CONTENTS

4 Introduction
The metabolic city
Federico Savini, Willem Salet and
San Verschuuren

6 Metabolism in Research
“If you want to make fundamental changes, the
real problem is the power distribution”
Interview Simin Davoudi
Federico Savini and Koen Raats

10 Metabolism in Practice
“We support such small-scale bottom-up
initiatives, because we think we can learn a lot
from them”
Interview Roelof Kruize
Tom Goemans en Koen Raats

14 Metabolism in Context
The Metabolic Planner: Reflection on urban
planning from the perspective of urban
metabolism
Mendel Giezen and Gerard Roemers

28 Metabolism in 5 CASES
Urban metabolism in five cases

34 PICTURES
Designing with Flows
Fabric

43 Rethinking Waste in Amsterdam
Cornelia Dinca and Sheila McGraw

48 Intelligent Grids and Distributed
Generation
Maarten Wolsink

50 Life in the Slow Lane
Ruggero Beretta and Christian Lapper

58 How history defined Dutch water
waste management
Lilian van Karmenbeek and
Mindy den Harder

64 Metabolism in a green economy
“To build a green economy,
you have to know what your strengths are”
Interview Joan Fitzgerald
Federico Savini and Koen Raats

68 Column
The Metabolics of City Planners
Len de Klerk

70 Column
Becoming circular
Zef Hemel

72 Samenvatting (Summary)
Koen Raats

74 Colophon
INTRODUCTION

THE METABOLIC CITY

It is almost impossible to disagree that climate change is an urgent issue today, and that cities are at the center of discussions addressing this phenomenon. Environmental sustainability has been a central policy concept for 20 years. Several institutional, legal, and economic reforms have been put in place to favor transition to a system of economic growth that is more sensitive to the long-term future of our planet. Yet, today’s debate is colored through the issues that emerge when this problem is addressed. The role of cities has become extremely prominent in political thinking. Cities are seen as the space where climate change can be mitigated and where adaptation can be experimentally tested and successfully implemented. Climate change remains a global issue, regarding macro balances between developed and developing regions; between wealth and poverty.

However, planners and policy analysts look to urban areas for new inspiration. Cities, as composite entities made of different social and economic dynamics, are considered breeding places for creative solutions.

Is that so? To what extent does city planning and urban policy provide room for truly radical innovation in the field of environmental sustainability? Amsterdam is no different from other global cities within this debate. New and old political forces acclaim the innovative potential of urban neighborhoods, creative enterprises and progressive governments to stimulate new thinking over sustainable urbanism(s). Here the frontier of innovative thinking is grounded in known concepts. Recently published agendas for sustainable development reclaim the innovative potential of metabolic approaches. They emphasize the circularity of urban life, the systemic nature of cities, and the dynamic combination of material flows in understanding and addressing urgent urban problems.

The notion of urban metabolism has been around for 50 years. Yet, it has gained a rejuvenated interest in the field of urban studies, planning and architecture, becoming one of the most hip concepts of our time. The idea of metabolism is based on the assumption that the environmental pressure generated by urban life needs to be assessed in a systemic way: a (as much as) comprehensive view on the functioning of an ecosystem through a continuous process of input, throughput and output. The city is viewed by its’ material flows, generally defined into water, energy, materials (including food) and waste. These flows consist of inputs (local, regional, global inflow of resources), throughputs (energy required to transform these resources and waste produced by any process) and outputs (the material outcome of this process). The challenge for policy makers is to design ways to govern each material flow, enabling the reintegration of waste outputs into the cycle.

Technological solutions to improve material flows in cities are numerous. Technical advancement have made it possible to know and adapt almost every dimension of our daily living in cities. Yet, cities do exhibit highly conservative unsustainable behaviors. Even waste recycling remains limited in the city of Amsterdam. Why does this happen? The social, cultural and institutional dimension of sustainable policies is the key to a radical change. This is the fundamental starting statement of our education program at the University of Amsterdam. Innovation and experimentation must look at how people and communities behave and approach urban flows, and at the system of rituals, habits, norms and values that govern our behavior.

The Metabolic City was born in January 2015, built upon this mission: research and practice need to better problematize the social nature of urban metabolism. New policies, hence, do not need to focus exclusively on technological innovation, but must consider how these material aspects interrelate with the socio-cultural environments of cities.

The University of Amsterdam has a long tradition of research-based practical studios. Since the early ’90s we have annually addressed a new innovative and urgent topic in the field of urbanism and planning, using critical theoretical and methodological instruments to design new ideas. The 2014-2015 edition has brought together 45 students, more than 15 speakers and several experts and local politicians in the field of urban sustainability to discuss, reflect and experiment with the idea of urban metabolism. The publication here presented contains a snapshot of the studio and of the ideas rotating around it. The UvA, organizers and the coordinator of the studio are happy to thank the sLIM foundation, the EFL stichting, the Pakhuis de Zwijger and Waternet for making this possible.

We look forward for next year’s edition, with a new groundbreaking topic.

The organizers
Federico Savini
San Verschuuren
Willem Salet
What are the most pressing metabolism-related issues in urban regions?

The most pressing issue, and I explained this in my lecture for this seminar, is the reduction of carbon emissions. Another one, along with that, is water supply. I think these two are the most pressing issues today, but have also been the most pressing issues for the last 50 to 60 years. For research purposes, we have to make an important distinction. Metabolism and climate adaptation are not necessarily the same things, although they are related.

How does the concept of metabolism relate to other ‘sustainable’ research agendas?

I think that urban metabolism is more related to climate mitigation. In any case, what needs to be given quite a lot of attention is the question of disparities in the use of resources. I am convinced that to address this problem properly, we should take a political ecology approach rather than an industrial ecology approach. The political ecology approach’s challenges are not just about the relationship between human and environment. They also provide insight into the relationship between society and environment.

What are the challenges for human practice related to urban metabolism, and could you go deeper into some of these challenges you encounter personally everyday?

Regarding the issue of a clean and green environment, awareness is very important of course—but it is certainly not enough. People can be aware of the risks of climate change, but might not feel responsible to act and do something about it. The reason why this happens can be found in particular social, political and institutional barriers. In terms of my personal challenges, I have to say that I am quite aware. In my daily routines I am being careful about the use of natural resources, and I tend not to waste anything. I decided to walk as much as I can when I go to work. However, I am afraid that my carbon footprint is probably large because I travel a lot for my work, and I haven’t found a very good solution for that.

Is it possible to work on sustainability in a situation of zero economic growth?

First of all, a lot of environmental policies can have economic benefits. A clean, green and a healthy city is very attractive to investors. In
a way, some of these green transitions create co-benefits. There are also many green jobs that could be created. However, there are times that we have to make compromises between economic growth and environmental goals. Some academics have argued that we can have prosperity without economic growth. I don’t know about that, but I agree with the proposition that the economy doesn’t have to grow constantly.

**Who is bringing the issue of metabolism to the political agenda?**

This is a crucial question and an important point. If you look at urban planning at times of crisis, environmental concerns are often seen as a luxury because the most pressing issues are economy related. But that distinction is wrong. It seems that sustainability becomes side-lined. You cannot leave environmental issues aside and encounter these problems in isolation from each other.

**Different groups in society have different types of consumption. This is often differentiated by income. How do address these differences in adaptation and mitigation policies?**

Climate change is going to affect different people in very different ways. That is absolutely true. Some of us are more vulnerable to the impact of climate change than others. Vulnerability is a factor. Factors that could influence vulnerability are for example, age and income. These factors determine the extent to which people are able to take adaptation measures. A simple example is insurance. When flooded, it is likely that the poor have less means to go back to a routine after the floods are gone. If you think about this globally, the differences become bigger. The impacts of climate change effect the most vulnerable often most severely. Related to climate change, there is this irony that the people who are affected most severely are the ones who have contributed the least to climate change. This should be on the agenda of international negotiation.

**We see that cities become proactive when it comes to policies. What is the right balance between the organization and the scale?**

I think that mitigation issues can indeed be done at the higher level. There has to be agreement at the international level about carbon emissions, so mitigation issues need international attention. It doesn’t mean that we shouldn’t do our best at the local level. But adaption is a local issue. Different localities are going to encounter different kinds of local impact. In some places flooding is the most pressing issue, in others it could be drought. So for adaptation in a city or smaller settlements, the local is the right scale of action. But, the governance of climate change is multilevel. Adaption should not happen in isolation from other sectors.

**What kind of norms or rules could be used to address the issue of equality and sustainability and what are the most pressing legal issues?**

One of the most pressing legal issues is to find a Kyoto or a Kyoto equivalent target. A strict, broadly supported international agreement with mandatory targets that would reduce carbon emission, is crucial. It has to be an international agreement to make sure that other countries will not do free riding, and increase their emissions. A country that does not have the abilities or means to follow this path has to be helped and be given access to technology and knowledge.

**If there was an alderman sitting here, because he is working on a new agenda for urban development, what would you advise him to do?**

If we want to make fundamental changes, the real problem is the power distribution in the world with a minority of people being far more powerful than the majority. But, if we do not want to go to that extreme level, I would suggest that we need knowledge of the systems we live in to make meaningful suggestions. A good example is how we have dealt with waste. Originally, the definition of waste was quite strict which made export of waste to other countries impossible. That was useful but had perverse consequences; i.e. it stopped charitable donation of for example clothes to other countries. It is about knowing various aspects of the system.

**How do you cope with the tension between the tendencies to seek short-term solutions on the one hand, and keep an eye on long-term sustainability issues on the other hand?**

We need both, indeed. To address climate change properly, we need a long-term perspective. A short-term vision is not going to work. But on the other hand we are operating in a world of radical uncertainty. There has to be some flexibility to focus on the right actions. That is something that in planning we have to learn. Without a long-term perspective we are moving in the dark. We need a combination of: a long-term vision to guide us, and we have to be prepared to undertake short-term actions.

**How can research and practice be linked in the field of metabolism?**

There is no magic bullet that would solve this problem. What we can do is to reflect on the cycles of policy making which are often shorter than research cycles. So, what we need is an on-going dialogue between research and practice. And we need to understand the constraints upon each field. Another important point for researchers is that we should know the reality and ‘messiness’ of policy making. Researchers often claim that they have evidence, but these could be inconclusive or incomplete but politicians still have to find a way to make decisions. On the other hand, politicians could use the lack of knowledge as an excuse to do nothing. With regard to climate change, there is enough evidence, despite some uncertainties, that things are going wrong. These are enough to take some necessary and precautionary actions.
Roelof Kruize is CEO of Waternet, the water company for Amsterdam and its surrounding. Waternet is the only water company in the Netherlands that is dedicated to the entire water cycle. They supply in tap water, take care of the discharge of waste water as well as Waternet makes sure citizens will keep their feet dry by maintaining the water level and keeping the surface water clean. Waternet is a pioneer in applying the concept of metabolism in water management. Roelof Kruize talked about phosphate, regulation, bottom up initiatives and closing water cycles.

What are the main objectives of Waternet in the Amsterdam region?
We have three main objectives. The first objective comprehends asset-management to make sure that dikes, water supply, wastewater treatment and the water system are in decent shape. One of the key aspects of asset-management is the maintenance of thousands of kilometres of pipes and tubes. Every now and then we have to open up streets and this causes nuisance. Currently we are working on innovative solutions that reduce annoyance and still provide us the desired level of maintenance. Secondly, we have to take measures to be prepared for extreme weather conditions. This objective is very much about climate adaptation. Our third objective is to make our system more sustainable. With regards to this, we focus mainly on how to extract energy and natural resources from the water cycle.

The depletion of phosphate is an urgent sustainability issue since it is an irreplaceable element for food production. What measures are taken by Waternet to deal with the problem of losing phosphate?
A few measures have already been implemented to work on this issue. We have an installation for the production of magnesium phosphate. This installation extracts phosphate out of sewage water and is located at our biggest water cleaning plant. We are finding out whether we could implement this technique at other water treatment plants. Another measure is capturing urine separately at places such as the Amsterdam Arena and the Ziggo Dome music hall: our biggest ‘urine producers’.

