Heated debates: the transformation of urban warming into an object of governance in the Netherlands

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In the Netherlands climate adaptation policies and measures have been dominated by a strong watercentered discourse. However, the heat waves of 2003 and 2006 raised political and public awareness for adaptation to warmer temperatures. These events triggered the reification of a new object: urban warming. In this chapter, we use EGT to analyze the (re-)emergence and (de-)stabilization of new objects within governance and we follow them during distinct moments of transformation. We observed four moments of transformation of the object from science into governance, and will illustrate these transformations in two cities in the Netherlands: Arnhem and Rotterdam. Both cities jump on the bandwagon of climate change adaptation, introducing urban warming as an object of urban governance, while putting emphasis on different techniques of object stabilization. We show the transforming effects of attempts to objectify objects through connecting them to scientific discourses, and the destabilizing effects of these attempts. Stabilizing primarily through institutionalization risked stabilizing an object no-one cares to adapt to. While urban warming was quickly naturalized as a matter of fact in both cases, establishing it as a stable matter of concern proved far harder. Constructing the object into a legitimate concern for urban planning, public health or social policy affected the solidification and codification, transforming it into a multiple object.

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1. Introduction

The fact that the urban climate differs from that of the countryside is evident for anyone enjoying a walk on a warm summer night or a chilly winter evening. Systematic scholarly work on the urban climate dates back to the writings of Londoner Luke Howard in the early part of the nineteenth century. Remarkably, however, the use of knowledge from the discipline of urban meteorology in the design of urban settlements is considered to be a failure (Eliasson, 2000; Hebbert & Jankovic, 2013; Hebbert & Mackillop, 2013; Lenzholzer & Brown, 2013). Despite the urban climate research community's abundant ambitions to support the policy process with its expertise, productive science-policy relations did not institutionalize except for some notable examples in Germany and South East Asia.

In tandem with the increasing awareness for climate change adaptation, the urban climate also reclaimed attention. Global temperatures are projected to rise in the coming century and weather extremes such as heat waves are thought to occur more frequently, intensely and longer. Consequently, debates among policy makers are focusing on the issue of how to maintain urban regions as attractive, productive and safe places in the future. Often, these debates evolve in a direct relation to the governance of heat risks, an emerging policy field in Europe in the wake of the 2003 and 2006 heat waves which resulted in peaks in morbidity and mortality, and in a sharp controversy across the continent (Kovats & Hajat, 2008; Lass et al., 2011). The central question in these debates is whether and how urban warming should be a legitimate object for governance, and, if so, whether it should be a matter of social policy (Klinenberg, 2003), town planning (Hebbert & Mackillop, 2013), public health (Kovats & Hajat, 2008), or any other field of collective organization.

A core theme in constructivist social theory is understanding how particular ways of knowing are inextricably intertwined with societal order and ways of governing (Foucault, 1972; Jasanoff, 2004; Latour & Woolgar, 1986; Scott, 1998; Van Assche et al., 2014). The emergence and stabilization of new objects of governance, such as urban warming, has attracted scholarly attention, as the origin of societal transformation is thought to be found in these processes (Boezeman et al., 2013; Corburn, 2009). Around these objects new networks of cooperation may emerge between hitherto disconnected elements. Hence, disconnected social worlds, such as urban planning, urban meteorology, public health and politics, may form new productive relations around the issue of urban warming, through which these social worlds themselves change as well. Concepts such as constructed facts (Latour & Woolgar, 1986), standardized packages (Fujimura, 1992), boundary objects (Star & Griesemer, 1989), or boundary-ordering devices

2

(Shackley & Wynne, 1996) all focus on the negotiation process through which objects are reconstructed out of heterogeneous elements, get stabilized, and gain legitimacy.

Historically, the water-centered discourse in the Netherlands has been strong and the emergence of a new objects of governance, such as urban warming, provides an interesting case to study their formation and the ways in which they could be stabilized. Attention for the question whether to adapt to urban warming surfaced around 2007 in the Dutch discourse on climate change adaptation. The semblances of the object of adaptation, however, changed rapidly and co-existed within different discourses: urban warming, heat stress, urban heat islands, urban climate, and urban heat risks. This chapter aims to contribute to the understanding of the construction process of new objects of governance, by focusing on the (re-)emerging issue of urban warming in the Netherlands in the context of rising attention for climate change adaptation. Analytically we flesh out the different guises of the object of urban warming with the help of four 'moments of transformation' to make the process more intelligible. Our research question is twofold. Firstly, how can we understand the construction and transformation processes of urban warming as an object of governance in the Netherlands? And secondly, which processes affect these objects to become stabilized or fail to become stable?

