

MacAfee, E.A. 2022. Drinking water quality assemblages:
Scale, temporality and flexibility in Kaolack, Senegal.
Water Alternatives 15(3): 668-687



Drinking Water Quality Assemblages: Scale, Temporality and Flexibility in Kaolack, Senegal

Elizabeth A. MacAfee

Faculty of Landscape and Society, Norwegian University of Life Sciences, Ås, Norway; Department of Cultural Anthropology and Development Studies, Radboud University, Nijmegen, The Netherlands;
elizabeth.macafee@ru.nl

ABSTRACT: In this article, I argue that drinking water quality is a sociomaterial phenomenon with scale and temporality; I argue further that the way in which actors in urban environments influence drinking water quality affects how people access water and the degree to which they are exposed to drinking-water-related hazards. Understanding the complexity of the multiple possible impacts on drinking water quality requires attentiveness to the heterogeneous social, political and technical relations that together constitute a 'drinking water quality assemblage'. Different problematisations of drinking water quality can also contribute to the emergence of multiple contested assemblages. Using a qualitative case study developed over eight months in Senegal including interviews, participation, observation and document review, I explore coexisting assemblages of drinking water quality in Kaolack, Senegal. I categorise the assemblages as state, implementer, provider and consumer. These vary in the degree to which each assemblage is flexible or rigid: they also exhibit differences in the scales and temporalities of concern for drinking water quality problems. I argue that this theorisation of drinking water quality relates better to the dynamic and multiple materiality of water and water quality than do the static and inflexible technical definitions that are more commonly found in policy and planning documents.

KEYWORDS: Drinking water quality, assemblage theory, urban water, Senegal

INTRODUCTION

Access to safe and sufficient drinking water is fundamental to human health and well-being; it has also been identified as a universal human right. Even so, the number of people worldwide who do not have access to safely managed sources of drinking water is estimated to exceed two billion (Global Water Practice, 2021). Despite widespread recognition of the urgency of improving drinking water quality, and even with the large investments that have been made around the world, it is likely that the Sustainable Development Goal 6 target of universal access to safe, affordable, acceptable and accessible drinking water will not be achieved (WHO, 2021). In part this is because while rates of access continue to improve, in many places drinking water quality remains inadequate (Global Water Practice, 2021). A more nuanced understanding of the social, material and political aspects of drinking water quality challenges could potentially contribute to an understanding of why extensive technical investments have not yet succeeded in delivering on the promise of safe and sufficient drinking water for all.

The need for improved water quality should, in theory, be straightforward and yet there can be deep misunderstandings and disagreements about water quality problems and solutions (Freitag, 2014; Bouleau and Pont, 2015). Disagreements can, in part, stem from the fact that water quality is deeply entwined with knowledge and values (Berry et al., 2018). Furthermore, along with the taste, smell and appearance of water, social relations like trust can contribute to consumers' determination of tap water quality (de França Doria et al., 2009). In the critical social science literature, water quality is increasingly treated as more than an objective condition that can be measured or a naturally occurring phenomenon

(Pine and Liboiron, 2015); scholars instead highlight the social relations of power that shape who has access to water of acceptable quality (Boakye-Ansah et al., 2016) and who is able to participate in knowledge production and standard-setting with regard to water quality (Russell and Ens, 2020; Karpouzoglou, 2012).

In this article, I bring together, and build on, insights from critical environmental studies of water quality. I argue that understanding the risks of poor quality drinking water and the possible responses to drinking water quality challenges requires understanding quality as something that is embedded in particular sociomaterial contexts with emergent and dynamic characteristics. I therefore theorise drinking water quality as an assemblage – a conceptual framing which recognises that drinking water quality can be heterogeneous and malleable. Quality can thus vary depending on context, or on the different actors involved, meaning that there can be multiple coexisting assemblages and that these assemblages can change. I use the city of Kaolack, Senegal, to exemplify a case where drinking water quality varies in terms of scale, temporality and flexibility, depending on the assemblage. Drawing on eight months of qualitative data collection in Kaolack, I identify and describe the different ways that drinking water quality is assembled by the state, implementing actors, providers of water and consumers.

The main contribution of the article is a theoretical exploration of the concept of drinking water quality assemblages. Through carefully tracing the boundaries and elements of drinking water quality assemblages and the practices that contribute to their emergence, it challenges uncritical assessments of water quality that limit engagement with possible underlying complexities, tensions and contradictions. I begin with a brief introduction to drinking water quality (and water quality more generally) as it is found in the critical social science literature. I introduce assemblage theory and drinking water quality assemblages together, in order to show the potential for assemblage theory to highlight and explain some of its sociomaterial complexity in ways that expand on current understandings. I then present the methodology and background of the case study. The findings from Kaolack show that multiple assemblages of drinking water can coexist and that they can vary in their scale, temporality and degree of stability. I conclude by arguing that the dynamic and multifaceted nature of drinking water quality requires concepts and theories that are equally dynamic, and that assemblage theory may provide these tools.

CRITICAL PERSPECTIVES ON WATER QUALITY

In the critical environmental social science literature, water quality has thus far received far less attention than have issues of access and scarcity (Karpouzoglou et al., 2018; Lavie et al., 2020; Rusca et al., 2017). Recently, however, there has been a turn towards addressing this gap. Among studies focusing on water quality, three trends have emerged. The first trend is toward interdisciplinary approaches that demonstrate the role of social relations and power in the inequitable distribution of water quality harms and hazards; the second trend examines the social production of water quality knowledges and standards; and the third trend is toward studies that emphasise the materiality of water and infrastructure.

There are several examples of interdisciplinary studies that investigate the relations that influence the inequitable social and spatial distribution of water quality. Water quality decline is often portrayed as neutral and directly solvable; a foundational claim in this body of work, however, is that politics and power play an important role in determining where water quality decline occurs and who is exposed to pollution (Karpouzoglou et al., 2018). Lavie et al. (2020), for instance, have argued that in cities in Sudan and Argentina water quality is embedded in drinking waterscapes through cultural and political practices. Boakye-Ansah et al. (2016) showed that in Lilongwe, Malawi, engineers prioritised responding to complaints about water quality from higher-income and more politically influential areas of the city, thus reinforcing patterns of marginalisation. Sultana (2007, 2012) demonstrated how, in Bangladesh, discourses of development and connectivity to a certain kind of water source contributed to widespread

exposure to arsenic in drinking water. Scientific measurements of water quality have also been considered alongside examinations of the everyday practices of water users as they pertain to, for example, storage (Burt and Ray, 2014) and the use of multiple sources for different uses (Rusca et al., 2017).

Another group of scholars argues that the socially constructed nature of water has material implications that are inseparable from knowledges, values and ontologies. Orlove and Caton (2010), for example, conducted an anthropological study of the cultural and religious use of the Ganges River. They observed the continued use of the river despite scientific assessments that attested to its highly polluted water, using this to demonstrate the socially constructed nature of the river's perceived water quality. Karpouzoglou (2012) argues that the use of technical language in water quality discourses can be a practice of depoliticisation that also prevents citizens from effectively participating in conversations about water quality in their surroundings. Bouleau and Pont (2015) and Pine and Liboiron (2015) have also shown how negotiations of standards and thresholds for surface water quality and pollution are political as much as scientific. Distinct values and knowledges (Ayre and Mackenzie, 2013; Berry et al., 2018), multiple ontologies of water (Yates et al., 2017), and incompatible concepts for environmental governance are more than just misunderstandings or imprecisions; they are sites of struggle (Moran and Rau, 2016).

In research on water more generally, there has also been a turn towards recognising the lively materiality of water (Bakker and Bridge, 2006), infrastructure (Amin, 2014), and technologies (Furlong, 2014). A distinct 'water bias' can be identified in this literature, however, leading to under-representation of the qualities of water and of the substances found in it (Parrinello and Kondolf, 2021). These substances have largely been treated as background noise, subject to being passively absorbed, carried or distributed. While water's ability to carry and redistribute things is often referred to among its active capacities, aspects like sediment receive limited attention (De Micheaux et al., 2018; Parrinello and Kondolf, 2021). Thus far there have been limited attempts to rematerialise water quality alongside the consideration of its sociomaterial aspects. I suggest that assemblage theory could be a way to bring the social and material together by viewing drinking water quality as a heterogeneous and unstable collection of social and material elements that are brought together through the agencies and practices of a range of actors. I elaborate on this further in the following section.