Is this phosphate objective something that is pushed by governmental agencies?
No. In fact, they have worked a bit against it. We have been confronted with impediments in sewage pipes. It turned out that this was caused by spontaneous accumulation of magnesium phosphate in the pipes. We thought that we could also capture this phosphate with an installation. In this way we would solve our impediment problems and reduce maintenance costs. But we ran into trouble when government regulation disallowed our usage of the phosphate as the phosphate was defined as ‘waste’. This disabled us from capturing and selling the phosphate. Government has been working to change the legislation on this matter to allow us to sell phosphates to the fertilizer industry. This has taken years; in Germany they were able to adjust this legislation earlier.
Is this an example of how regulation could hamper innovation?

Well, sometimes technologic or societal dynamics develop faster than legislation. Legislation forbids passing waste of vegetables and fruit through the sewage. There are many rules in the Netherlands; they are on the one hand important, since we are a small country with many people, but on the other hand it could limit your ability to think outside the box.

Back to metabolism: one of the main assumptions behind this perspective is that all possible streams can be found and mapped out. However, to what extent is this possible and which information is possibly missing with respect to water cycles?

I do think we already know a lot about our water cycles. As already mentioned, phosphate is one of the topics we can still make some progress. But there are still many unknowns on nitrogen streams. Regarding the process of salinization, many of our sensors are delivering us valuable data.

What kinds of measures are implemented to closed cycles in the water system?

Waternet preserves the entire water system in the Amsterdam region. In other parts of the Netherlands, responsibilities are often divided between municipalities, regional water board authorities, and commercial drinking water suppliers. In the Amsterdam region there are less transfers of water responsibilities in the cycle, which makes it easier to optimize close water cycles.

Many studies emphasize that routines and cultures have to be changed to achieve fundamental change with respect to sustainability. Which routines have to be changed for the employees of Waternet?

I think that our staff, as well as our customers, have to change routines. I notice that we still think quite traditionally when we want to build a new neighbourhood. Besides the point that people don’t want such large-scale neighbourhood developments anymore, they also want to be involved and co-create their environment. Participation is crucial. The difficult projects for us are not the technical ones but the projects that entail intensive citizen participation.

How does Waternet deal with projects that require intensive citizen participation?

By engaging with citizens on time. This sounds simple, but experience tells us that when we do so, 98 percent of the people will support the following process. As Waternet, we also have to be open to suggestions and problems citizens might bring forward. People do know a lot, much more than is often expected.

Koen Raats (k.a.raats@uva.nl) is a Phd-researcher and Tom Goemans is student assistant. Both work at the department of Urban Planning, Human Geography and International Development Studies at the University of Amsterdam.
With more than half of the world’s population and three quarters of its industrial production, cities are the primary consumers of resources such as water, food, and energy in the world. Although urban areas comprise only around 3% of the land surface of the earth, some estimates state that they use approximately 75% of the earth’s natural resources and emit 60 to 80% of greenhouse gas emissions (United Nations Environmental Programme, 2012). Mitigating the resource thirst of cities is therefore crucial to global sustainable development.

Over recent decades, the concept of urban metabolism has gained traction as a framework for operationalizing resource flows within cities to find possible improvements. Key to the approach is changing resource flows from linear (i.e. resources come in, are used and then leave as waste) to circular (i.e. waste becomes another resource and therefore the urban system becomes self-contained). Originally developed within the field of industrial ecology, the concept has spread to related fields such as urban geography, political ecology, and spatial planning. While the concept has been embraced, both theoretically and politically, the practical application of it has remained limited to the optimization of specific waste or energy flows: a comprehensive implementation on a broad range of flows at the neighbourhood or city scale remains a big challenge. It seems that the temporal and spatial dimensions of linking urban flows of energy, material, and water are particularly difficult to address in practice. Geographical aspects such as land-use, infrastructure, building density, and biophysical characteristics differ from location to location and over time. In addition, the metabolism of cities is the result of the dynamic interplay between the institutions that govern the behaviour of different actors within the city and social and global power structures. So this research asks the question: What should the role of urban planners be in translating the concept of urban metabolism from a scientific paradigm into a practically useful tool for urban (re)development?

In this article we argue that, as spatial professionals that transverse specific communities of practice, urban planners are key actors in bringing together the different types of knowledge and actors needed to promote urban metabolism. By using the scientific paradigm of urban metabolism to create a planning strategy, and explicitly addressing the spatial and temporal dimensions, they can enable cities to complete the transition to more sustainable, circular systems of resource and waste flows. To illustrate and develop this argument we first introduce the concept of urban metabolism more broadly. Then we discuss the role of planners in implementing
the concept in practice. And before the conclusion of the article, we introduce cases in the Netherlands where urban metabolism has been applied in practice and describe how urban planners have, or could have, facilitated the process. The first is International Architecture Biennale in Rotterdam (IABR) and the second is the ‘Living Lab’ Buikslootserham in the north of Amsterdam.

A brief history of urban metabolism as a scientific paradigm
To understand the concept of urban metabolism, it is necessary to return to the introduction of metabolism as a metaphor in social analysis. Metabolism is originally a biological concept describing the processes through which an organism produces, maintains, and destroys its material substance and energy. In his analysis of societal inequalities, Karl Marx identified that in the process of industrialization, and its related urbanization, a ‘metabolic rift’ has been created between humanity and nature (Foster, 1999) in which the material substance is no longer clearly traceable to its original source. The products and resources that are consumed in the city have become decontextualized from their ecological origin. Urban inhabitants appropriate their resources from large quantities of land and nature that they no longer perceive (e.g. McClintock, 2010). This human-nature rapture has been increasing since Marx’s analysis, and the urban metabolism concept has been introduced to find a way of addressing this metabolic rift.

Wachsmuth (Wachsmuth, 2012) broadly identifies three strands of literature developing the concept of urban metabolism: human ecology, industrial ecology, and urban political ecology. Human Ecology, dominated by the Chicago School (e.g. Robert Park and Ernest Burgess), conceptualizes the growth and structure of a city as the result of the organization and disorganization of mobility flows. The morphology of the urban is closely related to the ability or non-ability of city developers to organize mobility along specified paths. In the case of their non-ability, the disorganization will lead to a reconstruction of the city in an unsteered or unplanned manner. The human ecology of the city is a direct consequence of the metabolic processes within a city and between the urban and the rural. These metabolic processes, however, are completely social from the perspective of human ecology and devoid of interaction with nature or physical flows.

To the contrary, Industrial Ecology focuses primarily on the flows of material and energy through the city. This field has developed from Wolman’s (1965) seminal work “The Metabolism of Cities”, in which he hypothesized the development of a city of one million inhabitants. This article sparked the conceptualization of the city as a machine that takes resources as input and produces waste as output. This approach is primarily used by researchers to quantify these resource flows, to determine the impact on the environment, and to see where efficiency gains can be made. Where Human Ecology was focussed on societal processes, Industrial Ecology leaves societal processes such as power structures or cultural paradigms out of the understanding of the city’s metabolism. In other words it is an engineering approach to the city. The researcher Girardet has been credited for bringing in circular thinking (Wachsmuth, 2012). Circular metabolism, as commonly seen in natural ecologies, reuses waste as a resource. This is contrasted with a linear metabolism, which only focuses on changing resources to products and then to waste without ensuring the reuse of this waste as a resource. This has lead to the conceptualization of urban metabolism as an approach to identify linear flows and make them circular.

Urban political ecology is the third strand identified by Wachsmuth (Wachsmuth, 2012). It builds forth on the concepts of the previously discussed strands, but argues that the city is an assemblage of both natural and social processes. Therefore, urban nature is, similar to urban society, the subject of politics. Swyngedouw (2006) argues that urban development is in essence socio-natural as every product we use and every house we build is a social reconstruction of nature. The one cannot exist without the other and, therefore, a separate analysis of either of them makes little sense. The way flows enter and leave the city is as much the result of political and societal choices as it is determined by the natural limitations and possibilities.

Thus, urban metabolism can be defined as the processing of inflows and outflows of resources and energy within the city. It is, however, determined by a combination of (1) the physical needs of a city and its infrastructure, (2) the opportunities and limitations that the natural and geo-physical environment poses to the provision of these needs, and (3) the socio-economic and political processes and power structures within the city. These factors are interrelated, influence each other, and cannot be separated. The potential of the concept for urban planning therefore needs to be understood from the position of the urban planner in this spectrum of factors.

So where do urban planners fit in?
While we use the term ‘urban planning’ to describe a profession or process for organizing urban development, it is actually a field without clearly defined boundaries. Urban planning is taught at schools of architecture as well as schools of geography, even business schools. In other words the ‘urban planner’ is without a clear identity. However, in our opinion, this is
not a weakness but a strength. The multi-disciplinary knowledge base of the urban planner enables him or her to transcend the dichotomies of human versus nature and the objective versus the discursive. Related to urban metabolism, the planner is the designated person to unite the engineering approach generally taken by industrial ecologists with the human and political approach of urban political ecology. The metabolic planner, as we call him/her, conceptualizes the city as an assemblage of flows that are determined by socio-natural processes and that only get their meaning and significance from a social and political perspective. The metabolic planner translates between these processes and perspectives and tries to steer flows in the city with either physical interventions or discursive interactions by actors within the city.

The rise of social media and general technological developments can be important instruments for the urban planner in these processes. Technological development has increased the metabolic rift: transportation technologies, for example, have led to an increased distance between rural production areas and urban consumers, making the impact of production less visible for consumers. However, technological developments have also given the urban planner more means of monitoring, analysing, and interpreting flows throughout the city. The omnipresence of the mobile phone, traffic measurement equipment, GIS, and citizens’ platforms make it possible to dynamically interact with the city and its population over time and space. Not only does the planner have access to these dynamic modes of information, digital technologies have also made it possible to provide direct feedback to actors on the relation between their actions and flows. The recent popularity of home energy meters and personal fitness wearables show the desire of citizens to be more aware of their internal and external metabolism. Planners should develop ways for actors to interact with their surroundings: in this way technology may enable the closing of the metabolic rift that it has caused in the first instance. However, the planner can also give meaning to this data and thus move data beyond the realm of quantity to measurements that have quality (i.e. transforming data for it to become useful for policymaking and behavioural change).

The metabolism of cities and urban planning in the Netherlands: The International Architecture Biennale Rotterdam and Buiksloterham as a ‘Living Lab’ for circular cities

Until now, the incorporation of urban metabolism in urban planning has been limited in the Netherlands. Studies such as those of Nelson (2007) on the “Erasmusveld” neighbourhood in The Hague show that the concept of urban metabolism can be a useful framework for guiding urban planning and design. However, actual large-scale urban planning practice explicitly

Figure 1: Urban Metabolism Analysis at different scales. (IABR Project-Atelier 2014)
mostly at a limited geographical area, or a specific type of flow. For example, in both of these examples the planning and analysis looks at the neighbourhood rather than the city as a whole, and, especially in the case of the Waterlooscholen project in Sneek, the main flows addressed are water and energy, excluding a range of material flows from the intervention.

However, two recent publications indicate that the concept is finding its way from the academic community to city governments and the broader urban planning community: the papers “Urban Metabolism: sustainable development in Rotterdam” (IABR Project-Atelier 2014), and “Circular Buiksloterham: Transitioning Amsterdam to a Circular City” (Gladek et al. 2015).

The International Architecture Biennale, Rotterdam

This report mostly focuses on the urban metabolism concept as a design perspective; a tool to explore new forms of sustainable urban development. The analysis deals with the following urban flows: goods, people, waste, biota (inter alia plants and animals), energy, food, fresh water, air, sand, and clay. Information and data flows are also briefly addressed. These flows are analysed mainly for the city as a whole and its wider regional and (inter)national environment.

The authors acknowledge that urban development’s trend towards circular as opposed to linear economies means that the spatial planning and development of the city will change significantly, and the observation is made that it is necessary and valuable to explore the role of urban planners with regards to urban metabolism: “The spatial perspective has not yet received the attention it deserves: In what form can we best apply the characteristics and possibilities of substance flows to urban life by means of spatial design?” (IABR Project-Atelier 2014, p. 14). With regards to the tasks of those concerned with the spatial design of the city (i.e. spatial planners) the following tasks are discerned:

1. Securing access of city-dwellers to flows such as water, food, and energy;
2. Creating cohesion between urban flows through infrastructure innovation and optimization;
3. Increase the positive impacts of substance flows and production and consumption chains on the urban environment;
4. Taking advantage of the urban landscape’s “spatial order”, which is affected mostly by the location of infrastructure. These infrastructure networks should be used deliberately to drive urban expansion and development in a sustainable direction.

