FIELDS OF FRICTION

PRACTICES AND POLITICS OF IRRIGATED URBAN AGRICULTURE IN DAR ES SALAAM, TANZANIA

Matthijs T. Wessels

Propositions

1. Irrigated urban agriculture is essential to prevent growing cities from growing hungry. (this thesis)
2. Following water qualities and flows reveals the lived inequalities in the city. (this thesis)
3. The paradox of interdisciplinarity is that it is universally praised but academically undervalued.
4. Anonymisation is wrongly considered a universally good ethical research practice in social science.
5. Science flourishes in the ritual of a coffee break, but only when the coffee is undisputed.
6. The African philosophy of Ubuntu offers a remedy to polarisation in Dutch society.
7. The intricate and majestic essence of African cities is best captured by mosaic art.

Propositions belonging to the thesis, entitled

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Fields of Friction

Practices and politics of irrigated urban agriculture in Dar es Salaam, Tanzania

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Thesis

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Upepo umepinduka,

la shamba lake mjini

'The wind has changed, your field is in the city.'

Swahili proverb

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CHAPTER 1

1

Introduction

1.1 Agriculture and the city

The city is hot, busy, and noisy when I visit the city of Dar es Salaam in 2019 to search for agriculture in the city. The dense urban landscape complicates the search, as one can only see as far as the next façade of high-rise office buildings or small retail shops. While hopping on and off daladala's[1], I talk to people hoping to collect stories about farming in the city. Many know someone who decided to start farming in Dar es Salaam. However, I also quickly realise that agriculture is looked down upon. "He could not find a job, so he became a farmer" is what somebody mentioned when referring to one of his relatives who had come to the city. This phrase stuck with me throughout the past years as an example of the complex relationship between agriculture and the city. The presence of agriculture within the city appears for some incompatible with their images of urban living. Yet, despite this, the farmers of Dar es Salaam continue to utilise urban water and land to secure their livelihoods and provide for the wider citizenry.

Home to some of the world's largest cities and the fastest urban growth, the future of Africa is urban. The majority of the global population growth is expected to occur in sub-Saharan Africa between 2019 and 2050 and concentrates in cities (UN, 2019). This urban transformation has (and is expected to have) a significant impact on Africa's economic, social, and political landscape; thus reshaping landscapes and societies in a myriad of ways. The demands for and competition over water, land, and food are expected to become more pronounced and creates disparities in access to and the quality of these resources. Disparities in water access are particularly prominent in urban areas where population growth, changing lifestyles, increasing pollution, and climate-induced effects will continue to widen the gap between water demand and available supply. This will disproportionately affect the informal settlements where the majority of sub-Saharan Africa's urban population resides. Despite and aside from these concerns, the continent's growing urban population has become a major interest for state authorities and international development organisations who regard it as a powerful asset for development. Urban growth and the role of cities present opportunities to accelerate

[1] The privately-owned buses that serve as the most common form of public transportation.

progress towards the 2030 Agenda for Sustainable Development, the New Urban Agenda, and the Agenda 2063: the Africa We Want (the blueprint and master plan for the continent) (AU, 2014; UN, 2015, 2017). Although it is unclear to what extent the urban transition will be consistent with these discourses, African cities clearly will be the centre of attention for the coming decades.

While cities are popularly presented as catalysts for development, Africa's urban development is not always and for everyone a panacea. The capacity of cities to cater for new urban dwellers is often limited, and the majority of the African urban population lives with limited economic opportunities that underscore patterns of inequality and social marginalisation. Just over half of the urban residents in sub-Saharan Africa face the daily deprivations of slum life and experience distance between themselves and those who have greater access to urban opportunities (50.2 per cent in 2020, see UN-Habitat, 2020). When living in these informal settlements with limited access to basic services, people may feel trapped in places where the prospects of prosperity are remote (Fox, 2014; Watson, 2014). This daily reality of slum living in African cities is not a 'passing phase' but rather an urbanism in its own right with its own comprehensible infrastructures, flows and 'ways of living' (Parnell & Pieterse, 2014; Pieterse, 2011b; Swilling, 2011). Given that urban development creates patchworks of uneven geographies, understanding the city requires a differentiated understanding of the city that acknowledges that the city is not experienced equally by everyone.

As the city grows, more people struggle to access the amenities of urban living. This challenge also applies to those urban dwellers that rely on agricultural activities within the city. Urban farmers attempt to sustain their livelihoods amidst the pressures of urban development, but their access to essential resources, like land and water (of adequate quality), becomes increasingly constrained by the competing needs of a growing urban population. This dissertation therefore centres on the role that irrigated agriculture plays as part of growing African cities. The city of Dar es Salaam, Tanzania, is taken as a case example in this research. Although the results are specific to the context of Dar es Salaam, they exemplify how agricultural activities conflict with urban expansion, placing pressure on the livelihoods of urban dwellers who practice farming. Particular attention in this dissertation is given to the struggles around access to water for irrigation. The dependence of agricultural practices on urban water flows is widespread and growing. Farmers tap into urban return flows and are responsive to the opportunities of water and

nutrient reuse. The benefits and risks that these waters carry are, however, inseparable. This results in discussions around the acceptability of such water use practices as part of the water sector and as part of the agricultural sector. Meanwhile, farmers often have limited say in the flows and qualities of water they can tap into. This creates a heightened competition and discussion between different actors around land and water use (including its effects on resource degradation) in urbanising landscapes.

The use of urban land and water for irrigated agriculture, as described in this dissertation, is a common practice in many city regions across sub-Saharan Africa despite facing the physical and political pressure of urban development (Crush et al., 2011; Davies et al., 2021; Drechsel et al., 2006; Foeken, 2005; Lee-Smith, 2013; Orsini et al., 2013; Smit, 2016). Agriculture in the city, as well as the reuse of urban water for irrigation, is however often not accounted for and does not fit the discourse of the modern city nor that of modern agriculture (Smit, 2016; this dissertation). This leaves most farmers disconnected from urban development trajectories and not accounted for in their struggles for space and belonging (Figure 1). The responses of farmers to processes of urban development are rarely examined, as they are typically regarded as helpless in the face of urban growth and often considered a rural (thus separate) activity rather than part of urban narratives (Follmann et al., 2021; Shannon et al., 2021). For this reason, this dissertation explicitly considers the role that farmers play as part of Africa's urbanisation. The dissertation's title "*Fields of Friction*" encapsulates the physical and discursive tensions present in irrigated urban agriculture. The fields described represent more than just the spaces for growing food; they are spaces where issues of access, equity, and sustainability are contested. The presence of irrigated agriculture as part of urbanising landscapes in sub-Saharan Africa is studied using an interdisciplinary approach that considers the interlinkages between food, water, and (urban) land. Doing this, the dissertation explores the relationship between agriculture and the city and raises questions about who holds (and determines) the right to the city, both now and towards Africa's urban future.

Figure 1. Illustration based on this research portraying the tension between urban agriculture and urban development plans.

1.2 Dar es Salaam, the African metropolis

The city of Dar es Salaam is the centre point of attention in this dissertation. The city exemplifies the growing number of large-sized cities in Africa where rapid growth puts pressure on the access to land, water, and food. Agriculture has been consistently present in Dar es Salaam, which also allowed to relate current dynamics to earlier research. Before introducing the study areas and elaborating on the research design, I briefly introduce the city in two ways. First, three distinct developmental eras describe the city's historical background: the colonial, post-independence African socialist, and neoliberal era. After that, the contemporary city of Dar es Salaam is characterised. Altogether, this shows the political and geographical context in which this research should be understood.

The history of an emerging metropolis

Dar es Salaam (derived from the Arabic for 'harbour of peace') has grown from a fishing village on the East African coast in the mid-19th century to one of the largest cities in Africa. The city has a pre-colonial history in which it was called Mzizima (derived from *Mji Mzima*, meaning 'complete town' or 'healthy town') and served as a meeting point between the Zaramo (based inland) and Shomvi (based on the coast) people. In 1887, the Germans took over control after a 'land purchase' at gunpoint and started stimulating urban development based on colonial development ideas (Brennan et al., 2007). The German

colonial power planned racially-segregated settlements that were further underscored under British colonial rule later (from 1916) through sanitary buffers between different settlements. The African townships were seen as subordinate when looking at for example service provision and land security (Dill & Crow, 2014). A newspaper cites: "The Municipality is busy cleaning the town by demolishing the older African houses in order that multi-storeyed houses may be built reaching to the skies, without considering the suffering caused to Africans compelled to move because they are powerless" (Iliffe, 1979, p. 387). Ideological aspirations emphasised transforming rural hinterlands into modern centres of development (Brownell, 2016).

Following independence in 1961, Tanzania's first president, Julius Nyerere, presented his development vision guided by 'African socialism'. The principles of *Ujamaa* ('familyhood') were based on an egalitarian and cooperative society with a strong focus on rural communal villages rather than the metropolitan bourgeoisie (Hyden, 1980). Nyerere argued that colonialism had brought more selfishness and less equality, resulting in a rejection of village life in favour of urban living. The city was therefore perceived as an example of the colonial disruption of African rural society. His political work aimed to reinstate the pre-colonial traditions as a development strategy. This included the (forced) migration of people to rural communal villages based on *Ujamaa* principles: respect, common property, and the obligation to work. Respect refers to the notion that the individual recognises the place and rights of other community members. Common property relates to the equal distribution of wealth. Wealth accumulation itself was not perceived as problematic, but its distribution is what causes inequality. The obligation to work refers to the shared responsibility towards the production of wealth. In his essay on *Ujamaa*, Nyerere illustrates this through a proverb: "*Mgeni siku mbili; siku ya tatu mpe jembe*"[2] (Nyerere, 1968, p. 5). He thus reminds the reader that although Africans take pride in their hospitality, it is impossible to benefit from society's services without contributing to it. These principles show a communitarian understanding of the relationship between the individual and society.

From the end of the 1980s, the Tanzanian government started to welcome liberalisation and privatisation of the economic base. Reforms towards market economies and capitalism meant the end of state-based structures reflecting socialism. The city expanded

[2] 'guest for two days, give him/her a hoe on the third day'

both physically and economically (more private investments and foreign trade) while heavily relying on bilateral aid projects for infrastructural development (Brennan et al., 2007). Dar es Salaam turned into a metropolitan city that nowadays plays an important role in connecting the nation with a globalising world. Yet, these reforms are not equally experienced by everyone, which raises critical questions about who benefits (Briggs & Mwamfupe, 2000). With a continued image of Dar es Salaam as a place of opportunity, one requires a sharp brain (street smartness) to thrive. This fits the city's nickname, Bongo ('brain').

Contemporary Dar es Salaam

The contemporary city of Dar es Salaam is among the fastest-growing cities in the world and one of the few of this size and at this growth rate in Africa. In 2018, Cairo, Kinshasa, and Lagos were the only megacities (over 10 million inhabitants) in Africa, and Dar es Salaam and Luanda (Angola) were the only cities expected to reach the 10 million mark before 2030 (UN, 2018). This trend seems to be recently offset by significantly lower growth figures, as the population of Dar es Salaam was counted in August 2022 at 5,383,728 inhabitants. Census data for the Dar es Salaam Region (the administrative border of the city) has shown annual growth rates of 4.4 per cent (1988-2002) and 5.8 per cent (2002-2012), while the annual growth rate over the latest decade was 2.1 per cent (2012-2022). The exact reasons for this change have not yet been written about as far as I know, but the observation of a sudden population growth in the adjacent (rural) Pwani Region is worth mentioning. Part of the actual growth of the city may be counted as part of the adjacent (rural) region.

The city's structure has grown along the coastline of the Indian Ocean and the four arterial roads (Bagamoyo, Morogoro, Nyerere, and Kilwa Roads) towards the country's interior. Urban expansion has predominantly occurred along these routes, as seen in Figure 2. The city is divided into five districts (or municipalities), which are subsequently subdivided into wards and sub-wards (or streets, referred to as *mitaa* in Swahili). The five districts are Temeke, Kinondoni, Ilala, Ubungo and Kigamboni (the latter two were only formalised in 2015). Ilala District and the related Ilala Municipal Council is since 2021 referred to Dar es Salaam City Council[3]. The city landscape is traversed by several rivers (both seasonal and

[3] Given that this change has only been recent and it is still very common to refer to Ilala as one of the five districts, this has also been done in this dissertation.

perennial) that carry water from the hinterland, as well as water from the city that is discharged directly. The city's tropical climate (featuring relatively high temperatures) experiences two primary rainy seasons (long rains from March to May and short rains from October to December) that contribute to flooding in low-lying areas and river valleys. Encroachment into these areas has increased flood risks and damage to urban settlements, and disruption of urban infrastructure is common. Recent floods in the city have reignited the discussion to look at the role that rivers play in (the disruption of) the city's functioning (Kironde, 2023). Plans are being carried out to redesign the city's largest river (Msimbazi River) based on Dutch 'Room for the River' principles to reduce flood risks (DASUDA, 2023; URT, 2021; World Bank, 2019).

Population increase in the city leads to increasing demands for housing, as well as other services such as health, education, water supply, sanitation, and transportation. The lack of adequate planning over the last few decades of growth has resulted in more than 70 per cent of the urban settlements being considered informal and access to services highly determined by affordability (Hill et al., 2014; Todd et al., 2019). The consequence of this is socio-spatial fragmentation across the different areas within the city, something which is spatially shaped by the city's masterplans and the concentration of urban development along the main arterial roads (Armstrong, 1986; Brennan et al., 2007; Hill et al., 2014; Todd et al., 2019). As described later in more detail, citizens employ different strategies to survive, if not thrive. A total of 58.0 per cent of all households in Dar es Salaam rely on self-organised types of employment (URT, 2020), which are economic opportunities that the state does not provide or even rules against. These processes of everyday city-making show how urban dwellers make a difference to an urban state of affairs in spaces where the state's capacity is limited.

