KNOWING THE CITY

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INAUGURAL LECTURE GIVEN (IN A SHORTENED FORM) TO MARK THE ASSUMPTION OF THE POSITION AS PROFESSOR OF INFRASTRUCTURING URBAN FUTURES AT THE FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION (ITC) AT THE UNIVERSITY OF TWENTE ON THURSDAY 14TH JUNE 2018

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Dear Rector of the University of Twente, Dean of ITC, PGM Department, ITC and other colleagues, family and friends. It is a distinguished honour to speak to you today about the city as an object of scientific investigation and to discuss questions that require our urgent attention, especially questions regarding cities in emerging economies in the Global South.

Why do we want to know the city?

Global trends

The 21st century is the age of accelerated urbanization. Already more than half of the world's population lives in cities or towns. This transformation is driven by global factors, such as changing demographics, rural–urban migration, economic growth strategies and global capital flows, as well as more localized drivers of change such as market-led developments. The UN Population Division predicts that, by 2050 the share of the urban population is expected to reach 66%[1]. Although these UN statistics and predictions are aggregated estimates and need to be interpreted with caution (due to inconsistencies in definitions and data availability), they do show a clear trend – the number of people living in cities is growing and the built-up area is expanding. We need to take this trend seriously and carefully consider both the positive and the negative social, economic and environmental consequences.

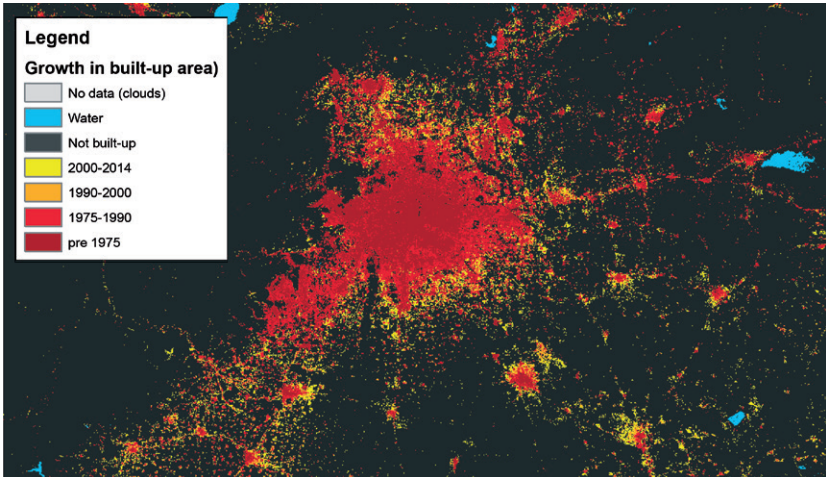

Figure 1
Growth in built-up area in the city of Beijing, China since 1975 (Data source: http://ghsl.jrc.ec.europa.eu)

We have a dilemma: we want urbanization, because it is associated with higher Gross Domestic Products, more jobs, more opportunities, innovation or creativity. But we also have to face the consequences. Unsurprisingly, accelerated urbanization increases the demand on services, housing, facilities and jobs. It depletes surrounding resources, such as agricultural land and water bodies. It intensifies environmental burdens, think of exposure to air pollution, traffic and industrial noise and heat islands. It also increases the exposure of cities to natural hazards due to limited capacities to absorb water in the ground, depletion of wetlands, deforestation or neglect of planning norms.

Urban Challenges in the Global South

The most pressing persistent urban challenges are in cities in the Global South, in Africa and Asia, where most of the current growth is taking place. Challenges include increase in sub-standard housing, which lacks tenure security, basic services and acceptable environmental living conditions. During fieldwork I have seen with my own eyes how low-income or marginalized groups struggle to access resources on a daily basis. The most vulnerable urban areas are thus also those where current and future urbanization will have the most extensive impacts.

Figure 2
Informal housing in the city of Bangalore, India (Photo source: Chloe Pottinger-Glass, 2017)

For example, like many other cities in the Global South, Nairobi in Kenya is growing uncontrollably. This also fuels the growth of informal settlements. People living in these areas often lack essential rights to the city. Therefore, they have limited access to basic urban services. The quality of the available services often varies and is rather costly. Besides, the majority does not own the house in which they live[2].

Data on the number of people in informal areas are inconsistent. For instance, estimates for the well-known Kibera settlement in Nairobi ranged between 200,000 to 1 million[3,4]. Pamoja Trust[5] and Slum/Shack Dwellers International have gathered data on informal settlements at the city-wide scale. These and similar efforts can provide essential input to determine what is needed and where. Nevertheless, such efforts should be continuous in order to strategically plan for the long term.

The much smaller city of Nakuru to the north-west of Nairobi was ranked among the fastest growing secondary cities in Africa in the period 1990–2006[6]. Our colleagues from the University of Cologne detected that this growth continues. Similarly to Nairobi, the rapid urbanization puts stress on providing adequate housing and expanding material infrastructures[7]. It also seriously impacts the vulnerable ecosystems of Lake Nakuru to the south and the Menengai crater to the north.

Just like Nairobi and Nakuru, many cities in the Global South cannot keep up with the need to provide and maintain adequate housing and essential services. For example, since 1990 the number of "urban" people living in deprived areas increased globally from 689 to 881 million between 1990 and 2014[8]. In urban Africa, only 54% had access to improved sanitation in 2010, and global challenges such as climate change put additional stress on scarce resources. For example, extreme weather events, which seem to happen now more frequently and at higher intensities, destroy entire settlements and disrupt critical infrastructures. Recent disasters in Metropolitan Lima testify this trend[9].

The current way of planning and governing these cities hinders an effective response to these challenges. Often mentioned issues are limited resources of local governments, poor communication between governance actors, lack of building and planning norms or scarcity of reliable data and knowledge. Moreover, power imbalances and conflicting rationalities within cities likely intensify existing urban inequalities. Emerging economic and political elites are often much more powerful than ordinary citizens. Especially low-income groups have limited or no agency, as we observed recently in the city of Bangalore[10].

Cities are complex and diverse

What makes knowing the city and tackling urban problems even more complicated is that cities are complex systems. They consist of multiple interrelationships within the city, across the globe and also with the natural environment. Because of these interrelationships, changes in conditions and behaviour at the micro scale can have unexpected – and even undesirable – outcomes at the city scale. For example, upgrade of material infrastructures in deprived areas may lead to gentrification and displacement. As you can imagine, this is not necessarily the desired outcome of upgrade interventions. Also, a change in the transportation infrastructure, for instance the opening of new subway stops on the 22nd of July 2018 in the city of Amsterdam, will considerably change accessibility and influence people's mobility behaviour. Cities are thus spaces where different systems overlap and are interrelated, thereby profoundly shaping how cities develop over time[11].