Interventions on multiple scales are deemed necessary when such objectives are to be fulfilled by planners and other urban professionals: “Metabolic thinking requires switching between different scales, between strategy and spatial design, intermediate flow and associated infrastructure. Instead of incoherent optimizations here or there on waste reduction, it is a better idea to develop a new, integrated perspective in which economy, ecology and spatial diversification are coupled to city, nature and landscape.” (IABR Project-Atelier 2014, p. 130). Aside from operating on multiple geographical scales, this statement also shows that a broad and holistic perspective is necessary when urban planners aim to structurally change the metabolism of a city.

The IABR report shows that the concept of urban metabolism can potentially guide urban design and planning, not just at the scale of the individual neighbourhood, but for the city as a whole. It shows that a wide variety of flows, including not just energy and water but also organic and inorganic materials, should be considered in such planning processes. However, the research also has its limitations.

Although the interrelationships between social processes and physical flows are recognized in the report, it focuses mostly on the different material flows (water and energy) throughout the cities as opposed to the social processes, institutions, and power structures that are interrelated with these flows. This is especially true when looking at the solutions and strategic interventions proposed in the report. While it is proposed that “geographical proximity of material flows and other flows [be] used and a conscious attempt [be] made to look for the synergy between the various flows by linking them to each other at local level or by making more exchanges between flows” (IABR Project-Atelier 2012, p. 78), these flows are influenced through technical solutions rather than by, for example, changing the behaviour of individual actors through different types of urban governance (see figure 1 and 2). Thus, many interventions proposed in the report seem to be rooted in the tradition of material flow accounting as developed within the field of industrial ecology.

Furthermore, although the authors explicitly mention the importance of interventions and planning at multiple scales, the concept of urban metabolism is only applied to the two scales in this paper: the city and its wider environment. None of the flow analysis takes place at the scale of, for example, the individual neighbourhood, although some of the interventions that are proposed are conceptualized at the level of individual houses or industrial locations.
The study of the potential for circular development within the Buiksloterham area complements the research published by the IABR Project-Laboratory in several ways. First, the analysis presented in the Buiksloterham report deals more specifically with the optimal scale at which the different flows constituting the metabolism of a city or neighbourhood should be closed. Second, changes to resource use in the neighbourhood over 20 years are modelled, based on the known development plans, policies, and projects already in place and the intentions of stakeholders. The modelling exercise results in an overview of the current material (water and energy) demands of the area as well as the projected expectations of these flows in 2034. Based on this analysis a set of specific technological (e.g. a renewable energy production plan) and systemic (e.g. the designation of the area as a ‘living lab’, reducing regulatory pressure) interventions are implemented to guide the planning and development process of the neighbourhood.

The Buiksloterham research focuses on analysis at the scale of the neighbourhood rather than the city as a whole, although the city and metropolitan region are taken into account where this is necessary due to interrelationships between the neighbourhood and the wider urban area. Eight different urban zones, ranging from the city centre to the different hinterlands of a city and the (inter)national scale, are distinguished from one another on the basis of land-use types, economic value, density of living and working, etcetera.

Within the Buiksloterham research, general activities and characteristics for functioning within a circular city are suggested for every zone in the framework depicted in figure 3. It is assumed that the city centre has the least potential for closing material cycles since it has “the highest density, the highest property values, and often the least flexibility for reconstruction or technical interventions” (Gladek et al. 2015, p. 80). Since space and activity restrictions are generally less of an issue towards the edge of a city or outside of it, the potential for closing such loops should increase when the distance from the city centre increases.
Aside from the characteristics of different urban areas, recommendations regarding the extent to which cycles within the urban metabolism should be closed at a location depend on the properties of urban flows themselves. The higher the costs of moving a flow (for example because of losses or transportation costs), or the more spatially ubiquitous materials, water, or energy are, the higher the priority for closing the flow locally. Following these principles, the priority for locally closing cycles of rainwater (which has a high degree of spatial ubiquity) or heat (which is relatively expensive move, due to heat losses during transportation), for example, are relatively high. For metals, which are rare materials that can be transported without significant losses and at low costs compared to their potential value, the priority for locally closing the cycle relatively low. In fact, such complex materials may benefit from economies of scale when processed at a central facility, which may be difficult to achieve in zones with high population and land-use densities but may be possible in adjacent zones where more space is available – especially when such areas are well connected to the functional centre(s) of the city (such as the Buikslotherham area).

Aside from providing a theoretical framework for the location at which circular developments ideally take place, the Buikslotherham research broadens the analysis beyond physical flows alone to include the behaviour of actors as well as the institutions and regulations which may influence (or be influenced by) the current and future metabolism. This is done by complementing the analysis of the metabolism of the neighbourhood with an analysis of the context (i.e. infrastructure, current and past activities in the area, policies and strategies influencing these activities, and possible future developments), together with a stakeholder analysis. Thus, the research process comes closer to the analysis of socio-natural systems as advocated by Swyngedouw (2006), Gandy (2004), and other urban political-ecologists.

The awareness of the interrelationships between the biophysical urban system (including the urban infrastructure), actor behaviour, and the institutional context can also be seen in the recommendations for future interventions: aside from possible technological interventions, a range of systemic interventions that may guide future developments is presented, such as the designation of Buikslotherham as an official experimental zone or ‘Living Lab’ for circular urban development.

Obviously, the Circular City Model presented in the paper has its limitations. In the case of Amsterdam it might be true to some degree that the city has one functional centre, whereas a polycentric city (e.g. Los Angeles) is likely to have several of these ‘white zones’. Furthermore the characteristics of these zones, such as population density, morphology, or zoning, may vary by city, or even for different zones within the same city. This illustrates that recommendations regarding the scale and zone at which cycles of different flows are ideally closed should be used as guidelines rather than a set of deterministic principles.

As with the IABR research paper, the Buikslotherham report represents a conceptual framework and a range of possible technical and systemic interventions. The actual planning and implementation process are, for the most part, yet to begin.

However, with the inclusion of many area stakeholders in the research process and the recent signing of the Manifest Circulaar Buikslotherham by several aldermen, private actors, and knowledge institutes in the city of Amsterdam, the concept of urban metabolism has become more than a design exercise. Buikslotherham may well become the first neighbourhood in which the urban metabolism concept is actively implemented as a planning strategy. This provides a unique opportunity for the metabolic planner to perform...
his or her role in practice, operating within both socio-political and biophysical urban systems.

The analysis presented by Gladek et al. (ibid) shows that interventions related to both physical infrastructure and the socio-political urban system will be necessary to ensure that the vision of a circular city becomes a reality. In line with the IABR research, the analysis shows that such interventions will need to take into account the locational characteristics of different parts of the city and the region surrounding it, as well as the characteristics of different urban flows, to determine the appropriate spatial scale at which to close different urban cycles. Urban planners are well suited to operate on the crossover between these different environments, and thus play a central role in getting the concept of urban metabolism implemented in practice.

**Conclusion**

Cities are the main consumers of resources and the main producers of waste in the world. As such, the urban domain offers great potential for reduction of the environmental impact of humans on the world. A promising approach is urban metabolism, which looks at different material, mobility, water, and energy flows within a city. Since the industrial revolution, there has been an increasing rift between humans and their environment, especially within the urban context. This has led to a linear process of resources coming into the city and waste going out. The urban metabolism concept can reduce this rift by changing from linear resource flows to circular ones, wherein waste becomes another resource.

Urban metabolism thinking has three strands: human ecology, industrial ecology, and urban political ecology. The first conceptualizes metabolism from a social standpoint while the second does the same but from the standpoint of material and natural flows. Urban political ecology literature argues that urban metabolism is an assemblage from socio-natural processes that are heavily influenced by political power structures. The latter perspective provides the most comprehensive and most relevant perspective for urban planning as a field that moves between the physical and the discursive domain.

However, the practical implementation of the concept of urban metabolism in spatial urban development has been limited. Crucial to the further integration of urban metabolism in the development of cities will be the role of the urban planner. This new metabolic planner has an eye for the flows in the city over time and space. He or she is then able to analyze these flows, bring stakeholders together, and try to steer from linear to circular flows. As is seen in the two presented cases, technology is not the limiting factor to achieving urban metabolism goals. The difficulty lies in the integration of different scales and different stakeholders. This multi-level, multi-stakeholder inclusion has been at the heart of the planning doctrine over recent decades. Therefore, the planner is particularly suited to make a strong contribution to the implementation of urban metabolic thinking in spatial development.

Planning as a profession has always been a field where scientific and experiential knowledge have been closely integrated. It is therefore well positioned to push this scientific paradigm forward into the concrete reality of urban development. As can been seen from the case studies discussed earlier, improving urban metabolism is not a purely technological intervention. It requires actors, people, to come together in an effort to close resource cycles. The case of Buikslotheram also shows that there is currently a strong will with a wide range of stakeholders to make it happen. The metabolic planner can be a broker between social, spatial, ecological, and technological systems. Thus, he can and should play a crucial role in developing the city towards a more sustainable urban metabolism. The Metabolic Planer is crucial to pushing the city from a resource intensive consumer and polluter to a self-containing entity, and thus the metabolic planner holds the key to the sustainable development of the world in its urbanized future.

**References**

AMSTERDAM SMART CITY

Amsterdam Smart City (ASC) is a unique partnership between businesses, authorities, research institutions, and the people of Amsterdam. Our common goal is to develop the Amsterdam Metropolitan Area into a smart city.

A city is smart when investments in capital and communication infrastructure enable sustainable economic growth. This will increase the development of a high quality of life in combination with an efficient use of natural resources. Over the past three years, the Amsterdam Metropolitan Area has been successful in becoming a smart city.

City-zen is a pilot project that showcases several innovative solutions in the field of applying smart grids, heat networks, and sustainable housing. This pilot was not applied in a separate test location, but in existing urban districts such as Nieuw-West in Amsterdam and Eco-Cité in Grenoble. The tested technologies and concepts proved their value in real life, which makes scaling up and broadening application in the rest of the city (as well as in other European cities) possible. Amsterdam and Grenoble functioned as model cities in this project.

In Amsterdam, the following projects have been implemented:
1. Intelligent net
2. Sustainable heat network
3. Drinking water used for cooling of business area
4. Energy saving by residents
5. Testing living lab
6. Serious gaming
7. Roadmap to city zero energy

Another example in Amsterdam is the Vehicle2Grid pilot program, which has yet to start. The idea of this project is simple: residents will be able to use the battery in their electric car to store their locally produced energy. In this project, residents are free to decide how to put their locally produced energy (i.e. from solar panels) to use. The energy can be used immediately, transferred to the energy grid, or stored in the battery of an electric car.

www.amsterdamsmartcity.nl

AMSTERDAM ROOFTOP SOLUTIONS

Amsterdam Rooftop Solutions believes that we can transform our cities into the metropolis of the future by making use of our rooftops. With our partners we have investigated the potential of the rooftop landscape. Amsterdam has 12 km2 of usable flat roofs and the number of solutions is enormous! Specific combinations of solutions could even have synergetic effects. For example, blue roofs retain water, which is perfect for green roofs. At the same time, a blue/green roof could lower the energy consumption of a building and...
could enhance the efficiency of PV-panels on yellow roofs by cooling the air around them. The Polder-roof is the confirmation that it is possible to combine various functions on one roof. A dike on the roof temporarily retains rainwater. On top of the rainwater basin, a substrate with sedum grows and evaporates some of the water, which has a cooling effect on the building and its surroundings. In the middle of the roof a herb and vegetable garden flourishes. The herbs and vegetables are used by a restaurant situated in the building. Last but not least, a bee colony is kept on top of the roof that pollinates the flowers.

With innovative pilots like the Polder-roof we want to show that multifunctional roofs could make a business case for many stakeholders, both public and private.