2. Research Strategy

Because of our objective to gain in-depth insight into the gradual formation and transformation of urban heat effects as an object, we chose a simple nested case study strategy to enable a rich and detailed understanding of the construction process. We draw upon both the traditions of interpretive policy analysis (Wagenaar, 2011; Yanow & Schwartz-Shea, 2006) and constructivist science and technology studies (Clarke, 2005) focusing on the 'microprocesses' (Jasanoff, 1990; Latour & Woolgar, 1986) through which objects get articulated, negotiated, gain legitimacy, and restructure practices. We supply thick descriptions providing sufficient detail of these processes of construction, to allow the reader an inside look as well.

As the community involved in climate change and urban heat effects is relatively small in the Netherlands, we discuss the emergence of the object in the Netherlands and use two sub cases as illustrations for our story: Rotterdam and Arnhem. One the one hand, we selected these cities as illustrations because of their active involvement in the construction of urban heat effects. Both cities got involved in research projects on the effects of urban warming due to climatic changes around 2008. For a

substantial period of time, these cities were among the few Dutch cities which considered heat effects and were indicated as being the leading cities by actors involved. In addition, these cities are interesting because the articulation and constitution of urban warming as an object of governance emerged in quite different institutional settings with different associated practices. This enables us to compare the effects of different constellations on the process of (de-)stabilizing urban heat effects as an object.

Our research material consists of three main sources. Firstly, we did twenty semi-structured interviews between early 2012 and late 2013. All interviews lasted for at least one hour and were audio recorded with permission. Our respondents included municipal project leaders, policy advisors, public health officials, NGO campaigners, and (senior) scientists with different disciplinary backgrounds. Secondly, we collected relevant documents dealing with the effects of climate change on Dutch cities. These documents include assessments with a predominant scientific character, e.g. academic publications, heat maps, effect studies, and synthesizing documents for decision makers, as well as proposed actions for governance, e.g. urban adaptation strategies, fact sheets for urban planners, and communications to the public. Thirdly, we complemented our research strategy with a media analysis of items of (local) newspapers and news channels on the issue.

3. The formation of objects

In studying object formation and stabilization, we draw upon the theoretical work developed in the light of EGT (Duineveld & Van Assche, 2011; Duineveld et al., 2013; Kooij, 2014; Van Assche et al., 2014). The basic ideas for object formation and stabilization have been developed by Foucault throughout his entire career. His theories of the processes of object formation and stabilization cannot be grasped without understanding his work on discourse as power/knowledge. Through entwining power and knowledge, discourses can be regarded as modes of objectivation of objects and subjects. Discourses are conceptualized as practices of acting and thinking at the same time, as powerful acts that constitute the object (Foucault, 2009). Consequently, both subjects and objects are formed within governance (Van Assche et al., 2014).

From the perspective of EGT, the production of objects can be understood through three different techniques of object formation: *reification, solidification* and *codification. Reification* is the emergence of an object, a process in which a distinction is drawn between an object and its environment, which simultaneously enables an object to surface within discourse. *Solidification* can be understood as

Foucault's *grid of specification* (Foucault, 1972), the differentiation and articulation of elements within an object, and is focused upon the internal world of the object. *Codification* is directed towards the external environment of the object. It refers to the articulation of the boundaries of the object and consequently excludes or includes certain elements of the environment. The techniques of object stabilization are *naturalization, objectification* and *institutionalization. Objectification* is the establishment of an object as scientific fact. *Institutionalization* is the articulation of an object within organizations, policies and plans. *Naturalization* entails the increased naturalness of an object within daily life; within the normal order of things (adapted from (Kooij, 2014) after (Duineveld & Van Assche, 2011; Duineveld et al., 2013).

For analytical purposes we introduce the concept of 'moments of transformation' to allow us to follow distinct episodes in which an object gets re-assembled. While the actual process is messier and more pluriform, we use this analytical lens to better grasp the transformation of the object. Close to an episode of translation, we use these moments to showcase how during particular moments new relations with other elements are established, while others seize to exist. This process effectively leads to a transformation of the object.

In the following sections, we elaborate upon the formation of urban warming as an object. First we will focus on the question of the reification of urban warming as an object in the international scientific discourse, and its relative absence in both Dutch scientific and governance discourse. We pay explicit attention to the absence of urban warming and urban meteorology in the Netherlands as object of scientific knowing. We then describe the emergence of urban warming as an interfering factor for Dutch meteorology, and the surfacing of urban warming in the Dutch climate adaptation discourse. To flesh out the attempts to stabilize the urban warming we turn to the cases of the Dutch cities Rotterdam and Arnhem. Due to their particular power/knowledge configurations the stabilization of urban warming within these two cities differs considerably, which enables us to highlight the performance of stabilization under these different circumstances.