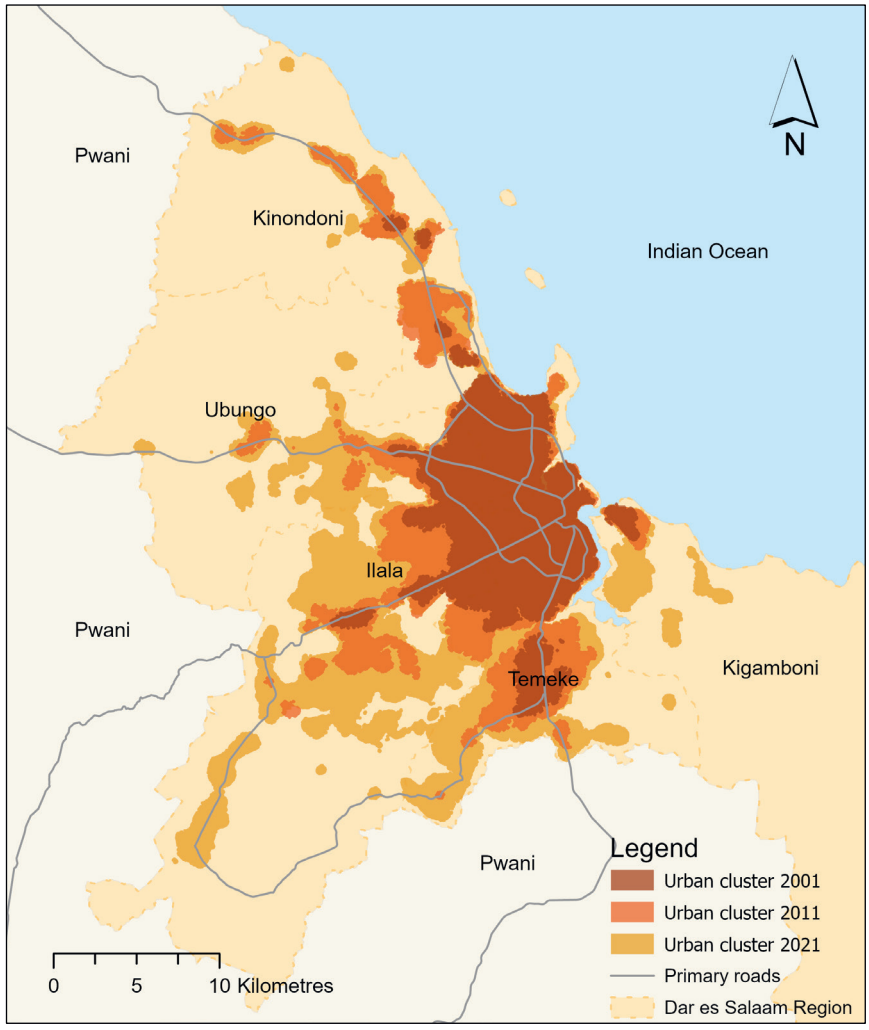

Figure 2. Map of Dar es Salaam with the different districts and the urban sprawl between 2001 and 2021.

1.3 Conceptual considerations

The cities we live in or see around us are not fixed spaces but rather dynamically-produced spaces of interaction. The life and flux of cities and urban life (also commonly described as urbanism) can be considered as mutually constituted by that what is 'technical' and what is 'social' (Coutard & Rutherford, 2016; Graham & Marvin, 2001; Monstadt, 2009). Swyngedouw (1996) uses the concept 'socio-nature' to understand the city as a hybrid in which the social and the natural are "inseparable, integral to each other" (p. 66). The term 'sociomateriality' is used similarly to refer to the constitutive entanglement of the social

and the material within social practices that altogether construct society (Hui et al., 2016). As these concepts show, speaking across the artificial divide of the material (or physical, or technical) and the social emphasises their mutual constitution which produces the spaces in which we live and interact. The spaces that we are part of (and in which irrigated urban agriculture takes shape) are thus not static spaces but rather socially-produced products, spaces that are "malleable, transformable, and potentially transgressive" and inherently bound up with historical-geographical dynamics and power geometries (Lefebvre & Nicholson-Smith, 1991; Smith, 1984; Swyngedouw, 1999, pp. 446–447).

In order to understand this sociomaterial character of irrigated urban agriculture and the dynamics around its configuration, this dissertation has put a primary focus on practices as the moments of *doing* through which everyday city life is crafted and (in one way or the other) functions. I regard practices as connecting people and things in socio-material relations that sustain urban life. This is further explored in Chapter 2 where we have drawn insights from Social Practices Theory and Urban Political Ecology to study the dynamics of urban water in East Africa. A focus on networks of practices allows to focus on what is happening (the actual acts of doing) rather than what is technologically or institutionally planned. This focus emphasises the unique dynamic of an urbanism in which people flexibly cope with the challenges and opportunities of day-to-day city life. The theoretical and philosophical appreciation of an urbanism 'in its own right' recognises the lived reality of Southern cities and explores the city through the eyes of those who effectively build the city for their own ends (Pieterse, 2011b; Swilling, 2011). As I show in this dissertation and discuss in Veldwisch et al. (2024a), irrigated urban agriculture is part of what can be regarded as an everyday urbanism or a process of city-making-from-below.

Besides understanding practices as a sociomaterial entity, practices are conceptualised in this dissertation as the 'in-between' where agency and structure intertwine. These concepts are central in the theory of structuration that explains how the agency of people constructs society but is simultaneously constrained by it (Giddens, 1984). With a focus on practices, the research is positioned in the middle ground in social theory between individualism (society as the result of the agency of sovereign individuals) and structuralism (society as made up of structures which 'govern' our daily lives) (Arts et al., 2014; Spaargaren et al., 2016). Human agency can be found in the capacity to act with effect, as "to engage in a practice is to exercise a power" (Cetina et al., 2005, p. 28). These power dynamics that are structuring trajectories of practices remain rather implicit in

Social Practice Theory given that it studies the practice that 'is' rather than 'what it could have been'. Also, "power relations never result only from distinct, specifiable, moments of practice, but are effects of the ordering and the churn of innumerable moments of practices" (Watson, 2016, p. 181). This shows the structuring elements that are inseparable from the sovereignty of human action. For this reason, Urban Political Ecology is used to explore further how relations of power shape who will have access to or control over urban spaces and water. The capacity to mobilise power allows actors to maintain or contest a social order; creating divergent geographies of urban elites and social marginalisation.

Building on the above (and further elaborated on in Chapter 2), I regard irrigated urban agriculture as an example of a social practice that is part of a politically-constituted space. Although these two are actually inseparable and complementary as two sides of the same coin, I analytically study these social dynamics from the different angles of agency and structure. Urban farmers interact and adapt their practices in novel ways, but these social interactions exist in the contexts that influence them. Actors are active agents in constituting everyday practices, while having identities and associated interests that may contradict one another and create competition over how urban space unfolds. The research shows that farmers take an active role in the urban (food) geography through the production of perishable vegetables, income generation, and maintaining open spaces. By doing this, farmers claim their (informal) right to the city. These practices, however, are shaped by the sociomaterial context in which they are situated. The pressure of urban densification and peri-urban expansion forces farmers to be mobile in order to continue their livelihood practice, and urban pressures result in the marginalisation of the resources to which they have access. Water is a prominent example in this dissertation, as the availability and quality of water for irrigation are often largely dependent on return flows from other (adjacent) water use practices. Human agency thus operates through the effects of water use practices on downstream flows and qualities.

1.4 Focus and aim

Agriculture in cities (and the use of urban water sources for irrigation) is since long a common sight across sub-Saharan Africa (Crush et al., 2011; de Zeeuw & Drechsel, 2015; Drechsel et al., 2006; FAO et al., 2022; Foeken, 2005). Most urban farmers grow food on small plots, publicly or privately owned, in planned or unplanned high-density areas. With

short distances to its consumers, urban agriculture offers unique opportunities of growing market-oriented, high-value crops. As cities grow, access to land and water (of adequate quality) is a critical concern for urban farmers. Agricultural activities often conflict with urban expansion, placing pressure on the livelihoods of those who practice farming. Farmers are forced to relocate to marginal or peripheral areas where access to clean water is physically or economically out of reach, leaving them with no option but to irrigate with polluted urban water (Drechsel, Qadir, & Galibourg, 2022; Scott et al., 2004; Thebo et al., 2014; Veldwisch et al., 2024b; Wichelns & Drechsel, 2011). Despite these challenges that reconfigure urban agriculture, the practice is often persistent, and consumers continue to rely on it for parts of their diet (Davies et al., 2021; de Zeeuw & Drechsel, 2015; Drechsel & Dongus, 2010; Hemerijckx et al., 2023; Karg & Drechsel, 2018; Orsini et al., 2013). There are ongoing debates about the actual contribution of urban farmers to the city. Food provision and income generation generally stand out as features of urban agriculture, but there is a growing attention to the other ecosystem services that urban farming contributes to the city. Examples of these services are reducing heat island effects and beautifying the lived environment of residents (Langemeyer et al., 2021; Lwasa et al., 2014; Tapia et al., 2021). Through this, urban agriculture is increasingly being re-valued as part of new paradigms around the planning and design of future urban landscapes (Coles & Costa, 2018). Meanwhile, the engagement in agriculture is for many primarily to provide livelihood security; a perspective that is the most prominent in this dissertation.

The agricultural production in and around cities is commonly referred to as *'urban agriculture'* or *'urban and peri-urban agriculture'* (respectively abbreviated as UA and UPA). Ambiguity exists around the type of practices it entails and up till where it takes place (FAO et al., 2022). The work by Mougeot (2000) and the recent sourcebook on urban and peri-urban agriculture (FAO et al., 2022) present key elements that help identify the different typologies of agricultural activity in the city. Where these definitions primarily focus on the type of agricultural practices in relation to their land use modalities, linkages with water and irrigation often remain implicit in the field of urban agriculture. In many cases of urban agriculture (i.e. urban crop production, so not related to animal keeping), however, access to water is a conditionality. Water has received ample attention both in the academic field of irrigated agriculture and urban water management, and the practice engaged with in this research is generally referred to as '*unplanned wastewater reuse'* or *'wastewater irrigation'* according to the definitions from this field. Although wastewater

irrigation could also be used to broadly refer to the practice of using wastewater (treated, untreated, or partially treated) to irrigate crops or landscapes, it is mainly used in settings where levels of wastewater treatment and institutional capacities to plan and regulate are low (Scott et al., 2010; Wichelns, 2020).

Since the above terms do not clearly capture the interrelation of water, food, and the city of this practice in a way that represents the views of different stakeholders, I refer to this practice as *'irrigated urban agriculture'*. The term has not been commonly used so far, but we have adopted it in our Special Issue on irrigation in urban catchments in Water International (Veldwisch et al., 2024b). By integrating elements from both the fields of urban agriculture and urban water management and considering the multiple perspectives among different stakeholders, irrigated urban agriculture highlights the connecting tissue between agriculture and the city: the locality of land (i.e. urban) and the collective use of water (i.e. irrigated) for food production (i.e. agriculture). The definition of irrigated urban agriculture is given below.

Irrigated urban agriculture is defined as the irrigated production of food crops on land located within cities or as part of urbanising landscapes, interacting both quantitatively and qualitatively with other urban water usage, surrounded by policies and other institutions, while serving multiple functions.

The **objective** of this research is to understand how practices of irrigated urban agriculture take shape and stay of relevance in contributing to urban livelihoods under the influence of physical and institutional pressures affiliated with urban growth. Studying how irrigated urban agriculture becomes more (or less) effective in contributing to livelihood security within the city furthers our understanding of the interplay between urban and agricultural socio-material demands in light of the continued urban growth trend across sub-Saharan Africa. Also, the research insights offer entry points to learn more about the (contested) appropriation of urban space. The outcomes thereby guide a better engagement with irrigated agriculture in and around cities, enhancing safe and productive agriculture, strengthening urban planning and governance, and helping to balance different water use demands.

Following this research objective is the main research question as follows:

> **How do the practices and politics of irrigated urban agriculture configure urban space in the growing city of Dar es Salaam, Tanzania?**

The main question spans the entire dissertation, while five specific research questions highlight different aspects of this question through the different empirical chapters. The last chapter of this dissertation discusses this study's overall empirical and conceptual insights.

> *1. How can the crafting of water use practices be understood as part of growing cities in East Africa?*
>
> *2. How does irrigated urban agriculture contribute to urban food availability and accessibility, and to what extent is this subject to urban growth?*
>
> *3. How do farmers respond to the impact of urban growth on their irrigated agricultural practices?*
>
> *4. What is the influence of institutional and political structures on the configuration of irrigated urban agriculture?*
>
> *5. What are the contestations surrounding the reuse of urban water for irrigated agriculture in cities?*

This research contributes to the understanding of and engagement with the day-to-day practices of smallholder farmers in urbanising landscapes. With cities in Africa continuously growing, the presence of farmers and their land and water use are increasingly under pressure. Simultaneously, the issue of urban food insecurity is becoming more prominent. The urban poor, when compared to rural areas, are believed to be particularly vulnerable to food insecurity given the high dependence on the cash economy in cities (de Zeeuw & Drechsel, 2015; Ruel et al., 2017). Especially in the case of food system disruptions (which we have also seen globally with the Covid-19 pandemic and the war in Ukraine), rising food prices directly lead to more food insecurity in cities. The FAO stresses the growing need to invest in resilient and sustainable food systems while acknowledging cities as a patchwork of uneven geographies (FAO, 2019). “Focusing

on the urban landscape does not imply a simple orientation towards food in cities, but instead draws attention to the (re)connections, (dis)locations and (in)justices that can be reworked through institutional and governance practices that place participatory action and decision-making at the centre of an agenda to develop resilient, sustainable food systems through harmonisation of international trade and local production with solid rural-urban linkages" (FAO, 2019, p. 6). Relating it to this research, looking at irrigated urban agriculture requires zooming out to understand how these practices provide employment and food security to the city while carrying risks related to degraded urban water sources for irrigation and insecure land use configurations. This research contributes to recognising the socio-geographical diversity of the city (a patchwork of uneven geographies), social inclusion and equity (leave no one behind) by showing the different capacities of urban dwellers (including farmers) to participate in and reap the benefits of development, and safeguarding an inclusive urban future through highlighting ways of engagement for resilience and sustainability.