THEORISING DRINKING WATER QUALITY ASSEMBLAGES

Assemblage theory is a conceptual approach that has been inspired by the philosophical work of Deleuze and Guattari (1987). It is often interpreted in geography, planning and urban studies via the more recent work of Manuel DeLanda (2016, 2006). The concepts and ontology of assemblage are used to interpret and understand how human and non-human phenomena are coproduced in ways that are emergent, dynamic and situated (Müller, 2015); work, process and agency are also emphasised more than outcome (Williams, 2018). The concept of assemblage refers, in particular, to heterogeneous collections of human, non-human, material and immaterial elements that are brought together in provisional wholes that are more than the sum of their parts (DeLanda, 2016). The elements remain in relations of exteriority, which means they are conditioned but not determined by their relations (DeLanda, 2016). Something remains outside of the relationship, in the realm of possibility and potential that Deleuze and Guattari refer to as the virtual.¹ The same element in a different context can thus behave differently. In this paper, I argue that drinking water quality is an assemblage that comprises, among other things: 1) the potentials and properties of water and of substances in water, including physico-chemical pollutants and bacteriological

¹ This characterisation of relations as external rather than internal is an important distinction between assemblage theory and actor-network theory (Müller, 2015).

pollution; 2) human bodies and their differential vulnerability to water-related hazards; 3) water-related knowledges, perceptions, discourses and values; and 4) relationships between human actors.

Assemblages are always context-specific. They emerge out of encounters between such heterogeneous elements as are listed above, all of which are attributed a form of distributed agency (Bennett, 2010). Li (2007), for instance, has employed an assemblage analytic to examine the political and material practices of community forestry management. This analytic is used to understand how diverse parts are made to cohere into a provisional whole, including trees, groups of people, livelihoods, forms of expertise, and discourses about conservation. The community forestry assemblage that Li identifies would not exist independent of the practices and ongoing work of human agents. Gorostiza and Sauri (2017) have further shown how the capacities of material elements in an assemblage can play a part. Chlorine, for example, could potentially be in the category of pollutant; instead, it is seen as beneficial because it reduces the impact of organic pollutants that are relevant to public health. Mapping the boundaries of assemblages in this way can provide opportunities to ask how an assemblage could have been different given a different set of relations or materialities (Anderson and McFarlane, 2011; McFarlane, 2011).

Drinking water quality is particularly amenable to an assemblage theory approach because it is inherently both social and material. Water quality includes values, intended use, and perceptions (Berry et al., 2018), while blending a range of qualitative and quantitative elements such as taste, smell and measurements of priority substances. The assemblage approach that is being proposed here for integrating the social and material aspects of water quality could be contrasted with Marxist studies that focus on the production or social construction of nature. Arguably, such studies pay limited attention to the materiality of the nature that is being produced (in this case water) or to its more-than-human aspects and can fail to distinguish diverse materialities from uniform categories (Bakker and Bridge, 2006). For this reason, Rusca et al. (2017) argue that water quality echo a critique by Smith (2008) and Lefebvre (1991) that quality is left out in processes of production of abstract nature. They go on to say that in the process of abstracting nature into a purely social object that can be translated into economic value and exchanged for money, quality is almost entirely replaced by quantity (Rusca et al., 2017). The commodification of water therefore leads to an overemphasis on connectivity, access and particular amounts of water while quality – while acknowledged and included to some extent – plays a lesser role (Rusca et al., 2017). An assemblage approach to water quality therefore responds to calls to re-materialise analysis of urban water systems and to recognise their fundamental heterogeneity (Furlong and Kooy, 2017; Lawhon et al., 2018).

Maintaining awareness of the role of actors (human or non-human) helps to avoid the 'passive voice politics' of which assemblage theory has been accused (By authors like Brenner et al., 2011). The inclusion of both human and non-human actors is in line with trends in political ecology and geography that note the agential properties of the technology and matter that were previously treated as merely the passive backdrop or context of social relations of power (Bennett, 2010; Meehan, 2013). Assemblages are emergent, practical achievements that require work and are open to contestation and tension (Bueger, 2018). This work includes practices like classifying, sorting and defining objects and their roles (ibid). Instead of describing how assemblages are anonymously stabilised, structured, dismantled and so on, assemblage analysts continue to ask who or what is doing these things, to whom, and for whose benefit. Human motivations and the associated strategic and intentional actions can play an important role in how assemblages develop (Savage, 2019), sometimes resulting in coexisting and perhaps equally valid assemblages.

Assemblages may overlap and can coexist without displacing one another. Conflicts and tensions may arise around framings of issues and what elements are included or excluded (Hillier, 2011). Hillier (2011), for instance, describes the multiple assemblages that coalesce around a public art installation on a beach. She identifies the groups of actors that are constructing distinct assemblages relative to the installation; they include an environmental 'risk assemblage' a 'tourism assemblage', a human-focused 'safety

assemblage', and an 'economic assemblage'. The object of interest is the same in each assemblage, but it is approached from a different angle so that it becomes "a site of affective contradiction and political conflict" (Hillier, 2011: 862). Such diverging assemblages can be sources of tension and can challenge attempts to communicate. This approach offers a way of understanding how it is possible to consider water from the same location and time and yet reach different conclusions about its quality – conclusions that each are correct according to their own criteria.

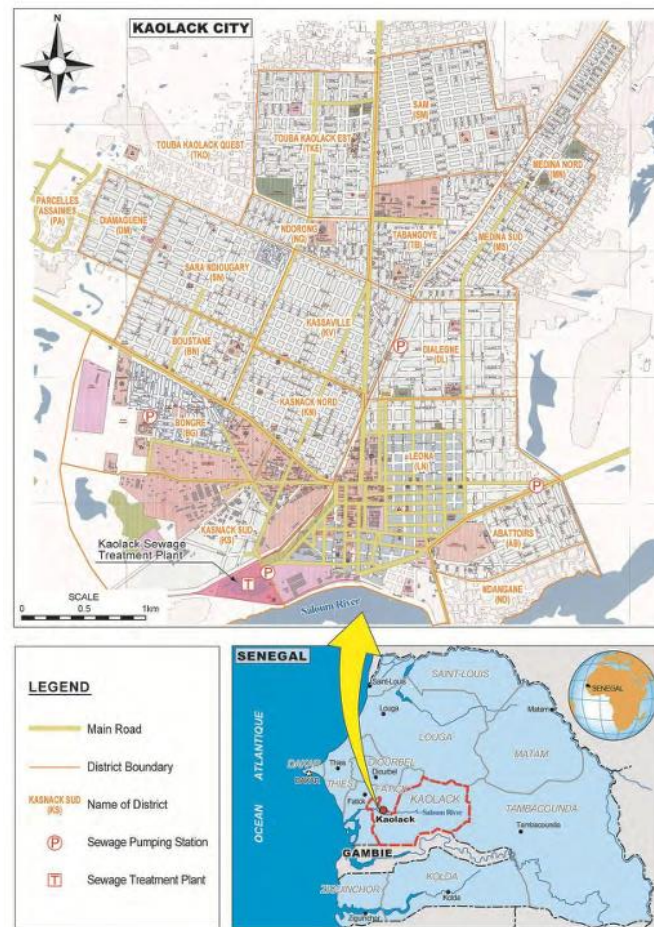
A further defining characteristic of drinking water quality assemblages is how they relate to context-specific drinking water quality problems. Water quality varies both over space and time and according to personal and societal preferences. There are also variations in how drinking water quality is understood and how it is framed as a problem by different individuals and groups. In assemblage theory, problems "are not to be thought in the usual sense as obstacles in need of overcoming (...) [but rather as] problematic[s], a horizon that indicates the limits of thought" (Adkins, 2015: 199). Assemblages are limiting because they allow actors to see only some of the infinite possibilities, but as a concept they reopen these potentials for analysis (Lancione, 2011). Considering drinking water quality as a problematic object raises practical questions about what escapes, or is excluded from, a drinking water quality assemblage; it also gives rise to questions as to what is possible with regard to specific drinking water quality assemblages.

