Water Purificative Landscapes – Constructed Ecologies and Contemporary Urbanism

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Abstract
Historically the cultivation and urbanization patterns of cultural and urban landscapes used to be tied very closely to the logics of their watershed, with the flow of water being one of the most important factors creating landscape relations. However in modern times centrally controlled and mostly invisible water infrastructure systems have disconnected urban land-use from the logic of the watershed as well as people's experience from the ecological processes of the landscape. Due to the worldwide processes of simultaneous urban growth and decline, we are currently facing huge challenges concerning the affordability and functioning of centralized water infrastructure as a precondition for human survival. This situation and the urgent need to rethink concepts of water infrastructure are considered a strategic chance to strengthen the profession of landscape architecture. By the examples of two cases from a shrinking city in Germany and a growing city in China it is discussed how a drainage and water purification network as a hybrid of built infrastructure, ecological functions and people's green space can serve as a fundamental component of changing urban and regional form.

Keywords
Landscape infrastructure, ecosystem performance, ecological engineering, water sensitive urban design

INTRODUCTION

Traditionally the landscapes that ensured human survival were closely related to “Living with water” in a way which tied urbanization patterns closely to the underlying hydrological conditions. But in contemporary times “Living with Water” basically is related to the dependency of human survival on the centrally organized and mostly invisible infrastructure systems that transport drinking, rain and waste water for hundreds and thousands of miles. These systems have disconnected the land-use from the logics of the watershed as well as people’s experience from the water-related processes of the landscape. The potentials of these water infrastructure systems for shaping urban form and meeting broader human, ecological and aesthetic objectives have almost been lost. However the simultaneous worldwide processes of extreme and unpredictable urban growth and decline are leading to huge challenges concerning the affordability and functioning of present water infrastructure conceptions and thus demand new solutions. Taking these challenges as a departure point, this paper will introduce a landscape approach for the design of water management, movement and purification systems as an integrated part of an open space framework.

WATER INFRASTRUCTURE AND THE DEVELOPMENT OF URBAN LANDSCAPES

Historically the cultivation and urbanization patterns of cultural landscapes used to be tied very closely to the logics of their watershed, with the flow of water being one of the most important factors creating landscape relations (van Buuren/Kerkstra 1993, Picon 2005, Shannon 2007). Water infrastructure systems, meaning the methods of distribution, storage and recycling of water, were based on a deep understanding of a site’s geography, topography, hydrology, climate and ecology. Based on the existing “hydrological landscape structure” (Buuren/Kerkstra 1993) in order to make the best use of natural water resources, a man-made system of canals, ditches, ponds, dams and reservoirs was introduced during the process of cultivation and urbanization. The appearance of these man-made water infrastructure systems, further accentuating the underlying natural physical landscape structure, became a major visual and spatial component of structuring and organizing cultural landscapes. The applied techniques of both linear and punctual water infrastructure are inextricably related to the resulting patterns of land-use and urbanization. The sensibility for a site, its natural characteristics and ecosystem performances, were the key skills of farmers and essential in order to achieve efficiency and survive. The relationships between natural and human processes, based on a deep understanding of complex and dynamic ecological processes, were actively applied into the physical construction of infrastructure landscapes and settlement patterns.

Figure 1: Cultural landscape patterns resulting from the adaptation to the characteristics of the watershed

With the increasing concentration of human activities and settlements during the development of pre-industrial cities and urban landscapes, the water systems had to perform even more functions. Water infrastructure could create synergies with other important urban functions such as providing transportation routes for goods and building materials, serving as an open space network for social needs, supplying water for domestic and industrial uses as well as serving as a system for stormwater retention, irrigation and waste water disposal. In this context hydraulic engineering used to be a major component of territorial planning and water infrastructure systems were extremely prominent in most cities. Not just that most urban agglomerations were located on the

banks of natural rivers – at the same time the urban tissue was criss-crossed by a dense system of man-made open canals and ditches. Picon 2005 points out that most European cities resembled Venice or Amsterdam before the canals were filled in during the 19th and 20th century for space, traffic and sanitary purposes. It is hard to believe that also Tokyo still in the 19th century used to be a very open, green and wet city. A system of segmented rice fields was planned as an integral part of the urban tissue, which did not only provide food to the citizens, but at the same time performed as a system of preventing floods and irrigation (Yokohari 2000). Overall it can be stated that in the first phase of urbanization and intensification of land-use, water was gaining even more importance as a structural and visual component of urban and regional form than in cultural landscapes dominated by agricultural land use. Many of the few still existing examples of such kinds of cities have become popular tourist sites - clearly showing that the most profoundly moving urban water landscapes are nothing more than the irrigation, domestic water supply, transportation, sanitary sewer and flood control systems of the time. These landscapes allow the site-specific natural processes to still be revealed and utilized within the urban setting.