Cities are also diverse. The cities of today are the result of historical development. They are shaped by the interactions between demographic, socio-cultural, political, economic and technological developments, planning cultures and the natural environment. Let me give you an example from one of my PhD graduates[12]. Chennai in India and Durban in South Africa are both coastal cities with a similar population size, a colonial history and persistent urban poverty. However, due to the specificities of the situated geographic context – consider the caste system in India or the apartheid legacy in South Africa – solutions developed in one geographic context may not be fully transferable to another context and need to be carefully reviewed and adapted. Place and context are thus of paramount importance.

We know that cities are complex and diverse, and that they are facing multiple challenges, especially in developing countries and emerging economies. However, we do not know everything. Increasing complexities, dynamics and uncertainties will continue to challenge our current knowledge of cities and strategies for planning the city and negotiating life in the city.

During the past 20 years I was fortunate to have the opportunity to work on numerous research projects throughout the globe as well as to collaborate with outstanding researchers and inspirational communities. Drawing on my experiences acquired through these stimulating collaborations, I want to take you on a journey from different ways of knowing and knowledge types to Infrastructuring Urban Futures, where people, geo-technologies and infrastructures are important parts of my luggage.

How do we know or can we know the city?

Let me start the journey with how we know the city or can we know the city. I depart from the understanding that there are multiple types of knowledge, knowers, and ways of knowing[13,14]

Figure 3
Tacit knowledge
Context-embedded professional knowledge
Context-embedded community knowledge
Codified knowledge

(Source: bart tekent 't ©, 2018)

Tacit knowledge

First, everybody has tacit knowledge. You and I acquire tacit knowledge through practice, in other words, through personal experiences or social interactions. It is not formalized in written text, numbers or maps. In an email conversation about different ways of viewing and knowing, a colleague defined tacit knowledge as 'the view from here', because it requires physical proximity with people or a material object. In the city, the knower can be an ordinary resident, learning through everyday practices, but also a professional or scientist who acquires skills and knowledge through daily work interactions, both with colleagues and equipment.

The email I received from my PhD candidate on his first day in the Indian city of Patna in Bihar is a vivid illustration how one acquires tacit knowledge through experience:

> "Navigating through Patna also wasn't easy. In each Indian city, transportation works slightly differently, and each urban transport system seems to have its own particularities. In Patna you cannot hop in an auto by yourself, one that gets you to any destination in the city. […]. Here, slightly bigger autos (which hold up to seven people, 10 if the driver feels like it) run in diagonal lines from key entry points to key exit points (visual). If you don't know the names of these entry and exit points, like me when I first arrived, you're in for some frustration because no one will take you anywhere. After two days I figured out that if you wanted to go east, you look (shout) for an auto to take you to Rajendra Nagar, west is AN College or Boring Road, north is Maidan, south is Mithapur Bus stand, centre is Junction. You can get in and out almost anywhere along the diagonal lines, but autos will not take you into the streets. Once you figure that out, Patna's system is incredibly efficient and cost effective. One auto ride costs between INR 5 and 10 (meaning 6-12 euro cents), and you can get from one side of the city to the other in about 20 to 30 minutes." (Robbin-Jan van Duijne, 11 March 2018, e-mail conversation)

Context-embedded community knowledge

A second type of knowledge is context-embedded community knowledge. This is knowledge that members of a social or spatially bounded community obtain about the place or context to which they belong. Haraway[15] also calls it situated knowledge. Community members are well aware what is happening in their immediate surroundings.

Through regular interaction with the context, they acquire knowledge about what they experience, see, hear, smell or feel. In contrast to tacit knowledge, this knowledge can be made explicit.

During fieldwork in the South Durban Basin area, I observed how important mind maps are in making contextual knowledge explicit, especially for people who felt less comfortable expressing themselves in direct conversations with me. Within minutes, an elderly man crafted a beautiful drawing of his perception of the neighbourhood, highlighting locations where he experiences bad smells and suffers respiration problems, due to the presence of oil refineries.

This type of knowledge is very important. It provides knowledge that is often not visible in standard statistics, graphs or maps, but can be made explicit through participatory and collaborative processes.

In that same area, the environmental agency SDCEA showed me how it collected people's experiences of health issues in order to generate spatial-temporal community evidence about pollution problems, and how it linked the community evidence with their air pollution measurements. By linking these two different knowledge types, the environmental agency could make visible that pollution values below official pollution standards already caused health problems. Official pollution standards were thus not adequate. Because of this advocacy process by the environmental agency, more-rigorous environmental legislation was adopted. This example highlights that a particular environmental standard is not always adequate for a particular context, and that this shortcoming – as well as the subsequent improvement of regulation – can be addressed by operationalizing community knowledge.

Digital information and communication technologies and easy-to-use sensors have become popular tools for tapping into community knowledge. People share reports about the malfunctioning of municipal services, give feedback on planned interventions, enter disaster related observations or contribute environmental measurements. For example, due to the absence of public flood risk information during the 2015 flood in Chennai, five colleagues from MapBox India developed an interactive social media application to crowdsource real-time information during the flood[i]. When the flood became critical, people heavily contributed what they saw in their neighbourhoods: whether streets were flooded and where relief camps were installed.

[i] *Accessible via: https://osm-in.github.io/flood-map/chennai.html#11.65/13.0493/80.2593*

Through the app "several teams and NGOs were able to identify high-risk areas, coordinate relief supplies and deliver them to those in need"[16]. The Chennai Flood Map app became a crucial instrument in the humanitarian disaster response.

The Chennai Flood Map is one of many such systems that have changed the landscape of knowledge generation and navigation, and how we organize and govern individual and collective urban life. However, it is important to realize that not everybody has access to such systems, that the information or system may be used for the wrong purposes, or that people purposely choose not to use such systems due to privacy concerns. While such technology platforms have shown to be useful, they do not always provide the full picture.

Context-embedded professional knowledge

Similar to the second type of knowledge, the third type is context-embedded professional knowledge. As you can see from the name, it is knowledge urban professionals like municipal officials or public works engineers acquire through their training and work experiences. Our research on spatial information infrastructures and participatory spatial knowledge management in Indian and South African cities revealed that ward councillors know a lot about their ward, because of their direct interactions with residents. They are often the key link between the city and the people, and they build up their knowledge through their social networks. An interactive workshop in Kalyan, India with municipal officials and ward councillors resulted in spatial representations of which ward had what kind of problems[17]. Although the produced coloured maps were simple in nature – and would not fit the cartographic visualization scheme of my cartography colleagues – they were of crucial importance. The maps made explicit what councillors knew (and were willing to share) about their ward and helped reach refined mutual understandings and led to social learning.

Another example about making contextual knowledge explicit comes from a conversation with a young municipal professional from the water board in Chennai. He told us that he started to learn geographic information systems to codify the rich knowledge regarding the technical water infrastructure of his senior colleagues. He was worried that their essential contextual knowledge acquired over many years would disappear when they retire from the department.