The results of this research guide better engagement with irrigated urban agriculture and thereby stimulate safe and productive agriculture, as well as lower water stress due to water reuse in urbanising landscapes across sub-Saharan Africa. Though primarily focused on the case of Dar es Salaam, the research exemplifies a larger phenomenon of city expansion on the valuable agricultural land (both urban and rural) that feeds the city. This is relevant at different institutional levels (city authorities to international organisations) and from various domains (water, food, urban planning). Relating the contribution of this research to popular international policy agendas, the 2030 Agenda for Sustainable Development with Sustainable Development Goals recognises resilient and sustainable urban development and management as crucial to the quality of life (UN, 2015). Adding to this, the New Urban Agenda acknowledges the need for integrated urban and territorial development and recognises the centrality of food security and nutrition in planning for sustainable and resilient cities (UN, 2017).

1.5 Research design

The following section describes the methodology employed in this research. Emphasis is put here on describing the process of conducting ethnographic research. Ethnography forms the backbone of this research but does not cover all research done. Chapter 3 uses a foodshed analysis to study the contribution of urban farmers to the city's foodshed and

Chapter 6 uses a bibliometric analysis to understand the academic field of wastewater reuse. These analyses are explained in detail in the respective chapters. Starting with the research strategy, this section continues by describing the case selection, data collection, and analysis, and finishes by discussing research ethics.

Research strategy

The point of departure in this research is the continuous interaction between actors and their material surroundings that shapes our environment. As practices can be considered the recognisable conjunction of human and non-human elements, understanding social practices is central to this research (see Chapter 2). Understanding the multiple dimensions of everyday life through its social practices holds the potential to be an unstructured and rather messy journey. For this reason, two guiding principles have been used to structure the research design: **grounded theory** and **zooming-in-out** (Figure 3).

Inspiration was taken from grounded theory approaches to give more structure to the research while limiting the reliance on a set of theoretical positions. Grounded theory, first developed by Glaser and Strauss (1967) as a way to study social phenomena, aims to construct theory grounded in data via cycles of data gathering and analysis. This iterative process leads to a rich, dense theoretical account grounded in empirical data while maintaining structure by systematically going back and forth between data and theory (Green & Thorogood, 2009). An advantage that is relevant here is that it allows to give more control to the research participants, as theory is built based on what is presented to the researcher and this theory can be tested in subsequent stages. A process of data collection, data analysis through coding, and memo writing have been gone through several times during this research. Data collection started by making sense of 'life as lived' and finished with the in-depth study of a number of topics that emerged in earlier stages of the research. Throughout these multiple cycles of data collection and analysis, the metaphor of 'zooming in' and 'zooming out' was used to understand the different ways to study social practices (Nicolini, 2012). By zooming in, I aimed to understand the lives of the places, practices, and practitioners (I consider places and practices also having a 'life' with a past, present, and future that can be studied) of irrigated urban agriculture. Zooming-in is about taking a closer look at specific practices and experiencing first-hand how they are constituted. Zooming-out implied studying interconnected practices and the embeddedness of practices in more extensive networks of occupying space, using water and producing food. Combining and alternating these different lenses enabled the

understanding of urban farming practices and studying its interaction with water use, marketing, consumption, and its general embedding as a type of city-making.

While moving from data to theory through cycles of data collection and data analysis, the process of data collection is controlled by the emerging theory. 'Data collection is followed by analysis. Analysis leads to concepts. Concepts generate questions. Questions lead to more data collection so that the researcher can learn more about those concepts' (Corbin & Strauss, 2015, p. 147). This sampling strategy maximised the opportunities of studying irrigated urban agriculture from different angles and keeping an open mind for discovering new ways of understanding these practices and how they are (dis)embedded in urban space. As the researcher decides on analytic grounds what or where to go next, they should also be seen as an instrument for developing data that requires reflexivity; something I will return to later in this dissertation.

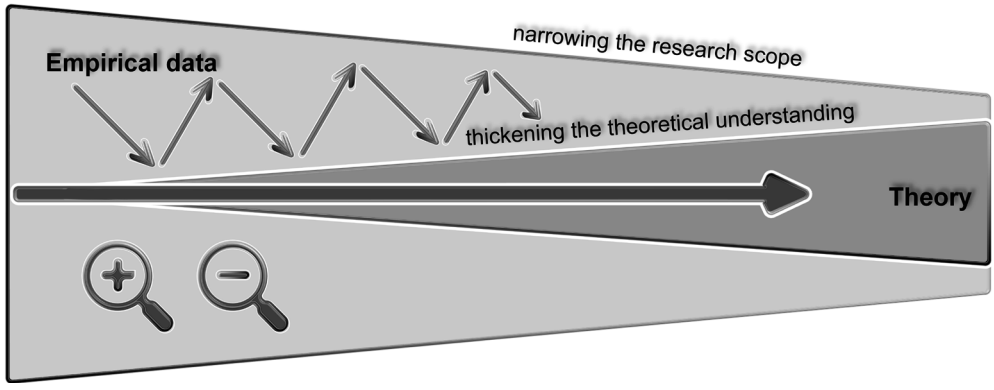

Figure 3. Research approach based on going back and forth between data and theory and the use of alternating (zoomed-in and zoomed-out) research lenses.

Study areas

Six agricultural areas that represent common types of irrigated urban agriculture in Dar es Salaam were selected for this study. This selection was based on 20 exploratory field visits in late 2019 and early 2021, a literature study, and expert interviews in the run-up to this fieldwork. As urban agriculture – as a concept – is much larger than what is taken as an object of study here, this research specifically focuses on the market-oriented, irrigated production of leafy vegetables in open spaces within the city of Dar es Salaam (also see Table 1). The study sites can be subdivided into three categories: irrigated urban agriculture in (1) river floodplains, (2) low-lying areas, and (3) developing urban areas. The latter category captures irrigated cultivation in urban areas where plots await

development. For each category, two different study sites were selected to enable comparison. It was decided not to focus on peri-urban agriculture or backyard farming (also referred to as home gardens), as agrarian change is distinctly different. Additionally, fieldwork was done in two peri-urban wards through field visits and undertaking interviews to support the understanding of the primary study areas. This confirmed the research hypothesis that urban and peri-urban areas experience different types of pressures with regard to the use of land and water. The locations of all study areas are shown per ward in Figure 10.

Table 1. Research focus based on the dimensions of urban agriculture as defined by Mougeot (2000)

Dimension	Research focus
Economic activity	Production phase (i.e. irrigated agriculture).
Food category	Horticulture
Character of location	Within the city
Types of area	Off-plot; open space; no selection based on modality of tenure or official land use category
Product destinations	Market-oriented production
Production systems	No selection based on the scale of the production system

Data collection

The combination of the research strategy (visualised in Figure 3), eighteen months of consecutive field research, a limited number of study areas, and a selection of research methods allowed the in-depth study of irrigated urban agriculture while seeing the interlinkages with the broader urban fabric. The research was designed in such a way as to promote the generation of shared knowledge and a more egalitarian connection between the researcher and the research participant. I reflect on this in Chapter 1.7 and the final chapter in further detail. Here, I describe the primary data collection methods. It must be noted that many informal interactions have surrounded these methods. Unstructured observations and informal conversations during field visits are considered supportive to the methods described below.

Observation

Through observation and participation, a researcher can better understand everyday situations and settings that are difficult (or seen as irrelevant) to transmit by theoretical instruction (during interviews). Observation activities and 'show and tell' (discussed later) have been central in the study of practices of agriculture and water use in the different study areas. Although I participated in these everyday practices (e.g. preparing planting beds or carrying water), most of the observation activities were done while taking more distance. From the beginning, extra emphasis has been put on observing the flow of water as an entry for analysing the networks of practices around it. Water flows were followed to observe water infrastructure (whether makeshift or part of formal urban water infrastructure), water sources, and water use interactions. As discussed in several chapters, water used by farmers originates from different sources. In several cases, these sources could be traced while other sources were complex to retrace due to accessibility (both physical or related to safety). A detailed study of upstream water use practices was outside the research scope given the complexity of local water use systems within the agricultural areas itself already. The thesis research by Lamochi Roozalipour (2023), which was part of this research project, does elaborate on the multiple connections that different sanitation service regimes have with agriculture. The study demonstrates how different sanitation system configurations contribute to water security for farmers and add to the existing complexity of irrigation water mixtures.

It has been common practice to spend a morning in the field for observations and sit down with my research associate at the end of the morning to discuss what we observed. Our observations have also regularly been used during interviews with research participants. All observations were written down while differentiating between observation and interpretation to be conscious of what was observed and how this related to our understanding. The observation sheets have been analysed similarly to the interviews and secondary sources (discussed later).

Interviews

This research used semi-structured interviews to collect information on water infrastructure, land use planning, and legislation around land and water; explore agricultural practices, typologies of water use and marketing; and understand why people do something and reconstruct interpretations, perceptions, and meaning. Interview

guides were created for the different research phases and different groups of interviewees. All farmer interviews were captured through field notes and transcribed within the same day or days. It was common to conduct interviews and do observation activities in the morning while processing these in the afternoon. These interviews (generally in Swahili) were translated in-situ while elaborately discussing them afterwards with my research associate. Uncertainties were followed up on if needed. Interviews with other stakeholders (often in English) were either audio-recorded or captured by taking notes. The decision to follow one of these procedures was made based on the preference of some of the interviewees not to be audio-recorded or in some instances by my own judgment of what would be most practical.

A wide range of stakeholders were interviewed, with farmers making up the largest group. Over 100 interviews with farmers were conducted, with 37 of them being visited regularly and interviewed multiple times. Nearly all farmer interviews took place at the farm plot while interviewees were doing activities such as soil preparation, harvesting, or waiting for customers. This strategy of meeting farmers at work (several farmers referred to their plot as their office) helped to understand the farmers' realities better (benefiting from 'show and tell', which adds depth and reliability to the data) and minimised disruption to the farmers' routines. Through this, interviewees are more in control of the situation (more equitable) and the researcher becomes more of an insider (more legitimacy). In addition to this group of farmers, 33 individuals were interviewed from relevant ministries at the central government, various departments of local government authorities, as well as from government-affiliated, private, community-based, and research organisations, all of whom are involved in urban planning or urban agriculture specifically. A number of them have been interviewed several times. As part of the foodshed analysis (Chapter 3), an additional 11 interviews were conducted for scoping and data interpretation. These numbers represent the formal interviews (i.e. an interview guide and consent protocol were used), while the number of informal conversations that occurred throughout this research is several times greater.

The agricultural study areas are spaces of interaction between different people. Talking to women in the field happened often, as they are the majority in these areas. Most of them, however, are not farmers but rather come to the area to buy, harvest, wash, and sort the crops. It was therefore more difficult to find women who were farming or would consider themselves a farmer; something which has created an issue of gender representation.

Many female farmers would leave quickly in the morning since they also have a vegetable stand or market stand where they sell their own produce. Because of this, female farmers were not always willing to take the time for an interview or did consider themselves a vendor rather than a farmer. This resulted in conversations with female farmers more often staying informal and having fewer interview opportunities. As a consequence, many of the conversations with female farmers have not been reported as formal interviews. Since male farmers generally had larger plots, they spent more time in the field and this led to more frequent interactions. Subsequent interviews were therefore more often directed to male farmers than female farmers. While I tried to balance this by conducting additional interviews with female farmers, I ultimately built stronger relationships with male farmers, despite the relatively equal numbers of male and female farmers in the various study areas.

Literature review

Dar es Salaam has many relevant policy documents and research publications on urban agriculture, urban water management, and urban planning. These documents have been collected and analysed to provide context, compare with different locations and historical periods, and triangulate the data collected based on available secondary sources. Research on urban agriculture in Dar es Salaam has already been done for over three decades. However, the academic attention for this practice seems to have faded after the finalisation of the Urban Vegetable Promotion Project.[4] Given the city's rapid growth, this means that not all research data was easily comparable. Nevertheless, relevant research and policy documents were collected and used where possible. At the onset, it helped to get a general understanding of irrigated agriculture in the city, while later, it was used in relation to the primary data collected. A literature review has been most important for the policy analysis discussed in Chapter 5. This analysis required collecting the relevant policy and academic documents about urban planning, agriculture, and agricultural water use. Additionally, literature studies have been done for the conceptualisation in Chapter 2 and the study on global wastewater reuse in Chapter 6.

Besides the relevant policy documents on the national and local government level, particular attention has been paid to using locally-grounded sources. While the work

[4] Project launched in 1993 by the Tanzanian Ministry of Agriculture and the German Development Cooperation to assist agricultural production in the city of Dar es Salaam.

done by Western researchers is generally more easily found using online search queries, a wider body of academic literature gives further insight into the dynamics studied in this dissertation. To relate my work to that of local academics, connections were established with researchers at different universities in Dar es Salaam, as well as the Sokoine University of Agriculture in Morogoro. In several cases, the publications I refer to are not publicly available but I hold a physical copy. All documents collected for review have been analysed through coding (explained later). This has allowed the triangulation of different sources and drawing parallels between current urban dynamics and the historic understanding of water use, agriculture, and urban expansion.

Vendor and consumer surveys

Given the lack of empirical understanding of the contribution that urban and peri-urban farmers make to food security in Dar es Salaam, it was decided to study the status quo by quantifying and spatially mapping the contribution of urban and peri-urban agriculture to the availability and accessibility of leafy vegetables in the city. This part of the research relied on stakeholder interviews and three rounds of surveys conducted between September 2021 and April 2022. The combination of interviews and over 700 surveys have contributed to acquiring specific (quantitative) information on the configuration of the foodshed. All surveys were conducted using the Kobo Collect app, allowing easy data collection and well-organised data outputs. The survey forms were tested and discussed before the official rounds of surveys started. The surveys were conducted by my research associates who were more familiar with the local context. Every survey location was complemented with a survey report where observations and reflections were written down and discussed afterwards. This allowed to capture the broader context of data collection. The analysis was ultimately carried out by adhering to the consumer foodshed workflow of Hemerijckx et al. (2023). Further details of the methodological steps taken are described in Chapter 3.