Drinking water quality can be problematic in multiple ways. It can be seen as primarily a public health or hygiene problem caused by inadequate sanitation infrastructure or by a lack of cleanliness and handwashing among the population. Alternatively, drinking water quality challenges can be blamed on factories that discharge their waste into rivers; it could also be a non-anthropogenic issue of aquifers being naturally rich in arsenic, fluoride or salt. Spatial variations in drinking water quality can also be an environmental justice problem; in such cases, the problem is understanding how and why some groups are more impacted than others by substandard drinking water. In each of these cases, there is some matter of concern that implies corrective action. After presenting the background to the case study of Kaolack, Senegal, and the methodology of the study, I examine the problematic framings of drinking water quality in Kaolack and discuss how these contribute to the emergence of specific drinking water quality assemblages.

THE CASE: KAOLACK, SENEGAL

Though drinking water quality challenges are global, the highest proportion of people relying on unsafe sources live in sub-Saharan Africa (Deshpande et al., 2020). Kaolack, the case study site for this article, is no exception. It is the fifth-largest city in Senegal and, as of the most recent census, has a population of 310,066 (ANSD, 2019: 21). The Kaolack region is a productive agricultural area that is colloquially known as the "peanut basin" (*bassin arachidier*). The Saloum River, along the southern edge of the city, is far too salty for consumption or agricultural use, making residents primarily dependent on groundwater (Dieng et al., 2017). Unfortunately, the groundwater also contains significant quantities of salt and fluoride, that is, up to five times the World Health Organization (WHO) recommended levels. The high levels of fluoride in local groundwater contribute to widespread fluorosis (Diène et al., 2014; Agence Belge de Développement, 2013), which is characterised by painful bone and joint deformations and tooth discolouration (UNICEF, 1999). Long-term residents of the Kaolack region are considered to be recognisable by the brown, red or yellow colour of their teeth. For these reasons, Kaolack is locally infamous for its poor quality drinking water (Faye et al., 2005; Dieng et al., 2017); however, the Senegalese government continues to maintain that tap water in Kaolack meets all the required norms, focusing on microbiological potability. Kaolack thus represents a case where the quality of drinking water is contested.

Figure 1. Map of Kaolack.



Source: Included with permission from JICA (2014, p. vii).

People access, buy and sell water in Kaolack through diverse hybrid configurations. These include tap water that is delivered through a public-private partnership; private actors who sell bottled water, plastic sachets of water, well water, and filtered water; and seasonal household collection of rainwater. The quality of each of these sources is monitored and governed by different actors in Senegal. Key actors regarding drinking water quality in Kaolack include: the National Society for Senegalese Water (Société nationale des eaux Sénégalaise; SONES), the Directorate of Management and Planning of Water Resources (Direction de la gestion et de la planification des ressources en eau; DGPRE), the Ministry of Health and Social Action, and the Senegalese Association of Normalisation (Association Sénégalaise de normalisation; ASN). The Senegalese approach to drinking water quality is outlined in several documents, including a national integrated water resource management (IWRM) plan, a national strategy for improvement of drinking water quality, and legislation which specifies the requirements for water to be considered potable.

For tap water quality, SONES maintains a public-private partnership with a for-profit company with whom it contracts to deliver tap water to Senegal's urban areas (an *affermage*, or lease, contract); with Sénégalaise des Eaux (SDE);² and with an independent NGO laboratory. SDE chlorinates the tap water

² During my field work, SDE (a division of the French company Eranove) was still the private company responsible for urban drinking water in Senegal; they have since been replaced by Sen-Eau, which is a division of another French company, Group Suez.

supply and regularly monitors tap water quality in various points throughout the network, reporting to SONES on compliance. The NGO laboratory also reports directly to SONES but does not share testing results with SDE, thereby maintaining neutrality and independence from the provider. There are three of these independent laboratories in Senegal, each of which is responsible for monitoring urban tap water quality in a specific region. One of them is based in Kaolack.

The Hygiene Service is responsible for monitoring water sold for human consumption outside the tap water network; local and regional branches share an office in Kaolack and both report directly to the national Ministry of Health. The Hygiene Service is responsible for enforcing rules about water (and food) safety. Its mandate includes all water sold for human consumption; they thus test drinking water quality and issue hygiene certificates or fines for noncompliance. The Hygiene Service regularly inspects the sources of water that is sold for human consumption, including boutiques that carry bagged water and kiosks that sell filtered water; they also respond to consumer complaints. Engineers and field agents determine the quality of water based on field or laboratory testing and on assessments of surroundings and hygiene practices, and staff of the Hygiene Service try to educate consumers on how to protect themselves.

METHODOLOGY

The empirical material for this article consists of data collected during eight months of qualitative data collection in Kaolack, Senegal, from April to December 2019. The research approach is grounded in three primary methods of data collection: 1) observation and participation, 2) interviews, and 3) document review.³ While I would not say that I conducted a full ethnography as a part of this study, I maintained an ethnographic sensibility in my approach, and observation and participation played an important role throughout the data collection process. I cultivated social relationships with several households and individuals and often spent entire days visiting with families in their homes to share meals or break fast during the month of Ramadan. I also undertook extended periods of participant observation with actors who had a stake in drinking water quality governance and drinking water provision, including employees of the Hygiene Service, water sellers, and representatives of SDE.

Throughout my time in Senegal, I also conducted interviews that varied in terms of sampling strategy and degree of structuredness.⁴ Informal conversations and observation provided background knowledge that allowed me to develop targeted questions for these interviews. To understand interfaces between government practices of assembling drinking water and the everyday practices of consumers, I conducted interviews with both key informants involved in provisioning, governing and planning for drinking water in Kaolack and members of consumer households. Key informant interviews were semi-structured, and I targeted sampling to include the perspectives of multiple stakeholder groups in the governance, planning and provision of drinking water. This included representatives of the private company that manages the provision of urban drinking water in Senegal, the Hygiene Service, the mayor's office, the regional prefect's office, the local urban planning office, the Ministry of Environment and Sustainable Development, and the urban sanitation office. I also interviewed 4 sellers of well water and visited 18 filtered water kiosks for semi-structured interviews. For each group of providers and governance actors,

Representatives of SDE were not very open to conversation, at least in part because they were in the process of settling a series of complaints and lawsuits with the Senegalese government about the upcoming termination of their contract.

³ The data collection procedures adhered to the NMBU Ethics Guidelines (adopted by the University Board, 26 November 2015), and the Guidelines for Research Ethics in the Social Sciences, Humanities, Law and Theology of the Norwegian National Research Ethics Committee (June, 2016). The research project was assessed by the Norwegian Centre for Research Data (NSD) with regard to the processing of personal data and was deemed low risk. Consent to participate was primarily obtained orally, following an explanation of myself and the aims of my project, the voluntary nature of participation, and the right to cease participation or decline to answer any questions at any point.

⁴ All interviews were conducted in either Wolof or French, often a mixture of the two.

I asked questions about their role in providing drinking water, how their water differed from other options that were available in Kaolack, the rules and regulations they had to follow, and their relationships with their customers. This process lasted throughout my time in Senegal and was supplemented by three trips to Dakar for interviews with national governance actors and with a hydrology researcher from the University of Cheikh Anta Diop. I was thus able to obtain a broad picture of drinking water quality in Kaolack and in Senegal in general.

I also conducted a total of 84 structured household interviews. The structured format of these interviews allowed me to target conversations towards specific topics and to seek out trends in responses. In the household interviews, topics included: perceptions of various sources of drinking water in Kaolack and their impacts on health and well-being; household access practices and preferences; and relationships with drinking water providers and governance actors. These interviews aimed to engage a broad sample of the population of Kaolack, spread over several of the city's neighbourhoods. For interviewees, I intentionally selected those living in neighbourhoods where (I had been told) water quality was a particular challenge or where water access practices might be of interest. As the interview process continued, I followed suggestions from interview participants and other connections into different areas in the city, a mixed form of theoretical and snowball sampling. With the aid of a research assistant, the household interviews consisted of a verbally administered questionnaire with a mix of yes/no and open-ended questions.