Codified knowledge

The fourth type of knowledge is codified knowledge, i.e. knowledge that we acquire through our professional education and research. Potential "knowers" are sectorial experts: the city planner trained in urban planning; the underground specialist who knows everything about the geology and underground piping system; the statistician who knows how to carefully collect and process urban statistics to monitor urban conditions and policy targets.

As urban scholars, we aim to create codified knowledge on the city or parts of the city through reproducible, scientifically sound methodologies. We often do this at our desk, mostly with a computer, in the laboratory, and via data collection in the field. For example, in a joint research projects on mapping deprived areas, we generated codified knowledge about the different types of sub-standard settlements in the city of Mumbai[18]. We collected relevant data from different sources in a systematic manner, processed and analysed the data with adequate methods, validated and made sense of the results by using knowledge and theories acquired throughout our academic development. Another example is the analysis of transit oriented development areas in the city of Beijing, where our PhD candidate was highly creative in accessing data from digital open data platforms[19].

The digital data revolution of the 21st century has clearly shifted the knowledge landscape. Sensors on satellites, lamp posts, in chip cards, mobile phones or in dwellings generate massive digital datasets on all facets of the built environment and urban life. Together, we produce over

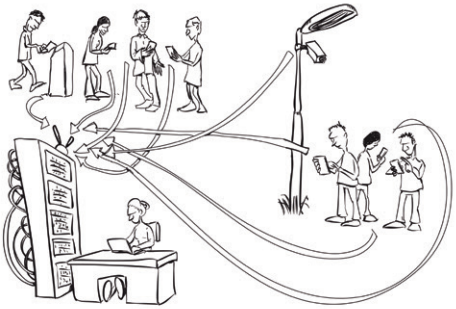

Figure 4
Digital data revolution (Source: bart tekent 't ©, 2018)

2.5 quintillion bytes of data every day[20], equivalent to 1 trillion mobile phone pictures each day! This data revolution creates opportunities for new knowledge actors to contribute to understanding the city. Physicists, big data scientists, computer scientists or e-science engineers are producing new ways of learning, knowing, visualizing, and governing the city, namely as presented through physical laws, sensors, algorithms and data analytics.

I would like to highlight that there are multiple ways of building codified knowledge, depending on the disciplinary background and how knowledge producers see the world. And there are also different understandings about the validity of codified knowledge. Some consider statistical approaches or maps to be a more "objective", neutral and credible way of knowing, because they involve scientific methods of data collection, analysis and interpretation and produce numeric results or a map. The massive task of data crunching done by national and global statisticians to compute Sustainable Development Goal indicators seems to overshadow the discussion on what knowledge is actually needed to advance progress in improving urban living conditions.

It is no surprise then that others critique such approaches because they only present one reality, while often multiple, competing "realities" co-exist in the city. I tend to position myself in this camp.

Knowledge dialogue

Each type of knowledge has its own merit, be it knowledge that we acquire through everyday experience or from sophisticated algorithms. But, knowing and acting in silos is insufficient, especially amidst the fast changing dynamics and complexities of today's cities. Our deprivation mapping study in the city of Delhi showcases the added value of a combined approach[21], as follows. Opposite to the common assumption that poverty is concentrated in slums, in Delhi we obtained a low correlation between multi-dimensional poverty and the percentage of slum dwellers at the ward level. We could only attach meaning to the number by including contextual knowledge and further investigation through qualitative fieldwork and satellite image analysis. The combined approach revealed that resettlement colonies did not have sanitation within their premises and are high density areas. This was the main reason for a high level of deprivation in wards with resettlement colonies, but no or just a few slum dwellers, as classified by the Indian census.

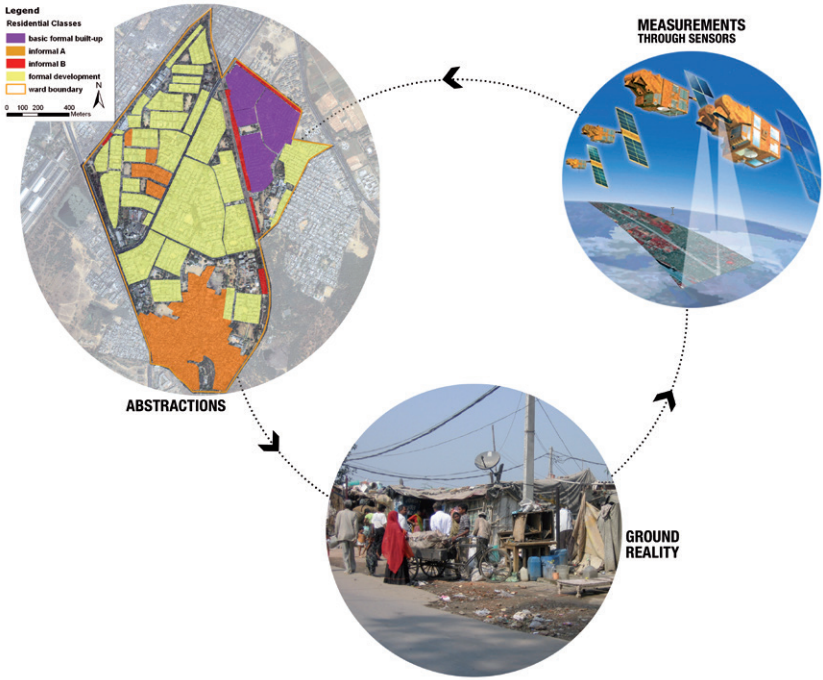

Figure 5
Combining satellite images, classification, and ground reality (Source: Karin Pfeffer, 2016)

Researchers are gradually recognizing that urban studies is a team sport. For example, data-driven approaches cannot give meaning to numbers, and cannot reveal unrecorded city areas or identify the real needs of communities[22,23]. Conversely, single, qualitative case studies suffer from low generalizability. My hope is that by combining knowledges from different disciplines and fields we can arrive at a richer understanding of current states, practices, relations, dynamics and future trajectories.

But how to create this much-needed dialogue between different knowledges as well as different disciplinary backgrounds? And how can contemporary urban practice become more sensitive to different values and meanings, power and knowledge asymmetries and the reality on the ground?

These questions bring me to the core focus area of my chair, namely Infrastructures and Infrastructuring.

Infrastructures and Infrastructuring

Infrastructures

For many in this room or those following the livestream, the term infrastructuring is perhaps an unfamiliar concept. We all know what infrastructures are and the key role they play in the development and organization of our urban life. Infrastructures are connected to our daily activities, like consuming water or energy, travelling from home to work, or communicating with each other. Often, we are not aware of their existence because they are tightly aligned with each other and embedded in the urban fabric and social arrangements. Think of all the systems and interactions involved in a single train journey. A train runs on the rail tracks, using electricity from the energy grid. It is steered through a remote control centre and staffed with the train driver and conductors, who are all interconnected through their mobile devices. Passengers acquire information on the train schedule at the front desk, from the physical boards on the platform, the app on their mobile phone, a printed schedule, a computer or human voice on the platform, or from another passenger and plan accordingly their trip. They can enter the train with a valid ticket, in the form of a paper ticket, a digital ticket or the public transport chipcard.