Data analysis and writing

Data analysis has been primarily based on a combination of coding and memo writing. Decomposing the (ethnographic) data through intense coding has helped to structure the data and build theory. Two types of coding practices were performed while using the qualitative data analysis software Atlas.ti: (1) an initial phase of open coding and (2) a focused, selective phase following up on specific codes from the initial phase and pinpointing and developing theoretical positions from the data. This coding strategy has

been performed on both primary and secondary data. Following a process of coding, a set of memos was written as a way to make sense of the data collected. "When researchers write memos, they are doing analysis. They are dialoguing with data and moving the analysis further" (Corbin & Strauss, 2015, p. 122). Especially for this research which consisted of one consecutive period of fieldwork, analysing data to spark new ideas for data collection (or discover gaps) and hypothesising on emerging theories was essential to stay in control. The writing of memos has been beneficial in more than only designing subsequent data collection. They have also allowed me to 'touch base' with my supervision team, as the memos provided a record of the empirical and analytical process. The memos (which were often rough writings of a preliminary finding) have also been helpful in the starting up of writing papers.

The main research findings have been presented to most farmers (both pre-arranged and based on their presence during two visits per study area) during the final phase of the fieldwork by means of a postcard (in Swahili) with the main research lessons and a personal gratitude note. This allowed for a last round of conversations with farmers, which served valuable as a reflection on both the research and the regular interactions. Also, a policy brief (in both English and Swahili, see Supplementary materials) was shared and discussed with the different local authorities in Dar es Salaam, as well as distributed to a broader audience.

Codes of practice

Different aspects of research ethics were considered in order to secure the fair and respectful treatment of the research participants involved, professional handling of data, and acceptability of potential risks caused by the study. All research activities have taken place after thorough research discussions at both Wageningen University and Ardhi University, a review of the research protocols by the Social Sciences Ethics Committee of Wageningen University, and a review of the research design by the Tanzania Commission for Science and Technology. The fieldwork activities in the different study areas were preceded by visits to local government offices to notify government officials and local leaders about my presence and intentions. In this section, I address two aspects regarding conducting ethical research. Chapter 1.7 and Chapter 7.1 also share some considerations related to the researcher's position.

Informed consent

It is important to get permission through informed consent when studying social practices and disclosing the lived reality of individuals. "Informed consent is the principle that individuals should not be coerced, or persuaded, or induced, into research 'against their will', but that their participation should be based on voluntarism, and on a full understanding of the implications of participation" (Green & Thorogood, 2009, pp. 68–69). Common practice is that codes of conduct propose working with written consent forms to document participants' consent. Given that the use of written consent forms would likely reinstate power imbalances between researcher and research participant in this study, I decided to look for alternative ways to ensure informed consent.

In qualitative field research, informed consent evolves naturally by developing a relationship as a researcher with research participants. Trust is often the most critical factor for people to agree with research participation. Building rapport and being transparent in research intentions can contribute to establishing a trust relationship and avoid intimidation and pressure. Working with formal documents in such situations is unnatural, especially at the onset of research interactions. Working in a context where people rely on the (temporal) absence of formalised systems of access and regulation, legal forms can be an unknown procedure to people and can even be considered insensitive to the direct context. Lie & Witteveen (2017) describe informed consent as a Western concept that is difficult to explain in cross-cultural research. Also, it is not always clear whether research participants fully understand what they are consenting to, nor is it always clear to the researcher what specific consent is required.

Different steps were taken to establish informed consent in this research. Data collection took place over 18 months of multisite ethnographic field research. An extended and consecutive period of being present as a researcher in a limited number of study areas has allowed me to establish relationships and develop rapport that, combined with the selection of research methods, stimulated the generation of shared knowledge and a more egalitarian connection compared to a dialectical relationship between the researcher and the research participant (as a research subject). A lot of the interactions with farmers have been informal by visiting the field, chatting about daily business, and in this way being present. As research is generally burdened with time pressure, there is a tension here between the efficiency of knowledge production processes and the development of rapport and consent.

Every research participant was verbally informed (in some cases, an information sheet was used) about this research and verbal consent was either audio recorded or documented in field notes in case of interviews. It has also happened that farmers did not consent during earlier encounters but later showed their interest and agreed to participate. This relates to the durability of consent given over the course of fieldwork. It was not always clear from the beginning what people would consent to and when this consent would end. Since the research entailed multiple rounds of interviews and regular encounters with farmers, this consent procedure was repeated at different stages of the study to keep research participants informed and allow the re-evaluation of the participants' involvement.

One conflict (or dilemma) concerning research consent is worth reflecting on as an example of acquiring consent (and its durability). In March 2021, I started visiting the area TAZARA-Mchicha in the ward Sandali. The area was selected as one of the six study areas and described in particular detail in Box 1 (Chapter 4) and by means of a research story (Supplementary materials). After acquiring consent from farmers and visiting the area regularly for informal interactions, observations, and interviews, the situation changed when the area – used informally by farmers – was sold to construct a dry port. Although I would still receive consent from the farmers to discuss what was happening to them and the area, I would get approached by the new building supervisors who questioned my presence, forbade me from taking pictures, and insisted on the permission that I needed to acquire first in order to return. This posed an ethical dilemma for me concerning who I needed to acquire research consent from and who held the power to terminate research consent. There was also a dissymmetry here where farmers informally 'owning' the area for decades already were evicted by a large company formally owning the area now. Given the importance of studying this process of eviction of farmers and transformation of the area, I decided (after consultation with my supervisors and talking to the local *mtaa*[5] leader) to continue my research activities based on the farmers' consent and without acquiring additional consent from the new owner.

[5] *Mtaa* refers to a subward or street, which is the smallest administrative unit level within a city.

Confidentiality

In this dissertation, I aim to provide an accurate account of the lived reality of irrigated agriculture in an urbanising context while also ensuring the protection of the research participants. This creates a dilemma between conveying details of these practices while simultaneously being sensitive to the potential effects of this visibilisation. The visibilisation of the dynamics around urban water reuse and agricultural production contributes to addressing knowledge inequities regarding farmers' role as part of urbanising landscapes, moving forward in discussions about urban planning and governance. On the other hand, visibilising the use of urban land and water (with different degrees of pollution) for crop production may result in trading difficulties or threats of displacement and enforcement. For a diverse array of practices in the informal sector, visibility is a trap and more sight confers power to control practices.

Different confidentiality principles have been followed that create a disconnect between stories and their tellers (I reflect on this in Chapter 7). First, names and other personal information collected during interviews and informal conversations that may identify an individual have been anonymised by using randomly-generated codes. The identity of the research participants is protected in the published accounts of the research by either using these codes or using fictional names. In some cases, a reference to a professional affiliation is made to clarify the context of the statement. Second, the six study areas are named and visualised by their respective ward rather than pinpointed to their exact locations. In cases where information was collected that could potentially be considered sensitive for the area and its users, it was decided to write without a specific locational reference. In two cases, the study areas are mentioned by name. The area TAZARA-Mchicha in the ward Sandali is mentioned by name since the area disappeared as an agricultural area during the period of fieldwork. The discontinuation of the area was found important to explicitly refer to in order to relate to previous publications about this area and to give a detailed account of the experiences of farmers in the area. Also, the area of Sukita in the ward Buguruni is explicitly discussed in Chapter 6. This is one of the city's most well-known agricultural areas, and several scientific and news articles have been written about it. Given that there is a lot written about farmers without talking to farmers, it was decided to specifically describe the personal experiences of farmers regarding their water use and the perspectives around it. For all study areas, the main research findings have been presented to the farmers during the final phase of the fieldwork.

1.6 A word on language

Language is particularly important to consider in cross-cultural and interdisciplinary settings. While language is a form of *produced data*, it is at the same time the *method* that generates data (Green & Thorogood, 2009). Investing time in building rapport with research participants and learning Swahili contributed to becoming more fluent in the speaking and understanding of a common, cultural language. Chapter 1.5 and 1.7 elaborate on conducting research in a foreign context, while I want to spend a word on this dissertation's language here. Rather than weighing every word written, I highlight themes that are (implicitly or explicitly) prominent to this dissertation. As I aim to contribute to different research domains (see Chapter 1.8), these themes might be familiar to some, new to others, or would be explained differently by some of us. Several themes I introduce here are returned to in the concluding chapter. Particular (Swahili) words, abbreviations, or definitions are clarified at different places throughout this dissertation.

Wastewater

In part due to population growth and climate change, there is a growing pressure on freshwater resources to cater for the healthy functioning of agricultural systems and the natural environment. Water scarcity and the associated redistribution of water flows among water users occur in a growing number of catchments worldwide (Flörke et al., 2018; Mekonnen & Hoekstra, 2016; UNESCO & UN-Water, 2020). An often overlooked factor in this context is the pressure on water quality due to the intensified use of scarce freshwater resources (Drechsel et al., 2023). This is particularly prominent for cities in many low- and middle-income countries where the capacity to treat water after use is outpaced by growing water usage due to urban growth. With most of this urban water returning to the environment afterwards, agriculture benefits from these flows in many places. The importance of water quality (with its agronomic, health, and environmental facets) for agriculture has prompted ample research and the creation of various guidelines over time, on different territorial levels, and with varying levels of successful uptake. Academic engagement with the topic dates (to what I have seen) back to the late 19th century (I hold an original copy of Rafter (1897) on sewage irrigation) up till one of the latest publications by the FAO and WHO on water quality in agriculture (Drechsel et al., 2023). Besides the emergence of national guidelines, influential (global) guidelines have been the work of the WHO and FAO (Ayers & Westcot, 1985; Pescod, 1992; WHO, 1989, 2006).

Given that the anthropogenic use of water reproduces the resource into wastewater, this term has been commonly used in the context of irrigated agriculture. The term 'wastewater irrigation' is often coined and covers a wide range of practices that are influenced by returning water flows from various prior usages. Especially the 'unplanned' reuse of water is commonly referred to as 'wastewater irrigation', while the planned reuse of water is moving towards choices in terminology that lower the risk perception of its users.[6] Research shows, for example, different acceptance rates among consumers and farmers when referring to 'recycled' or 'reclaimed' water in comparison to 'treated wastewater' (McClaran et al., 2020). These negative perceptions, often called the 'yuck factor', influence public opposition to and rejection of water reuse practices (Duong & Saphores, 2015; Ricart & Rico, 2019; UNEP, 2023). With several of my thesis students working on wastewater reuse over the past years, we found the challenges around risk perception in different contexts which lower the willingness to reuse or require authorities to take more measures than strictly needed to guarantee public health (Branco Pereira, 2023; Hoek, 2020).

The acceptance of wastewater reuse is surrounded by perceptions of risks and cultural taboos related to the use of waste streams. The normative ideas around the desirability of water reuse for food production prompt processes of social marginalisation in which farmers have a limited say in the allocation of water streams and the perceptions related to these streams. Chapter 6 of this dissertation elaborates on the naming and framing of water flows and problematises the reference to 'wastewater irrigation' in the context of farmer-initiated (thus informal and often labelled as unplanned) water reuse practices. For this reason, I sparingly use 'wastewater' in my writing and generally refer to 'water' or 'urban water' or describe in detail what type of water flows I refer to. I realise this might confuse those involved in urban water (supply) and sanitation, as this water supply is also commonly referred to as urban water. However, and I return to this in the end of this dissertation, it is important to rethink our reuse terminology in order to offer a more emancipatory account of water use practices.

City

Urban growth trends worldwide alter the demographic and social structure of both urban and rural areas, including how they interact. Cities have become the centre of attention

[6] The distinction between 'planned' and 'unplanned' water reuse is further discussed in Chapter 6.

given both their potential and challenges, but what exactly is a city? Many definitions for the classification of cities exist that vary between using a single criterion (e.g. population size) and a mix of criteria (e.g., a combination of population size, density, and economic function). This use of different definitions makes it difficult to compare different cities or even the same city over time. Additionally, more terms are used to define the territorial scale of these urban settlements, such as city proper, urban agglomeration, and metropolitan area (OECD, 2020; UN-Habitat, 2020). The reference to 'city region' has also become more prominent in the context of food systems. Global development organisations have been trying to establish a standardised approach for defining (i.e. primarily measuring) the city (UN-Habitat, 2020). Two city definitions have appeared from this, but neither corresponds with the official definition used in Tanzania. I therefore rely in this dissertation on both the Tanzanian definition of the city and one of the universally applicable definitions (i.e. urban extent), which are explained below.

In this research, I emphasise a relational understanding of different spaces, practices, and people. As shown throughout, distinguishing between different types of spaces often shows irrelevant when looking at how networks of practices are constructed across these spaces. As an example, the foodshed analysis for Dar es Salaam (Chapter 3) shows a network of food flows across space, including across administrative boundaries that differentiate the urban and rural. These boundaries cause ambiguity around the significance of agriculture in cities and create difficulties in quantitatively studying the impact of urban sprawl on urban agriculture over time and across cities. The delineation of the city does, however, play an important role in urban and regional planning and has therefore also been adhered to where needed. Two definitions are used to define the city of Dar es Salaam. First, the administrative boundary of Dar es Salaam Region serves as the boundary of what is formally considered the city by the authorities. Everything within these borders is considered urban, and everything outside is rural. With a high demographic variance on both sides of this border, the lived experience of people is rather specific. For this reason, the second definition used conceptualises the city based on the level of built-up space within a so-called walking distance circle (a circle which constitutes a ten-minute walk from a particular location) (Angel et al., 2016). This method shows differences compared to the first definition as it emphasises looking at the level of 'urbanness' in one's direct lived environment (both definitions are shown in Figure 2). Clearly (and not surprisingly), the city is not a homogeneous entity but rather diverse in

its composition. This raises a more philosophical question about what it means to be urban, which I return to in the last chapter of this dissertation.

Development

When asked about the future of Africa, the Senegalese president (and recent chairperson of the African Union) Macky Sall responded: "Development has gone around the world, to Europe, to America, to Asia. It's Africa's turn now" (Sall & Reid, 2013, p. 8). Since development is usually seen as synonymous with positive change, it is hard to object to it. Also in this dissertation, development is often referred to in relation to processes of growth and progress. Although it is pretty easy to be in favour of development – i.e. to point at the need to strive for something better – there is less clarity about 'development towards what', 'whose development', 'development in what form' or 'at what cost', or even 'why develop'. This dissertation describes different forces of city-making (or development) and ideas about the 'ought to be' of agriculture and the city that raises the question about the universality of ideas around 'development' or 'being developed'. The point that I want to make here, and will return to in the final concluding chapter, is that development is not neutral but has a performative character given that our notions about the world make us think and act in certain ways. Consequently, whoever gets to define this development and how it can be achieved holds a position of power (Ziai, 2007).