Document review and analysis provided a secondary research method and yielded information that acted as background for the findings of interviews, observations and participation. The reviewed documents included laws, policies, plans and reports pertaining to drinking water quality in Kaolack and Senegal. I took detailed notes about the content and source of each document, including how the Senegalese state and international organisations define and respond to drinking water quality. I supplemented and compared these notes with the results of the other methods, specifically considering similarities and differences in how drinking water quality is defined and responded to by consumers, providers and diverse state actors. My approach to focusing on problematisations of drinking water quality by various actors owes much to the conceptualisations of problematisations in the writings of Foucault and in that of scholars who rely on his work (Legg, 2011). The policy studies work of Carole Bacchi (2012), in particular, has inspired the idea that problematisations can be identified by the assumptions inherent in chosen solutions.

Applying assemblage theory to data collection and analysis requires an open-ended perspective whereby the most important actors are not predetermined but, rather, emerge through engagement with sites and situations (Bueger, 2014). This provides an opportunity to take note of agential actors, which may be overlooked in other approaches. My multi-method research design thus allowed me to consider a blend of the material and social elements in assemblages, all of which have the potential to matter. I used an analytic strategy whereby key themes were allowed to emerge from coded transcripts and field notes; I then analysed coded data using concepts drawn from assemblage theory literature.

ASSEMBLAGES OF DRINKING WATER QUALITY IN KAOLACK

I identify four kinds of assemblages of drinking water quality in Kaolack: state, implementer, provider and consumer.⁵ The terms I use to name assemblages and to capture the core problematisations of each group emerged from my engagement with collected empirical data. The names I have given them reflect

⁵ I direct most of my attention to the Senegalese state at the national level, as it is events here that most directly affect how drinking water quality is assembled in Kaolack. Although I do not go into detail about the problem framings of global health actors, the national and international levels are entangled. In Senegal, as in many countries, the current WHO Guidelines for Drinking Water Quality (WHO, 2011) influence how the state defines and responds to drinking water quality (Diop, 2014). Further discussion of processes of international standard-setting and assemblages of drinking water quality at that level are beyond the scope of this article.

their tendencies more than their types and, as will quickly become clear, the boundaries between them are not always distinct. An individual or group of actors can participate in multiple assemblages relative to a single issue; for instance, everyone drinks water so everyone must be part of consumer assemblages, but some actors simultaneously take part in implementer or provider assemblages. In order to talk about assemblages, however, it is helpful to give them each provisional labels.

In the following sections, I show how the drivers and problematisations of each assemblage, in contact with the materiality of Kaolack and the particular tools and realities available to different actors, cause the emergence of distinct assemblages. The drivers and problematisations of these assemblages may be explicit or implicit and can take different forms for different assemblages. The ones I identify for the state are primarily outlined in policy and planning documents, which I then confirmed with interviews. Implementers of policies and plans are influenced by these documents, but they also construct their own assemblages of drinking water quality contextually, given the opportunities and constraints they face in the course of doing their jobs. For providers and consumers of water, the ongoing existence of each type of water source represents a solution to a drinking water quality problem. I therefore incorporate the materiality of sources into my analysis of the problematisations of each assemblage and ask what kind of drinking water quality problem each alternative source could be solving.

The Senegalese state assemblage

The Senegalese state strives to provide clean and safe drinking water to citizens in order to ensure the health and well-being of the population and make progress towards measurable health-related indicators, the goal in turn shapes how the problem is defined. The quantitative indicators used by the Senegalese state and the WHO include: health-based targets; percentages of households with access to improved and safely managed sources; and the chemical, radiological, microbial and acceptability aspects (WHO, 2011). These indicators have clear links to public health and are translatable and repeatable across all situations. An assemblage of drinking water quality emerges from this perspective as a technical, solvable problem and the focus on quantifiable and measurable indicators implicates experts in the process of knowing and determining appropriate responses to drinking water quality. This is a mutually reinforcing process because experts bring with them a particular way of seeing the world in terms of their expertise and what is visible using the tools they have.⁶ Because experts are trained to collect data and see the world in terms of quantitative, measurable objects and clear cause-effect relationships, this is also primarily how they view drinking water quality.

In the DGPRE's national strategy document on developing a policy for the improvement of drinking water quality (DGPRE, 2016),⁷ three axes are proposed for improving drinking water quality. First, build infrastructure to improve water quality; that is, identify and implement efficient technical solutions that can be supported by the population and that will improve the physico-chemical and bacteriological quality of the water that is distributed and consumed; second, put in place monitoring and protection systems for water quality and improve the state of knowledge related to the quality of resources; and third, establish operational and effective governance of water quality (DGPRE, 2016 1). These axes and their associated actions primarily implicate the state in solving drinking water quality problems. From this list we can work backwards to see what are presumed to be the three main problems that can be addressed by these solutions: 1) a lack of technical infrastructure to improve quality; 2) insufficient knowledge and data about quality; and 3) ineffective governance. Elsewhere in the strategy document, I identified three categories of causes of inadequate drinking water quality. They were: collection and distribution of water without appropriate treatment to remove the naturally occurring salt, fluoride and

⁶ Scholars in science and technology studies have long argued that expertise shapes its object; for a summary of the politics of measurement, see Collins and Evans (2002) or Pine and Liboiron (2015).

⁷ This document is the second deliverable in a process of developing a national strategy for the improvement of drinking water quality. The first phase consisted of a report on the status of drinking water quality in Senegal.

iron; collection and distribution of water without appropriate treatment for man-made contamination from agriculture, mining, inadequate sanitation, or poor hygiene behaviour; and a lack of, or inadequately adapted, technical solutions for improving the quality of water (DGPRES, 2016: 10). These are all national-level problems resulting from lack of knowledge and technological capacity, and from failures of governance; the solutions are thus also state-driven and focused on the national level.

Meanwhile, public-health-oriented policies and plans tend to prioritise hygiene issues for which individuals can take responsibility, such as handwashing, household chlorination and filtration, proper storage, and avoidance of open defecation (DGPRES, 2018). Relatedly, the DGPRES approaches the problem from a different angle, listing the socio-economic factors that lead to the consumption of poor quality water (DGPRES, 2016). Here, the problem is flipped from being attributable to poor quality supply to being grounded in the behaviour of consumers. The list of behavioural factors includes: inability or unwillingness to pay for expensive treated water; the habit of depending on wells that supply water of inferior quality and are more exposed to degradation; and ignorance and bad practices in terms of hygiene and protection. The core issue here appears to be not the quality of the water itself, but rather the consumption of that water by recalcitrant consumers (Interview 1, 2019). The solutions that are thus proposed pertain to information, education, capacity building and improved governance, with a focus on altering the individual consumer's behaviour through education and accountability (DGPRES, 2018).

Alongside the problem framings of drinking water quality in national-level policy documents and plans, the Senegalese government acknowledges that Kaolack has particular drinking water quality issues that require attention. These locally specific problem framings can be aligned with particular types of solutions to drinking water quality challenges in Kaolack. The urban planning directorate's development plan for Kaolack, for example, describes some potential solutions to drinking water quality problems (Cabinet d'Architecture et d'Urbanisme du Senegal, 2019). Plans for improving drinking water quality in the city emphasise large-scale infrastructure projects, while individual consumers' behaviours appear to a lesser extent. Some of the strategies under consideration are: building large pipelines to transfer water to Kaolack from regions with better quality water; mixing water from shallow and deep aquifers, thus diluting both fluoride and salt; and constructing two large-scale desalination plants to treat groundwater (Interview 1, 2019). For the most part, the problems of drinking water quality in Kaolack are framed at the level of the city and thus can be uniformly addressed at the municipal level. At the time of writing, funds had not yet been obtained to implement any of these proposed solutions (Interview 2, 2019); therefore, while the necessary knowledge exists for improving drinking water quality and even though the technology has been identified, there remains a lack of resources and political will (Interview 3, 2019).

Given such constraints, the language of the WHO and Senegalese water law allow the state to avoid setting unachievable goals by tying the setting of drinking water quality standards to the capacity of a local government or provider to implement those standards. Senegalese water law says, for example, that, "The Code emphasizes health aspects, because it incorporates the standards defined by the World Health Organization, while adapting them *to our level of development* and to the nature of our hydraulic works" (Loi Portant le Code de L'eau; Loi n. 81-12, 1981; emphasis added). The WHO allows for these kinds of provisions as well; the introduction to the Guidelines for Drinking Water Quality, for instance, specifies that every effort should be made for water to be "as safe as is practicable" (WHO, 2017: 1). Because of these stipulations and the realities of implementation, the idealised versions of drinking water quality as it appear in policies, laws and plans do not always reflect what happens on the ground. Thus while this policy and planning version of the drinking water quality assemblage is influential, the stubborn materiality of urban water in Kaolack means that implementers are forced to assemble drinking water quality in distinct ways. I show this in the following section.