Figure 2: Settlement patterns resulting from the logics of the watershed being evident within the city

However the increasing pressure, intensity and speed of urbanisation lead and is still leading to the disappearance of any visible form of water infrastructure in most cities. In almost all fast-growing urban agglomerations especially of the developing countries this process can be observed happening within a much shorter time than in the Western countries. Analyzing the effects of the urbanization processes on water systems by the example of Cantho in Vietnam, the typical development towards the disappearance of water from the originally water-based urban settlement patterns becomes comprehensible:

In the rural areas of Cantho each farmer´s house is located next to come watercourse, either a stream or a man-made canal used for irrigation and drainage as well as transportation. The pond next to each of the houses on the one hand serves for the disposal of human faeces which are used for raising fish, on the other hand provides the soil for mounds which protect the buildings constructed on top of them from floods. The citizens are not dependent on any kind of municipal infrastructure but are self-responsible to make the best use of resources and take the advantages of nutrient recycling. But as the population rapidly expands due to the urbanization pressure these independent methods are not effective against the rising problems of water pollution – with the open water channels being used mainly for wastewater disposal resulting in very bad sanitation and health conditions. To solve these pressing problems as the urbanization increases even further the water channels are being covered up with the buildings and sealed surfaces connected to them by underground pipes – which eventually leads to very dense urban fabrics and the loss of all visible water and open space .

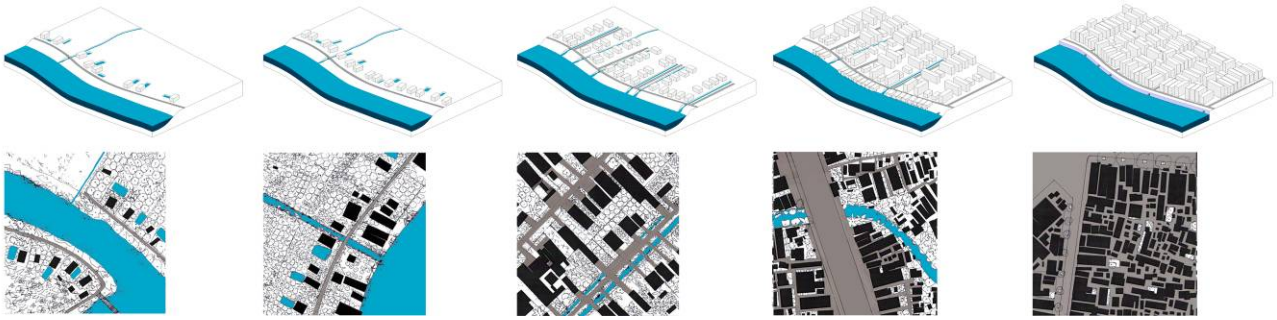
Figure 3: The loss of visible water systems within the urban landscape of Cantho, Vietnam (Nemcova/Wust 2008)

Such as in downtown Cantho, in most of today´s urban agglomerations there are hardly any visible open water systems and the cities have become dry. A vast network of underground water pipes and sewer systems is replacing the smelly and dangerous open water courses, being considered a major progress in the field of engineering and urban planning. At the same time the urban structures of cities are increasingly dissociated from the organisation of the hydraulic system, erasing the visual and spatial logic of the urban watershed. The water problems are solved by engineers in a technical and preferably invisible way, so the urban and landscape designers gain the freedom of being able to focus on aesthetic and spatial design issues of the urban layout – with the effect of their designs becoming arbitrary, exchangeable and one city looking much like another, regardless of where it is being built.


Figure 4: Networks of invisible water infrastructure replacing open water systems

Today´s autonomous technical water infrastructure systems designed by engineering specialists are widely considered the only way to solve the huge problems of water pollution and flood control related to urbanization. But can we afford this kind of merely technical approaches to problem-solving in the future, looking at actual tendencies of urban development and their effects on conventional water infrastructure systems? And how could landscape architects contribute to the discussion about affordable and effective water management strategies?