4. The formation and transformation of urban warming as an object of governance

4.1. Scientific discourse: compensation for urban interference

The reification of urban climates as an object of scholarly interest can be traced to the work of Luke Howard and his publications on the *Climate of Londen* in 1833. Subsequently, urban climatology developed into an interdisciplinary field involving meteorology, physical geography, construction science and medical epidemiology (Hebbert & Mackillop, 2013). In the 20th century, urban climatology developed into a scientific discourse with standardized methods of assessing urban climates, institutionalized in newly set up branches of e.g. the World Meteorological Organization (WMO), dedicated conferences, and associations with organizations such as the World Health Organization, the International Federation of Housing and Planning, and the United Nations Environmental Programme. A constant and important theme within the scientific discourse was the ambition to influence policy processes and transfer its knowledge to improve the (re-)development of towns (Hebbert & Jankovic, 2013). Specific conference sessions aiming to explain the relevance of urban meteorology to urban planners, standardized handbooks with principles for the built environment, or direct initiatives aiming at knowledge transfer via education and training all reflect that ambition. Those ambitions have, however, failed to institutionalize as a notable part of urban planning practices, except for some exceptions mainly in Germany and Asia (Hebbert & Mackillop, 2013; Lenzholzer & Brown, 2013). The Netherlands is a prime example of this failure, where there was not even success in establishing a dedicated meteorological scientific group focusing on urban matters.

In the Netherlands, urban climates and urban meteorology are not at all considered to be demanding topics. Neither in Dutch scientific discourses (interview, urban meteorologist, 2013), nor in planning practices (interview, landscape architect, 2013). For a long time, the only scientific study into the *urban heat island* effect in The Netherlands was by Conrads in the late 1960s and early 1970s (Conrads, 1975; Conrads & Van Der Hage, 1971). This can be understood as the first moment of transformation of the object in which the 'existence' of the phenomenon in the Netherlands was discovered and scientifically proven for the first time. In the subsequent period, however, the issue did not receive much attention. A nationwide monitoring system for urban temperatures, or a comprehensive system to monitor heat related health effects did not materialize.

In terms of institutionalization, too, the attention for the urban climate can be characterized as an institutional void within policy and planning. Dutch law does not formalize a specific policy process for dealing with urban climate, nor does it warrant knowledge production on the effects of city design upon the urban microclimate, in contrast to flood or environmental policies. The Dutch Building Decree does not specify regulations for thermal indicators inside or outside buildings. The specifications most closely related are those for insulation or energy standards. In planning law there are no generic goals or norms for urban temperature, other than a broad objective of a 'good spatial planning' which means that different functions have to be considered in order to avoid clashes between them. The National Heat Plan, adopted in 2007, and the centre piece of heat risk governance by the public health sector, does not deal with the specificities of urban climates (Ministry of VWS et al., 2007).Therefore, urban heating or urban warming did not exist as an object of scientific interest nor as an object of governance in the Netherlands.

Particularly illuminating for the way the heat island issue was approached by the meteorological community in the Netherlands, is the publication by a group of scientists working at the Royal Netherlands Meteorological Institute (KNMI) (Brandsma et al., 2003). In their study, urban heat is approached as an *interfering factor* for the proper construction of global and regional temperature time series data sets for climate change research. Using statistical techniques and a benchmark weather station in a rural area, the expanding urban settlements near the institute's main measuring station 'De Bilt' are found to significantly *"contaminate* the long-term temperature variability of such stations" (Brandsma et al., 2003, p. 829, emphasis added). The study concluded with a discussion of the desirability of a factor correcting for the urban heat advection to "systematically [...] homogenize long-term daily to hourly temperature time series" (ibid, p. 844). Following this particular understanding of the effects of human settlements on temperature, the KNMI and WMO developed protocols to secure standard ways of measuring weather data and rendering the comparison of data possible. The KNMI located its weather stations in rural or open areas to avoid interference of urban areas in its measurements. So instead of being reified as an object itself, urban warming was excluded from another object: that of reliable global and regional temperature data sets.