Implementation assemblages of drinking water quality

Aspirations for drinking water quality by the state are supposed to be supported and implemented by actors on the ground; in Kaolack, this means the Hygiene Service, the tap water provider, and the NGO laboratory that monitors drinking water quality. The bureaucratic and technical limitations and constraints faced by these actors typically mean that in practice they are not able to realise the state's goals in terms of water quality (Interview 4, 2019; Field notes, Hygiene Service). Their assemblage is also coloured by the day-to-day realities they face in ways that are more individual and immediate. This contrasts with the assemblage of the Senegalese state that is presented in the previous section, which is oriented towards the longer-term and towards public health at the level of the country, rather than to its impacts on individuals.

The Hygiene Service is one example; equipment shortages and understaffing limit the scope of its activities (Interview 5, 2019). Bureaucratic overlaps were also identified by interviewees as being challenging, in the sense that redundancy dilutes funding and when everyone is partially responsible for everything no one is fully responsible for anything (Interviews 6 and 7, 2019). Despite these constraints, the staff of the Hygiene Service expressed a desire to protect the public from illness and to serve their community. While the state makes long-term plans for large-scale infrastructure investment over the long-term, the Hygiene Service staff do not have the luxury of waiting for new treatment plants to be built or for pipelines to bring clean drinking water in from elsewhere. The solutions to drinking water quality problems for the Hygiene Service therefore prioritise immediate action, such as shutting down sources that do not meet standards and destroying compromised or expired bags of water.

The actors in the Hygiene Service describe drinking water quality problems as primarily stemming from unclean behaviours at both the individual and community levels. From their point of view, citizens and providers need to be taught how to be sanitary and should be watched over to make sure they do not break rules that exist for their own protection. Another assumed problem is that water vendors do not respect the regulations that apply to the water that they sell and/or they are unaware of the risks their practices pose. For instance, sellers of well water do not cover their wells or treat water before they sell it to consumers, or construct their wells too close to latrines or other sanitation infrastructure. The staff of the Hygiene Service thus see drinking water quality and other threats to health as being solvable by aggressive action. They can be intimidating: they dress like police and many of them are former members of the military. Their slogan is 'Fight dirtiness – Defeat illness'. For them, water quality is a fighting matter and substances in water are the enemy.

Provider assemblages

Providers of drinking water in Kaolack view the quality of their product as part of its monetary value. Their primary objective is to sell their water and they therefore need to ensure its quality in order to entice people to purchase it. In this way, good quality drinking water has become a commodity to which people are not entitled unless they can pay for it.⁸ Requirements for water providers are also set out in the water laws of Senegal and in the omnipresent WHO Drinking Water Quality guidelines; these are enforced by the Hygiene Service and the NGO laboratory, and water sellers must meet them in order to be allowed to continue selling water.

For SDE, as the urban tap water provider, drinking water quality problems largely arise through its relationships with the Senegalese state and consumers. SDE treats drinking water quality as a technical challenge that must be overcome. The staff of SDE are preoccupied with maintaining the residual chlorine content of water and ensuring the absence of *E. coli*, as set out by the requirements of their contract. SDE has created extensive systems for monitoring and evaluating water in key locations throughout the

⁸ The tensions set in motion by commodification of water quality are discussed in the literature on bottled water (Pacheco-Vega, 2019) and filtered water kiosks on the US-Mexico border (Jepson and Brown, 2014).

network; they also regularly clean and flush the water towers and add chlorine to the system (Interviews 8 and 9, 2019). The SDE must also deal with consumers' perceptions of drinking water quality because if consumers are not satisfied they will complain or refuse to pay for tap water (Interview 8, 2019).

Providers of water other than tap water distinguish themselves and convince people to buy their products by identifying and filling gaps left by other types of available water service. So when one considers people providing and paying for a certain kind of water, what problem are they solving? For example, the owners of filtered water kiosks identify a problem in Kaolack, which is that affordable and healthy drinking water options are perceived as absent. One kiosk business was founded by a person who visits Kaolack annually for a religious festival. They noticed that most guests and residents relied on bag water, which they considered to be of dubious quality. They therefore decided to start a filtered water business near the mosque in order to both make money and do something good for the community. Kiosk owners note that with even a small amount of money you can purchase enough water to supply a family's needs for a few days. They argue that well water, bag water, and even tap water to some extent, cannot be trusted because one is not able to know the source or witness the treatment process. Filtered water sold from these locally operated kiosks tries to address this problem, in that the machines are right in front of the consumer and so they can be certain that nothing is being added to the water, that quality has not declined from the point of treatment to where they receive it, and that a vendor they trust is taking responsibility for maintaining high standards.

Figure 2. Filtered water seller in Kaolack.



Source: Author's photo.

Another example is bag water, which is convenient, mobile, cold, affordable and trusted by many consumers. Bag water sellers meet a need to have water outside the home, or in small, trustworthy quantities. Many people in Kaolack are employed in the area around the market and do not have access to nearby running water. They must either bring with them what they need or buy water while they are there. A similar situation prevails when one is travelling, even across town. Temperatures can rise well over 40 degrees Celsius and waiting for a bus or taxi to fill can take hours. Bag water sellers are there, ready to give you exactly what you need in the form of 400 millilitres of ice-cold water.

Figure 3. Sachet of drinking water.



Source: Author's photo.

Consumer assemblages

Consumers are driven by a daily, urgent need to obtain consistent supplies of clean and safe drinking water for themselves and their households; to do so, they must navigate a complex field of possibilities and limitations. Consumers' drinking water quality assemblages are not written down, rather they are experiential and contextual. The core question for most households and individuals is not a quantitative one: "what is the amount of x, y, z in this water, thus its quality", but rather a qualitative one: "does this particular instance of water meet the standards I have for determining it is safe and pleasant to drink?"

The problematisations inherent in consumer assemblages of drinking water quality are expressed in the decision-making processes and practices by which consumers obtain drinking water for themselves and their family. The choices they make represent their ways of solving the problem of drinking water quality. Consumers to whom I spoke in household interviews and observed during home visits customise or adapt to drinking water quality concerns in several ways. Most individuals who rely on well water treat it with chlorine or a product called Aquatabs[®] to kill microbes and bacteria. Many also strain water through a cloth or decant it prior to filling their drinking water reservoir, although some consumers expect that the delivery person will strain and decant water before bringing it to clients. People who drink tap water sometimes also treat it with chlorine, and six household interview participants noted that the unpleasant taste of Kaolack water is less noticeable when water is cold so they either store containers in a refrigerator or add ice before drinking. Consumers that rely on bottled or bag water mentioned that they trust the quality of these products and do not do any additional treatment. Seeking out alternatives to tap water is quite common in Kaolack, although residents with taps inside their home continue to use tap water for most other household tasks and sometimes cooking.⁹ Decisions to respond to potential safety problems or the aesthetic characteristics of water in such ways indicate that microbiological contamination, turbidity, and taste are among the top concerns of consumers in Kaolack. All of these solutions are undertaken at the individual level, with consumers doing what is necessary to maintain quality at the level of their household. Almost all household interview participants identified someone within their household (often a woman) as being primarily responsible for determining whether drinking water quality is adequate and for taking action if needed.

⁹ This varies, as eight interview respondents complained about the way tap water feels in the shower or how it damages their nice clothes. When they can afford it, these individuals pay for well water for laundry, bathing and cooking.

Advocacy for improved water quality at the city level was nearly absent.¹⁰ Participants in only 6 of the 84 household interviews noted that ideally the government or the SDE should be responsible for maintaining a safe supply of drinking water, but that the company was not currently considered to be reliable or trustworthy. Some household interview respondents, however, also offered suggestions of city-level actions that could improve the quality of tap water. Some residents of Kaolack were aware that the neighbouring city of Fatick had already constructed a drinking water treatment plant, and commented that they would like to see similar action taken in Kaolack. Three individuals who had spent time in Dakar or in the northern regions identified water transfers from Lac de Guiers as an option for bringing good quality surface water into Kaolack. One group of participants (three men who responded to the household interview questions together) and one individual participant also criticised the SDE and SONES for digging deep bore wells in places where the water is salty and has fluoride; they argued that better quality hydrological or geological studies could have saved the population money and provided better water. Despite these suggestions, the majority seem to suspect that politicians do not consider Kaolack's drinking water quality to be an urgent problem and would not be able to raise funds for drinking water quality improvement projects in Kaolack. They accepted that they, as individuals, bear most of the burden of knowing and ensuring drinking water quality.