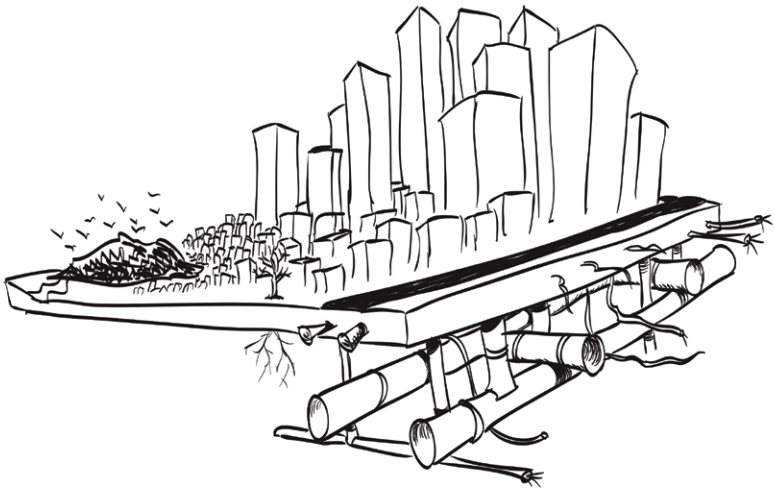

Figure 6
Infrastructures are tightly aligned with the urban fabric (Source: bart tekent 't ©, 2018)

We only notice a particular infrastructure when it breaks down: a signal interference at the rail track, if there is no drop of water coming out from the tap, or if there is an electricity power cut.

Once we learn how to use the infrastructure, we know how to use it for future tasks. My PhD candidate had to learn how to use the public transport system in Patna. Once he knew about the diagonal system and that he had to shout the starting or end point, it became an efficient system for moving around in the city. Note that access to and use of infrastructures is likely unequal across socio-spatial groups, especially in the Global South. Some actors are more powerful and have more rights, information or financial resources than others to organize and negotiate access to infrastructure and its use.

All infrastructure has a number of typical characteristics[24]. *First,* it is not limited to a single site or a single moment in time but has a wider spatial and temporal reach. It can thus accommodate demands and activities that happen in different locations and at different moments of time, for instance collaboratively working on a shared document in the cloud. While it is potentially open to a variety of users, it is highly contingent on the type of infrastructure and – more importantly – on the rights and capacities of users.

Second, infrastructures are expandable: they can grow and change and can be plugged into or aligned with other infrastructures. But this can only happen if they are compatible. I mean if there is the willingness to make use of the same conventions and standards, or if there is a work around to create a connection between different standards. Incompatibility is often a problem at the borders of countries, for instance, when the size of rail tracks suddenly changes. In terms of social infrastructure, this would mean speaking the same language or finding another way of communication, for example via a translator.

A *third* characteristic is that infrastructures are often built on what is already there in terms of (physical) infrastructure, practices and systems. Infrastructure scholars[24–26] call this the installed base. A public transport system does not just come about by itself but is related to what is already there, such as roads or electricity power lines, inheriting both the good things and the problems. An often-mentioned problem is technological lock-in, meaning that we are stuck with technology used in an earlier period.

Many view infrastructures as the substrate upon which actions and things can run[24,27]. Drinking water flows through the water pipes in the underground, our emails are transported through the optical cable network at close to light speed and so on. But, and this is very important, infrastructure is not only a substrate but also relational[24]. It is related to our daily practices and use. The emphasis is on the relations between material elements, institutions, people, or natural elements.

Infrastructuring – a socio-technical process

Now that we know that infrastructures are both a substrate and relational, what is then infrastructuring? And how can it help develop and organize urban life and provide access to urban infrastructure? Already the pronunciation is not easy.

Infrastructuring – as the -ing form already suggests – is an active process. Literally translated it means "building infrastructure". It continuously connects and aligns elements or living organisms with each other. For example, infrastructuring connects two habitats through a corridor in such a way that deer can cross the highway safely. Expanding and aligning these connections from habitat to habitat area over time, an ecological corridor emerges, particularly through the deer making use of the infrastructure. This process of becoming an ecological corridor and how it changes over time is infrastructuring.

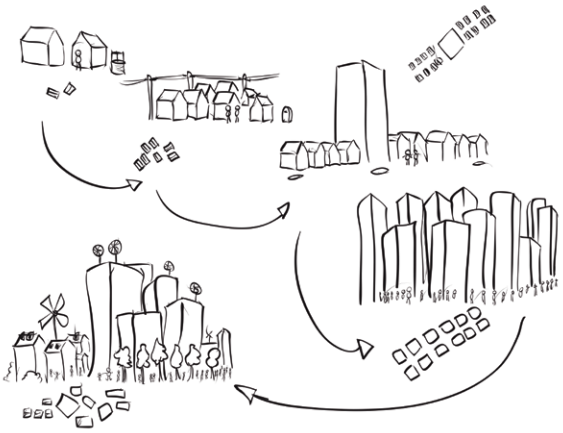

Figure 7
Infrastructuring is a longer-term process (Source: bart tekent 't ©, 2018)

Infrastructuring is thus a long-term, continuous process in which different relations evolve[28]. It is the opposite of products and projects, which are finished things and have an end date. In such a process, infrastructures shape people's behaviour and practices, and in return, people shape the infrastructure through their practices and behaviour[29]. The emergence of transportation services like the motorcycle ride service Go-Jek[ii] in Indonesia or free bicycles systems in Vienna[iii] are shaping how people move through the city. While Go-Jek started as a motorcycle ride service, it transformed into a multiple-demand service through people's practices. You can use it to get around the city, for food delivery or to have a massage therapist service in your home, should you live in Indonesia.

With regard to *Infrastructuring* Urban Futures, infrastructure emphasizes the mutual relationships between urban development, material infrastructures (e.g., transport, energy, water, telecommunication, etc.), services and people. *Infrastructuring* emphasizes the process of mutual adjustment between infrastructure, services and people during urban development, now and into the future. In a nutshell, infrastructure is the relational system, while infrastructuring pronounces the mutual adjustment of the relational system over time.

Information and knowledge about the material infrastructure – formal and informal, digital and analogue, spatial and non-spatial – and people's use of the infrastructure are part of the mutual relationships and how they change over time. Being also an infrastructure, information and knowledge can potentially be created, accessed, shared and changed at multiple sites and points in time. Thereby, it can support activities in different parts of the city and at different moments in time. This could be information about the functioning of an infrastructure, the properties of infrastructure, its layout, planned interventions communicated through newsletters, but also about breakdowns and repairs.