4.2. Re-entering on the bandwagon of climate change

Urban warming (re-)entered the Dutch scene on the 'bandwagon' of *climate change adaptation* around 2007. This time, its surfacing came with substantially more attention from both the scientific and policy

community. At the time, the Dutch climate adaptation discourse was highly water-centric, and mainly dealt with flood risk issues (Swart et al., 2009). Under the influence of political attention for long term issues, the development of new research programs, and the development of a national comprehensive climate adaptation strategy, the adaptation discourse took off and efforts to go *beyond* flooding were proliferating. This period can be understood as a second moment of transformation. The reification of urban warming as an object of governance went hand in hand with two processes. The first was discussing climate change ever more beyond an issue of adaptation next to mitigation, and a subsequent search for climate vulnerabilities and new risks the Dutch had to adapt to. Secondly, an active policy-oriented scientific community aimed to raise awareness for the effects of climate change in planning communities. For example, two 'definition' and 'dialog' projects were installed aimed at developing a knowledge agenda for research on climate change impacts and cities. The object of urban warming transformed from an object one aimed to isolate in scientific measurement, into a phenomenon one potentially needed to adapt to. During these projects, urban warming was increasingly solidified and codified. In addition, a small number of other projects emerged, involving both the KNMI as well as a newly found university research group on the urban climate.

Two cities were particularly active: Rotterdam and Arnhem. Rotterdam's approach is firmly embedded in an economic development and city branding narrative, or a "promotion-oriented framing" (De Boer et al., 2010). The Rotterdam Climate Proof (RCP) program aims to make Rotterdam a leading water and climate knowledge city, a 'showcase for urban delta technology' to be exported, and to profile Rotterdam as a safe, innovative and renewing delta city and harbor. Quickly after the RCP project was approved by the Rotterdam Council early 2008, Rotterdam became a 'hot spot' for urban adaptation research in the national program Knowledge for Climate (KfC) (2008-2014). In concrete terms, that meant a 5 million Euros subsidy for co-financing, making Rotterdam's total research budget around 10 million euro for 5 years. However, being granted these financial means meant Rotterdam had to broaden its water-oriented focus to include other urban climate risks as well.

In Arnhem, the project on the urban climate adaptation emerged within the civil service of the municipality. The Interreg IVB project Future Cities (2008-2013), a consortium consisting of Dutch, German, French, Belgian and English governments, got a European Regional Development Fund grant of 5,5 million euro, of which Arnhem received half a million. Its initiation had a two causes, largely interrelated and partly coincidental. First and foremost, the European funds offered the opportunity to engage in a large scale project on adaptation. Having participated in the Interreg Urban Water project, civil servants were looking for a follow up on climate change, yet not a water related project as "*at some*

moment in time that is not subsidizable anymore" (interview, project leader, 2013). A second reason was the preoccupation of the city region authority with air quality and liveability, an explosive discourse receiving substantial political attention in the Netherlands after several major construction projects had come to a grinding halt. The city region wanted to invest the air quality funding it was granted by the national government in research on which green infrastructure could contribute to the regional air quality. Because of the relation between policies alleviating bad air quality and urban heat, both issues could be merged into a single project.

The constellation of the projects in the two cities had direct consequences for the following stabilization of the object. Rotterdam had set up a new municipal adaptation unit and used a science-oriented approach, financed by and firmly embedded in the emerging academic adaptation community. The approach in Arnhem, on the other hand, never had a scientific objective per se. From the start, Arnhem was developing a new 'Comprehensive Vision' (*structuurvisie*) for the city. When the leader of that project recognized 'heat' as something adding to the Vision's novelty, the involved civil servants decided from the start of both projects that they would aim to embed heat in that new city vision. These constellations did not only affect the dominant techniques of stabilization, objectification in the former and institutionalization in the latter, it also had consequences for the solidification of the new governance object, the point we turn to next.

4.3. Adaptation to urban heat islands

Urban warming as part of scientific discourse

In Rotterdam, research on adaptation to warming was organized in roughly two phases, also called 'tranches' of KfC. The first phase, March 2009 until March 2011, was 'demand led', meaning that the city could determine what the research questions were. Under the name *Heat stress in Rotterdam*, research was done by a small group of TNO¹, Wageningen University/Alterra, Deltares, Foundation for Building Research Rotterdam, Public works department Rotterdam, and GGD Rotterdam-Rijnmond (Public Health Agency Rotterdam-Rijnmond), chaired by the project leader of the city of Rotterdam. Although the municipality officially steered the consortium in the first phase, its orientation was predominantly scientific. This meant a further solidification of the object of urban warming, as well as an increased stabilization of the object within scientific discourse. No clear normative positions were attached to the issue and for those at the municipal adaptation unit, urban warming was an add-on issue.

¹ Netherlands Organisation for Applied Scientific Research

matter of urban warming than the municipal civil servants: "99% of the direction of the research and questions were determined by the people participation in research", she assesses, and then adds: "it is my belief their discipline has been crucial for the framing [of the project]." (interview project leader Rotterdam, 2013).