PROBLEMS OF CENTRALIZED WATER INFRASTRUCTURE SYSTEMS AND PROSPECTS FOR INTERVENTION

The construction and maintenance of a conventional waste water system's vast underground sewer network covering the whole urban built-up area is very costly. Thus the necessary investment for these centralized systems needs to be distributed over a long amortization period of at least 50-100 years. This also means that decisions have to be made on the spatial layout, dimensioning and technical standards based on predictions concerning population and urban development processes for the following 50-100 years. However the actual simultaneous and unpredictable development processes of extreme urban growth as well as urban decline taking place within only a few decades cannot be comprised by centralized large-scale systems.

Infrastructural challenges of shrinking cities and urban population decline

While global urbanization is progressing quickly with already more than 50% of the global population living in cities, the urban growth is becoming increasingly unevenly distributed: In the

1990s more than a quarter of the world's largest cities shrank with their number continually increasing (Oswalt/ Rieniets 2006). This means that many cities, such as Detroit in the U.S. or Halle in Germany, were built for populations two or three times their current size. However planning concepts and engineering techniques traditionally always only had to deal with problems relating to urban growth and densification, not with shrinking cities and sparser urban population. Many cities in Germany are already affected directly by the problems and consequences resulting from keeping up the existing water infrastructure paradigms under changing urban conditions:

After the German reunification huge sums of money were invested into upgrading and extending the water infrastructure of Eastern Germany's cities, expecting their prosperous development for the future. However, due to high levels of outward migration, in many areas within only ten years the amount of wastewater dropped down to less than one quarter of the expected intake that the systems had been dimensioned for (Koziol 2005). Even in cities that so far did not lose any population, like for example Hanover in Western Germany, people and companies tend to move out of the city centres into suburban areas. This means that even in the non-shrinking cities the amount of wastewater flowing through the pipe systems is much reduced due to decreasing urban density with sparser populations distributed over larger areas. As a result in many German cities the under-loaded sewers need to be flushed constantly to avoid smell and the accumulation of pathogens.

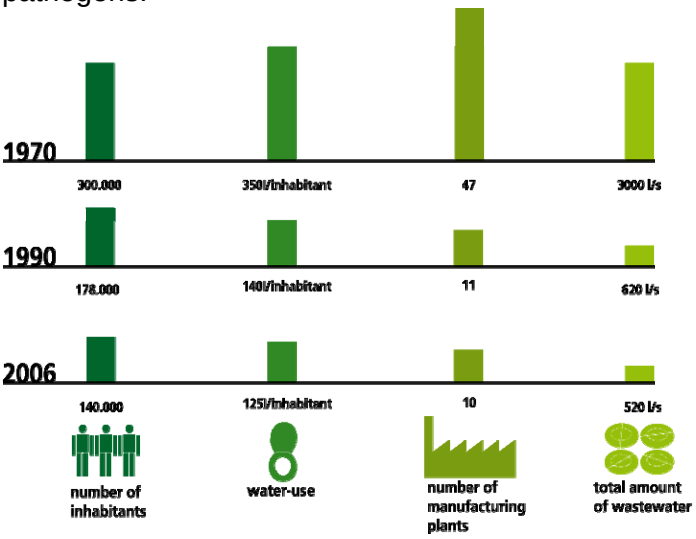

Figure 5: Amount of wastewater in catchment area of Hannover´s city centre reduced to 1/6th within 30 years due to urban development trends

The maintenance of the over dimensioned water infrastructure demands enormous expenses. At the same time there are rising costs for the design and maintenance of the increasing area of open space within cities, due to reducing population densities and building vacancies which partly lead to the demolition of built-up areas. It becomes more and more obvious that under these circumstances the existing kind of urban landscape and infrastructure cannot be maintained to keep functioning in the future. There is an increasing need for concepts addressing transformation and deconstruction issues while safeguarding function, compatibility and appearance.