For more information contact: Sacha Stolp, sacha.stolp@amsterdam.nl or Jasper Passtoors, j.passtoors@amsterdam.nl

GREENLABEL

In balance, outside.
To bring people back in balance with nature is the main objective of Nico Wissing (visionary expert on sustainable landscape development) and Lodewijk Hoekstra (green pioneer and tv-presenter on various gardening shows). With NL Greenlabel they want to bring sustainability and biodiversity back in our daily environment. NL Greenlabel tells their story by measuring the sustainability level of products. In cooperation with Royal Haskoning DHV, they created an integral sustainability index for products and plants. Also, an entire area can be valued through this index. As of the end of 2014 (2 years after starting), NL Greenlabel and 125 partners have labelled 200 products in various categories ranging from water management, fertilizers, plants, electric lamps, sustainable energy, and so on. The number of labels awarded yearly continues to grow steadily.

Energy management is an essential building block in creating sustainable gardens and spaces outside. Think about the huge energetic value greenery represents. In the products we label, the amount of sustainable energy that was used creating it is reflected on the label. To name a few projects: a stainless steel solar carport, olivine products in which CO2 is absorbed, and products made of locally produced wood or bioplastic.

An example of a successful sustainable project is the labelled and energy neutral neighbourhood of Plantsoenensingel Noord in ‘s-Heerenberg. Also solar park “De Kwekerij” in the town of Bronckhorst is a perfect example of an integral design of various landscape qualities. This is how NL Greenlabel designs hybrid landscapes.

For more information, www.nlgreenlabel.nl

DE CEUVEL

Polluted brownfield becomes Amsterdam’s creative eco-hotspot

A polluted plot of land in Amsterdam has been transformed into a “small piece of paradise” through a community-driven development. De Ceuvel is now an eco-hub for creative and social enterprises. People visiting De Ceuvel immediately notice the key feature of the development: almost all of the buildings are houseboats taken out of the water and placed on land, creating a unique feel. With the use of clean technologies for managing water, energy, sanitation, and food production, as well as cleaning polluted soil with plants, the project is a demonstration ground for “closed loop” and regenerative urban development. The social and innovative aspects of De Ceuvel attract hundreds of visitors every week.

De Ceuvel is on a water-bound plot of land that was secured for a 10-year lease in 2012 through a tender held by the Amsterdam municipality. From a neighbouring collective private housing project, a group came together to put forth the winning concept for re-imagining the site of a former shipyard. Because of the temporary (10-year) nature of the development and a low budget, the multidisciplinary team focused on developing an innovative concept where mobility and reuse were central. The design of the urban plan combines ‘waste’ land and ‘waste’ materials into a source of new value. This green oasis creates a new on-land harbour for these boats, which otherwise would have ended up demolished. As largely autarkic elements, the boats will be able to leave the site after 10 years without much of a trace, leaving the land more valuable and biodiverse.

The polluted soil at De Ceuvel will be purified by phytoremediation techniques, in which plants are used to clean the soil. A specially selected combination of plants is used to stabilize, break off, and take up pollutants. This organic way of cleaning the soil results in a working land-
scape, cleaning the soil and producing low-impact biomass. After ten years, the entire site will be returned to the municipality of Amsterdam cleaner than we got it. Research on purification and low-impact biomass production at 'De Ceuvel' is being conducted by the University of Ghent (Belgium). The particular combination of plants represents a new layer in the landscape that remained hidden before. An alternative approach to pollution transforms the negative history of a place into a positive perspective; a rich and vibrant purifying park.

By first gathering the community of creative entrepreneurs and founding the association before renovating the boats, a lot of building could be done by the members themselves. Not only did this save money, it also taught the users about the clean technologies on the site. Moreover the lively community of De Ceuvel was already arising before any boat was on land.

The De Ceuvel site is a ‘Cleantech Playground’ for the exploration and testing of new green technologies as they become available. The site’s compost toilets and biofilters will collectively save around 6 million liters of water from being used to flush waste and divert 10 million more liters into on-site biological treatment. The eco-retrofits and renewable energy production on site have saved an estimated 600 tonnes of materials throughout construction and will save over 200,000 tonnes of CO2 emissions throughout the site’s existence.

In collaboration with partners such as Waternet and the DOEN-foundation, research is taking place to learn how cities can transform from resource-drains to sustainable cities with a ‘circular’ resource metabolism.


THE ROTTERDAM METABOLISTS

The Rotterdam Metabolists consists of seven Rotterdam-based organizations, all working with passion in a systemic way on sustainable and resilient urban areas. We are Van Bergen Kolpa Architects, Doepel Strijker Architects, Except Integrated Sustainability, Paul de Graaf Design and Research, Superuse Studios, the Urbanisten, and studio Marco Vermeulen. Together we represent about 50 professionals who work on a daily basis on research, design, and realization of groundbreaking projects in the domain of urban development, architecture, and design.

Our shared approach offers insight, ideas, and solutions for working with (material) flows, closing loops, organic urban development, circular economy, urban farming, and resilient sustainable development. We do this by revaluing polytechnic design, transitioning to social-ecological and economic urban development, dissolving the apparent boundaries between local and regional, and discovering the new chains of value and business models in complex systems.

For more information or to express interest in collaborating, contact: info@deceuvel.nl. For information about the urban plan and architecture contact: pr@spaceandmatter.nl and for more information about the sustainability plan, contact: sanderine@metaboliclab.nl

Some examples of the Rotterdam Metabolists:
Top left: Chains in Core Business Models by Superuse Studios.
Top right: the Stormwater retention Square Rotterdam (Benthemplein) by the Urbanisten Middel: San Francisco Transbay Terminal by Except and Value
Bottom right: the ELSIA- approach (Energy, Life, Society, Individual, and Actions) by Except

Urban metabolism
DESIGNING WITH FLOWS

Four Strategies for a New Metabolism for Rotterdam
A project by .FABRIC and James Corner Field Operations

IABR-Project Atelier Rotterdam studied opportunities for the urban metabolism framework to contribute to the sustainable development of the city. To this end, nine vital flows were identified: goods, people, waste, biota, energy, food, fresh water, air, and sand & clay. The Atelier developed a methodology – a design methodology, or the interaction between thinking and doing – beginning with the identification and mapping of the waste per flow, followed by the exploration of opportunities to create prospects for the city and the region.

Designing on the basis of urban metabolism requires an integrated approach in which data is collected, organized, and made accessible. This project demonstrates the city doesn’t need to be reinvented to become more profitable, more vital, more sociable and more alive; it is up to designers, administrators, and investors to organize and exploit existing initiatives intelligently, and make waste a thing of the past.

.FABRIC philosophy
.FABRIC is a knowledge intensive design practice, which is conducted by Eric Frijters and Olv Klijn. Their involvement in architecture, urbanism and research results in FABRICations, which appear in a large variety of media ranging from actual buildings to visual representations and written texts.

.FABRIC concerns testing. Thinking while doing rings our motto, whereas a hands-on approach ultimately leads to knowledge based designs. Our aim is to challenge our clients into a joint adventure. The goal is to find innovative solutions during a common process in which the client is seen as a partner in the project.

In each project FABRIC largely invests in research to expand the available knowledge. We believe that this is necessary to widen the amount of possible solutions. To make sure that this is also the most accurate knowledge FABRIC regularly forms alliances with other offices.

.FABRIC won the Prix the Rome 2010 for architecture, which is the most prestigious prize for young architects in the Netherlands that is awarded once in four years.

www.fabrications.nl

Project credits:
Commissioners
IABR and Municipality of Rotterdam
.FABRIC: Project director(s): Eric Frijters and Olv Klijn
Project leaders
Rens Wijnakker and Bas Driessen, Team: Victor Fernandez Strohanz, Roxana Florescu, Simone Ierardi, Olga van Lingen, Jack Lipson, Andrea Ng, Li Shuyang, Veronika Trnovska
James Corner Field Operations
Project director(s): Richard Kennedy, Team: Megan Born, Aaron Kelley, Veronica Rivera, Sanjukta Sen
Partners
Havenbedrijf Rotterdam (Isabelle Vries, Bram van der Staaij), Planbureau voor de Leefomgeving (Ton Dassen, Arjen Harbers, Anton van Hoorn, Hans van Amsterdam), Rotterdam Climate Initiative (Paula Verhoeven, Fred Akerman)
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Pierre Bélanger (Harvard University Graduate School of Design), Lisa Diedrich (Swedish University of Agricultural Sciences), TNO (Jacco Verstraeten-Jochemsen, Judith Borsboom, Bart Jansen, Harm ten Broeke, Elmer Rietveld), Jan Willem van der Schans (LEI-WUR)
Master studio urban planning 2014-2015

Urban metabolism

Designing with Flows
.FABRIC and James Corner Field Operations
Urban metabolism

Four strategies to design 'Flows'
"Ours is a culture and a time immensely rich in trash as it is in treasures."

Ray Bradbury
Emergence of the Circular Economy

Many of the challenges of the 21st century, including climate change, result from resource overexploitation, consumption and ensuing waste production at rates that exceed the biosphere’s capacity for regeneration and waste assimilation. Our generation’s urban thinkers must now shift development and economic activity to a path that leaves less of a burden on the natural systems we depend upon.

With the OECD projecting a doubling of the world’s economy and resource consumption by 2030 (OECD, 2012) it is urgent that we separate economic growth from resource consumption and waste production. This shift to “green growth” will depend on a broad adoption of policies centered on the 3Rs: reduce, reuse, and recycle.

Figure 1: European Waste Hierarchy
(Adapted from European Commission, 2015)

MOVING UP THE WASTE HIERARCHY

These principles are substantiated in the building blocks of the EU Waste Hierarchy, illustrated in Figure 1, which orders waste management strategies in terms of energy and material conservation: from waste prevention, to reuse of products, recycling of materials, recovering of energy (incineration) to disposal (landfilling). But despite a wide recognition of these principles, waste reduction has remained peripheral, shadowed by policies focused on disposal, recovery of energy, and now recycling, as mandated by the EU’s current waste directive.

Enter the Circular Economy - promising to close the loops of resource consumption and waste production, resulting in a society where humans can live in balance with nature for improved socio-economic outcomes. The circular economy distinguishes itself from current policies by moving beyond waste disposal to consider resource consumption and material conservation. It promises development that decouples growth from resource exploitation.

The Circular Economy in Amsterdam

These principles are found in Amsterdam’s vision for a circular economy, as described in the city’s new Sustainability Agenda (Gemeente Amsterdam, 2014). This document lays out a roadmap for the future of the city based on the dual and interconnected goals of improved management of waste outputs and resource inputs. It aims to increase the recovery of resources and materials by focusing on two priority areas. First it aims to increase household recycling rates from the current level of 19 percent to 65 percent by 2020. This will be achieved by implementing a system of organic waste (accounting for approximately half of household waste) recovery and by increasing the recovery of other materials (i.e. glass, paper, textiles). Second, it proposes to institute circularity within the construction and demolition sector, which is estimated to account for 40 percent of the resources flows in and out of the city. This will be achieved by redefining how the industry operates so that any materials resulting from renovation, construction and demolition projects are reused locally.

These policies align directly with the goals of recycling and reuse, and somewhat indirectly with the goal of waste prevention by reducing the amount of virgin materials that will be exploited. But to really achieve sustainable levels of resource consumption without compromising quality of life, these waste management policies must be coupled with measures that produce less waste in the first place.

In order to do so, the municipality aims to promote improved resource use by supporting innovations that target improved designs that are more durable, resource efficient, and circular. They also aim to promote alternative models of production and consumption that enable a more efficient use of resources, for example through the sharing economy.

To identify the implications of this vision, we undertake an analysis of Amsterdam’s waste management sector and place current ambitions for achieving a circular economy into context to evaluate potential for sustainable growth to be achieved.

