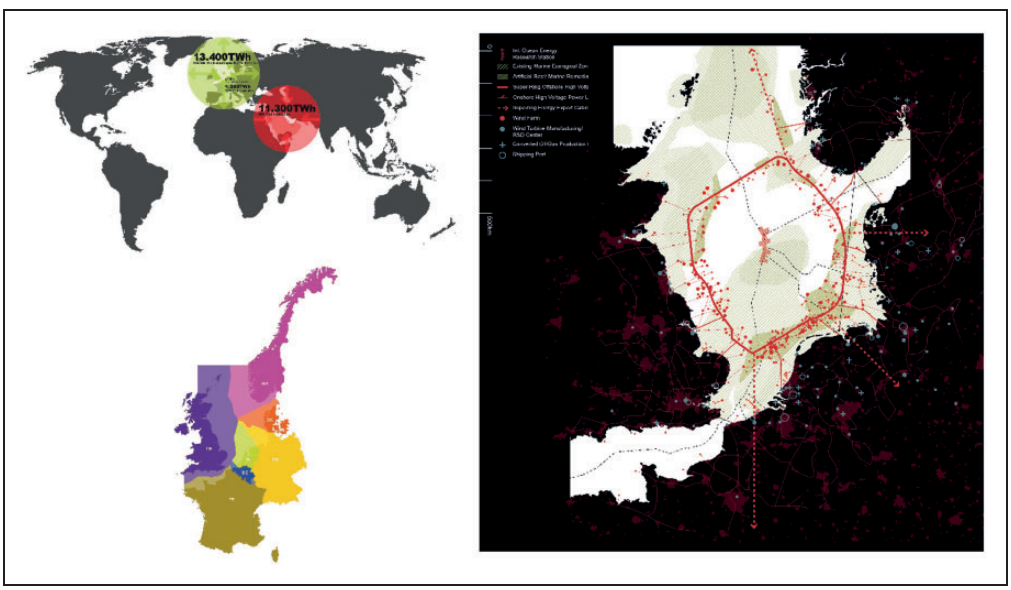

Figure 6. Schemes for renewable energy production in the North Sea, by OMA. The wind farm development collectively creates a new and dynamic landscape at sea and land, beyond competing claims. The masterplan attempts to reposition wind farm development in positive and productive relation to the cultural forces by which it is currently challenged. Copyright OMA.

concerns with radical strategies and imaginaries generating more socially just constellations (Kaika and Swyngedouw, 2014). Debates about green infrastructure should move beyond the self-referential discourses of (landscape) architecture and urbanism focusing on its 'necessity' and ability to work with complex data,[6] and focus on a critical re-coupling of radical territorial engineering of a green 'common' with careful landscape architecture. Instead of designing smooth harmonious surfaces in which politics are foreclosed or black-boxed under the zeal of complexity and sophistication, ecological infrastructure should be constructed as a radical, progressive project, as a space of confrontation and conflict, where political antagonism can be played out and the 'socio-ecological common' can slowly be composed out of a multiplicity of voices. Evidently, these questions become particularly relevant when design rationales that spring from the (ivory) towers of our academic knowledge are 'exported' into global practice, often into countries where social inequality with regard to (ecological) infrastructure is even more pertinent.

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Notes

1. Landscape urbanism was launched in 1997 at conference at the Graham Foundation (Chicago). Main publications propagating *landscape urbanism* include *Landscape Urbanism: A Manual for the Machinic Landscape*, edited by Mostafavi and Najle (2004); *The Landscape Urbanism Reader*, edited by Waldheim (2006); and the special issue on landscape urbanism of *Topos* (No. 17, 2010) (see Thompson, 2012: 7). Ecological urbanism was presented as the progression of landscape urbanism at a conference at the Harvard Graduate School of Design in 2009, followed by a publication in 2010, edited by Mostafavi and Doherty (2010).
2. Nature is here narrowly defined as bio-physical processes.
3. See George Orwell, *Nineteen Eighty-Four* (1949), referring here to dystopian scenario of total control and predictability, where technological systems determine social order. For a link to social science work on biosecurity, see Hinchliffe and Bingham (2008).
4. See for example Foucault's work on biopolitique: Foucault and Senellart (2004).
5. James Corner refers to the general French meaning of milieu, that is 'surrounding' and 'middle', implying a field of connections. In his discourse, milieu emerges and is not, like in the nineteenth century design based on Lamarck, and thus exterior to human beings/organisms.
6. See for example the upcoming conference *Landscape Architecture as Necessity* organized by the University of Southern California, September 2016.

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