Infrastructural challenges of growing cities and uncontrolled population growth

While the processes of shrinking and declining cities are most evident in the industrialised countries, the rate of urban growth rapidly increases in the developing countries in a high-speed process of catch-up urbanization. In less than 30 years some cities like Bombay, Beijing or Lagos developed to become large metropolises – whereas in the industrialised countries it took a metropolis such as London, New York or Tokyo more than a century to grow to a megacity. Urbanisation processes in these new megacities are taking place with a speed and intensity that puts the strategic and innovative capabilities of planners and politicians to a difficult test. Due to the ongoing high influx of urban migrants and high rates of natural population growth the cities are increasingly subject to a loss of governability and control – with the consequence that more and

more processes are unregulated and take place informally or illegally. There are all kinds of living and urbanisation stages and conditions next to each other – merging of villages and urban expansion, slum districts alternating with upper-class residential districts, chaotic and random patterns of land use with a large spectrum of varieties, formal and informal patterns of "patchwork urbanization".

The speed and intensity of densification processes seriously outpace any kind of planned water infrastructure provision and the expensive construction of pipe and technical treatment systems cannot be adjusted to the rapid and unplanned processes of construction developments. Supported by international organizations like the World Bank a lot of money is invested into building up high-tech wastewater treatment plants. However they often can not be operated properly due to the incomplete or deficient sewer networks. As a consequence most megacities suffer under extreme water pollution and hygienic problems due to unsolved water management. In many cases the provision of drinkable water and sewerage services especially to the residents of informal settlements has been abandoned. At the same time the sealing of huge areas leads towards big problems of groundwater subsidence and increasing floods.


Figure 6: Water pollution and water infrastructure problems in developing countries

However contemporary landscape and urban design still usually do not address these issues, looking at urban landscapes with mainly aesthetic considerations constrained by an attachment to the picturesque. To become more attractive most cities are developing programmes to open up their inner-city waterfront locations on canals and rivers and attract new residents with concepts like "lake paradise" or "blue lake county". Landscape architects so far mostly have not questioned the technical nature of infrastructure, either applying the "camouflage approach" of hiding and cosmetically beautifying infrastructure or the "mitigation approach" by implementing laws and compensation measures to limit its negative effects. While the expensive ornamental landscape beautification of cities is increasing very fast, the infrastructural and ecological conditions within the urban environment are deteriorating even further.

APPROPRIATING WATER INFRASTRUCTURE AS URBAN LANDSCAPE

The need to rethink concepts of water infrastructure can be considered a strategic chance to strengthen the profession of landscape architecture. As Elisabeth Mossop and Kongjian Yu suggest in their claims for "affordable landscapes" (Mossop 2005) and "Recovering landscape architecture as the art of survival" (Yu 2006), the profession of landscape architecture should shift away from its current focus on privileged and expensive landscapes towards landscape-based solutions to current issues of landscape problems related to urbanisation. One of the key problems of the current urbanization trends described in this paper is related to conventional concepts of urban drainage and purification systems – and a lot of money needs to be invested into exploring new solutions in the future. Rather than leaving this field to engineers the profession of landscape architecture should use this window of opportunity to take a leading part in the reconstruction and development of urban infrastructure systems – taking the landscape as a starting point.

Why could the profession of landscape architecture take a major role? The strength of landscape architecture lies in its ability to extend our current understandings of infrastructure, linking the performance of natural processes with engineering and urban design strategies. By reuniting the

built and the natural we may find new logics towards a more resilient development of infrastructural landscapes as a base of sustainable urban and regional form. One of the precursors of our profession, Frederick Law Olmsted, is often mentioned as the first landscape architect actively applying this approach as early as the 1880´s in his proposal for Boston´s “Emerald Necklace” – integrating ideas of transport infrastructure, flood and drainage engineering, purification functions of wetlands and ecological restoration into the creation of an aesthetic scenic and recreational park landscape for citizens (Zaitzevsky 1992).

Considering the described challenges related to water infrastructure provision within shrinking and growing cities it is all the more necessary to develop systems involving both human and natural processes. Rather than trying to eliminate ecological processes and invest huge sums of money to replace them within controlled technical systems, we need an “intellectual leap by comprehensively applying the understanding of ecological processes and natural systems to human settlements and planning” (Mossop 2006).