Geographic Information Science (GIS) technologies, which I term geo-technologies, have or can have an important role in infrastructuring the knowledge about material infrastructures[30] to improve the planning of and access to urban infrastructures. For me, although you might define it differently, geo-technologies is the ensemble of tools, devices and infrastructures used to acquire, process and visualize geo-spatial data, e.g. Geographic Information Systems, remote sensing tools, spatial modelling and simulation tools, location-based technologies and digital data platforms. Because of the multiple mutual relationships between infrastructure, services, people and institutions, infrastructuring is a socio-technical process (Star and Ruhleder 1996), interwoven with underlying political mechanisms.

[ii] *https://www.go-jek.com*

[iii] *https://www.citybikewien.at/en/*

Infrastructuring – a participatory process

But I see infrastructuring also as a participatory process. Think of bringing people together in a social space (physical or virtual space) for a particular goal, for example to create awareness of the importance of changing energy or water demands or to design alternative services to more effectively support different community concerns. This way of infrastructuring invites people to enter a social network of active relations and has the grand ambition to enact new relations, activities, ideas, social learning and maybe even behavioural change. But how can we do this? How can we engage people and sustain their interest on the long term? Well, as in any other participatory process, infrastructuring requires careful design and a good understanding of the context for it to become a long-lasting infrastructure. Most importantly, it requires an understandable and relevant issue of concern that people can relate to that captures the imagination and spurs action with a sense of urgency to participate and enacts change in the long-term. Our repeated efforts to build a community in two neighbourhoods in Amsterdam to learn about people's energy behaviour have shown that if energy consumption is not of a concern, there will be little interest to participate.

Another aspect of the careful design is to consider what is already in place *(the installed base)*; for example, which actors and networks are actively infrastructuring, what are major problems, what are the differences in needs and capacities and what are the underlying power relationships.

A particular challenge is to find the right balance between facilitating a participatory process and giving sufficient space for alternative ideas and initiatives to emerge. As you may have experienced yourself, participants like to be treated as equal partners, that they have enough space to bring in their own ideas and that these ideas are taken seriously. It also requires cultivation of established relations and regular feedback. People are not books that can be read and put back on the bookshelf but need to be treated with care to motivate lasting engagement.

I find interactive mapping processes and products effective devices in such a participatory process. In the participatory workshop in the city of Kalyan, India, mapping the councillors' knowledge brought the background to the foreground, revealing what they knew or wanted to share. I found it fascinating to see how a simple map triggered the discussion on deprivations: why certain areas pop up; that the framing of problems had to be re-considered; or what the underlying causes for certain problems were. I also learned that not every municipal official

is familiar with ward boundaries; they are used to referring to names of wards or colonies within the wards, not the geographical delineation. I did not think of this at all when preparing the workshop; I had not sufficiently engaged with the context prior to the workshop.

With regard to my chair, I see infrastructuring as an interactive way of knowledge building. A process whereby different "experts" recognize the value of each other's knowledge and co-create new knowledge through collaborative, inter- and transdisciplinary processes[31–33]. It is an important element in the emerging field of collaborative, co-creative urban planning research and practice. And it will be key for improving existing infrastructures[34] or building new ones[35], because of the mutual relationship between people, services, infrastructures and urban development within the situated urban context.

This way of knowledge building also resonates very well with the long-standing project activities of my ITC colleagues as well as the recent call for collaboration by several urban scholars[22,23]. Introducing the term infrastructuring into this debate emphasises building and sustaining long-term social relationships between different actors in the city.

A major challenge of infrastructuring is precisely its interactive aspect. To what extent are people willing to share their knowledge, to trust each other, to value each other's contribution? How committed are they to long-term participation, or do they even have the necessary means for participation? The structuring of this dialogue is another focus area of my future work.

Infrastructuring Urban Futures

"The study of cities needs to become more than the sum of its parts."[22]

I started the speech by emphasizing that the 21st century is the age of accelerated urbanisation; that cities are facing increasing complexities, dynamics and uncertainties; that cities in emerging economies in particular face a major planning challenge to provide and improve access to basic services. Southern scholars increasingly remind us that, given the differences of Southern cities, established planning and policy models from developed Northern cities cannot be simply transferred to this context. I also underscored that conventional ways of knowledge generation are

are insufficient for responding to these challenges and that relying on only one knowledge type or discipline (be it knowledge from data analytics or knowledge from experts) will not help us address the upcoming infrastructure challenges.

Accelerated urbanization moved the city into the spotlight across the world and among multiple disciplines, both research disciplines and professional sectors. While it has become a prominent object in research and policy agendas, "the study of cities needs to become more than the sum of its parts"[22]. I strongly believe that a multi-, inter- and transdisciplinary research approach can shift our current understanding of the mutual relationship between urban development, infrastructures, services and people. It can inspire urban planners and professionals, but also citizens, to re-invent or re-organize their practices. This shift in perspective is very much needed to reach the ambitions set out in Sustainable Development Goal 11 and the New Urban Agenda in securing access to urban infrastructures.

But how are we going to achieve this shift?

Techniques of Infrastructuring

Given the time and the complexity of the subject, I will not be able to elaborate on all the details today, but I wish to briefly put forward four ways of infrastructuring that I consider important, what I term as Techniques of Infrastructuring.

The first technique is to move alternative modes of knowing and people's practices into the foreground. As I said earlier, we all know something about the city, through our experiences, practices and education. The aim is to make visible what infrastructure users and producers know about urban infrastructures as well as what they do, including how they perceive their access to and the quality of urban infrastructure. The focus is on tacit and context-embedded knowledge, thus, on knowledge that is not captured in documents, standard datasets and digital "smart" urban systems. In order to make this knowledge visible, a longer-term engagement with citizens is necessary, for instance through community meetings, neighbourhood safaris, walking interviews, but also digital community platforms and engagement with urban professionals. It will produce stories, rich description of practices and personal experiences that can elucidate current bottlenecks but also new ideas for infrastructural improvements.

A second technique of infrastructuring is imagining alternative futures. I wish to trigger people's creativity, to motive them to think out of the box

Figure 8
Techniques of Infrastructuring (Source: bart tekent 't ©, 2018)

about: what could happen if certain changes would take place. What if access to public transportation infrastructure is free for everybody? Or what are we going to do if all water reserves are used up? The current water situation in Cape Town highlights the urgency of this problem. Speculative questions, scenario-building processes, but also gamification and spatial simulation models are important tools to awaken these kinds of imaginations. The joint research project on spatial knowledge management[iv] has shown that scenario building can even work in a hierarchical governance context such as India and produced interesting insights on future water-related vulnerabilities[36].

In addition to thinking and talking about the future, experiments and interventions can help showcase the possible effects. They may actually

[iv] *http://Chance2sustain.eu/*

give us a much better understanding of how the current system works. Inspired by scholars from infrastructuring studies, I am calling the third technique prototyping the urban future. I like to adopt the term prototyping, because it involves actual interventions or experiments with regard to the current infrastructure, interventions and experiments from which we wish to learn and can make different expectations of a specific issue visible and discussable[28,34,37]. Prototypes (or mock-ups) could be a new water purification installation, a public toilet information tool in sub-standard settlements; a change in traffic regulations; or a garbage collection infrastructure. Prototyping could happen in an urban living lab, now widely used to develop and experiment with bottom-up smart city strategies.