Short history of waste management in Amsterdam

Historically, the concept of waste management in Amsterdam gained importance during the 1800s when Samuel Sarphati and a group known as the “hygienists” improved understanding of the relationship between human waste, sanitation and public health. This was at a time when the city’s canals served as both a drinking source and as waste dumps. Sarphati is believed to be the first to institute a system for collecting household waste in Amsterdam in 1847 (Parto et al. 2007). As a result, Amsterdam made its first transition from a decentralized, unregulated system of waste management, to one that was managed by the government. As a result, the city’s first incinerator was constructed in 1918. While public health improved during this transition, the circularity of resources was compromised, as small-scale entrepreneurs dealing in markets of food waste, compost, glass and other resources were replaced by a formal system of waste disposal (Parto et al. 2007). Resource consumption was not per se a problem before or after this transition, as the society was by today’s standards poor and the strain on natural resources was not yet relevant.

Following World War II, Amsterdam, as the rest of the country, saw a rapid increase in resource consumption and resulting waste production. The existing incinerators could not process the additional waste, so there was an expansion in landfilling (Parto et al. 2007). This lead to pollution, particularly of water sources, fuelling environmental concerns in the 1970s. This resulted in a national ban on landfilling and the institutionalization of incineration as a preferred method for waste management (Parto et al. 2007).

While this transition was fuelled by environmental concerns, the same period was characterized by a surge in consumption that laid the path for the unsustainable resource exploitation we see today. Although efforts to increase reuse and recycling emerged, they could not match the sweeping growth in resource exploitation of the emerging consumer age.

Rising environmental concerns combined with the recent economic crises has prompted Amsterdam’s current transition towards a circular economy.

The current transition

The previous section described how changes to waste management policies of the past century have been driven first by public health, and later by environmental concerns. Result-
ing policies have targeted the “tail-end” of waste, but have failed to address resource consumption, which exploded following World War II. With the adoption of a vision for a circular economy, Amsterdam is entering a third transition that has the potential to align with the principles of waste reduction, resource conservation and prevention by expanding the discussion of waste management to include the production and use of materials.

Below we provide a summary of the transitions according to the model by Parto et al. (2007) and our own analysis of the current transition. Our analysis indicates that Amsterdam’s vision for a circular economy can be equally, if not more transformative than the previous two transitions. This can be achieved by bringing into question the current systems of linear production and consumption. For example, through the creation of the Amsterdam Sharing City, the municipality is creating support for new models of collaborative consumption that emphasize access to services as opposed to the ownership of products.

![Figure 2: Transitions in the Dutch waste management system (Parto et al. 2007 p.236)](image)

<table>
<thead>
<tr>
<th>Transitions</th>
<th>Primary drivers: consumption, hygine, changing composition of waste (no profit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>improvements in hygiene and sanitation</td>
</tr>
<tr>
<td>T2</td>
<td>improved recycling and alternative disposal via incineration</td>
</tr>
<tr>
<td>T3</td>
<td>environment liberalized markets and changing wastes (packaging)</td>
</tr>
</tbody>
</table>

Table 1: Analysis of waste management transitions in Amsterdam (own analysis)

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Transition Topography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved sanitation</td>
<td>Throughput economy</td>
<td>Circular economy</td>
</tr>
<tr>
<td>Key Drivers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor public health</td>
<td>Environmental pollution and resource</td>
<td>Economic crisis and overconsumption depletion</td>
</tr>
<tr>
<td>Response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste collection and disposal via incineration</td>
<td>Ban on landfilling, improved incineration and some recycling</td>
<td>Increased reuse and recycling and alternative forms of consumption</td>
</tr>
<tr>
<td>Outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved public health</td>
<td>Improved quality of life</td>
<td>Green growth decoupling quality of life and resource consumption</td>
</tr>
<tr>
<td>What was missed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air and groundwater pollution; consumption becomes a problem later on</td>
<td>Expansion of unsustainable consumer economy</td>
<td>?</td>
</tr>
</tbody>
</table>

However, the outcome of this transition is not clear. Changing old institutions implies challenging vested interests and investing in new ideas. As well, this all must happen against the backdrop of political will and the limited capacity of the City to enforce real changes to new models of production and consumption. The extent to which horizontal, bottom-up and decentralized initiatives are permitted and promoted by the municipality will determine whether these changes are incremental, on a small scale, or whether a fundamental transformation will be achieved at the level of production and consumption.

Achieving green growth

Amsterdam has come a long way since Sarphati’s time when the city’s canals were used as open sewers. But after achieving improved public health, the city adopted a linear, throughput model of economic development and consumption. While wealth and quality of life increased drastically over the past half-century, there is now an improved realization that these developments were made on the back of unsustainable resource consumption and consequent waste production.

In light of a recent economic crisis, Amsterdam is reconsidering its development path and attempting to break the link between economic growth and resource exploitation by envisioning new models of production and consumption that deal with resources and waste in efficient and circular ways. If implemented Amsterdam’s ambitious vision for a circular economy has the potential to show that sustainability can indeed act as the engine of society and that through innovation, green growth can be achieved in the 21st century.

Cornelia Dinca and Sheila McGraw are both finishing their Masters Urban Planning at the University of Amsterdam. This article was selected as one of the best papers written for the Metabolic Atelier.

References

Traditional power plants are large centralized units. Today’s trend is towards smaller, numerous geographically dispersed power generation units situated close to energy consumers, so called Distributed Generation. Attuning the production patterns of multiple generation systems, and matching their production to the variable loads of end-users increasingly is the key question of how to change the Socio-Technical System of power supply. Technically a smart grid is defined as two networks: one for electricity connecting multiple power generation and consumer units and a parallel information network for data generated by smart metering devices that monitor, analyse and regulate energy production and consumption. Together with improvements in smart grids that serve efficiency and reliability, a system with a large amount of DG and preferably tapping renewable energy sources is considered an environmentally friendly alternative to the traditional power supply system.

Why social actors, including all tiers of government, would accept the elements take part in this development – and under what conditions – remains a largely neglected topic. However, how to get the required institutional changes accepted by the key actors in society is in fact the key question in how to establish a low carbon energy system (Wolsink, 2012). As noted in the master studio, this would require a full social and economic transformation, but it is not widely recognized – neither in the metabolic city sessions – what these institutional changes are.

The real issue of acceptance concerns the lack of acceptance to break down current institutional lock-ins (Unruh, 2002) that impede renewables’ deployment in most countries. Institutional factors have proven to be the main determinants of renewable energy deployment. The institutional changes needed for full deployment are strongly resisted, mainly among actors that are linked to the existing energy supply system, including government agencies and policy makers. This lock-in issue will probably become even more important for smart-grid developments. Distributed generation in micro-grids with a fair amount of control for the new co-producers – ‘prosumers’; all types of consumers also involved in production – run counter to today’s highly centralized power grids. There are several major institutional changes needed; here two are mentioned that are relevant for planning professionals.

Central to the new socio-technical energy system is the recognition that the development of smart grids completely changes the underlying organizational principles of current power supply. A single public power grid will cease to exist, to be replaced by many different interconnected ‘microgrids’. Current institutional arrangements are designed to serve the centralized model (path dependency), including the technological choices for high voltage transmission and AC 220 V distribution, as well as the socio-economic factors as centralized billing and large scale centralized power generation companies. Within the most prominent Danish academic planning department, a comparative study on 12 decision making processes concerning new system with renewable energy was carried out. The main conclusion: “Alternatives representing radical technological change have to come from outside organizations representing the existing technologies, whereas the existing incumbents even make efforts to eliminate alternatives from decision-making processes.” (Lund, 2010). Denmark is, in the developed world, the country that first started and so far the most successful in deployment of new renewables. If this would be valid there, how would it be in far less successful countries like the Netherlands? The truth is, an institutional change has hardly started in this country. The key issue has not even been recognized among policy actors, including different tiers of government and governmental agencies, who by the way are among Lund’s ‘existing incumbents’ within the energy system (as noted by Zuidema).

A second category of relevant institutions are the rules and practices within the current spatial planning systems. Although they are very differently designed in most countries, there is no country in which the current system is really furthering renewable energy and intelligent power systems. Within policy there is hardly any awareness of the fact that utilization of renewable energy is about the management of common pool natural resources. The need for institutional arrangements furthering multilevel, policentric, and self-governance, as outlined in all research by Lin Ostrom (2010) also applies for the natural resource of renewables. And the scarcity in that kind of resources is not the amount of available energy, but it is the amount of space needed for the conversion and distribution of that energy. The required amount of space, and the nature of that space – as close to the place of consumption as possible, for reasons of energetic, economic, and social efficiency – is unknown to and highly underestimated among policy makers, and most planners alike. The reality is that all space that can be made available for power generation and the other infrastructure around interconnected micro-grids is urgently needed. Current planning systems are not designed for the optimization of the utilization of space for distributed power generation. Most studies on the deployment of renewables concern conflicts about the siting of renewables’ infrastructure, with the general outcome that current planning systems generate conflict, invoke and enhance opposition, and support projects that follow paths and support the actors the existing socio-technical power supply systems; the ones that are cornerstones in the current carbon-lock in (Unruh, 2002).

Maarten Wolsink is associate professor Environmental Geography at the Department of Human Geography, Urban Planning and International Development Studies at the University of Amsterdam.

References

Wolsink, M. (2012) The research agenda on social acceptance of distributed generation in smart grids: Renewable as common pool resources, Renewable and Sustainable Energy Reviews 16(1): 822-835
Cities across the world have begun to re-examine the very fabrics of their being, rigorously self-assessing in attempts to understand and influence their urban metabolisms. Defined as “the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste” (Kennedy et al., 2007: 44), the urban metabolism is an increasingly hot topic in academic and political circles, as cities look to ‘close the resource loop’. But, despite sustainability’s growing importance in both academia and policy-making, the actual transformation to a circular expression of urban metabolism is a complex process. These difficulties are never more prominent than with regard to issues of urban energy use, as throughout the world urban areas are characterised by high spatial densities of energy use and account for between 60% to 80% of global usage.

One of the most prominent causes of anthropogenic energy usage within cities, and thus an increasingly important policy concern, is urban transportation. However, urban transportation is a contentious issue not only for its prominence in the functionality of cities, but also the financial and political influence of its many stakeholders. Petroleum companies and automobile manufacturers, to name but two, all have vested financial interests in maintaining the current (unsustainable) status quo regarding transportation. And yet, as cities aim to become more sustainable urban environments, the need to break free from institutional and infrastructural lock-in regarding transportation and introduce progressive, green mobility initiatives which focus on both carbon neutral modes (walking and cycling) and well-patronised public transportation schemes has never been higher. As Grubler, et al., (2012: 1388) state concisely, “the overriding goal is to turn the often automobile-dependent ‘vicious’ policy cycle into a ‘virtuous’ cycle that favors non-motorized and public transport choices” but how can cities ensure that their sustainable transportation interventions ensure that they arrive at this ‘virtuous cycle’?

One way to aid this process is through the use of symbolic urban ecology, a theoretical approach introduced by Nas (1993) which examined the influence of socially produced symbolic markers on the cultural dimension of a city. Due to the deep cultural resonance of transportation, and the socially embedded norms and perceptions regarding its usage, a form of institutional innovation is required to ensure that sustainable interventions do not hit an institutional wall upon implementation. The use of symbolic markers is one method through which this innovation can occur. As Dembski (2013) states, these symbolic markers act as visual elements of institutional change, often used by planners to mobilise actors and frame processes of urban change-leading to the internalisation of new social norms and discourses. Using the approach of Dembski (2013), this article attempts to answer the question; how do London and New York use symbolic urban ecology to instill new social meaning regarding sustainable transportation strategies? In London, the historical connectivity of the River Lea was opened up to green mobility through a bike and pedestrian transport corridor running alongside the river, while in New York, a main traffic artery was redesigned to incorporate green mobility through the provision of a cycle path. However, despite the obvious sustainable merits of the two schemes, can the use of symbolic ecology transcend the vastly disparate socio-cultural climates of the respective local areas?