Case study “Mueßer Holz”, Schwerin - towards an infrastructural landscape approach within shrinking cities

Some areas within German cities may resemble scenes of Alan Weisman´s book “The World without Us” describing what happens to our cities´ seemingly solid infrastructures and buildings if nobody cares about them any more. There are buildings without residents, roads without buildings, green spaces without parks, sewer systems without any waste water. One of the main reasons of the past to invest into expensive underground water infrastructure does not exist anymore: the limitation of urban space and high concentration of citizens. On the contrary, in shrinking cities it is hardly possible to maintain urban coherence and functions which speeds up the process of the citizens leaving and these areas deteriorating even further.

Figure 7: Shrinking urban areas in Germany: the example “Mueßer Holz”, Schwerin.

One example of these shrinking urban areas is a district of the German city Schwerin named "Mueßer Holz". It is located in the south of Schwerin and is one of the younger districts of the city built from 1978 to 1989. All the buildings are constructed of large prefabcricated concrete slabs with an average height of 5-6 stories – they are the typical style the former German Democratic Republic´s large housing development schemes which were the most favourable places to live before the German reunification in 1990. The city of Schwerin is located within a landscape of lakes and forest. Originally laid out for 29.000 inhabitants, in 2004 there were only 13.000 inhabitants still living in "Mueßer Holz" and additionally one fifth of the apartments were unoccupied. Thus the municipality decided to tear down some houses in order to relieve the housing market but can only invest very limited financial resources into upgrading the remaining open space and infrastructure systems to improve living conditions.

Within her diploma thesis Berit Miehlke developed a concept taking the water infrastructure challenge as a starting point for the generation of a new urban landscape to meet the challenges of the future development of this district. Every time a building is pulled down, its remaining concrete basement will serve as a basin for a plantation of willows within a gravel filter for wastewater purification. Hence the remaining domestic sewage water can be treated within the district and the area can be disconnected from the sewage network. The sewage water serves as fertilizer for the short-rotation willow plantations which can be harvested every 3-4 years to provide biomass for energy production and heating of the district´s remaining buildings. The money saved, which would otherwise have to be invested into the maintenance of the under-worked wastewater pipe systems, can now be used for the construction of the proposed new and affordable landscape infrastructure. This landscape infrastructure at the same time gives a spatial and aesthetic framework indicating the positions of the lost buildings, with their volume substituted by growing blocks of trees and their appearance continuously changing. At the same time this concept provides the flexibility for different future options of development: to organize the building demolition and infrastructure construction process step by step, to develop the green infrastructure as a framework for developing new urban functions here or eventually to give up the whole district and leave the willow plantations to develop into forest.

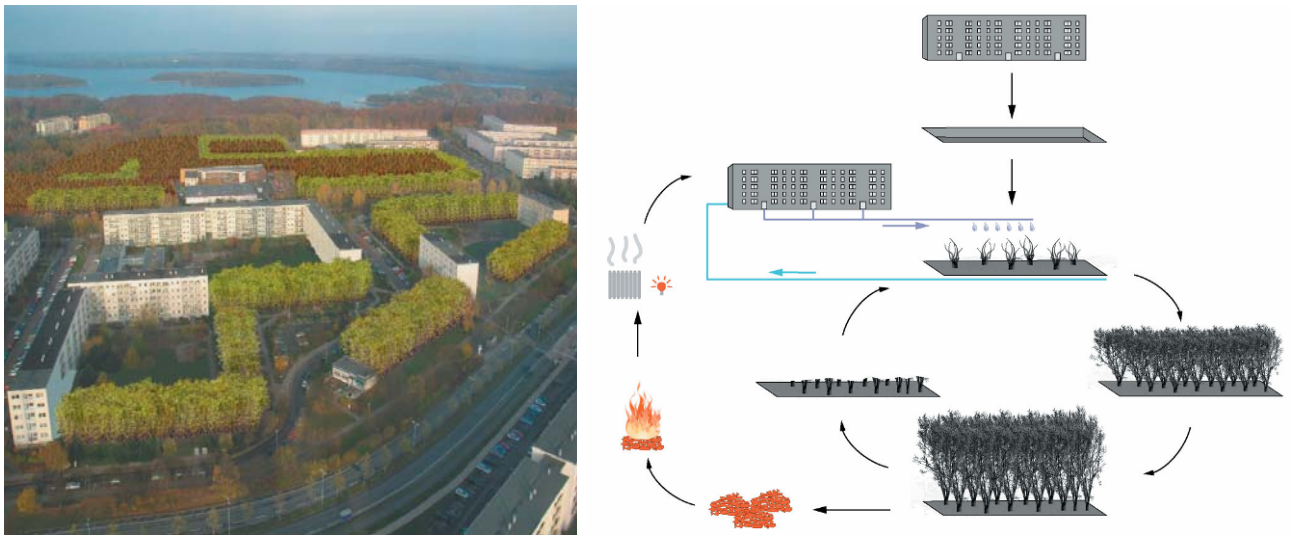

Figure 8: Construction of new landscape infrastructure as a landscape framework for “Mueßer Holz” in Schwerin, Germany (Miehlke 2007)