Throughout my lecture I highlighted the importance of linking different knowledge types and disciplinary expertise. This brings me to the fourth technique, which I call co-creating the urban future. The process of co-creation involves collaboration and participation of different actors, as explained earlier about infrastructuring as an interactive way of knowledge building. Co-creation can happen in different constellations and different space-time combinations. Constellations refers to different knowers, whether from different knowledge fields or not. Space-time combinations relate to whether participants are in the same space at the same time (a typical workshop setting); or in different places, but at the same time (teleconferencing/conference calls); or, even in different places at different moments in time (exchanging information through web-based applications). One of our PhD candidates will explore how these different co-creating settings can be supported by advanced geo-based technologies, namely the MapTable and web-based technologies. A MapTable (also called table top) is an emerging geo-technological tool in urban planning that supports social interaction on a horizontal touch-based computer screen that displays interactive maps; it is thus an important device in co-creation processes[38].

In all four Techniques of Infrastructuring, geo-technologies are considered as enablers in a multi- and transdisciplinary knowledge production, use and exchange. Necessarily it needs to be grounded in the specific places concerned and recognize the uniqueness of Southern cities.

Future directions

Via these four different Techniques of Infrastructuring, together with the research group, I aim to investigate how different urban actors develop, organize and practice access to urban infrastructure (transport, energy, water, sewage, etc) and to what extent geo-technologies can improve the planning of and access to urban infrastructures. A particular challenge will

be to make visible the tension between socio-spatial inequalities and how resources are allocated in resource-scarce urban environments exposed to the challenges of accelerated urbanization and climate change impacts.

The research on urban infrastructures and infrastructuring has two methodological directions.

The first direction literally unpacks infrastructures. How have they become infrastructures? How are information and knowledge created about the infrastructure? How do or could people use geo-technologies in developing, organizing and practicing access to urban infrastructure? What are the major social and environmental problems? Overall, I aim to understand what is happening where and why, in order to highlight the multiple relations in place. The relations are between: individuals; their situated context; the activities they perform; their social arrangements; the material infrastructure they use; and the geo-technologies they use to perform activities and organize their practices. The emphasis is thus on the mutual relationships between material infrastructure, geo-technologies and the wider social systems.

The second direction makes use of the analytical strength of geo-technologies, which include Geographical Information Systems (GIS), remote-sensing based mapping algorithms, dynamic models of urban and natural processes or geo-based digital platforms. This also involves the interactive generation and visualisation of spatio-temporal information, which will, among other purposes, be used as an input in co-creation processes as a mediator (e.g. displayed on a MapTable). Interactive generation emphasizes the collaboration between different experts to combine their disciplinary strengths, for instance between a simulation model maker, a social scientist and field workers. Examples are the delineation of deprived areas through remote sensing analysis tools, quantification of urban accessibility, spatio-temporal patterns of urbanisation or computation of the impacts of different urban interventions.

In a workshop in Durban on ecosystem services in which I participated as an observer I realized how useful it was for urban professionals to make use of GIS during the workshop. Participants interacted with the pre-processed geographic information by asking the workshop facilitator to zoom in to certain areas in the city, remove spatial layers or add additional sets of spatial information. This was quite an eye-opener for me.

The envisioned work on Infrastructuring Urban Futures will build on the installed base of the institution where my chair is located – the rich knowledge, existing social and professional networks, and the technical expertise of my own department PGM, but also ITC in general as well

as the other UT colleagues working on cities, infrastructure, and socio-technical topics. The five floors of the ITC building bundle disciplinary knowledge about nearly every facet of system earth: the underground, hazards, water, biodiversity, and of course about people (how they shape the built and natural environment, how they are affected by the environment and how they interact with the environment). We can also draw on the extensive knowledge in the field of geo-spatial data acquisition and analysis tools, advanced computer models and algorithms, very high-resolution geo-spatial data and advanced methods. ITC's broad network of international organizations and stakeholders from Southern cities – especially our international Master students and PhD candidates, but also international staff members – provide essential support in conducting research that is aware of the situated, local context and will be conducive for empirical contributions to the emerging field of comparative and critical urban studies.

Through joint activities and projects, I aim to establish links to other departments of the university and to strengthen existing relationships with the Centre for Urban Studies of the University of Amsterdam and other urban scholars like those involved in COMPASS.

In the context of my chair engagement, in addition to the work on infrastructuring and infrastructures, I aim to enhance the nexus between urban studies and the geo-spatial sciences and to reach out to other disciplines like philosophy and computational sciences. In my own academic trajectory, I crossed the boundary from the natural sciences to the social sciences. For me, crossing boundaries implied learning a new language, cultural norms, methods and techniques. It was an enlightening experience that made me realize the added value and joy of interdisciplinary work as well as the importance of recognizing the value of each other's perspective. Second, I aim to strengthen collaborations between academia and practice, to move from the demand–supply paradigm (meaning we develop and you apply) to co-design and co-creation. The first steps are set, but a continuous effort will be required. And finally, while geo-technologies provide multiple ways of knowing the city and urban infrastructure, and can function as enablers in infrastructuring, we need to be sensitive to the societal implications and limits of geo-spatial and digital technologies as well as the potential barriers they pose. How to deal with this challenge will be another important research focus.

It is my ambition that by appropriating a broad, integrated approach – bringing together different knowers and knowledge types, disciplines, actors, methods and tools – we will be able to get to know the city even better and will be empowered to infrastructure more equitable and sustainable futures.

Words of Thanks

Arriving at the end of my inaugural lecture, I would like to take the opportunity to thank the Rector of the University of Twente, the Dean of ITC and the appointment advisory committee for their trust in my ability to develop the chair "Infrastructuring Urban Futures" and their incredible efforts to make the appointment happen.

To ITC, and in particular to the PGM department, a special thanks for the warm welcome upon arrival. During my first days at ITC, colleagues from other departments emphasized their good relationships with PGM colleagues; and I can tell you why: there is an incredible team spirit, positive energy and trust which is a very valuable asset for the kind of work we do. I am proud to be part of this department now.

I also want to thank the GPIO department and AISSR of the University of Amsterdam for all the possibilities and support during my academic development from Postdoctoral Researcher to Associate Professor. Thank you GPIO and AISSR colleagues for the great collaboration, inspirational discussions and social exchanges.