Interestingly, it led to various different techniques to measure and model the spatial distribution of temperature in the city, while the temporal dimension of climate change was largely disregarded. The object of urban warming became increasingly defined as 'urban heat island', with projects focusing on its quantification and visualization in maps. Here, pre-existing techniques of using satellite data to measure a 'surface heat island' and the urban meteorological toolkit to quantify temperature difference within the urban borders were imported. These developments increased the stabilization of the object of urban warming. By quantifying and mapping the urban heat island, the object did not remain only a scientific concept; it became more real through a topological existence. This effect was even stronger in the second 'supply led' KfC phase (2010-2014), meaning that a scientific consortium was first in formulating an urban adaptation research agenda. According to the scientific consortium leader, it implied a focus on developing fundamental knowledge on heat, as that terrain was considered far less scientifically explored than other urban climate effects (interview project leader consortium, 2013). For instance, research focused on quantifying the heat reducing effects of measures in much detail, or developing location specific urban climate models. While adding to the objectification of the object, it increasingly alienated the object from the governance discourse in Rotterdam.

Within the Future Cities consortium, Arnhem coordinated climate research into heat effects. However, from the start, the civil servants did not want to do scientific research per se. Rather, they wanted to do applicable research, or, "*to put it bluntly, wanted to see 'what is known?', cut and paste, and let's go ahead and do that*" (interview, project leader Arnhem, 2012). The city started with a threefold question. How strong are the city's urban heat islands, what does that mean and, if it is bad, what can you do about it? Civil servants worked closely together with a so called 'knowledge broker' of Alterra, an institute of the Wageningen University focusing on applied research and consultancy work. Interestingly, in this instance, the international partners offered access to new types of knowledge and techniques used in the German urban climate community: climatopes (Ren et al., 2012).

Transforming urban warming into an object of governance

Increasingly however, discussions started to go beyond the urban heat island as a nice scientific artifact into debates on the particular meaning of it as an object of governance. Important to observe here is that

the continuous engagement of scientist in the governance processes had *naturalized* the urban heat island as an object. Thus, the existence of the urban heat island as a matter of fact was never much disputed, yet more so whether it was a matter of concern. The third moment of transformation was about whether it was worthwhile to adapt to urban warming and what policies were natural counterparts in that process.

In Rotterdam, the approach chosen resulted in tensions in the project teams with strict demarcations of the boundary between science and policy: "*When I asked for meanings [of numbers or effects], they said: you are the policy maker. We deliver the facts and you do the translation to practice.*" (interview project leader Rotterdam, 2013). In Arnhem, it led to an approach of pragmatically using material that was already collected. As an object of governance, urban heating became subject to a wider discussion than it was during the more scientific stage. Various governance actors articulated different problem framings of the risks of urban heating, and different normative positions on whether these risks would actually pose a problem. Discussions focused on who should respond to those risks and if there should actually be a government responsibility, or whether it should be a public health matter or a task for urban planners.

Together with the articulation of urban warming as an object of governance, the object was coupled with particular normative positions and aligned with existing governance institutions. Through this coupling, the framing of urban warming shifted in both cases. These frame shifts can be understood as processes of aligning urban heating with existing policy institutions on the one hand, and political and societal pressures on the other. This had consequences for the substantial scope of knowledge production, as well as for the relation between scientists and civil servants. In Rotterdam, the alarming framing of the object as 'heat stress' shifted to the more moderate 'urban climate'. As knowledge on the topic developed in the first phase, it became apparent that 'heat stress' was not compatible with the promotion-oriented framing of Rotterdam's strategy. Increasingly, internal discussions were about "what message do you want to spread, what policy do you want to make? To prevent heat stress? No! To make and keep the city more attractive. [...] The entire philosophy in Rotterdam to do something about climate change was that "climate offers chances!" (interview project leader Rotterdam, 2013).

The newly installed climate adaptation project group in Rotterdam needed to enroll other policy domains, and felt an increasing need to demonstrate the relevance of their claims to actors inside and outside the Rotterdam government. The main domains were the green department, urban development and public health. In order to institutionalize attention to heat in those fields, efforts were made to operationalize heat to integrate it in Rotterdam's sustainability assessment, societal cost-benefit analyses and other formal planning procedures. Covenants with housing corporations were considered. In addition, lists were made

of potential heat reducing materials and measures, which then had to be entered into the standardized urban design catalog *Rotterdamse Stijl*. Despite the fact that the civil servants became leading in defining what types of knowledge they needed, scientific evidence and quantification of effects were key to the strategy to mobilize support for the heat issue. "*We wanted broad support for policies*. *It is often the case that the more knowledge you have, the more support you can get*" (interview theme coordinator Urban Climate Rotterdam, 2013).