A limitation to considering actions as the main way to understand drinking water quality problematisations stems from the fact that consumers do not all have the same ability to customise their drinking water or to pay for higher quality sources. Resources, financial and otherwise, are required to do these things and the available options can be limited. In some cases, therefore, it may appear that no action is being taken, but this does not mean that drinking water quality is considered to be unproblematic. To convey their inability to do more to ensure better quality drinking water, three household interview participants used the Wolof proverb, "In the absence of choices your choices are made for you".¹¹ Quite commonly expressed was also the sentiment of, "This is the water Allah has provided to us and so we make do". Once a connection is established inside a house, tap water is the least expensive option by volume. Households that are not connected to the tap water network have no choice but to pay significantly more for tap water from public standpipes or to rely on alternative sources like well water, bag water, or filtered water. Households without taps in their homes are also constrained in their ability to act because they are not direct customers of SDE with customer identification numbers. These households therefore do not have a clear channel through which to make a comment or complaint about the quality of the water they purchase from public standpipes or their neighbours (Grönwall et al., 2010)Field notes and interviews with unconnected households). The wealthier people who are likely to have more political power to contest current conditions and demand better service are often the same people who choose to exit the piped water network (Kjellén, 2006).

DISCUSSION

In the preceding sections, I have shown the intimate connections between the way that drinking water quality is problematised and the type of response that is generated in terms of human intentions to act. How these problems are framed – that is, how drinking water quality is assembled – has real consequences for how people access water and for the degree to which they are exposed to potentially harmful substances in water. For instance, implementers of water quality standards monitor drinking water quality at different places and times than providers. The justification for their processes can be summed up in this quote from an interviewee at the Hygiene Service: "We measure drinking water quality

¹⁰ The exception was one household interview participant who suggested that he would like to sue the city for better quality water and said that he has a friend who is a lawyer. When I followed up with him later, however, it became clear that he was not pursuing this in any concrete way.

¹¹ *Ñakk pexe, pexe la*; this is a rough translation, as *pexe* can also mean strategy.

to protect the people, [SDE] measures because they want to sell a product" (Interview 10, 2019). This suggests different understandings of the problem of drinking water quality as either a public health or profit maximisation challenge. This is more than a semantic issue. What water is measured, and how, where and when it is measured, play important roles in what water quality measurements find. A review of 57 studies, for example, found that drinking water quality declines significantly after collection if water is stored or transported (Wright et al., 2004). The goal of measurement therefore plays an important role in results; if the intention is improved health for consumers then water quality monitoring should happen at the point of use, whereas if the goal is quality of service it makes sense to measure at the point of delivery (Wright et al., 2004).

Given these fundamentally different understandings of what *kind* of problem drinking water quality can be, multiple assemblages can coexist and can be organised around the problem of drinking water quality, while remaining in tension with each other. Actors associated with distinct assemblages of drinking water quality can therefore struggle to communicate across their differences. Representatives of the state and consumers, for example, may believe that they are talking about the same entity, but may encounter fundamental differences in the ways they conceptualise drinking water quality. These barriers to communication can manifest as tension or even frustration. In Kaolack, SDE staff are upset that consumers continue to reject water they have worked hard to provide (Interview 8, 2019). Consumers, at the same time, are frustrated by what they feel are misleading or disingenuous claims that water sold to them is of good quality, especially in the face of their embodied experiences of negative health impacts and visible marks on their family's teeth. Consumer preferences can result in a kind of "tug of water between potability and palatability" if, for example, the chlorination process which prevents microbial contamination results in odours and flavours that consumers will not accept (Spackman and Burlingame, 2018).

Drinking water quality assemblages can also vary in their degree of stability or openness to change. The Senegalese state assemblage of drinking water quality as a quantitative object facilitates translation across contexts. This allows for awareness of progress and identification of areas that need to improve. However, the requirement that drinking water quality refers to the same collection of elements in multiple contexts also makes the assemblage rigid. State assemblages are thus less open to uncertainty and to the possibility that people may disagree about what constitutes quality. The Senegalese state assemblage is fairly stable in the sense that its form is written in legal documents that are only revised every few decades, and it is comprised of policies that last several years and planning documents with distant end-dates such as the Horizon 2037 of Kaolack.¹² In contrast, the Hygiene Service is generally driven by similar problem framings and principles, however, it is more flexible because the materiality of the situations it encounters means that it needs to respond to problems as they arise. Provision assemblages that are driven by profit maximisation must be even more flexible; they must be able to change on the basis of the needs of individual consumers in any situation. Finally, consumer assemblages are not static; rather, they are always shifting and transforming in response to their changing context. Selection or customisation of drinking water sources is not something consumers do once and then maintain consistently. Individuals may drink one kind of water at home and another at work or they may shy away from certain sources in the rainy season when contamination is more likely. Tap water cuts off regularly in many neighbourhoods, so even people who are comfortable drinking from the tap need to have back-up plans and alternatives (Field notes; household interviews). As the availability and materiality of drinking water sources change, so do consumers' assemblages of drinking water quality.

Because of this potential for change, it is important not to reify an assemblage as a "thing" instead of a relational process (Featherstone, 2011). Instead, empirical analysis should consider what is fluid, what is fixed, and why (Müller, 2015). Both the concrete elements and the conditioning relations of any

¹² The existing water law is from 1981 and at the time of writing is under revision. The WHO revises their guidelines for drinking water quality more frequently, and the current (fourth) edition of the guidelines is from 2011.

assemblage are always susceptible to change (Nail, 2017). For example, Kaolack is changing materially with regard to the encroaching salinity of the groundwater, expanded connectivity to the tap water network, and the increased availability and affordability of technology for water filtration and treatment. It is also changing socially in terms of consumer expectations and desires. Considering multiple drinking water qualities (instead of a singular drinking water quality) that vary in their degree of stability and change can help to understand the real complexity of urban drinking water challenges.

Furthermore, drinking water quality assemblages and the actors and solutions they implicate are mutually reinforcing. For example, if drinking water quality is a technical, solvable problem whose solution is primarily knowable by experts, these experts will consistently define quality in ways that are compatible with their world view. Such a view lends itself towards more rigid, quantitatively oriented assemblages. If, on the other hand, drinking water quality is personal and situated, as it is for consumers, then drinking water quality problems and solutions are also more flexible and responsive. Because consumers lack the equipment or skills to participate in conversations about drinking water quality as a technical, scientific problem, they are prevented from affecting the state assemblage of drinking water quality. It can also become more difficult for them to benefit or learn from knowledge the state produces because the state is not speaking about quality in a way that is intelligible to consumers.

These differences further relate to the perceived scale and timeline of drinking water quality problems. For the Senegalese state drinking water quality is a long-term problem affecting public health as a whole. In the implementation assemblages drinking water quality is an immediate problem that can be solved through aggressive action on a small scale. For consumers, quality is immediate and individual. Still, what these assemblages have in common is as important as their differences. The question of what they have in common returns to a philosophical question that Deleuze and Guattari have asked about assemblages (Deleuze and Guattari, 1987): they are interested in how much you can change something before it becomes something else (Adkins, 2015). One can add or remove some elements from an assemblage without fundamentally changing its essence or identity, but is drinking water still drinking water quality if it cannot be measured? What if it does not include taste? The answers to such questions may vary between assemblages, but the overarching problematisation of drinking water quality remains oriented towards the suitability of water for human consumption.