Development cannot be seen as a concept holding one objective truth but rather as a value-laden concept that is tied up with historical, cultural, and institutional contexts, which are formative in political and ideological positions (Boogaard, 2019). Development discourses have been influential in the transformation of sleepy towns into metropolitan cities, as I describe for Dar es Salaam in Chapter 1.2. The development paradigm, however, relies on philosophical, theoretical, and practical assumptions that are largely Eurocentric and maintain a hierarchical dichotomy of developed and undeveloped (or underdeveloped) based on normative ideals around (future) wellbeing (Boogaard & van Norren, 2021; Sartorius, 2022; Ziai, 2016). This ideal reflects an individualistic and materialistic anthropology where industrialised societies are the norm and 'underdeveloped' societies need modernisation, economic growth, and technology (Sartorius, 2022; Ziai, 2016). This mainstream notion of development can be diversified (or even contested) by indigenous philosophies. An example of this are African philosophies in which notions of development centre around the thesis that the individual is defined by recognising the humanity of others and choosing the wellbeing of the community over

the personal accumulation of wealth (Ramose, 1999). The essence of development would herein imply that development must be realised under the premise of human dignity, solidarity, and inclusiveness. This has also been foundational to the political vision of Tanzania's first president, Julius Nyerere (Hyden, 1980; Nyerere, 1968).

Where much of the current and expected urban growth globally occurs in the South, many of the theories and images of the city (and its development trajectories) originate from the North (Roy, 2005; Swilling & Annecke, 2012). For this reason, I have actively engaged with understandings of the construction of society based on the work of post-colonial (urban) scholars and African philosophy. This is not to say that Africa does not deserve mainstream values of development, but I hope to recognise in this way that these values are not necessarily universal. From what I have learned, the African city cannot be solely understood through the macro-level structures often looked at in Western cities, such as large-scale infrastructure roll-outs and neoliberal market structures. Where the state struggles to cater for all citizens, the everyday (micro-level) life in African cities largely relies on a relational network of people who appropriate the city for their own ends. The African city herein is far more dynamic than the Western city, like an organism that is in constant motion given the relations that people build among themselves and the opportunities that appear through this. For this reason, I remain hesitant to write in a prescriptive manner about the position of irrigated urban agriculture to point towards the improvement of a space of which I am no part. Rather, I emphasise the collaborative production of knowledge and interventions at several places. Also, I reflect on ideas regarding planning and governance in the concluding chapter that hopefully help to think about the development 'for whom' and 'towards what'.

Global South

The 'Global South' is an expression often used in geopolitics, economics, and development to describe a group of countries and regions in contrast to the 'Global North'. The expression does not compare one-on-one with the geographical South, as the equator (as geographical delimiter) does not do justice to the differences aimed to describe. The North-South division rose to prominence with the 1980 Brandt report that focused on disparities in economic development on both sides of an imaginary line (the 'Brandt Line') drawn from east to west. Snaking across continents, this line divided the world into an industrialised North and an underdeveloped South (Lees, 2021). In the North-South dichotomy, the North is commonly associated with modernity,

development, capacity, and prosperity, while the South is often viewed as the 'other', as 'less' or subordinate, and in need of 'catch-up growth' (implying a particular ideal of being developed, see previous section) (Arce & Long, 2003). Rather than only distinguishing differences in levels of income, industrialisation, and political and economic power, it also "references an entire history of colonialism, neo-imperialism, and differential economic and social change through which large inequalities in living standards, life expectancy, and access to resources are maintained" (Dados & Connell, 2012, p. 13). These disparities not only exist in the distinction between North and South but also homogenise both worlds in a way that renders the diversities in living invisible. On both sides of this imaginary line are patterns of uneven development that cause inequalities and interdependencies.

Although retaining the Global South as a concept that signifies commonality might seem unattainable, the term may still be relevant as a way to consider the differences in lived realities and the related epistemic injustices that have played a part in this divide. Rather than doing away, I have decided to refer to Global South and Global North for two reasons. First, the divide remains in the relations between different 'Northern' and 'Southern' countries. This study shows that urban planning and service provision in Tanzania – but also in other African countries – is influenced by 'Northern' models of cities and associated infrastructures. Particular ideals of progress or development play an influential role in the planning of water use, agriculture, and cities. Second, as I also point out for several other words in this thesis, I try to shift the (normative) point of reference to a provincialised understanding of the South. Approaches to planning and development originating from the Global North often rely on assumptions about local contexts that are not applicable in other parts of the world. By engaging with the work of postcolonial scholars focused on social dynamics across the African continent, I aim to describe the features that characterise the city in their own right rather than in a comparative manner. When referring to the Global South in this dissertation, I broadly refer to those spaces that are shaped by people's efforts of survival while engaging in diverse ways with systems of governing by the state (Watson, 2009). As will be shown in several places throughout this dissertation and similar to the following section on informality, this understanding of social interaction in an African city – referred to by Watson (2009, p. 2273) as the "the spaces of citizenship, the successes of encroachment, the cracks, spaces and moments of alternative practice, or the positive hybridities" – can provide a basis for a positive

engagement with alternative forms of planning that take into consideration the clash of rationalities between government and civil society.

Informality

Many cities in the Global South have evolved into a diverse patchwork of spaces and associated service delivery models given the inter alia limited capacity to accommodate the rapid growth experienced. Rather than looking at singular scales or governance modalities, different approaches analyse the heterogeneity of urban infrastructure provisioning in these cities (van Vliet et al., 2024). Given that informality is a key feature in the functioning and planning of these spaces and services, this concept has been subject to discussion on how it should be understood and what role informality plays in different locales (Roy, 2005, 2009). The formal-informal distinction is generally found to distinguish differences in the territorial categorisation (e.g. the slum as informal space), organisational form (e.g. referring to either the formal or informal economy), and governmentality (forms and levels of intervention and control) (McFarlane, 2012). Two frames around informality seem to be sharply at odds. On the one hand, there is the understanding of informality as a state of ungovernability given that informality is (by definition) outside the realm of what is controllable by the state. Where the formal is identified as the norm and a state of control, informality is regarded as "that which is backward, undesirable, to be eliminated or incorporated in the formal through formalisation and state regulation" (Ahlers et al., 2014, p. 4). In contrast to this frame of crisis and failure, the informal economy can be regarded as a space of 'heroic entrepreneurship' in which people creatively and ingenuously respond to the state's incapacity to satisfy the needs of the poor (Roy, 2005). The latter perspective on informality is further elaborated on in Chapter 4, which focuses on people's agency to shape their environment according to their own demands. More broadly, I show in this dissertation how the tensions between the ideals of formality and realities of informality create struggles over the recognition of informal practices and their 'right to the city'.

When talking about informality in this dissertation, I emphasise the capacity of people to be flexible and adaptive to a diverse and changing socio-material environment. Non-state actors play a prominent role in shaping space and the embedded resource flows, although this has often been seen as the purview of the state. The binary notion of formality and informality does not mean these can be understood separately. "Informality is not 'outside' formal systems, but is instead produced by formal structures and always

intimately related to them" (Porter, 2011, p. 116) and "formal governance structures produce the conditions for informality to develop" (Ahlers et al., 2014, p. 5). The two should rather be understood in a transactive and relational way, creating a heterogeneous configuration or bricolage of spaces and practices that are also subject to change. Given the (Northern-derived) ideal of a universal, uniform infrastructure – described by Graham & Marvin (2001) as the 'modern infrastructural ideal' – alternative[7] types of urbanism (in the functioning of urban spaces and its associated services) where non-state (thus informal) actors play a prominent role are often under pressure. Informality is central to this work as a driving force in urban city-making. I do, however, acknowledge that the recognition of informality is no shortcut to progress or solution to the exclusionary infrastructures dating back to colonial times (see Chapter 2). Informal service providers are also critiqued given steep prices and the varying quality of their services. Informality has not been discussed very explicitly throughout the different chapters. However, the ability to remove or render practices invisible or undesirable is closely related to the politics of informality. In the final chapter, I return to this formality-informality debate when considering the state-society interaction in city planning.

1.7 On positionality

Ethnographic research is a process of producing an account of reality that is as loyal as possible to the context in which this knowledge was produced, yet is socially-constructed and based on one's own experiences. Therefore, "the researcher cannot conveniently tuck away the personal behind the professional, because fieldwork is personal" (England, 1994, p. 85). Here, I want to reflect on my positionality regarding research motives, fieldwork experiences, and role as a researcher.

Engagement with the topic

While living and working in Dar es Salaam, I have often been advised to 'go outside'; referring to travelling to the city's adjacent rural regions where 'real agriculture' can be found. The small patches of agricultural land within the city, as well as smallholder production systems in general, are often seen as less desirable compared to the large agricultural estates where technology and innovation embody the potential that agriculture has to tackle global hunger. Nevertheless, of the estimated 608 million farms

[7] I use this term to emphasise the dominance of the first system configuration.

in the world, more than 510 million are smaller than 2 hectares (Lowder et al., 2021).[8] This suggests that smallholder farming systems play a vital role in feeding the world yet receive little attention and popularity. An international research consortium found that more than 95 per cent of agricultural research publications were not relevant to the needs of smallholder farmers (those who comprise the far majority of farms worldwide). Most studies did not show any direct engagement with farmers, and "applied research involving working with smallholder farmers and their families doesn't immediately boost an academic career" (Nature, 2020, p. 336). This shows that research on agriculture (or any other topic) cannot be seen separate from personal and career development and the politics of academia.

Given the multiple demands on agriculture to meet food and nutrition security, biodiversity conservation, and climate change mitigation and adaptation, it is vital to address these knowledge inequities in science and engage with smallholder agriculture in more meaningful ways. The response of smallholder farmers to the above-mentioned demands (including the farmer-led expansion of irrigated agriculture) is substantial and based on the efforts of millions who rely on agriculture for their livelihood security while receiving little scientific interest and little recognition by state and development organisations (Hoogesteger et al., 2024; Woodhouse et al., 2017). Learning from day-to-day practices of agriculture and water use is of prime importance for development trajectories, also for the people and practices that shape and get shaped by these narratives. Given my prior interest in urban-agricultural water use interactions and particularly the role of water quality in this, I have engaged with smallholder irrigated agriculture in the context of urbanising landscapes. With urban development in Africa transforming landscapes in a myriad of ways, there is a valuable contribution to make here by providing insight into the role that smallholder farmers play as part of these rapidly-changing landscapes. Increasingly aware about my own positionality, I have become more careful to enthusiastically figure out 'how to make things work'. I believe that my role is not to offer simplified answers to complex questions but rather to provide a richer and more emancipatory understanding of the world. My writings have, therefore, emphasised what 'merely is' rather than being on a constant lookout for what it could or

[8] Data by the FAO (2014) shows slightly lower numbers with a comparable proportion of smallholder farmers.

should be. This is not to say that I do not aim to relate to planning and policy. However, it is important to acknowledge that effective governance cannot be reduced to scientific input but requires commitment, participation, political will, and the balancing of adjacent interests.

My involvement with this topic is out of an interest in the unseen and unheard stories that are part and parcel of development. As sociologist and philosopher Zygmunt Bauman describes, the environment we grow up in trains us to note production and development rather than taking stock of its secrets. "Designing 'makes sense' in as far as not everything in the extant world is as it *should* be. More importantly yet, it comes into its own if that world is not what is *could* be, considering the available or hoped-for means of making things different. The aim of designing is to plot more room for 'the good' and less room, or no room, for 'the bad'. It is the good that makes the bad what it is: bad. 'The bad' is the waste of improvement" (Bauman, 2003, p. 29; original emphasis). Since development is usually seen as synonymous with positive change, it is hard to object to it. Impressive urban visions and development plans exist for many large African cities, offering pathways to modernisation through urban renewal, urban extensions, and entirely new (satellite) cities. City masterplans are presented as a testament to a 'rising Africa', representing progress and development on the continent (Côté-Roy & Moser, 2019; Watson, 2014). Although it is pretty easy to be in favour of development – i.e. to point at the need to strive for something better – there is less clarity about 'development towards what', 'whose development', 'development in what form' or 'at what cost', or even 'why develop'. By reversing the tone of the subject, I aim to present the negative to the image of urban growth and progress often presented. Often out of sight (and therefore perhaps also largely out of mind) are groups of people that make use of 'vacant' land and urban water to produce food for the city. These informal networks of provision – similarly found in urban water supply or sanitation – craft the city as a colourful mosaic of diverse people, places, and practices.

Finding my way

Doctoral researchers – as 'novice' researchers – are taking their first steps in academia, ready to 'produce' knowledge. What it means to do research is not only based on personal ambitions and motivations but also conditioned by institutional requirements and boundaries imposed by funding bodies and timelines. Especially as a researcher based in a Global North institution conducting fieldwork in the Global South, navigating these

different worlds can be challenging for different reasons. There is much to say about this bifurcation, as it exemplifies places of difference. The process of 'finding my way' in this is hard to reconstruct, can feel challenging to talk about, and might be experienced differently by others. I do, however, want to share something about my personal learnings here. First and foremost, I come from a place of difference. I am a white, male researcher who has received education in water resources management at a European university. My cultural and academic upbringing have shaped my worldview in this regard, as well as my ideas about helping others. Taking time has been central for me to – while coming from a place of difference – better understand and perhaps even find places of sameness in the context studied. Although not exhaustive, I want to illustrate this by elaborating on taking the time to travel, to search for a common (cultural) language, and thus to understand.