During this third moment of transformation, stabilization of the object was pursued through substantiating and demonstrating the added value of heat adaptation, especially because political and societal pressure was growing. However, some domains proved far easier to enroll than others: "when we showed that greening policies had potential, the response was "then it is no problem, we already do much about greening policy and climate is an extra argument to green the city' [...] when the result was that we had to adapt skyscrapers, that you could no longer do high rise development, then things would have been different." (interview project leader Rotterdam, 2013). So even though the concept of 'sky view factor' is important in the urban heat island object, a relation the urban development department was much more difficult to establish than with the green department that quickly recognized a shared interest. Green policies can be established as 'no-regret' while intervening in the urban morphology is a 'regret' option. Interestingly, as we saw above, the stabilization of the object in terms of institutionalization also created new problems, which had to be countered in order to avoid destabilization. In the next section, we turn to the public reception of the object of urban heating in Rotterdam.

In the meantime in Arnhem...

In the case of Arnhem, however, urban warming did receive bureaucratic and political support in a very early stage after the reification of the object. The idea was immediately accepted by the new Alderman as something nice, new and interesting for the liveability of the city of Arnhem. Hence, there was a strong political commitment to use heat as an argument in the city promotion objectives of Arnhem. The 'heat proof city' was adopted as one of the six themes in the city's 'Energy Made in Arnhem' program (2011-2014) and incorporated in the Comprehensive Vision 2020-2040 (*structuurvisie*). The concept of the urban heat island with its spatial distribution of temperatures across the city fitted the planning and zoning logic of drafting a comprehensive vision. While a project on measuring temperature differences within the urban perimeter demonstrated the heat island "*as something real, just like in Rotterdam!*" (interview project leader Arnhem, 2012), it was especially the technique of the 'climatopes' imported from Germany that formed the basis for further solidification and codification of the object. Based on existing climatic, topographic, and land-use data, climatopes represent different microclimates in built up areas, such as

12

industrial sites, inner city locations, garden towns, or open land locations (figure 1 shows Arnhem's climatope map). These maps not only made the urban heat island visible, they also transformed the object into a visible scientific fact because it also offered a starting point for zoning-based policies. Note that this map does not specify temperatures in quantitative terms nor that it relates to temporal climate *change*.

Figure 1. Climatope map of Arnhem. (Burghardt et al., 2010, p. 7)

To make the urban climate governable in Arnhem, the urban climate had to be tailored to have spatial consequences. The project group started to invest time into making a 'heat attention map' (see figure 2). In this map, normative positions needed to be articulated, e.g. which locations had priority over others to adapt, as well as what measures could be taken in different locations. A connection was made with 'engineering knowledge', by developing factsheets of policies coupled to the suggestions for the different sub-areas. These factsheets provided those actors interested in taking physical measures to adapt to heat with information, e.g. effects of green policies or of removing physical blockages.

Figure 2. Arnhem's heat attention map. (Arnhem, 2012, p. 52, translation: authors)

These maps provide 'attention' and 'suggestions', and hence non-binding information to urban development organizations, and that is approximately the extent to which urban warming was and still is institutionalized in Arnhem. There are no clearly delineated objectives in the future planning of the city, nor does it make recommendations (the original name of the map). Despite the fact that civil servants tinkered with whether to approach the issue as one of 'liveability', 'public health', or any other way, taking up the topic was only possible if its framing was mild: the urban climate was to remain a "cuddly" issue that wouldn't interfere with other planning objectives, nor with the branded image of the city as liveable shopping town (multiple interviews, 2013). While following the technique of institutionalization yielded quick acceptance within central institutions of planning, it also created an object without much urgency to adapt to.

4.4. The Rotterdam urban heat island as an object of risk?

In 2011, the topic of urban heating became controversial in Rotterdam. The project received a substantial amount of (national) media attention. However, after publication of the summary report *heat stress in Rotterdam* (Nijhuis, 2011), some influential media - and a notable Dutch climate skeptic journalist - framed the issue as "*tons for a nonsense study*" (AD newspaper & Elsevier magazine). Presenting the results of the scientific project backfired, not only because those journalist claimed that the project 'discovered' something well known since Luke Howard, but also because it now imported the climate change skeptic discourse to the project. It triggered attacks from the opposition in the Rotterdam council, making it a sensitive political topic for the city's administration. From then on, it increased the need "*to account for why we have eight tons in research program. What does it deliver? This is a constant pressure*." (interview theme coordinator Urban Climate, 2013). Next to this political pressure, the societal pressure in 'no-nonsense city' Rotterdam, strongly framed policies in terms of costs and benefits. The catch phrase "*How much adaptation do I get for my euro*?" uttered by a Rotterdam civil servant to the CPC consortium aptly illustrated that.