East London Green Grid
The East London Green Grid (ELGG) - a strategic planning framework published in 2004 by the office of Mayor Ken Livingstone - focused on the promotion and production of green infrastructural links within East London. Using the proposal of two mega-projects planned for
the region (the Thames Gateway and, later, the London Olympics, respectively) as catalysts, the aim of the framework was to create a “network of interlinked, multi-functional and high-quality open spaces that connect with town centres, public transport nodes, the countryside in the urban fringe, the Thames, and major employment and residential areas” (Greater London Authority, 2010) Recent decades has seen East London become an essential canvas for the capital’s regeneration strategies, despite the area’s longstanding image as the most deprived part of the city, framed by heavy industrial activity and greatly deficient in terms of its urban form and infrastructural links. In an attempt to alleviate these issues, the ELGG framework provided an overarching vision aimed at the encouragement of sustainable, bottom-up initiatives; an approach which would allow a great deal more flexibility in such a spatially heterogeneous environment. In line with this, the ELGG focused on six geographical areas within the East London region to further local, grassroots involvement; one of which was Lea Valley.

The renaissance of the River Lea, the backbone of the Lea Valley area, forms a key tenet of the ELGG, and one objective is the creation of a bicycle and pedestrian transportation corridor running the entire length of the river (see Figure 2). The River Lea has been a symbolic avenue for both industry and water-based transportation for over a millennium. While the Upper Lea Valley is a lush, green landscape sweeping out towards the countryside, the Lower Lea Valley is scarred by the derelict, rusting ghosts of its industrial past. The reopening of the river, including this previously abandoned part of the city, focuses on highlighting long-forgotten avenues of connectivity in the East London region. While this scheme addresses several key issues regarding the issue of urban metabolism, including improved protection against climate change and increased urban cooling via vegetation cover, the most prominent aspect of this scheme is the development of a large-scale, sustainable transportation initiative centered on ‘non-motorised mobility’. In addition to vastly improving sub-regional accessibility, the provision of large-scale green infrastructural links, and the consequent encouragement of sustainable, carbon-neutral transportation modes (such as cycling and walking) greatly reduces both anthropogenic energy usage and carbon emissions, aiding the progression towards a circular vision of urban metabolism.

The most prominent symbolic marker within the Lea Valley scheme is undoubtedly the complete reopening of the River Lea (from source to mouth) to the public through the creation of a green infrastructure corridor alongside the length of the river. The conception of this sustainable mobility corridor which transcends the entire East London region not only sees previously inaccessible, neglected industrial land replaced by green spaces, but also promotes the safe use of carbon neutral transportation through the provision of hard infrastructure along the length of the river, in the form of cycle lanes and pavements. By doing this, the scheme re-opens the traditional connectivity of the River Lea, an ancient transportation route whose importance is deeply embedded into the collective memory of the area. This reimagining of the existing landscape, referred to by Dembski (2013: 2017-2018) as a process of “symbolization that build[s] on the historicity of a place to create a new future” is an example of symbolic reconstruction; seen as an influential aspect in the use of symbolic markers as vehicles for instituting new social meaning.

The scheme was promoted by a coalition of governing bodies working on several spatial and hierarchal levels, including both governmental and non-governmental actors. However, despite this mélange of interests (and changing political visions on both a city and national level), there has been little by way of conflict between insti-
By using the historical transportation corridor of the River Lea as a basis for an area-wide green infrastructural avenue, the ELGG framework has provided a prominent example of symbolic reconstruction on a regional level. The urban metabolism implications for the scheme (related to climate change durability, urban cooling and sustainable transportation) are clear, whilst the social implications of opening up a previously inaccessible area for both residents and visitors through carbon-neutral mobility initiatives are plentiful. The scheme also taps into larger societal shifts related to the increasingly popularity of cycling, whilst integrating into other city-wide initiatives of the London Assembly to move towards a more sustainable transportation system.

Bike Lanes in New York City

The Ninth Avenue Bicycle Path and Complete Street Project - a localised green mobility intervention in Manhattan - can trace its policy roots back to 1997, when the New York Department of City Planning, in collaboration with the New York City Department of Transportation (NYCDOT) published the New York City Bicycle Master Plan, a 74-page document which suggested a package of interventions (both infrastructural and educational) targeted at issues of accessibility and safety for bicycle users.

Figure 3: Location of Ninth Avenue in Manhattan (with regard to other schemes) (NYCDOT, 2014); Current conditions on Ninth Avenue (NYCDOT, 2014)

A decade later, the Bloomberg administration published the PlanNYC, a flexible policy document which contained targets and measures linked to a wide range of sustainability-related issues, followed, in immediate response, by the NYCDOT’s publication of ‘Sustainable Streets’- its own strategic plan. This policy framework resulted in nearly fifty complete streets and over twenty bicycle routes, following on from the successful pilot scheme- premiered in 2007- on Ninth Avenue.

Ninth Avenue - one of the main thoroughfares in west Manhattan - had been, until 2007’s strategic intervention, almost exclusively dedicated to the use of motor vehicles, with four carriageways, a total absence of bicycle infrastructure, and spatially detached pavements. However, in 2007 NYCDOT embarked on a pilot scheme entitled the Ninth Avenue Bicycle Path and Complete Street Project, aimed at transforming Ninth Avenue into a ‘complete street’. The first intervention was the substitution of one of the four lanes of automobile traffic for a cycle path, running alongside the pavement, and a ‘buffer zone’ of parked cars and trees to protect cyclists from motor traffic. In 2008, the project was declared the winner of the Institute of Transportation Engineers (ITE) Best Program Award. Progressively, further improvements have been carried out; while the project itself was linked to other neighbouring schemes (see Figure 3) The Ninth Avenue project, in addition to improving accessibility to green mobility alternatives by increasing comfort and safety, is seen as the flagship scheme in what had been a decade-long process regarding sustainable transportation interventions.

The symbolisation evident in the scheme is the creation of a safe transportation corridor for sustainable, green mobility along what has historically been a busy, and strategically important, avenue of movement within Manhattan. Transforming a lane of motor traffic into a bicycle lane through innovative design is a prominent symbolic marker; protected cycle lanes (as well as related initiatives, such as pedestrian islands) have a practical function regarding safety as well as a greater symbolic social implication- namely the increased attention of local authorities to non-motorised road-users, visible in the creation of a pedestrian/ cyclist-friendly environment.

The Ninth Avenue project can be seen as a reconstructed symbolic marker, in that it uses a translation of past meaning into a (more desirable) new future. However, despite the long-lasting tradition of being an important transportation artery (an elevated railway along Ninth Avenue was removed in 1940), the dominance of the automobile in recent years had replaced this tradition with that of a “motor vehicle dominated thoroughfare” (Russo et al., 2008) It is, therefore, debatable whether the scheme has actually managed to instill the ‘sense of place’ discussed by Dembksi (2013) The public opposition to the project suggests that, even though the intervention is fully embedded into the institutional make-up of the city, it has been perceived by some as an ‘alien’ concept; meaning the strongly embedded nature of motor vehicle use rendered this scheme a form of symbolic construction, instead.

Isolating the actions of NYCDOT (in charge of both the scheme’s design and implementation) from other branches of city administration would be a mistake. NYCDOT co-operated with the Department of City Planning in the creation of the Bicycle Master Plan, whilst the city’s Department of Parks and Recreation was tasked with greening the area. Influentially, the scheme also enjoyed considerable support from Mayors Bloomberg and de Blasio, while the participation of the Community Board and other local associations provided strong grassroots support. The most evident example of counter-framing came...
from the vociferous local opposition, which included residents, workers, commuters, and business-owners. However, the strength of political will in the implementation of this project allowed it to bypass those dissenting voices with relative ease.

Symbolic Meaning
The two case studies examined show different approaches to the use of urban symbolism in sustainable transportation strategies. Although the Lea Valley project implied a heavy material intervention, it had very little impact on the existing transportation infrastructure of the area. On the other hand, Ninth Avenue project’s wide-reaching impact and radical perceptions are embedded into the cultural meaning of the operation, more than the physical alterations it prescribed. These distinctly different profiles can somehow justify the vastly different reactions within local communities, with the New York project coming under some vocal, and active, opposition. Another considerable dissimilarity between the two cases can be seen in the process of symbolic reconstruction itself. With regard to the overarching vision of the Lea Valley project, the symbolisation recalls the collective memory of the River Lea as a natural transportation corridor whilst drawing attention to the need for both non-motorised infrastructure and accessibility to urban green space; the Ninth Avenue scheme instead emphasises the increased accessibility of green mobility through the vastly improved issues of cyclist safety.

However, the two interventions share several features. The first concerns the overarching ambitions for the projects; the promotion of sustainable transportation behaviour amongst citizens as part of wider urban metabolism strategies. Moreover, both the selected locations allow the message to reach an audience that transcends solely the residents of the adjacent areas; encompassing commuters, tourists, visitors. Finally, both the ELGG and the Ninth Avenue project highlight the importance of continuity in political support, helped by the coherent embedding of both schemes within wider policy trends.

Evolution vs. Revolution
These two case-studies can both be considered as attempts by governing coalitions of actors to use symbolic urban ecology for inculcating new social norms and perceptions regarding sustainable transportation; planners and politicians alike are looking to “tap into” a deeper layer of cultural identity, but this can often be fraught with difficulties. The resistance to the New York City scheme could be seen as an inability to fully embed the markers into the collective cultural memory of the city; perhaps it is this very point which highlights something of a more pressing concern for planners looking at ways to move towards a circular economy through sustainable interventions. New York City enjoys the lowest rate of car ownership of any large US city, yet there was still widespread opposition to the project; therefore, it is perhaps a fair prediction that the implementation of similar schemes in cities with greater levels of automobile dependency may well be seen as unwanted ‘revolution’ instead of much-needed ‘evolution’. It is this institutional wall in many urban environments that will likely pose the biggest obstacle for planners in the near future, and the role that symbolic urban ecology can play in overcoming these issues is likely to be crucial.

Despite the importance of behavioural issues, such as those that have been examined in this paper, it is essential that attention on individual behaviour is not at the expense of other structural factors. It is the responsibility of every facet of planning to work together in order to arrive at a circular expression of urban metabolism. In light of this, urban symbolic ecology can, as Dembski & Salet (2010: 812) suggest, assume a role of the “glue that holds together strategic frames of planning” in a discipline which needs to embrace different ideas, perspectives and innovations as it moves into the future.

Ruggero Beretta and Christian Lapper are both finishing their Masters Urban Planning at the University of Amsterdam. This article was selected as one of the best papers written for the Metabolic Atelier.

References

NYCDOT (2014) Protected Bicycle Lanes in NYC, New York City: NYCDOT
Water management and urban sustainability are closely linked to each other. Urban sustainability refers to the city as a whole, while it also takes the natural environment surrounding it into account. This implies a transition from traditional water management towards sustainable water management. This transition is moving slowly. Currently, the world faces various water problems (disruption of water supplies, growing demand for clean drinking water, water pollution, water shortage, and heavy rain falls to name a few) that are affecting the water cycle. Climate change further problematizes these issues. The crucial role of water on earth requires accurate and effective water management. The main objective of urban water management is to provide clean water and deal with waste and peaks in storm water. Fulfilling these three objectives can be accomplished by closing the loop of water cycles. To close water cycles, a shift towards sustainable water management is needed. Change is always dependent on the ability of institutions to change. This is hard to accomplish because barriers that will appear are mostly institutionally rooted and are not able to be surpassed with technological interventions. These barriers are often caused by decisions made in the past. This article shows how such decisions hinder the transition towards a more sustainable Dutch wastewater management.

Sustainable urban water management
Abel Wolman developed the urban metabolism concept in 1965 when deterioration of water and air quality was a key issue in cities. He focused on inputs (such as energy and materials) and outputs (such as waste and pollution) in cities. In other words, he approached the city as a system that uses resources and generates pollution or waste, and is thereby affecting the broader environment. Due to population growth and a more affluent society, the concern raised has been fulfilled—this would become worse over time. Urban sustainability can only be accomplished if the city is seen as an ecosystem. As one part of the ecosystem, water should have a closed cycle. Closing such a cycle is also called metabolism. Metabolism in cities includes four main cycles: materials, nutrients, energy, and lastly water. The role of water is crucial on earth. Water issues are related to economic prosperity and in many other ways it is needed to sustain human life, yet it is not replaceable. It is therefore necessary to have accurate and effective water management. The urban water system has three main objectives: (1) the provision of clean water for all kinds of users, (2) the removal of wastewater in order to prevent unhygienic conditions, and (3) the redirecting of storm water to prevent flooding. The main challenge is to be sustainable; in other words, to prevent environmental damage while providing these objectives. A way to do this is by closing the loop of water cycles in urban water management. According to Beck & Cummings (1996), cities have always had a water cycle. Over time, cities have interrupted this cycle strongly. In order to be sustainable, cities need to get back to a state that influences the water cycle as little as possible (see figure 1).