The selection of transportation influences both how the researcher perceives its environment and how the researcher is perceived by others. Although I promised to use private transport and practice social distancing to be allowed by Wageningen University to leave for fieldwork (the university held strict travel restrictions during the early stages of Covid-19), I quickly realised that navigating the city in a manner and at a pace familiar to many residents would provide me with a better understanding of the city. Leaving early-morning by *daladala*[9] for field work – which included the risks of Covid-19, delay, and standing completely cramped – helped me slowly find my way through the city. Unlike a car, public transport allows you to see, smell, and hear better what is happening around you and respond to this. Trying to memorise bus stops and taking in the surroundings helped me to learn from new parts of the city or notice changes, such as the widespread removal of *machingas* (petty traders) described in Chapter 5. Arriving on foot or at the back of a *bodaboda* (motorbike taxi) reaching the different agricultural study areas also lowered the perception of being important or considered an expert. This (to an extent and according to my impression) lowered farmers' expectations, removed suspicion around my presence, and gave me more freedom to be learn about the daily experiences of irrigated agriculture in the city.

In order to listen, one has to understand what is said. This relates to language but also extends further than words alone. Besides overcoming language barriers, it is equally important to be culturally sensitive regarding cultural values, traditions, and

[9] The privately-owned buses that serve as the most common form of public transportation.

communication styles to ensure respectful and meaningful research interactions. Language and cultural sensitivity have certainly been barriers to my understanding of the research context. I come from a different cultural background and did not speak Swahili at the research onset. Although it might sound rather obvious, learning a new language has been transformational for me in the professional and personal context of living in Dar es Salaam. I have taken several language courses that helped me relate to others and demonstrate a commitment to understanding others better. Becoming familiar with communicating in Swahili – the national language of Tanzania – has been a way for me to relate to people more intimately: communicating with many research participants in (one of) their own language(s) rather than using the language of the urban elites (i.e. English). Nevertheless, I have worked with a research associate who (most of the time) helped with translations and understanding the local context. The interpreter plays an important role in conveying knowledge, which can be susceptible to the implicit imprecision of the act of translating but can also get enriched by post-interview discussions. Although dependent on an interpreter for many interviews, language allowed me to build a relation of trust and gain a better understanding.

Building meaningful relationships as part of research relies on trust and therefore takes time. This has been one of the primary reasons to spend one and a half years in a limited number of agricultural areas within the city of Dar es Salaam. Except for a few intermissions to analyse data, I have spent most of my time in agricultural areas while combining this with visits to other relevant stakeholders that engage in agriculture and urban planning within different institutes. I have turned down various opportunities of officials offering to 'organise farmers' to talk to me but rather invested much time visiting the field and relating to the lives of farmers. Many visits and small talk went by without 'tangible results', which made me question my own approach at times that somehow contrasts with the pressures of publishing that researchers can experience. Looking back, I believe that taking time to observe, talk, and understand has allowed me a more meaningful understanding of the research context.

While highlighting some of the experiences of finding my way, I have worked every day while being afforded all the privileges of being a white foreigner in Africa. I have experienced this by both having been granted and denied access to people's lives. Studying agricultural practices that are both physically and ideologically under pressure, people have been suspicious about my presence; afraid that I for instance might have

more interest in peoples' land than in their livelihood. On the other, many doors have opened by referring to my European origin or Wageningen academic background. I have been able to find time in the agendas of busy people who would otherwise probably have turned down a student interested in agriculture and the city (for many, not a topic high on their priority lists). One of the exemplary moments for how these privileges can go unnoticed quickly is when a senior colleague and friend commented on my daily commutes that fellow passengers would think that I travelled by *daladala* 'just for fun'. While I initially felt quite offended by this reasoning that I would do these things 'for fun', it made me realise that mimicking what I see and hear around me is helpful for me to understand the city better but does not make me experience the city in a way similar to many others. 'Many things I do, I do them for a reason while also being able to decide differently. I do this from the privileged position of having options to choose from. If I don't feel like going by *daladala* today, I can take my car. If I don't feel like eating *mchicha*, I can go to the supermarket to purchase something there. I try to participate in the ordinary ways of travelling and eating, but it does not make me an insider; perhaps only an insider from the outside' (research diary, 3 March 2022).

1.8 Research domain and scientific output

This research is positioned at the intersections of three different research domains: water, food, and the city (Figure 4). As discussed later in this dissertation, domain specificity is among the reasons that irrigated urban agriculture is shaped in particular ways. Tensions and ambiguities between urban planners, environmental experts, and agriculturalists create a space in which practices of agriculture and water use can take shape while being confronted with both physical and institutional pressures originating from urban growth. Approaching the interlinkages between different practices across disciplines is often overlooked due to sectorised (knowledge and capital) investments. This realisation is not new, as shown in the current-day calls for 'integrated' approaches that aim to find 'holistic' solutions by integrating different kinds of sectors, stakeholders, and perspectives. This research takes a similar holistic approach, as society takes its form through a web of interconnected practices. So, practices produce what the city looks like, how water flows, and where food travels and is consumed. The complexity of these social dynamics necessitates an academic approach that extends beyond the boundaries of a singular discipline.

As visualised in Figure 4, the term 'irrigated urban agriculture' shows the exact centre point of the different domains which are believed to be of high importance. For clarity, I generally refer to these research domains as the interconnections between water, food, and the city. In science, these cover the fields of water resource management (D4), food and agricultural science (D6/7), and urban planning (K4), respectively (classification based on the Joint Academic Coding System). Here, I shortly show the relation between this research and the respective fields. Starting at the territorial context in which this research takes place, **cities** in Africa and Asia receive ample attention nowadays given that nearly 90 per cent of the world's urban population growth between 2018 and 2050 is expected to be concentrated on these two continents (UN, 2019). Many of these countries are middle- and low-income countries that, as a result, struggle to accommodate this growth. With Africa being the most rapidly urbanising, more people will live in cities than in the countryside for the first time in African history. For this reason, cities have become a major interest for state authorities and international development organisations, describing them as catalysts for economic growth, functioning for the greater (economic) good of the nation. On the other, many cities are known for stark contrasts in living conditions and opportunities. The concentration of human activity poses pressure on the utilisation and distribution of resources (such as food and water) and causes degradation, competition, and social marginalisation.

The continuing shift of the world population from agricultural-oriented systems of living to the urban environment reconfigures **our relation to food**. Several global socio-ecological trends are a reason for concern regarding the ability to feed the growing world population (Barthel et al., 2019), of which I want to highlight two here. First, rural outmigration to pursue (perceived) urban employment opportunities causes a shift in the labour force that offsets the balance between producers and consumers (de Bruin & Holleman, 2023). More people become consumers without engaging in production or having direct access to agricultural sites. The consequence is a higher dependence on the cash economy to put food on the table and a higher risk of food insecurity in times of crises (e.g. rising food prices or economic unemployment) (de Zeeuw & Drechsel, 2015; Ruel et al., 2017). Second, urban growth and food production are in direct competition for land. Urban encroachment on agricultural land results in the loss of agricultural productivity; land whose productivity is generally above average and which plays a particularly important role in food provisioning given its strong connectivity with

consumers (D'Amour et al., 2017; van Vliet et al., 2017). Combined with the first point, these aspects create imbalances between supply and demand that increase the number of vulnerable and food-insecure spaces. The configuration of food systems can leave spaces of urban hunger or create so-called 'food deserts' (neighbourhoods characterised by high food insecurity and low dietary diversity) that directly relate to the inequalities present within the geography of the city (Battersby & Crush, 2014; N. Heynen, 2006).

Like food, **water is a basic human need and a resource that plays a formative role in the construction of society**. "The very sustainability of cities and the practices of everyday life that constitute 'the urban' are predicated upon and conditioned by the supply, circulation, and elimination of water" (Swyngedouw, 2004, p. 1). Water is studied in manifold ways in relation to the domains discussed above. Examples are the work on providing water supply and sanitation in the city or the role that water plays in agriculture when rainfall is absent or irregular. Especially in light of climate change and the continued increase in global water use, competition over securing access to water has become more prominent. This competition between water users is most apparent between agriculture (which accounts for 69 per cent of global water withdrawals) and water uses (industry; municipal) that take place in an urban setting (UN, 2021). Fortunately, a significant part of the water consumed in the city returns to the environment, although as wastewater with varying quality and not always directly available for reuse (WWAP, 2017). This urban use and subsequent disposal of water affect physical flows and water qualities in ways which are not only material but also symbolic. Given the intensified use of a limited freshwater budget in different sectors, circular economy principles and nexus thinking have emerged to look at water demands more holistically.

The academic journals that have been chosen for publication relate to the interdisciplinarity of this research and thus address different audiences. Chapter 2 is an unpublished chapter that conceptualises social practices and the contested spaces of urban water and sanitation. Lessons from this chapter are drawn for the context of irrigated urban agriculture (see Chapter 1.3). This chapter has served as a starting point for this research to think about how people's everyday ingenuities relate to social structures that shape and direct the trajectories of people and their practices. Chapter 3 is published in the journal Development Southern Africa and contributes to discussions around urban food insecurity and the role of (localised) food systems. There is

considerable discussion about the actual significance of urban agriculture for several reasons. This paper responds to this by giving an updated account of the role of urban agriculture in Dar es Salaam. It also shows the role that foodshed analyses can play in understanding the symbiotic relationship between producer and consumer. Chapter 4 is published in the journal Urban Forum and engages with the dynamics of everyday urban life in an African context. By studying agricultural practices as processes of city-making, this paper highlights a commonly found practice in African city regions that often remains peripheral to urban scholarship. Chapter 5 is published in a Special Issue on irrigated urban agriculture in the journal Water International[10], while Chapter 6 is published in a Special Issue on 'unconventional waters' in Water Alternatives. These chapters have different objectives (elaborated upon below) but focus on understanding the watery aspects that configure both the practices of irrigated urban agriculture and the politics around it.

[10] This Special Issue has been edited by me together with Gert Jan Veldwisch, Priyanie Amerasinghe, and Sammy Letema.

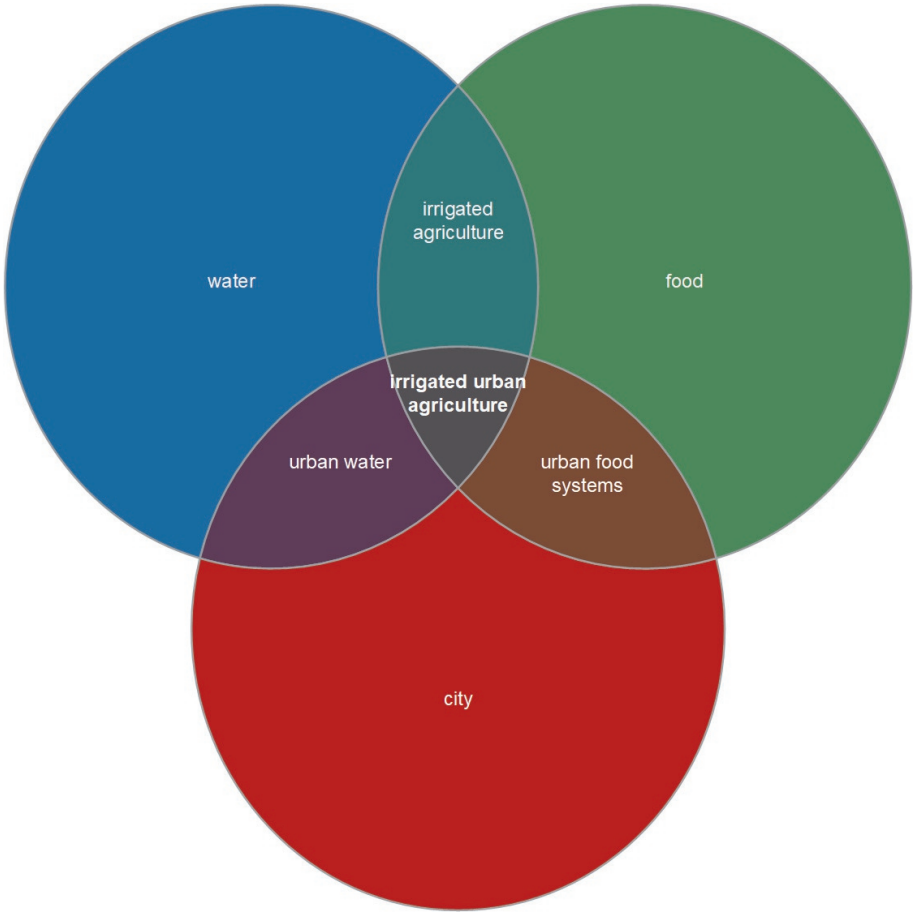

Figure 4. Visualisation of the research's interdisciplinary character given the intersection of three different research domains.

1.9 Outline of the thesis

This dissertation consists of seven chapters compiled from different scientific publications. At the beginning of every chapter, it is clarified whether and in what way the text has already appeared. The different chapters (introduced below) all contribute to the understanding of how practices of irrigated urban agriculture take shape and stay relevant in contributing to urban livelihood security under the pressure of urban growth. The structure of this dissertation (visualised in Figure 5) is as follows. The first two chapters introduce the research and conceptualise how urban practices can be understood using alternating theoretical lenses. Using these different lenses, Chapters 3 to 5 give a detailed account of these everyday practices while showing the politically-constituted space they

are part of and the food system they contribute to. Building on this, Chapter 6 zooms out and discusses the politics surrounding water reuse practices in agriculture. The last chapter synthesises the research by highlighting the empirical and conceptual lessons, as well as shedding light on the (contested) appropriation of urban space.