Here we observe a fourth moment of transformation which was concerned with reloading the normative elements of the object. The discussions in the media and council endangered the stabilization of the object within governance. They needed to be countered to avoid destabilization, partly because of the financial and emotional investments made into the object of heat stress. For the project team there was one possible ally who could increase the stabilization of the object, namely public health (GGD). However, public health was not only a lifebuoy, it was also troublesome due to the possible negative image of the city. Rotterdam as a city with serious heat related health risks was obviously a real problem for branding Rotterdam as an attractive city. Public health yielded a dilemma: framing urban warming as a health risk was considered unattractive, yet on the other hand "coupling the issue with health is necessary for legitimizing the problem. [...] You need the municipal health agency to demonstrate [the problem] and to generate a critical mass to take action." (interview project leader Heat Stress in Rotterdam, 2013).

besides the negative image of the city, public health on itself was also a difficult issue for governance: "The problem with heat stress is that it is not very clear whether it is a problem. It gets warm, that is clear. It has health effects on people, also clear. But we also have people dying because of traffic, or obesitas. When do you put it on the political agenda? [...] An administrator wants to know: how many [deaths] in Rotterdam [...] and how much worse does it get if we do nothing?" (interview project leader Rotterdam, 2013). Indeed, heat was an issue for Public Health Agency Rotterdam-Rijnmond (GGD), who informed vulnerable people and their caretakers to take action during heat waves. The Agency considered heat important, demonstrated by installing a dedicated work group, but not urgent. The policy priorities of the Rotterdam agency are based on a standardized measure of health loss, Disability-Adjusted Life Years, of different health risks, the degree to which the agency could actually achieve a result with its efforts, and the amount of public unrest of a theme. "*We keep track of the topic for which people call or complain. Not that many people call about heat.*" (Interview GGD, 2013). Still, in the *Rotterdam Adaptation Strategy 2013*, the object of urban warming got strongly aligned to the typical 'vulnerability' discourse of climate change adaptation. Transforming the object as a risk did offer the opportunity to solidify the object with new elements, such as vulnerable groups and vulnerable infrastructure, as the central map of the heat strategy makes clear (figure 3).

Figure 3. Heat as an object of risk. (Rotterdam, 2013, p. 62)

To conclude, stabilizing urban warming though the techniques of objectification ran into limits here. While connecting the object of the urban climate to other scientific discourses, climate change and public health, added to the solidification of the object, it also opened it up for controversy. Firstly, it meant articulating the project in the climate skeptic discourse, which was very unattractive for politicians. Secondly, it interfered with branding Rotterdam as the innovative and attractive city, the approach through which the city aims to position itself among the C40 cities² and which it followed even more strongly after publishing the *Rotterdam Adaptation Strategy* (Rotterdam, 2013). These controversies continually destabilize the object of urban warming.

5. Discussion and conclusions

The various transformations of urban warming can be productively understood through applying EGT, and more specifically through the perspective of object formation and stabilization. The different guises of the object as 'urban warming', 'heat stress', 'urban heat islands', 'urban climate' and 'urban heat risks', can be conceptualized as attempts to stabilize the object within different discourses. In the analysis of object formation and stabilization in the Netherlands, we drew on two cases in the cities of Arnhem

² A prestigious network of global cities addressing climate change <u>http://www.c40.org/</u>

and Rotterdam. Due to the effects of different power relations in both cases, the formation and transformation of the object formation are different as well.

We observed four 'moments of transformation' in the processes of (de-)stabilizing the object of urban warming. The first moment was its reification within the Dutch meteorological discourse in the 1960s. Within a scientific discourse centering around commensurable time series data on average temperatures, urban warming was considered an interfering noise factor for constructing reliable temperature series by the Dutch meteorological office.

The re-emerging of urban warming on the bandwagon of climate change adaptation in 2007 can be considered a second moment of transformation. In a water dominated adaptation discourse, urban warming and its effects were transformed into new potential urban risks to adapt to. This offered new financial opportunities to enter on heat related studies. The object was solidified and codified during projects in Rotterdam and Arnhem in a process initially dominated by scientists. The process of scientific objectivation and the engagement of scientists in the realm of governance naturalized important elements of the object. However, disputes were not so much about whether urban warming or the urban heat island were matters of fact, but whether they were also matters of concern. Here we observed that the paths of transformation in the two cities started to diverge.