Case study “HuaXin”, Shanghai - towards an infrastructural landscape approach within a growing megacity

Within the fast growing areas of megacities the conventional planners’ tools trying to control land-use and organize infrastructure services are put to a difficult test. As the cities are becoming more and more densely populated and industrialized it is indispensable to improve the sanitary and ecological conditions and at the same time introduce a system of urban green spaces for recreation reasons. However those parts of the city with the worst environmental and living conditions usually are the poorest parts that can neither afford any privileged landscapes of parks and gardens nor expensive technical infrastructure systems. In this case the basic necessity of infrastructure provision can be used by landscape architects as the most important and maybe only possible generator of public green space which is otherwise getting lost for other construction development.

This approach can be demonstrated by a project in HuaXin, Shanghai designed by the ecological engineering specialists Janisch & Schulz mbH. This district on the outskirts of Shanghai is still criss-crossed by a dense system of canals which have to take up more and more sewage water as the fast developing area is not connected to any water drainage and purification systems. The municipality was already planning to construct a wastewater treatment plant within a nearby park and to cover up all the small canals next to the roads, converting them to an underground drainage

system leading the water to the plant. Janisch & Schulz suggested another plan: to reuse the existing infrastructure of water canals by converting them into linear purification landscapes that can substitute a central water treatment plant. The municipality accepted their suggestion and within four months the first construction phase of this urban constructed wetland was completed. This way the territory of infrastructure was reclaimed as significant to the city's open space design. At the same time the interrelations of the system were kept visible by highlighting the purified water outflow through the installation of a fountain with clean water – for the citizens to understand the processes within this not only attractive but also meaningful landscape element as part of their living environment.

Figure 9: Constructed wetlands to create green and meaningful residential open space in HuaXin, Shanghai (Ingenieurgesellschaft Janisch & Schulz mbH)

CONCLUSION

Globally we are facing complex urban development processes leading to completely new challenges concerning the management and design of urban infrastructure systems and landscapes. Looking to the past it becomes clear that some of the most impressive and moving cultural and urban water landscapes are nothing more than solutions to the irrigation, domestic water supply, transportation, sanitary sewer and flood control problems of the time. And again today infrastructure networks, flows and their relationship to urban form and development are emerging as an increasing topic among contemporary urbanists (Graham and Marvin 2002, Angelil and Klingmann 1999, Allen 1999) as well as in the "Landscape Urbanism" discourse (Corner 1999, Shannon 2004, Waldheim 2006) and the "Green Infrastructure" discourse (Hough 1984, Tjallingii 1993, Sijmons 2004, Ahern 2007, Yu 2006). However the practice of landscape architecture still usually follows the landscape mitigation and camouflage approach, hiding and masking the urban water infrastructure rather than revealing its complex ecologies of intermingling connections between natural, social and technical processes. It is time to consider landscape design to be more than just the beautiful decoration of open space – designed landscapes should rather be inevitable, affordable, usable and ecologically performing components of our urban environments. For the landscape to become infrastructural landscape architects need a more profound and practical knowledge about ecological and infrastructure systems and dare to cooperate with the engineering and urban design disciplines.

The cases from a shrinking city in Germany and a growing city in China show approaches how a drainage and water purification system as a hybrid of built infrastructure, ecological functions and people's green space can serve as a fundamental component of changing urban and regional form. Making use of dynamic and self-correcting natural processes, the designed urban landscapes are working like "artificial ecologies". They contain a higher degree of ecological resilience, require less intervention and technical control than conventional systems and at the same time offer attractive landscape experiences. This way of thinking can shift the paradigm to a different understanding of landscape architecture: it is not something anymore that the society can bear the cost of, but that offers viable solutions for the sustainable design of urban systems.

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