Traditional water management is often seen as a top-down and large-scale system that focuses on expansion, efficiency, and control. Technical experts have generally managed traditional urban water management systems. Although this traditional system has been successful in the past, it seems necessary to reform the traditional way of thinking into a sustainable approach. According to Hellstrom et al. (2000), a sustainable urban water system should contain three main elements: (1) the system should be characterized as being robust and flexible, (2) it should be able to adapt to local conditions, and (3) it should be understandable to stimulate responsible behaviour.

To be successful in a shift towards this sustainable system, an institutional reform at all levels is necessary. A change in water institutions can refer to changes in water law, water policy, or water administration. Change in water law is the cause of the most fundamental changes. The shift towards sustainable water management highlights new ways of thinking, new approaches, and innovation. One of the primary conditions of this change is the ability of actors to reform water institutions. As was said before, these institutions often have barriers based on past decisions that may hinder or prevent institutional change, as they are outlining the decisions of the future. This is a process of entrapment that is also known as path dependency. Path dependency results in a hold-up of alternatives and other more adaptive and resilient forms of urban water management.

Path dependency is a theory that states that the decisions made in the past are defining the possible decisions that can be made now and in the future. Levi (1997, p.28) states it in a more visual way:

“Perhaps the better metaphor is a tree, rather than a path. From the same trunk, there are many different branches and smaller branches. Although it is possible to turn around or to clamber from one to the other and essential if the chosen branch dies—the branch on which a climber begins is the one she tends to follow.”

Events that have happened in early stages cannot be ignored because they are reflected into future choices. Path dependency is stronger in politics since politics lacks the efficiency-enhancing mechanisms that are stimulating learning and competition in the private sector. On top of that, most politicians are in their positions for only a short period of time. Consequently, they have a short-term horizon. One of the negative
effects of path dependency is that it creates less diversity in the system. When only one path is followed, it becomes more vulnerable. To solve this problem there should be several systems to create more resilience. In case a certain system fails, another system or feature can fill in and make sure the total system still functions. This is a form of redundancy that needs to be implemented. Doing this creates a safety net, in case something goes wrong.

It is possible to look at the water waste management of the Netherlands through a lens of this path dependency by using four indicators. These indicators are costs, formal rules, vested interests, and coordination. They cover most of the features as presented in the literature by Arthur (1994) and Heinmiller (2009). Formal rules are often hard to change because they are bound by contracts. The costs are the large set-up costs and sunk costs that determine the specific path that has been chosen. The vested interests are the actors that are involved, often benefitting if they continue along the same path. The coordination comes down to the fact that once a certain system is chosen, many choices on any system are followed upon it. This goes back to the costs as mentioned before. High investment often prevents replacing it (partly) with another system.

Water waste management in the Netherlands

The supply of wastewater in the Netherlands is almost 2 billion cubic metres on average per year. All this water needs to be drained away and treated to remove of toxins and other pollution, so that the water can be disposed in open water again. Technological innovations are possible but institutions are impeding these innovations with decisions made in the past. Formal rules, costs, vested interests and coordination will now be explored for the wastewater management in the Netherlands.

Formal rules

A new Water Act was implemented in 2009 at the national scale. This law combines several acts and permits in order to decrease bureaucractia. It has been designed to synchronize with the Spatial Planning Act and European water guidelines. Since the new Water Act has been implemented, the municipality is no longer necessarily responsible for collecting rainwater that comes down on private parcels. This means that citizens and companies are now responsible for it themselves, unless they are not reasonably capable of doing so. Gupta et al. (2014) argue that the new water act can be characterized as a more dynamic act than the previous acts. The act focuses more on context-specific solutions and institutional solutions in order to move beyond technical approaches. It seems that the current water law is more resilient, since it focuses more on institutional and context-specific solutions. The flexible nature of this law is thereby breaking with existing path dependencies.

Costs

Municipalities are responsible for the sewage system. They charge these costs on households with a sewage tax. Municipalities use the sewage tax to maintain and replace sewage pipes. This comes down to 2.25 billion euro on collecting and treating wastewater annually. Almost 1.5 billion euro of this amount is invested into the replacement of teardown pipes. A local company that is often owned by the municipality covers the costs for the water treatment. These local companies charge households as well by means of a water treatment tax.

A more sustainable sewage system is technically feasible, as will be explained below. However, the only way replacing the old system with a new divided system will be financially profitable is by replacing it when maintenance would be needed anyway. In other words, the technical innovation to create a more sustainable sewage system is hindered by the large set-up costs of the divided system. The government also invested a lot in the combined sewage infrastructure when it was first implemented. These high investment costs are a strong restriction to change the whole system. The costs of the sewage system in the Netherlands are determining a specific path.

Vested interests

There are many parties involved within the process of urban water management. The Netherlands counts 352 water treatment plants, which are controlled by 26 regional water authorities. The provinces are also involved, since there is a regional scale in urban water management as well. As outlined before, the national government is the party that sets out the acts and guidelines for the municipalities to follow. Next to these governmental institutions, there are also companies such as suppliers, consultancy companies, inspection companies, and contractors involved in the process of collecting and cleaning wastewater. According to Gupta et al. (2014) the role of the private sector in the Netherlands is minimal compared to other developed countries. The new water act, as outlined above, is not encouraging local entrepreneurs to participate either (Gupta et al., 2014). This highlights the dominant role of the public sector within urban water management. Heinmiller (2009) emphasized the amount of actors as a factor influencing path dependency. The more actors involved, the harder it is to change another path, as more people have to be convinced to do so. The high amount of actors involved in Dutch wastewater management therefore contributes to path dependency. The actors that are most involved often benefit if they continue along the same path. In this case it seems that government has the control and wants to maintain their control. So the government benefits if they continue to be the main actor within the urban wastewater management sector. This probably explains the minimal role of the private sector within wastewater management.

Coordination

Drainage of wastewater in the Netherlands is done with a sewage system. Almost all houses and households in the Netherlands are connected to the sewage system. The majority of the houses have a combined system where both rain- and wastewater go into the same pipes. Wastewater cleaning can be executed in two
In the combined sewage system, 75% of the water, such as phosphate, is reused through products that come out of this waste cleaning water and tries to close the water cycle. Amsterdam (located in Amsterdam) will be trickled down to local waterways. There it is there and when it is clean water again, it will be cleaned once through the sewage system to one of the wastewater treatment plants. It will be cleaned once, which contains two pipes. One pipe is for wastewater and the other is for rainwater. The implementation of another drainage system for wastewater (instead of the sewage system) is almost impossible, considering the fact that the path-dependent system is such an important and implemented part of the system. Although the system itself is highly influenced by path dependencies, several opportunities to create a more sustainable sewage system are technically possible (e.g., the divided system).

The role of time
Another important aspect of path dependency is its temporal dimension. The explanations can be considered in different time perspectives. Within the case study mainly costs and vested interests are contributing to path dependency. Due to the new water law, formal rules are more easily adaptable and resilient than ten years ago as the formal rules were less context-related. This basically means that urban wastewater management was more path-dependent prior to the new water law. Costs may provide another example of path dependency within Dutch urban water management. Some costs hugely decreased due to technological innovations. Cost reduction therefore changed the role of path dependency. Time has had an effect on the power that path dependency has on controlling the transition towards sustainable water management. It differs by time period to what extent path dependency is impeding or hindering changes. The Dutch water waste management system is a product of our past, but does not have to be imprisoned by it. Today sustainability is promoted, which gives room for innovation within the system. Therefore, the once strong path dependent system is now opening up a bit and innovations are possible. The choices made in the past are just slowing this innovative process down.

Lilian van Karnenbeek and Mindy den Harder are both finishing their Masters Urban Planning at the University of Amsterdam. This article was selected as one of the best papers written for the Metabolic Atelier.

References

What are the most pressing issues in the field of metabolism that should be addressed in urban policies?

One of the most obvious issues is water. We know that climate change will make dry areas dryer and wet areas wetter. For many cities throughout the world sea-level rise is presenting problems already. In Boston, where I live, at some point, nature will claim back the land on which much of the city lies. We are exploring strategies for letting the water move through the city, rather than trying to barrier it off. A connected issue to this is stormwater management. In many cities the sewage and stormwater systems are combined. With more frequent and severe storms, they overflow—into homes and waterways. Cities have to transition to green stormwater management techniques. And many cities that buried streams are now realizing the importance of “day-lighting” them. So I think recreating more natural water flow is a key aspect that is really obvious when you talk about urban metabolism.

Are there other issues, beyond water, that should be addressed in urban policies?

Another one is transportation. How we move more and more people through cities efficiently is a metabolism question. There are many different ways to organize sustainable transport—more public transit, electric vehicles, more walking and biking—the balance is different in different cities. Energy is another metabolism concern. Developing smarter grids and moving from centralized to decentralized energy production in some areas will assure a more reliable and resilient urban energy supply. And of course energy is connected to transportation—we see many cities supporting a charging infrastructure.

What are the most important academic challenges for researchers in the field of metabolism?

I would say that metabolism is not yet mainstream as an academic lens. In the United States this is not a theoretical orientation that many researchers would use to analyze a city. I believe that Europe is a bit further in this, and has a slight advantage. My current research focuses on the reduction of carbon emissions and, broader than that, how we can achieve sustainable development. I agree with the criticism that much research in this field is normative. Reducing the ecological footprint, making transport systems better, promoting renewable energy development and energy efficiency, are all goals that my own work addresses. Normative or not, I see making change on these fronts is essential.
What are you changing in your personal life to contribute to climate change objectives?
The most important thing I am doing is educating the next generation of urban planning and policy practitioners. They have to be very aware of the challenges and opportunities. At the personal level I live a fairly green life—little car use most of the time, we have made our house more energy efficient, I do organics recycling, etc. But it is almost impossible to live in a truly sustainable way. We have a car in order to get to our second house in the summer—we are full of contradictions—it is hard. I am aware of the fact that I came by plane to Amsterdam and fly frequently. That alone gives me an average above carbon footprint.

Now to your book Emerald Cities. One of the cases you bring forward is Vauban in Freiburg. The anti-nuclear movement drove the innovative aspects of this development. Is a core grassroots group like this needed to push for real innovation?
The grassroots-driven developments in the Vauban case started in the 70's, when there were plans to build a nuclear power plant in that area. But what caused growth in Vauban was not that movement per se. They built solar Freiburg, because it was such a lovely place to live. A lot of retired people moved there. They had a particular amount of consciousness and decided to go for environmentally friendly growth. And nowadays, since it has become "mainstream", this is the way that Europeans would like to keep going. State or city governments are increasingly driving these kinds of developments. It is driven from all levels—top down from EU mandates, member state regulations and below because it is what the public wants.

What is the best strategy for cities to become Emerald?
Emerald cities are those that have a climate action plan that acts upon the major sources of a city’s carbon emissions and also pays attention to adaptation/resilience—all while connecting these actions to social justice and economic development goals. It is not easy as it requires leadership at the top and a public that supports these goals. Some cities take a "low-hanging fruit" approach—going after little changes, hoping to build public support along the way. I think that will not lead to the level of change we need. I think of a famous quote from Daniel Burnham, the father of urban planning in the United States—"make no little plans for they have no power to stir men’s blood." If we are going to create sustainable cities, we have to think big.

Could you explain that with an example?
It always surprises people when I say that Los Angeles is one of my favorite Emerald Cities. Most people think smog and cars when they think of LA. It’s true. But it is relatively easy for many European and US cities with comprehensive public transit systems and dense housing to be sustainability leaders. These cities start out, to use a baseball analogy, on third base while LA starts out behind home plate. Yet LA has one of the strictest building energy codes and ties building rehab to low-income communities; has a strong renewable energy program supported by its business community and is trying to develop and expand public transit.