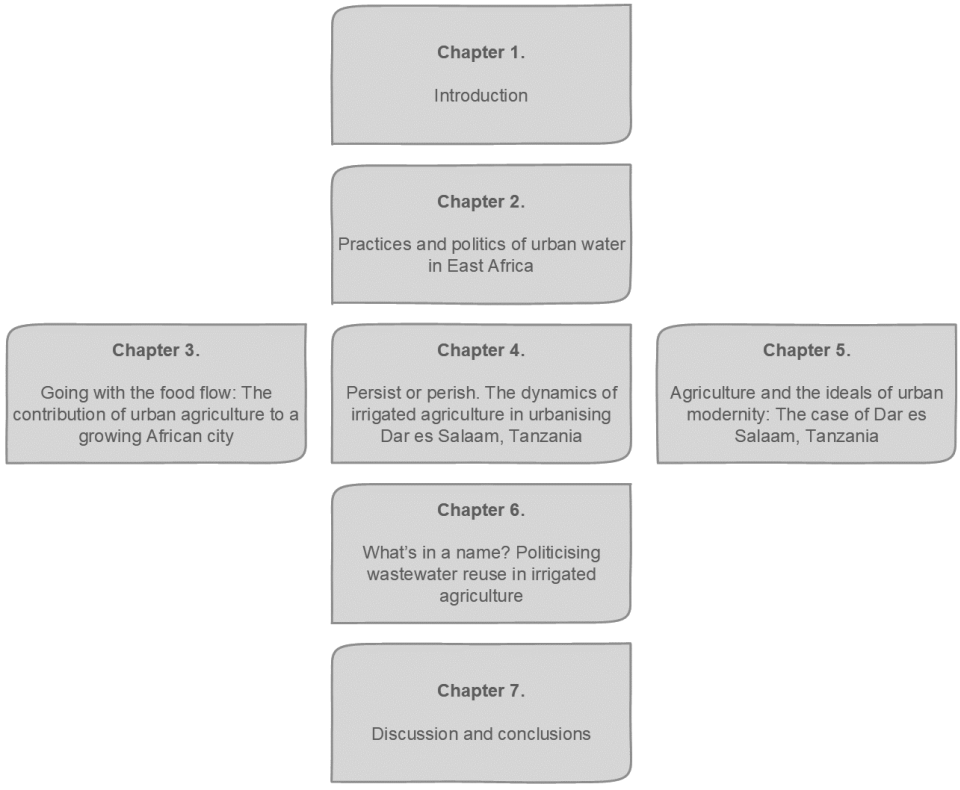

Figure 5. Structure of the dissertation

Following this Chapter 1 which introduced the research context and approach, **Chapter 2** presents the conceptual considerations that form the basis of the research presented in this dissertation. Alternating between two theoretical lenses when studying the field of water and sanitation in urban sub-Saharan Africa shows the interplay between day-to-day processes of city-making and the structuring of the socio-material environment within which people interact and society takes shape. This conceptualisation of social practices as part of politically-constituted spaces is related to the case of irrigated urban agriculture to understand in what ways these practices take shape as part of the city and what implications this has for engagement in the context of this research.

Specific research question central to this chapter: *How can the crafting of water use practices be understood as part of growing cities in East Africa?*

Chapter 3 positions irrigated urban agriculture in the larger context of food security and urban food systems. The position of agriculture in the city has often been advocated for as part of larger discussions on urban food security. Still, the actual significance of urban agriculture for a city such as Dar es Salaam is largely unknown for multiple reasons, among which is rapid growth that is changing the lived reality of citizens. Based on a foodshed analysis, the chapter gives insight into the relationship between producer and consumer and quantitatively shows the role that farmers play in Dar es Salaam. Showing the contribution that farmers continue to make raises questions about farmers' right to existence as part of the growing city.

Specific research question central to this chapter: *How does irrigated urban agriculture contribute to urban food availability and accessibility, and to what extent is this subject to urban growth?*

Chapter 4 zooms in on the everyday practices through which people shape the city. By studying practices of agriculture and its water use in different areas within Dar es Salaam, a detailed account is given of how these practices are embedded in bigger networks of occupying space, using water, and producing food. These networks are formative for irrigated urban agriculture, but farmers simultaneously co-shape the city in this way. The chapter describes the ways through which farmers are responsive to processes of growth and shows their responses to changes in access to land, water quantity, and water quality. Farmers take an active (yet insecure) role in contributing to urban wellbeing in different ways, and irrigated urban agriculture can therefore be characterised as a phenomenon of everyday urbanism.

Specific research question central to this chapter: *How do farmers respond to the impact of urban growth on their irrigated agricultural practices?*

Chapter 5 positions the dynamic configuration of practices (discussed in the previous chapter) in a broader political context. Institutional dynamics are studied by looking at contemporary policy practices and the impact that discursive change has on the context in which irrigated urban agriculture takes shape. This shows how farmers, although continuing to find ways to stay of relevance in the city, find themselves in a delicate space

of existence where their presence is conditionally condoned. The impact of influential ideas around what agriculture and the city should look like show influential in what is deemed fitting the modern African city.

Specific research question central to this chapter: *What is the influence of institutional and political structures on the configuration of irrigated urban agriculture?*

In **Chapter 6**, the research findings for Dar es Salaam are placed in the broader context of the growing attention for wastewater as a 'new' resource in irrigated agriculture. By combining a study of the academic field with the study of informal water reuse practices in Dar es Salaam, the politicised nature of water flows and its quality is discussed and reflected on. For most water reuse practices worldwide, farmers intentionally plan their (re)use of water for agricultural purposes while often being limited in their control over the physical quality of the water as well as the normative attributes associated with their practices. Rethinking the position attributed to farmers is believed to contribute to a richer and more meaningful description of, and engagement with, the everyday realities of reuse in many regions facing increasing competition for water.

Specific research question central to this chapter: *What are the contestations surrounding the reuse of urban water for irrigated agriculture in cities?*

The chapter that concludes this dissertation, **Chapter 7**, synthesises this research by answering the research questions, discussing the academic and societal contribution, and highlighting several ways of engagement that are deemed helpful to consider for those involved in research, planning, and policy around water use and agriculture in the city.

In the **Supplementary materials** of this dissertation, there are two sections that provide a different academic reading of the research by means of a research story and a policy brief. These will also be discussed and referred to in the preceding chapters. The research story offers a more intimate insight into the lived experiences of being a farmer, as well as the researcher being part of this environment. Also, using scientific storytelling can bolster engagement with the research topic. The research story is followed by a policy brief. The policy brief is a commonly-used science communication strategy to bridge the gap between science and policy. In this research, a policy brief was prepared in both English and Swahili to present research findings in an accessible format, with the goal of facilitating policy discussions and enhancing the uptake of research results.

CHAPTER 2

2

Practices and politics of urban water in East Africa

"Water makes boundaries and is part of the divisions and categorisations that produce both micro-ecologies and social identities."

Water networks play an influential role in urban development by embedding water flows in specific places, shaping social structures, practices, and the symbolic meaning of spaces. This chapter examines the role water supply and sanitation practices play in how East African cities take shape. We use insights from Social Practice Theory and Urban Political Ecology to explore the interplay between everyday practices and the structuring sociomaterial environment within which people interact. A focus on practices emphasises the actual acts of doing through which people co-shape the city and appropriate space to improve their lives. However, existing power relations determine who has access to or control over urban spaces and water resources, shaping how life is lived. This shows the politically-constituted space in which everyday practices are placed. The combination of conceptual insights in this chapter is helpful for understanding water networks in African cities, respectively focusing on the *how* of interaction and change through practices while raising questions around *why* social interaction and social change is structured in particular ways.

This chapter is referred to as Wessels, M. T., Veldwisch, G. J., & van Vliet, B. J. M. (2024). Practices and politics of urban water in East Africa. In M. T. Wessels, *Fields of Friction. Practices and politics of irrigated urban agriculture in Dar es Salaam, Tanzania* [Doctoral dissertation]. Wageningen University.

Quote: In Mosse (2008, p. 943).

2.1 Introduction

We live in times of water crises, marked by the over-exploitation of freshwater resources for agriculture, domestic, and industrial uses, as well as the increasing threats of droughts and flooding. Population growth, urbanisation, and socio-economic development, combined with the growing impact of climate change, particularly exacerbate the pressure on water management in the localised (and often hydrologically complex) setting of cities. At present, many of the world's urban populations face water scarcity, which is expected to become more severe in the future (He et al., 2021). People living in cities in sub-Saharan Africa (a region where a large part of population growth is expected) are highly exposed to water-related risks such as floods and droughts while having low capacities for measures against this (IPCC, 2022a; UN, 2018). Water-related issues are typically addressed via engineering and infrastructural solutions that supply water or protect against water in cases of floods. Infrastructural development, however, requires balancing different water users' interests, for example in inter-basin water transfers or the re-allocation of agricultural water to domestic and industrial users in the city. The control of water is often presented as solvable through technical knowhow, rational water use, and good governance, but often conceals political questions around who and in what way is accounted for in these development trajectories (Hommes et al., 2019; Wessels et al., 2019).

With the changes in water availability, demand, and supply as a result of climate change, it is imperative to consider the different demands that are put on water resources by various sectors and, thus, how power operates through the use of water and the effects on its flows and qualities. Studying configurations of infrastructure, institutions, and associated practices gives insight into how patterns of water supply, distribution and reuse take shape and, therefore, can serve as a lens for studying urban development trajectories. The central idea behind this chapter is to reveal and discuss the role water use practices play in how cities take shape. We study these social dynamics from different angles by showing how urban water users interact and adapt their practices and how these social interactions exist in a context that influences them through the workings of power. To understand the interplay between everyday practices and the structuring sociomaterial environment within which people interact and society takes shape, we use insights from Social Practice Theory (SPT) and Urban Political Ecology (UPE) when studying urban water in East Africa. As little has been published on irrigated urban

agriculture, we examine how the conceptual insights have been applied to urban water and sanitation. These configurations are similarly both social and material and part of a politically-constituted urban space. This conceptualisation of social practices as part of politically-constituted spaces is related to the case of irrigated urban agriculture throughout this work.

We continue this chapter by first describing how water supply and sanitation infrastructures are part of, contribute to, and get shaped by the configuration of East African cities. Infrastructure and institutional arrangements that we observe in contemporary cities are the response to social, economic and environmental challenges and opportunities, ending up with flexible management and governance configurations. Social Practice Theory helps to describe how exploring and following practices allows for understanding the dynamic configurations of water use in East African cities. Focusing on practices, we describe processes of change and interdependencies between different locales through shared elements of social practice. However, the evolution of water networks and associated practices is not occurring homogeneously across different urban locales and social groups. We therefore critically reflect on the role of water users and the ability to act as co-creators of society. By turning to Urban Political Ecology, we show the power relations through which contemporary cities become produced. The chapter ends with discussing the main insights from our analysis and highlights the implications for research on water use configurations, its network interactions, and processes of urban development.

2.2 Social production of space and urban water networks

The spaces in which we live and see around us are not a neutral, stand-alone backdrop to our lives. Instead, they are an active result of our human interactions. The relationship between humans and their environment is dynamic, involving an ongoing interplay between natural (or material) and social elements. This interconnectedness suggests that the concept of space is inherently bound up with the societal and environmental elements that continuously define and redefine it. Swyngedouw (1999, p. 446) states that "social relations operate in and through metabolising the natural environment which, in turn, transforms both society and nature and produces altered or new socionatural forms." In conceptualising space, nature and society are thus inseparable; they co-constitute each other and produce states of nature in which we live and interact (Heynen

et al., 2006; Smith, 1984). According to Lefebvre's theory on space, space is not something that exists independently; instead, it is actively produced. As human beings enter into relationships with each other through practices, (social) space is produced in a synchronic (particular moments of production) and diachronic order (processes of production over time) (Goonewardena et al., 2008; Lefebvre & Nicholson-Smith, 1991).

The city is a commonly-used example of how society produces space (N. Heynen et al., 2006; Lefebvre, 1976; Loftus, 2012; Swyngedouw, 2004). The city is a space shaped over time through social interactions, with urban geographies reflecting this *outcome*. At the same time, urban space serves as a *medium*, as how it is constituted (e.g. the resources available to its actors) determines how it can develop. This understanding of space touches upon a core theoretical debate in the social sciences concerning the relationship between agency and structure. Agency refers to the individual's (or group's) ability to influence its environment, whereas structure relates to the conditions which define the range or capacity to cause this effect. "[T]he structural properties of a system are both the *medium* and the *outcome* of the practices they recursively organise" (Giddens, 1984, p. 25; emphasis added), so structure and agency are seen as distinct but also inseparable from one another. The shaping, enabling, and constraining properties of social systems (structure) stretch beyond individual actors, continuously reproducing or modifying the structural principles that guided their activities in the first place. Actors thus adapt to and actively attempt to reshape space by leveraging the resources at their disposal, thereby becoming key agents in organising subsequent social interactions (Arts & Van Tatenhove, 2006; Giddens, 1984; McLaughlin & Dietz, 2008; Whittington, 2010). This implies that space is fundamentally historical and emerges as actors try to create an environment that aligns with their own interests (Goonewardena et al., 2008; Lefebvre & Nicholson-Smith, 1991; Swyngedouw, 2004).

Water infrastructures provide a helpful entry point for exploring the configuration of cities, as described above. Water infrastructures shape urban geographies and associated practices by embedding flows in particular places, rendering social structures and relations proximate and denoting the symbolic associations with particular kinds of spaces. These infrastructures have often become hidden underground, sectorised, and taken for granted (Graham & Marvin, 2001; Swyngedouw, 2004), yet have an important impact on social life. Analysing our lives within these 'invisible' systems requires moving beyond the material artefacts (e.g. water taps, pipes, and reservoirs); rather, seeing

materiality as part of sociotechnical configurations or urban assemblages for water service delivery (Coutard & Rutherford, 2016; Lawhon et al., 2018). Jaglin (2016, p. 184) describes such service delivery configurations as "made up of actors, technical objects, institutions, economic interests, social practices and representations, but also of material spaces, all interlinked and making it possible for a service to be provided in a given urban context." Similarly, Graham & McFarlane (2014, p. 5) emphasise that "[w]hat's important here is not infrastructure as a thing, but infrastructure as a set of operations." It is the 'what people do' rather than the engineered system of water control itself, as water infrastructures operate through the social practices surrounding it. The following section explores this further by examining how water supply and sanitation infrastructures carry important imprints that reflect and direct everyday water use practices in East African cities.

2.3 Water infrastructures in East African cities

The infrastructural properties of cities provide insight into how urban development has occurred across space. Different authors show how studying the layout of water infrastructures generates insights about citizenship and modernity (Coutard & Rutherford, 2016; Swyngedouw, 1999; Tiwale et al., 2018). This section describes the 'production' of water supply and sanitation infrastructures, which have shaped cities across SSA. When talking about infrastructures, we consider these as sociomaterial constructs or sociotechnical configurations that function in the moments that people engage in these systems of service provision. Infrastructure is "more than banal engineered artefacts and technological systems" but instead serves "to think through the politics, ecology, social relations and everyday experiences of urban life" (Addie, 2016, p. 273).