In what we term as the third moment of transformation, efforts were about making stable couplings to other domains that could enable adaptation. The constellation in which the projects emerged in the two cases, as well as the role of scientists therein, proved important for the particular paths of transformation. In Arnhem, the project developed in close relation with the urban planning department. This led to a 'spatialization' of urban warming induced by climate change. Temporal scales were transformed into spatial ones, and the urban heat island effect was integrated into concrete spatial visions (e.g. the *structuurvisie*) in connection to spatial recommendations. Heat was recognized by the alderman as a novelty and a way to improve the branding of the city, and therefore, it was not necessary in Arnhem to solidify and objectify the object to increase its stabilization. Scientific knowledge was quickly being applied with the help of a knowledge broker. However, despite of the easy acceptance, no real impact has been observed in policies and measures. The object remained a pet project of the Alderman and a select group of urban visionaries. While following the technique of institutionalization yielded quick acceptance within central institutions of planning, without the construction of the problem as 'urgent' one risks constructing an object no-one cares to adapt to.

16

Rotterdam's case demonstrates a more winding road in the sense that the object was first stabilized with the help of science due to a different power constellation. Urban warming emerged in Rotterdam as an 'extra' topic within a wider process of developing the first Rotterdam Adaptation Strategy within a dedicated adaptation unit of the city. The object was scrutinized by scientist and policy makers in order to demonstrate its legitimacy as a governance problem for the city of Rotterdam. However, with the transformation into an object of governance came the complexities and struggles inherent in governance. While the green department shared an interest in policies, other domains proved much more difficult to enroll. The institutionalization of urban warming produced controversies with the real danger of backfiring and thus destabilizing the object. These problems had to be remedied through increasing the legitimacy of the object with the help of accepted knowledge of stable institutions, such as public health.

In a fourth moment of transformation, attempts were made to reload the normative elements of the object and to transform it into an object of risk. Naturalization in the form of introducing the object to the public realm also created turmoil, such as the reactions from the climate skeptic discourse. Given the fact that Rotterdam tries to stay among the C40 cities and the object of urban climate has to remain legitimate, these destabilizations are likely to occur.

We conclude that that the construction of irreversibility in the case of urban warming has never been perfect (Van Assche et al., 2014). To localize global warming into urban effects ongoing negotiations to simultaneously stabilize epistemic authority and political relevance are the norm rather than the exception (Corburn, 2009). In the analysis of the formation and (de-)stabilization of urban warming as an object of governance three points stand out. Firstly, objects predominantly solidified and codified within science might seem stable within that particular discourse, but whenever articulated within bureaucratic discourses past performances are no guarantee for institutionalization in governance. The arena of governance consists of different power/knowledges than the scientific arena, and not only different, but rather more heterogeneous power relations. Negotiating the support of science is important to be able to draw upon science's epistemic authority and objectify it (Gieryn, 1999; Jasanoff, 1990), but it is not enough to naturalize it as an object worth adapting to. On the other hand, scientist also climb aboard the bandwagon if funding is granted for societal projects. Yet when controversies arise, they may draw firm boundaries stating that they just do the science, and that norms and values are not their business, as we saw in the Rotterdam case. Coupling an object to the climate change discourse may run the risk of importing the controversies of that discourse as well. This parallels the case of connecting the Dutch water safety discourse to the threat of accelerating climate change, and its subsequent disconnection when the boundaries of proper science were thought to be overstepped by the Delta Committee (Boezeman et al., 2013; Vink et al., 2013).

Secondly, increasing the stability of objects through new connections with multiple stable institutions, such as temporal and spatial dimensions, public health risks, infrastructure effects, and city marketing implies that these discourses will have an effect on the object. Transforming the object as an object of urban planning required a spatialization of which the urban heat island seemed fit, while transforming it into an health risks requires other elements and other was of knowing (cf. Eliasson, 2000; Klinenberg, 2003; Kovats & Hajat, 2008). These discourses need to be mediated, either through the seemingly openness of the object, or frictions have to be resolved, e.g. the problematic relationship between a positive city branding and health risks of heat stress. In this case, several discourses have been coupled through a particular framing, or have been decoupled through an alternative framing. For example, 'heat stress' was changed into 'urban climate' in Rotterdam, to avoid a problematic relationship with a positive city branding. Although these frame shifts might allude to conflicts around the existence of the object, the different ways of framing actually implied that the object had been naturalized. Institutionalization, however, proved to yield a more perilous landscape, as governance is interlarded with a multitude of power/knowledge structures (cf. Kooij, 2014).

Thirdly, introducing objects such as urban warming into a country focused on water does not automatically give the same weight to these issues. In the Dutch public perception, urban warming is not a problem, notwithstanding the fact that during heat waves vulnerable groups of people die. As such, urban warming is not naturalized as an object worth adapting to, while water remains a force to legitimately fight, no matter how safe people actually are in the Netherlands. EGT provides the concepts and flexibility of tools to understand these processes in a productive way.

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