CONCLUSION

In this article, I have shown that the concept of drinking water quality assemblages can help to destabilise assumptions that drinking water quality is a rigid, stable entity. One thing that an assemblage perspective on drinking water quality makes clear is the limitations to imposing a static and immovable assemblage onto a heterogeneous and dynamic world. In particular, the ways that consumers and implementers experience drinking water quality challenge the universal, abstract and translatable indicators on which the state relies. There is no 'universal' in assemblage theory. Relations are constantly constructed and emergent. Because there are infinite ways for relationships to form between the elements of assemblages, it is important to ask why some assemblages emerge and become dominant. The emergence of certain assemblages matters in terms of what those assemblages make possible, including how drinking water quality could be different (or not), along with the tendency of assemblages towards either stability or change. Assemblages can close down the range of possibilities by making one way of seeing problems seem natural and concealing other ways for the world to be.

Drinking water quality assemblages are further comprised of a range of social, discursive and non-human elements, in complex relations that involve geology, politics, capital and so on. Yet, much like Li's (2007) argument that one of the practices of assemblage can be to "render technical" and depoliticise certain phenomena, the harms caused by poor water quality are sometimes treated as if they were the fault of individual people for not washing their hands, relying on informal sanitation, and making poor choices about what water to drink (Subramanian, 2013). Showing that drinking water quality problems

emerge in dynamic and multifaceted ways that are not limited to one scale or temporality therefore expands the range of possible actors who can be held accountable or seen as agential in solving water quality problems. An assemblage approach can thus be a way to not only rematerialise but also repoliticise drinking water quality.

ACKNOWLEDGEMENTS

This work was supported by Norges Miljø-og biovitenskapelige universitet (NMBU) over the course of a stipend for PhD education. Thank you to Synne Movik, Tim Richardson, and Matthew Cashmore for supervision and support throughout the writing process, and to three anonymous reviewers for their constructive feedback.

DECLARATION

Parts of this article have appeared in my PhD dissertation (Assembling drinking water quality and inequality: the case of Kaolack, Senegal) at the Norwegian University of Life Sciences. The author identifies no conflicts of interest.

REFERENCES

- Adkins, B. 2015. *Deleuze and Guattari's A thousand plateaus*. Edinburgh University Press.
- Agence Belge de Développement. 2013. Fluor et sel dans l'eau: Défis et solutions, PEPAM-AQUA – Appui à l'amélioration de la qualité de l'eau dans le Bassin Arachidier, www.pseau.org/outils/ouvrages/ctb_pepam_ba_fluor_et_sel_dans_l_eau_defis_et_solutions_2013.pdf
- Amin, A. 2014. Lively infrastructure. *Theory, Culture & Society* 31(7-8): 137-161.
- Anderson, B. and McFarlane, C. 2011. Assemblage and geography. *Area* 43(2): 124-127.
- ANSD. 2019. Situation Economique et Sociale de la Région de Kaolack. Edition 2016. Dakar, Senegal: ANSD.
- Ayre, M. and Mackenzie, J. 2013. "Unwritten, unsaid, just known": The role of Indigenous knowledge(s) in water planning in Australia. *Local Environment* 18(7): 753-768.
- Bacchi, C. 2012. Why study problematizations? Making politics visible. *Open Journal of Political Science* 2(01): 1-8.
- Bakker, K. and Bridge, G. 2006. Material worlds? Resource geographies and the matter of nature. *Progress in Human Geography* 30(1): 5-27.
- Bennett, J. 2010. *Vibrant matter: A political ecology of things*. Duke University Press.
- Berry, K.A.; Jackson, S.; Saito, L. and Forline, L. 2018. Reconceptualising water quality governance to incorporate knowledge and values: Case studies from Australian and Brazilian Indigenous communities.
- Boakye-Ansah, A.S.; Ferrero, G.; Rusca, M. and van der Zaag, P. 2016. Inequalities in microbial contamination of drinking water supplies in urban areas: The case of Lilongwe, Malawi. *Journal of Water and Health* 14(5): 851-863.
- Bouleau, G. and Pont, D. 2015. Did you say reference conditions? Ecological and socio-economic perspectives on the European Water Framework Directive. *Environmental Science & Policy* 47: 32-41.
- Brenner, N.; Madden, D.J. and Wachsmuth, D. 2011. Assemblage urbanism and the challenges of critical urban theory. *City* 15(2): 225-240.
- Bueger, C. 2014. Thinking assemblages methodologically: Some rules of thumb. In Acuto, M. and Curtis, A. (Eds), *Reassembling international theory: Assemblage thinking and international relations*, pp. 58-66. UK: Palgrave Macmillan.
- Bueger, C. 2018. Territory, authority, expertise: Global governance and the counter-piracy assemblage. *European Journal of International Relations* 24(3): 614-637.
- Burt, Z. and Ray, I. 2014. Storage and non-payment: Persistent informalities within the formal water supply of Hubli-Dharwad, India. *Water Alternatives* 7(1): 106-120.

- Cabinet d'Architecture et d'Urbanisme du Sénégal. 2019. Plan Directeur d'Urbanisme de Kaolack "Horizon 2037" (Version Provisoire). Direction General d'Urbanisme et d'Architecture. Dakar, Senegal.
- Collins, H.M. and Evans, R. 2002. The third wave of science studies: Studies of expertise and experience. *Social Studies of Science* 32(2): 235-296.
- de França Doria, M.; Pidgeon, N. and Hunter, P.R. 2009. Perceptions of drinking water quality and risk and its effect on behaviour: A cross-national study. *Science of the Total Environment* 407(21): 5455-5464.
- De Micheaux, F.L.; Mukherjee, J. and Kull, C.A. 2018. When hydrosociality encounters sediments: Transformed lives and livelihoods in the lower basin of the Ganges River. *Environment and Planning E: Nature and Space* 1(4): 641-663.
- DeLanda, M. 2006. *A new philosophy of society: Assemblage theory and social complexity*. A&C Black.
- DeLanda, M. 2016. *Assemblage theory*. Edinburgh University Press.
- Deleuze, G. and Guattari, F. 1987. *A thousand plateaus: Capitalism and schizophrenia*. Bloomsbury Publishing PLC.
- Deshpande, A.; Miller-Petrie, M.K.; Lindstedt, P.A.; Baumann, M.M.; Johnson, K.B.; Blacker, B.F.; Abbastabar, H.; Abd-Allah, F.; Abdelalim, A. and Abdollahpour, I. 2020. Mapping geographical inequalities in access to drinking water and sanitation facilities in low-income and middle-income countries, 2000-17. *The Lancet Global Health* 8(9): e1162-e1185.
- DGPRES. 2016. Rapport Stratégie: Etude pour l'élaboration d'une stratégie nationale de l'Amélioration de la Qualité de l'eau potable au Sénégal. Dakar, Senegal, https://www.pseau.org/outils/ouvrages/dgpre_etude_pour_l_elaboration_d_une_strategie_nationale_d_ame_lioration_de_la_qualite_de_l_eu_potable_au_senegal_2016.pdf
- DGPRES. 2018. Le Plan de Gestion Intégrée des Ressources en Eau (PAGIRE). www.dgpre.gouv.sn/index.php/2018/09/14/le-plan-de-gestion-integree-des-ressources-en-eau-pagire/
- Diène, M.; Kane, C.H. and Dethie, S. 2014. Overview of the aquifer system in the Senegalese and Mauritanian sedimentary basin. *Sciences Appliquées et de l'Ingénieur* 1(2): 86-91.
- Dieng, N.M.; Orban, P.; Otten, J.; Stumpp, C.; Faye, S. and Dassargues, A. 2017. Temporal changes in groundwater quality of the Saloum coastal aquifer. *Journal of Hydrology: Regional Studies* 9: 163-182.
- Diop, M. 2014. Le partenariat public-privé: Une alternative à l'aide publique au développement? L'exemple des services urbains d'eau au Sénégal. *Mondes en développement* 42(1): 79-92.
- Faye, S.; Maloszewski, P.; Stichler, W.; Trimborn, P.; Faye, S.C. and Gaye, C.B. 2005. Groundwater salinization in the Saloum (Senegal) delta aquifer: Minor elements and isotopic indicators. *Science of the Total Environment* 343(1-3): 243-259.
- Featherstone, D. 2011. On assemblage and articulation. *Area* 43(2): 139-142.
- Freitag, A. 2014. Naming, framing, and blaming: Exploring ways of knowing in the deceptively simple question "what is water quality?" *Human Ecology* 42(2): 325-337.
- Furlong, K. 2014. STS beyond the "modern infrastructure ideal": Extending theory by engaging with infrastructure challenges in the South. *Technology in Society* 38: 139-147.
- Furlong, K. and Kooy, M. 2017. Worlding water supply: Thinking beyond the network in Jakarta. *International Journal of Urban and Regional Research* 41(6): 888-903.
- Global Water Practice. 2021. 2021 Annual Report: Global Water Security and Sanitation Partnership. Washington, DC: World Bank Group. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/470921636660686226/global-water-security-and-sanitation-partnership-annual-report-2021>
- Gorostiza, S. and Sauri, D. 2017. Dangerous assemblages: Salts, trihalomethanes and endocrine disruptors in the water palimpsest of the Llobregat River, Catalonia. *Geoforum* 81: 153-162.
- Grönwall; Mulenga and McGranahan. 2010. Groundwater, self-supply and poor urban dwellers: A review with case studies of Bangalore and Lusaka (IIED). IIED. <https://www.jstor.org/stable/pdf/resrep01273.1.pdf>
- Hillier, J. 2011. Encountering Gilles Deleuze in another place. *European Planning Studies* 19(5): 861-885.