The fact that I am standing here in this room today was made possible by many people. Unfortunately, I don't have the time to thank each of you individually, and please forgive me for that, but I would like to highlight a few:

A special vote of thanks goes to my co-promotor, Theo van Asch, and promotores, Peter Burrough and Berthold Bauer – for their faith in my ability to undertake a PhD research at Utrecht University in the GETS project; an EU project led by Andrea Fabbri from ITC. It was my first encounter with creating knowledge on infrastructures, namely the impact of ski pistes on the environment. Unfortunately, at that time, there was little interest from the ski ressort in Sölden to make it an infrastructuring effort.

I want to express my deep gratitude to Isa Baud for introducing me to urban governance, international development studies, and a sociological perspective on spatial information. You thought that I needed to see and experience the Indian context in-situ, and not only through Census data and GIS maps. This enacted what has become an exciting research network across the globe, with scholars from ITC, UvA, CNRS, University of Cologne, and institutions in Peru, Brazil, India and South Africa.

A special thanks to Yola Georgiadou, for broadening my horizon on geo-information science. After our first encounter in 2005, infrastructured by Erik de Man over dinner, I started to look differently at GIS-based systems. Back then, I saw the Amsterdam monitor as an analytical, objective tool that I fed with processed data to monitor urban characteristics. This view considerably changed during our joint project on spatial information infrastructures in Indian cities.

A big thanks to all my PhD candidates and graduates and MSc students; each of you shaped my thinking, understanding and knowledge in different ways, ranging from sophisticated sociological and anthropological theory to GIS and remote-sensing based analysis in different contexts.

Several people have read earlier versions of the inaugural lecture I delivered today. Many, many thanks for your valuable and constructive comments. At this point I also want to thank all the people who have helped organize this wonderful event of yesterday and today, in particular Petra Weber. Without you I would still be struggling with the online templates.

My valuable friendships have shown that social ties are disproportionally correlated to frequency of meeting. Thank you for all your encouragement and cheerful moments together.

A big thanks to my parents, Vati and Mutti, who taught me to become independent early on. You supported my wish to go to the Gymnasium which was the exception, but not the norm, and were enabling factors in all kinds of aspirations such as doing an Erasmus exchange programme in Utrecht which planted the seed of where I am now.

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Ik heb gezegd.

References

1. UN DESA (United Nations Department of Economic and Social Affairs). *World Urbanization Prospects – the 2014 revision.* (2014).
2. Gulyani, S. & Talukdar, D. Slum Real Estate: The Low-Quality High-Price Puzzle in Nairobi's Slum Rental Market and its Implications for Theory and Practice. *World Dev.* **36**, 1916–1937 (2008).
3. Desgroppes, A. & Taupin, S. Kibera: The Biggest Slum in Africa? *Les Cah. l'Afrique l'Est* **44**, 23–34 (2011).
4. Veljanovski, T., Kanjir, U., Pehani, P., Oštir, K. & Kovačič, P. Object-based image analysis of VHR satellite imagery for population estimation in informal settlement Kibera-Nairobi, Kenya. in *Remote Sensing Applications* (ed. Escalante-Ramirez, B.) 407–434 (2012).
5. Pamoja Trust. *An Inventory of the Slums in Nairobi*. (2009).
6. UN-HABITAT. *State of the World's Cities 2010/2011-Cities for All: Bridging the Urban Divide*. (2010).
7. UN-HABITAT. *UN-Habitat Support to Sustainable Urban Development in Kenya. Report on Capacity Building for County Governments under the Kenya Municipal Programme.* **1**, (2015).
8. UN-HABITAT. *World Cities Report 2016*. (2016).
9. Miranda Sara, L., Jameson, S., Pfeffer, K. & Baud, I. Risk perception: The social construction of spatial knowledge around climate change-related scenarios in Lima. *Habitat Int.* **54**, 136-149 (2016).
10. Pottinger-Glass, C. Life at the mercy of the bulldozer: The politics of urban development in contemporary Bangalore. (University of Amsterdam, 2018).
11. Amin, A. & Thrift, N. *Seeing Like a City*. (Polity, 2016).
12. Saharan, T. 'Slum' and the City: Exploring relations of informal settlements comparatively in Chennai, India and Durban, South Africa. (University of Amsterdam, 2018).
13. Pfeffer, K., Baud, I., Denis, E., Scott, D. & Sydenstricker-Neto, J. Participatory Spatial Knowledge Management Tools: Empowerment and upscaling or exclusion? *Inf. Commun. Soc.* **16**, 258–285 (2013).

14. Pfeffer, K., Martinez, J., O'Sullivan, D. & Scott, D. Geo-technologies for spatial knowledge: Challenges for inclusive and sustainable urban development in Geographies of Urban Governance: Advanced Theories, Methods and Practices. (eds. Gupta, J., Pfeffer, K., Verrest, H. & Ros-Tonen, M.) 147-173 (Springer International Publishing, 2015)

15. Haraway, D. Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Fem. Stud*. **14**, 575–599 (1988).

16. Hindu. The city's flood map goes global. *Hindu Online* (2016).

17. Pfeffer, K., Martinez, J., Baud, I. & Sridharan, N. Knowledge Production in Urban Governance Systems through Qualitative Geographical Information Systems (GIS). *Environ. Urban. Asia* **2**, 235-250 (2011).

18. Kuffer, M., Pfeffer, K., Sliuzas, R., Baud, I. & Maarseveen, M. van. Capturing the Diversity of Deprived Areas with Image-Based Features: The Case of Mumbai. *Remote Sens.* **9**, 384 (2017).

19. Lyu, G., Bertolini, L. & Pfeffer, K. Developing a TOD typology for Beijing metro station areas. J. *Transp. Geogr*. **55**, 40-50 (2016).

20. Jacobson, R. (IBM). 2.5 quintillion bytes of data created every day. How does CPG & Retail manage it? IBM (2013). Available at: https://www.ibm.com/blogs/insights-on-business/consumer-products/2-5-quintillion-bytes-of-data-created-every-day-how-does-cpg-retail-manage-it/. (Accessed: 9th May 2018)

21. Baud, I., Kuffer, M., Pfeffer, K., Sliuzas, R. & Karuppannan, S. Understanding heterogeneity in metropolitan india: The added value of remote sensing data for analyzing sub-standard residential areas. *Int. J. Appl. Earth Obs. Geoinf.* **12**, 359–374 (2010).

22. Acuto, M., Parnell, S. & Seto, K. C. Building a global urban science. *Nat. Sustain.* **1**, 2–4 (2018).

23. Parnell, S. & Robinson, J. The Global Urban: Difference and Complexity in Urban Studies and the Science of Cities. in *The SAGE Handbook of the 21st Century City* (eds. Hall, S. & Burdett, R.) 13–31 (Sage, 2017).

24. Star, S. L. & Ruhleder, K. Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Inf. Syst. Res.* **7**, 111–134 (1996).

25. Hanseth, O., Monteiro, E. & Hatling, M. Developing Information Infrastructure: The Tension Between Standardization and Flexibility. *Sci. Technol. Hum. Values* **21**, 407–426 (1996).