Another story I love to tell is the story of Toledo, Ohio. It started as a manufacturing city with 30 percent unemployment. The city was really in a bad shape. Their economic specialization was auto glass. The University of Toledo started doing solar research after encouragement from one particular person in the auto glass industry. This person was working on layers in windshields for cars. So out of that, they created new innovative research and products from that old industry. It doesn’t meet the “emerald” standard, but has really supported green technology as an economic development strategy.

There are many cities in the Netherlands that are craving fast, risk averse economic development in order to generate revenue. Is it possible to pursue sustainable development without the urgency of economic growth?
You are not talking about state economics but about local governance. I think that many places like Toledo in the United States, or places in developing countries, have an absolute need for economic growth. What I find intriguing is not so much how you get business on board with being greener, but how to promote a completely different message. Maybe reframing the relationship between profitability, growth and sustainability is more effective than all the regulation placed upon many industries. And besides that, stagnation or no growth is simply not possible; a steady state does not exist anywhere.

The next question is about legislation. What is the most pressing aspect of legislation that should be addressed?
The ultimate measure is widely applied carbon tax. And beyond that, there are many measures at all levels of government that are needed to support climate action. But it won’t happen in the current US political environment. I would argue that standards demanding a certain amount of renewable energy within a specific period of time have to be strengthened to reduce emissions. And we have to change the way we do business—there has to be more producer responsibility—Sweden has proved ecological modernism is possible. The Dutch concept of the circular economy is another way of stating this.

And we have to change the way we do business—there has to be more producer responsibility—Sweden has proved ecological modernism is possible. The Dutch concept of the circular economy is another way of stating this.

How about the role researchers have outside the university in decision-making arenas?
I really would like to be on the Green Ribbon Commission in the city of Boston. This is a group of business, institutional and civic leaders in Boston working to develop shared strategies for fighting climate change. There are many ways for university faculty to lend their expertise to government and the private sector.

Why are cities and politicians struggling so much to move towards an integrated, multi-sectoral strategy?
I think it is about ideology, path dependencies and specific interests. At the federal level it has been very difficult to get the support cities and states need. An important aspect of this lies in the sponsorship of political campaigns—the Koch brothers alone have tried to destroy environmental legislation in California and promote the oil industry at the national level. Congress is very much influenced by that. In some ways, it is easier to get support for integrated action on sea-level rise—the reality is in front of us and action does not require a debate on whether it is real.

It could be very difficult to translate the metabolism perspective into practical measures, since there are many institutional and social problems to overcome. What is the best educational process to match research and practice in the field of metabolism?
Northeastern University is the nation’s preeminent co-op university. This means that most students, regardless of their discipline, learn experientially. A co-op is like an internship. We have co-op faculty whose job it is to make sure that students are not just doing the filing or other irrelevant tasks on their co-op—they are doing research, developing programs and otherwise creating change. And it goes the other way—I bring practitioners into the classroom all the time. We read the articles from theory, and then discuss this with someone in practice.

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The Greek word metabolism (μεταβολισμός) refers to a complete set of bio-chemical processes of cells and organisms which keep living things alive, amongst them the human body. Urban planners often think that cities are living bodies too. Planning even cherishes, not to say nurtures, a long tradition of metaphors to understand cities. On second thought bio-metaphors are used for two major objectives: empirics and idealistic goals. The empiric category is about understanding how cities work, the second how they should work. A deeper look into the history of planning shows that the second category is older than the first. For example, the artistic Renaissance designs to design cities literary on the human scale. Head, limbs and spine served as metaphor-ic parts of a living city, depicting consistency of scale and mutual relationships.

How cities work is a typical 19th century question, a product of the industrial revolution and the upcoming social sciences. The aim was to discover social laws which could explain why city A flourished and city B did not. Basically the application of such laws would wipe out social and economic problems and bad neighbourhoods. Still many planners think that replacement housing wipes out social problems. The tale of the human body started to pervade the understanding of cities. Cities have a heart and blood which circulates in arteries and veins, they need oxygen and good food, including people as well as streams of traffic and information to stay alive. Poor functioning limbs and organs will be repaired or cut off and replaced by surgery. The city planner had promoted himself from artist to doctor.

In the 1960s medical science had made progress in analyzing the human brains, consisting of billions and billions of cells, fibers and interconnectors. Wasn’t that how we should look at cities, like human brains? Again city planners made a step upwards on the social ladder from ordinary doctors to brain surgeons. Did it help? Help what? What help? Is the recent positive turn in valuing cities as preferable places to work and live the outcome of the city doctors, or the outcome of economic forces (second machine age; third industrial revolution) and socio-demographic forces such as the numbers of highly educated people, high paid jobs and single households.

To-day city planners utilize the metabolics of cities as a concept to understand cities and to heal their intrinsic evils. However, metabolics is a rather complicated concept, consisting of two greater subdivisions: anabolism and catabolism. Anabolism means that living things only exist by consuming energy in order to maintain and renew their cells, organs etc. Catabolism is the process of releasing energy by braking down complex substances. In reading that metabolism is a means of understanding cities as complex and interactive systems which continuously work to meet the needs of their residents, I’m afraid that the concept says more about how city planners work by borrowing rather complicated concepts from other disciplines, than about increasing insight into how cities work. Understanding complex systems requires simple concepts. Only simple systems may be understand by complex concepts.

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In the Hague, they have been talking for years about ‘new steering philosophies’. One of the most interesting publications on this topic is the ‘energetic society’ (2011). The author is Maarten Hajer, the Director of the Netherlands Environmental Assessment Agency located in The Hague. The booklet is about a clean, circular economy, and the path to be followed. The New Practice of Urban Planning, as I call it, starts in the city. The starting point of this new practice is to make use of the creativity and learning capacity in urban environments. This entails a society with assertive citizens with, regarding to Hajer, “a reversed reaction-speed, learning capacity and creativity”. Thus, not a government that corrects tedious citizens, but a government that listens and mobilizes society. “The question in this report is, briefly, how governments could enable the energetic society to work their way towards sustainability”.

Hajer argues that the issue here is interests – interests that are locally embedded. These interests are better understood by ordinary people on the local level, instead of civil servants operating in upper tiers of government. It is quite simple to connect locally embedded interests with global issues such as food safety and climate change. His advice is to start at the local level, and new images can grow from the bottom up with regional identities that fit the broader picture. In this way, we could solve the problem step by step. What Hajer suggests is nothing more than ‘radical incrementalism’; national governments set clear objectives, decentralize power, share data, and help and support other stakeholders. “With taking a clear position in this, government could mobilise existing energy by focusing on the link between big public objectives on the one hand, and the direct environment of the citizen on the other hand. Thus… the challenge is mobilisation.”

We are in the middle of this transition right now – steering towards mobilization and producing policies of mutual learning. To get there eventually, it is necessary to decentralize, even more and faster as it happens today. There must be listened carefully, shared and helped. The contours of the new agenda for the city (Agenda voor de stad), which is set by the national government, are slowly appearing. National government wants to bring the cities to a focal position. However, the cities must act likewise and revise their persistent obsolete attitudes, which are clones of old national policies. The Dutch cities must also embrace radical incrementalism. They must, just as national government does, set clear objectives, decentralize resources and instruments (towards neighbourhoods and city districts), and, above all, listen carefully, aggregate insights and help citizens. This will not only be a huge transition for governments, but NGO’s, the private sector and citizens will also be affected. The public sector will no longer guarantee solutions; solutions will be shaped in communal processes.

In doing so, it is important that stakeholders admit that their knowledge is very, very limited.

This is exactly the subject of the experiments in the course-seminar The New Wibaut. Civil servants from the city and neighbouring municipalities try to solve societal problems in small, multidisciplinary teams. They do this in close cooperation with citizens by listening carefully to them, and by helping them in the first place. Every week, teams learned from one another by sharing learning experiences in organized sessions. Mentors, consultants and moderators supervised the participants. By building prototype platforms, which were focused on specific issues, the participants were able to solve problems collectively, while they were learning at the same time. In four weeks time, spread out over a semester, the New Wibauters built and tested their platform. An improved version is ready when the participants finish their course. This grand finale will be celebrated collectively.

Soon, more than 300 civil servants will have successfully completed the New Wibaut course seminar. At that time, 28 local societal issues will have been addressed and solved. The spin off created by this seminar is remarkably positive: not only NGO’s came up with issues, also citizens and associations that became partners in the platform. They all felt being heard and were actively involved. Locally embedded knowledge was found and used by solving the problems at stake. In short, the mobilizing capacity of the seminar is impressive. The New Wibaut could in fact serve as new organization model for a municipality. Management will be reduced to a minimum, overhead costs will be minimal, and the freedom to act will be maximized. For civil servants, however, it is necessary to invest in processes of reflection and learning. Due to the New Wibaut, a city like Amsterdam becomes circular in one generation.

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Deze publicatie is het resultaat van de Master Studio Urban Planning Metabolic Cities, georganiseerd door de Universiteit van Amsterdam in januari 2015. Ieder jaar brengt de Universiteit van Amsterdam studenten, internationale wetenschappers en professionals uit de praktijk bijeen om een week lang intensief één specifieke onderwerp gezamenlijk te onderzoeken. Dit jaar is het thema metabolisme in de stad intensief bediscussieerd. Aan de hand van deze publicatie wordt de opgedane kennis gedissemineerd.

In de introductie is het thema kort geïntroduceerd door in te gaan op de scope van het onderzoeksobject: de stad. Steden worden door verschillende wetenschappers gezien als centrale broeplaatsen voor innovatie. Klimaatverandering is een voorbeeld van een mondial complex probleem waarbij juist de steden het meest praktisch schaalniveau zijn waar wordt geëxperimenteerd met adaptatie- en mitigatiemaatregelen. Metabolisme is een voorbeeld van een innovatief concept met grote potentie voor diverse stedelijke toepassingen. Hoewel het concept al ruim 50 jaar bestaat is het recentelijk weer herontdekt door ruimtelijke planners, stedenbouwkundigen en architecten. Metabolisme is gebaseerd op het integreren van verschillende domeinen: integratie van verschillende schaalniveaus, integratie tussen praktijk en wetenschap en integratie van economische targets en duurzaamheidsdoelen.

Vervolgens wordt een aantal cases kort geïntroduceerd. Dit zijn onderzoeken die op deze vraag te beantwoorden: de Internationale Architectuur Biënnale in Rotterdam en de Buiksloterham in Amsterdam. De ruimtelijke planner moet oog hebben voor drie niveaus waarop metabolisme zich manifesteert, zo wordt geconcludeerd: de infrastructuur om de stromen te wijzigen, de ruimtelijke-fysische mogelijkheden om dit te doen, en de sociaaleconomische politieke processen en daarbij behorende machtsstructuren die aanwezig zijn in de stad. Als planner moet je dus tegelijkertijd op deze drie borden schaken. De casussen stemmen hoopvol dat dit daadwerkelijk mogelijk is.

In de interviews met Roelof Kruize en Simin Davoudi wordt vanuit de praktijk en wetenschap gereflecteerd op het metabolisme concept. Als directeur van Waternet spreekt Kruize over de praktische drempels die het sluiten van systeem moeilijk maakt. Simin Davoudi spreekt over de complexiteit van het integreren van verschillende domeinen: integratie van verschillende schaalniveaus, integratie tussen praktijk en wetenschap en integratie van economische targets en duurzaamheidsdoelen.


De Master Studio Urban Planning is ondersteund met bijdragen van de Stichting sLIM en de EFL stichting.
Cities are at the forefront of governing the energy transition of the 21st century. They are the key agents in mitigating and adapting to climate change. Yet, to what extent can urban planning truly contribute to this ambitious and urgent endeavour? The Master Studio Urban Planning is organised yearly by the University of Amsterdam. This year this central issue in dealing with climate change was addressed by discussing and re-thinking the city as a system of flows.

This publication presents the results of the 2014-2015 edition of the Master Studio. The concept of Metabolism was the core object of the studio. 50 students and 15 external participants rethought the city as a system of flows, of water, energy and waste, to design policy recommendations for a more circular city. This publication presents the best work done by the students as well as the contributions of experts and practitioners that participated in the master studio.