- Jepson, W. and Brown, H.L. 2014. 'If no gasoline, no water': Privatizing drinking water quality in South Texas colonias. *Environment and Planning A* 46(5): 1032-1048.
- JICA. 2014. The project for treatment of sewage, rainwater, and wastes in Kaolack City in the Republic of Senegal, Final Report.
https://www.jica.go.jp/english/our_work/social_environmental/id/africa/senegal/c8h0vm000090orig4.html
- Karpouzoglou, T. 2012. 'Our power rests in numbers'. The role of expert-led policy processes in addressing water quality: The case of peri-urban areas in the national capital region of Delhi, India. University of Sussex.
- Karpouzoglou, T.; Marshall, F. and Mehta, L. 2018. Towards a peri-urban political ecology of water quality decline. *Land Use Policy* 70: 485-493.
- Kjellén, M. 2006. From public pipes to private hands: Water access and distribution in Dar es Salaam, Tanzania. PhD Thesis, Department of Human Geography, Stockholm University, Stockholm, Sweden.
- Lancione, M. 2011. Homeless subjects and the chance of space: A more-than-human geography of homelessness in Turin. PhD thesis Department of Geography. Durham University, Durham, UK.
- Lavie, E.; Crombé, L. and Marshall, A. 2020. Reconceptualising the drinking waterscape through a grounded perspective. *The Geographical Journal* 186(2): 224-236.
- Lawhon, M.; Nilsson, D.; Silver, J.; Ernstson, H. and Lwasa, S. 2018. Thinking through heterogeneous infrastructure configurations. *Urban Studies* 55(4): 720-732.
- Lefebvre, H. 1991. *The production of space*. Oxford, UK: Wiley-Blackwell.
- Legg, S. 2011. Assemblage/apparatus: Using Deleuze and Foucault. *Area* 43(2): 128-133.
- Li, T.M. 2007. Practices of assemblage and community forest management. *Economy & society* 36(2): 263-293.
- McFarlane, C. 2011. Assemblage and critical urbanism. *City* 15(2): 204-224.
- Meehan, K.M. 2013. Disciplining de facto development: Water theft and hydrosocial order in Tijuana. *Environment and Planning D: Society and Space* 31(2): 319-336.
- Moran, L. and Rau, H. 2016. Mapping divergent concepts of sustainability: Lay knowledge, local practices and environmental governance. *Local Environment* 21(3): 344-360.
- Müller, M. 2015. Assemblages and actor-networks: Rethinking socio-material power, politics and space. *Geography Compass* 9(1): 27-41.
- Nail, T. 2017. What is an assemblage? *SubStance* 46(1): 21-37.
- Orlove, B. and Caton, S.C. 2010. Water sustainability: Anthropological approaches and prospects. *Annual Review of Anthropology* 39: 401-415.
- Pacheco-Vega, R. 2019. (Re)theorizing the politics of bottled water: Water insecurity in the context of weak regulatory regimes. *Water* 11(4): 658.
- Parrinello, G. and Kondolf, G.M. 2021. The social life of sediment. *Water History* 13(1): 1-12.
- Pine, K.H. and Liboiron, M. 2015. The politics of measurement and action. Paper read at Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems.
- Rusca, M.; Boakye-Ansah, A.S.; Loftus, A.; Ferrero, G. and van der Zaag, P. 2017. An interdisciplinary political ecology of drinking water quality. Exploring socio-ecological inequalities in Lilongwe's water supply network. *Geoforum* 84: 138-146.
- Russell, S. and Ens, E. 2020. 'We don't want to drink that water': Cross-cultural indicators of billabong water quality in remote Indigenous Australia. *Marine and Freshwater Research* 71(10): 1221-1233.
- Savage, G.C. 2019. What is policy assemblage? *Territory, Politics, Governance*: 1-17.
- Smith, N. 2008. *Uneven development: Nature, capital, and the production of space*. Athens, GA, USA: University of Georgia Press.
- Spackman, C. and Burlingame, G.A. 2018. Sensory politics: The tug-of-war between potability and palatability in municipal water production. *Social Studies of Science* 48(3): 350-371.
- Subramanian, S.V. 2013. Blame it on the community, immunize the state and the international agencies: An assessment of water supply and sanitation programs in India. ZEF Working Paper Series.

- Sultana, F. 2007. Water, water everywhere, but not a drop to drink: Pani politics (water politics) in rural Bangladesh. *International Feminist Journal of Politics* 9(4): 494-502.
- Sultana, F. 2012. Producing contaminated citizens: Toward a nature-society geography of health and well-being. *Annals of the Association of American Geographers* 102(5): 1165-1172.
- UNICEF. 1999. Flouride in water: An overview *Waterfront – A UNICEF publication on water, environment, sanitation and hygiene* (13).
- WHO. 2011. Guidelines for drinking water quality. Geneva, Switzerland. www.who.int
- WHO. 2017. Guidelines for Drinking-water Quality: First addendum to fourth edition. World Health Organization, Volume 1 Recommendations. https://www.who.int/water_sanitation_health/dwq/gdwq0506.pdf
- WHO. 2021. Progress on household drinking water, sanitation and hygiene 2000–2020: Five years into the SDGs. Geneva: World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF), <https://www.who.int/publications/i/item/9789240030848>
- Williams, J. 2018. Assembling the water factory: Seawater desalination and the techno-politics of water privatisation in the San Diego-Tijuana metropolitan region. *Geoforum* 93: 32-39.
- Wright, J.; Gundry, S. and Conroy, R. 2004. Household drinking water in developing countries: A systematic review of microbiological contamination between source and point-of-use. *Tropical Medicine & International Health* 9(1): 106-117.
- Yates, J.S.; Harris, L.M. and Wilson, N.J. 2017. Multiple ontologies of water: Politics, conflict and implications for governance. *Environment and Planning D: Society and Space* 35(5): 797-815.

LIST OF INTERVIEWS

- Interview 1: DGPRES staff member, 26-04-19
- Interview 2: Kaolack mayor’s office staff member, 22-05-2019
- Interview 3: Kaolack Urban Planning Directorate, 30-07-19
- Interview 4: Head of NGO laboratory, 05-09-19
- Interview 5: Hygiene Service field manager, 26-07-19
- Interview 6: Hygiene Service local and regional heads, 29-08-19
- Interview 7: Hygiene Service field agent, 19-08-19
- Interview 8: SDE technical staff member, 12-07-19
- Interview 9: Rural Hydraulic Office, 07-05-19
- Interview 10: Hygiene Service engineer, 19-09-19

THIS ARTICLE IS DISTRIBUTED UNDER THE TERMS OF THE CREATIVE COMMONS ATTRIBUTION-NONCOMMERCIAL-SHAREALIKE LICENSE WHICH PERMITS ANY NON COMMERCIAL USE, DISTRIBUTION, AND REPRODUCTION IN ANY MEDIUM, PROVIDED THE ORIGINAL AUTHOR(S) AND SOURCE ARE CREDITED. SEE [HTTPS://CREATIVECOMMONS.ORG/LICENSES/BY-NC-SA/3.0/FR/DEED.EN](https://creativecommons.org/licenses/by-nc-sa/3.0/fr/deed.en)