26. Monteiro, E. Scaling Information Infrastructure: The Case of Next-Generation IP in the Internet. *Inf. Soc.* **14**, 229–245 (1998).

27. Bowker, G. C., Baker, K., Millerand, F. & Ribes, D. Toward Information Infrastructure Studies: Ways of Knowing in a Networked Environment. in International Handbook of Internet Research (eds. Hunsinger, J., Klastrup, L. & Allen, M.) 97–117 (Springer Netherlands, 2010).

28. Dreessen, K., Huybrechts, L., Grönvall, E. & Hendriks, N. Infrastructuring Multicultural Healthcare Information Systems. in Participatory Design & Health Information Technology (eds. Kanstrup, A. M., Bygholm, A., Bertelsen, P. & Nøhr, C.) 30–43 (IOS Press, 2017).

29. Karasti, H., Pipek, V. & Bowker, G. C. An Afterword to `Infrastructuring and Collaborative Design'. Comput. Support. Coop. Work **27**, 267–289 (2018).

30. Richter, C. & Georgiadou, Y. Practices of Legibility Making in Indian Cities: Property Mapping Through Geographic Information Systems and Slum Listing in Government Schemes. Inf. Technol. Dev. **22**, 75–93 (2016).

31. Fazey, I. et al. Knowledge exchange: a review and research agenda for environmental management. Environ. Conserv. **40**, 19–36 (2013).

32. Shrestha, R., Flacke, J., Martinez, J. & van Maarseveen, M. Interactive Cumulative Burden Assessment: Engaging Stakeholders in an Adaptive, Participatory and Transdisciplinary Approach. Int. J. Environ. Res. Public Health **15**, (2018).

33. Straatemeier, T., Bertolini, L., te Brömmelstroet, M. & Hoetjes, P. An Experiential Approach to Research in Planning. Environ. Plan. B Plan. Des. **37**, 578–591 (2010).

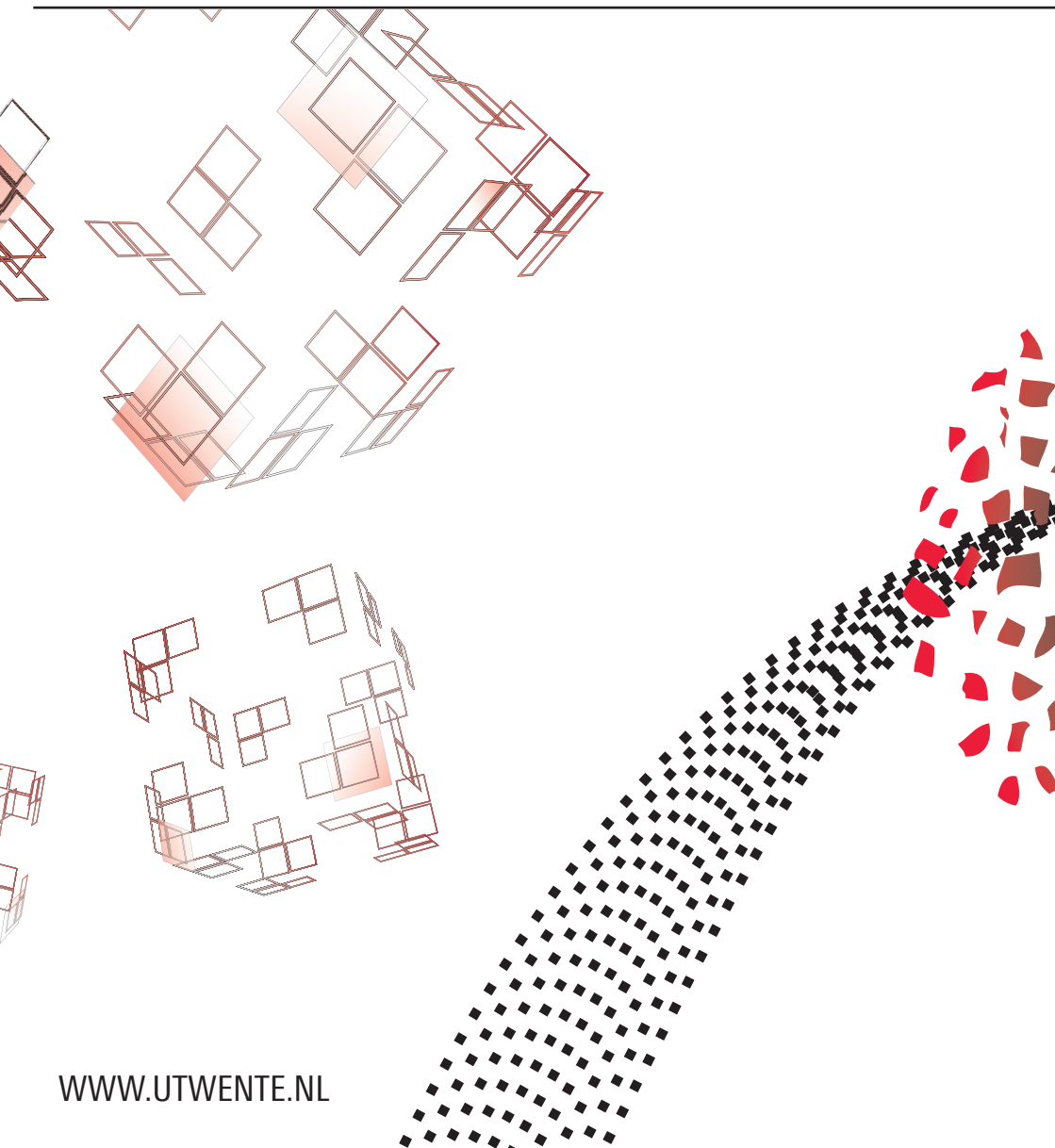
34. Munthe-Kaas, P. & Hoffmann, B. Democratic design experiments in urban planning – navigational practices and compositionist design. CoDesign **13**, 287–301 (2017).

35. Mosconi, G. et al. From Facebook to the Neighbourhood: Infrastructuring of Hybrid Community Engagement. Comput. Support. Coop. Work **26**, 959–1003 (2017).

36. Khan, S., Miranda Sara, L., Sydenstricker-Neto, J., Sutherland, C. & Hordijk, M. Scenario Building as a Process and Tool in Urban Governance. in Geographies of Urban Governance: Advanced Theories, Methods and Practices (eds. Gupta, J., Pfeffer, K., Verrest, H. & Ros-Tonen, M.) 193–214 (Springer International Publishing, 2015).

37. Bulkeley, H. & Castán Broto, V. Government by experiment? Global cities and the governing of climate change. Trans. Inst. Br. Geogr. **38**, 361–375 (2013).

38. Flacke, J. & de Boer, C. An Interactive Planning Support Tool for Addressing Social Acceptance of Renewable Energy Projects in The Netherlands. ISPRS Int. J. Geo-Information **6**, 313 (2017).



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