Examining infrastructure roll-outs from a historical perspective clearly shows how East African cities reflect historical-geographical struggles and social power geometries that play an important role in their functioning to date. The export of modern ideals by colonial powers in the form of large, European-style water supply and sewerage systems (where technology was rendered as a vehicle of modernisation) resulted in the uneven development of water infrastructure.[11] Examples from East African cities show how water supply and sanitation networks prioritise socio-politically influential spaces, rooted in

[11] 'Modern' refers to particular ideas around the construction of society rather than referring to present or recent times. This is further discussed in Chapter 1.6 and Chapter 5.

colonial segregation and sustained by the unbalanced access to land and infrastructure. Under colonial rule, networks of water provision and waste disposal were confined to zoning regulations (based on racial segregation) with different building and infrastructural standards. Investments in water and sanitation were consistently unbalanced, with the African townships receiving the smallest investments in infrastructure (Dill & Crow, 2014; Hirvi, 2012; Jackson & Robins, 2018; Monstadt & Schramm, 2017; Smiley, 2016; Velzeboer et al., 2018). In Kampala and Nairobi (the capital cities of Uganda and Kenya respectively), piped water systems were constructed with different water design demands and water pricing mechanisms that created segregation in service provision and thus living conditions (Nilsson, 2016). Similarly, Letema et al. (2014) describe how sanitary divides between different settlement zones in Kampala and Kisumu (the latter is the third largest city in Kenya) underscored racial segregation and the separation of infrastructure networks, creating distinctly different urban spaces that are still visible today. The examples above are not unique to water supply and sanitation (nor the cities mentioned) but can also be observed in the histories of other delivery networks such as public transport, telecommunications, and energy supply (Coutard & Rutherford, 2016; Silver, 2015).

The normative ideal of homogeneity and centralism continued to shape infrastructural planning during the post-colonial era. Large-scale, centralised models for water supply, sanitation, and waste services were adopted by governments with support from international partners. Governments, however, struggled to address the escalating demands of rapidly expanding cities, and their efforts failed to maintain modern water infrastructure standards for all (Jaglin, 2012; Lawhon et al., 2018). As service provision did not meet the growing urban population's needs, new water service structures arose that countered the ideal of large-scale infrastructure roll-outs and state control. Formal urban water networks get extended via vibrant informal networks: from alternative structures of water marketing and private water traders (Crow & Odaba, 2010; Rugemalila & Gibbs, 2015; Schwartz et al., 2015), latrine emptying services (Letema, 2012) to the reuse of urban water for food production (Drechsel et al., 2006, 2015; Scott et al., 2004). Alternative forms of service provision (unregulated or happening despite being regulated against) emerged alongside existing systems and operate in isolation, complementary to each other or competing (and with different levels of formalisation and social organisation). In Dar es Salaam, Tanzania, water supply and sanitation combine central and decentral systems

involving public authorities, private companies and self-organising actors. Formal water supply systems in the city generally reach higher-income citizens, while almost 90 per cent of those living in low-income areas rely on alternative, informal water supply practices to meet their daily water needs (Allen et al., 2017; Monstadt & Schramm, 2017). While alternative (informal) modes of service provision are often considered backward, they reach many urbanites who otherwise lack access to water and opportunities.

The efforts of building a modern city through large-scale infrastructure roll-outs and state control have shaped water use over time. Water infrastructures shape urban spaces and associated practices: embedding water flows in certain places, crafting social structures, and denoting the symbolic associations with particular kinds of spaces. In the outcomes of city-building processes, urban landscapes reflect the historical-geographical struggles and social power geometries they were subject to. Meanwhile, we observe the emergence of new, alternative forms of service provision that oppose state-led urban ideals and follow rather pragmatic bottom-up city-making. Water supply and sanitation services draw from various combinations of technologies and institutions, allowing for an effective moulding together of technological services and governance arrangements at different levels (Faldi et al., 2019; Schwartz et al., 2015; B. van Vliet et al., 2014). This creates 'hybrid infrastructure configurations' (Lawhon et al., 2018) or 'modernised mixtures'[12] (B. van Vliet et al., 2014) where processes of patching together different technological and institutional arrangements take place to align service provision regimes to local conditions (van Welie et al., 2018). The terms 'mixture' or 'hybrids' explicitly contrast with the modern ideals of uniformity and usefully extend beyond the dichotomy of formal and informal structures that is commonly referred to. In the next section, we turn to Social Practice Theory to further explore the interlinkages between social practices and infrastructures and understand how water use practices are socio-materially constituted.

2.4 A social practices view on urban water

As we have shown for different cities, structural imbalances in access to water supply and sanitation between different urban locales within cities lead to disparities in living conditions that have implications for day-to-day practices. Understanding urban water and sanitation requires looking beyond formal, state-initiated infrastructures and

[12] 'modernised' refers here to a re-evaluation rather than an expansion of modernity.

examining how user practices are pragmatically shaped and reshaped over time based on the sociomaterial context they are part of. Social Practice Theory allows us to better explore *how* these practices get dynamically-constituted as part of these sociomaterial spaces. Social practices are commonly described as existing across space and time and are continually recreated by social actors to express themselves in their interaction with others (Giddens, 1984; Hui et al., 2016; Shove et al., 2012). Practices "persist beyond any one moment of enactment (...) and have recognisable 'lives' of their own: they circulate and travel, and they emerge, endure and disappear" (Shove, 2016a, p. 245). In this section, we describe how dissecting and following practices allow to understand water use configurations.

In disentangling social practices, Shove et al. (2012) identify three elements that constitute a practice: *material, competence,* and *meaning*. *Materials* encompass tangible physical entities, technologies, and the stuff of which objects are made; *competences* include skill, know-how and technique; and *meanings* includes symbolic meanings, ideas and aspirations. *Materials* refer to the tangible aspects of infrastructure, devices, and resources used within a practice. Infrastructures are typically geographically distributed and relatively fixed (e.g. piped system), while devices are directly engaged in the practice (e.g. a tap or toilet). Resources, such as water in this context, are used in the practice, though not necessarily being used 'up' but rather transformed (Shove, 2016b). *Competences* are the know-how, background knowledge, and understanding that facilitate daily activities. They can be learned, transferred, or captured in manuals and instructions, making them adaptable across different contexts. Lastly, Shove et al. (2012) use the element of *meaning* to represent the social and symbolic significance of participation, loosely capturing what Reckwitz (2002) describes as mental activities, emotion and motivational knowledge. For example, meaning can be formed by being part of social groups (building social identity) and the cultural meanings associated with different types of water provision in society. The elements described above come together in specific moments of doing: the performance of a practice. Practices emerge from the interaction of these elements that shape and influence one another during moments of integration. Similarly, practices are embedded within more extensive networks and continuously interact with each other. Here, urban water infrastructures are enacted through the practices of social actors, who represent the elements of

competence and meaning while also interacting with the material components of water systems.

In the previous section, we showed how alternative forms of water provision cross the frontiers of formal and informal.[13] Water easily moves between these different discursive locales, showing how seemingly disconnected water networks are interlinked through practices that share the same material flow. When looking at the actual 'doings' of service provision in cities in the Global South, the formal and informal are often linked (McFarlane, 2012). Utilities and private entrepreneurs have a symbiotic relationship in the provision of water services, which can be complementary but also conflictive. Private water vendors typically operate in areas not covered by piped distribution systems, often unplanned areas with low-income households. Formal systems of water supply in Dar es Salaam, as an example, generally reach higher-income citizens, while almost 90% of those living in low-income areas rely on informal water supply practices to meet their water needs at an elevated price (Allen et al., 2017). These private water vendors do not only respond to poorly serviced informal neighbourhoods but also respond to multiple-sourcing strategies of wealthier households dissatisfied with their tap water (Bender, 2021). The quality of the water distributed by the small-scale water providers often varies, and the volume price of vended water is typically much higher than utility-provided water. Discussions to suppress these unofficial water supply services are opposed by the water vendors' effective practices to reach deprived residents who do not have access to conventional infrastructure, accounting for many residents in Dar es Salaam, Kampala, Nairobi, Lilongwe, and many other cities in East Africa. The informal sanitation service provision is even more substantial in many of these cities, where private companies offer emptying services for on-site sanitation solutions: septic tanks and pit latrines are emptied manually or by vacuum pump to be delivered to public treatment works or dumped elsewhere (Ahlers et al., 2014; Chakava et al., 2014; Dagdeviren & Robertson, 2011; Kjellén, 2006; Moretto et al., 2018; Nganyanyuka et al., 2014; Nilsson, 2016; Tiwale et al., 2018).

Studying urban water and sanitation through an SPT lens sheds light on how water infrastructures are enacted and reconfigured through practices and configure broader

[13] In using the formal-informal binary, we do not necessarily denote poverty or slums when referring to informality. Neither do we want to avoid this binary, since it is a common denominator with powerful political effects. Notions on informality are further discussed in Chapter 1.6.

spaces of metropolitan life. It also illustrates how seemingly disconnected practices are interlinked, such as when they share the same material resource. Water flows link people and practices, allowing dispersed people to reconfigure the flows and qualities of water for others. Putting water use practices central in empirical studies allows us to evade artificial divides of what is material and non-material, how water use is sectorised, what is planned or unplanned, and allows us to move into informality and back easily. However, an SPT lens does not help illuminate why some practices are more 'powerful' to endure than others or how structural properties can be observed through the effects that practices generate for others. When a practitioner, for example, does not have access to the appropriate material resources, or lacks the competences to organise sanitation effectively, the opportunity to perform safe water and sanitation practices becomes exclusive and particular. Structuring elements in society organise practices in this way, but these cannot be observed except through their effects on practices (Arts & Van Tatenhove, 2006; Greene, 2018; Sayer, 2013; Walker, 2013). To understand how existing power relations shape the performance of social practices, we further explore the politics around water use in the next section.

2.5 A political ecology view on urban water

Through the continuous engagement in practices, individuals draw on both material and non-material resources, which not only facilitate their actions but also influence the decisions that others can make. So, although space is produced through processes of social interaction, human agents are also part of a society which they can never fully control (N. Heynen et al., 2006; Spaargaren et al., 2016). Understanding how social practices emerge and evolve requires an examination of the (power) relations between these practices. In this section, we add insights from Urban Political Ecology to understand why some people can construct particular practices while others fail to, with differentiated effects on the distribution of burdens and benefits in society.

UPE approaches pay special attention to how power is exercised to shape the city. Urban development is a process infused with power relations that shape who will have access to or control urban spaces and water resources (Lawhon et al., 2014; Swyngedouw, 1997; Swyngedouw et al., 2002). One can even say that all human actions evolve around the capacity to act with effect, as "to engage in a practice is to exercise a power" (Cetina et al., 2005, p. 28) and power relations are built in the "ordering and the churn of innumerable

moments of practices" (Watson, 2016, p. 181). Both the material environment (e.g. physical layout of a city or infrastructures) and the social environment (e.g. social identities of class, gender, and race) – that together configure social practices – carry structural features that shape social interaction (Lawhon et al., 2014). The capacity to mobilise power allows actors to either uphold or challenge social orders, resulting in divergent sociomaterial geographies.

With structural arrangements influencing how space is organised – implying processes of empowerment and domination, and of inclusion and exclusion – actors do not have equal opportunity to act as the co-creators of society. The history of water infrastructure projects involves many contingencies – of the society's history, of previous rounds of infrastructure and capital availability – that mould water management options differently for different groupings (Amoako & Boamah, 2020; Crow-Miller et al., 2017; Nilsson, 2016a; Tiwale et al., 2018). Examples from Nairobi and Dar es Salaam show that the absence of convenient water supply networks forces people in informal settlements to fetch water over long distances or rely on informal networks of private water vendors, which take up considerable time and money. Similarly, the absence of sanitation and waste collection services results in open drains along roads doubling as sewers and waste dumps. The informal water networks and open waste drains affect human health and the interconnections with education, livelihoods, and well-being (Chakava et al., 2014; Crow & Odaba, 2010; Dill & Crow, 2014; Kjellén, 2006). This is not unique to water delivery (or drainage) networks, as the presence of other networks (e.g. electricity, roads, public transport) is often also skewed towards powerful actors and away from meeting equal access for all (Silver, 2015; Watson, 2014a). Infrastructures are moulded to fit particular social purposes and consequently create socio-ecological patterns (or inequalities) that include differentiated conditions of access (Nilsson, 2016a; Tiwale et al., 2018).

These conditions of having access do not manifest themselves overnight; in fact, infrastructural and institutional development shape the city-specific histories and politics that set out the trajectories within which urban dwellers interact. For example, tapping into the comfort and safety of piped water is not easy when the area where you live has been deprived of piped water infrastructure. Lawhon et al. (2018) give an illustrative example of Amaka, a composite character in Kampala, who, while moving through urban spaces, uses different sanitation devices with diverging social, spatial, ecological, and economic implications. While it shows that actors are (to a certain degree) flexible in how

their (sanitation) practices are configured, it also illustrates how elements of a practice are context-specific and how "small shifts in health, social relations, weather patterns or state actions – all outside her control – reconfigure her daily sanitation needs and patterns" (*ibid*. p. 721). The urban spaces where people live create material and social boundaries within which actors constitute their practices. Hence, discrepancies between urban spaces imply distinctively different elements from which practices can be constituted. The infrastructural systems in an area generally limit how water use takes shape, while the social group contributes to the availability of knowledge and the formulation of identity and belonging. These material and nonmaterial elements determine the actor's capacity to exert agency and to act with effect. The "user agency to change, adapt, or ignore the available arrangements is circumscribed by social relations, and determined by class, age, gender, race, or religion" (Ahlers et al., 2014, p. 6). Although people are active agents in constituting their own practices, their identities and associated interests may be contradictory and create competition over how the city is made to work.

Earlier, when describing alternative modes of service provision, we have shown how independent water and sanitation providers respond to urban diversity and expansion. Using SPT, we showed the capacities of human agents to be flexible, adapt, and endure, thus accessing and actively producing service configurations. Although presenting it as the active co-production of service provision networks, we also observe that many of these service providers operate in a position where they have limited control over the stability of their practice. Independent providers of basic services complement municipal efforts until local authorities decide to take over and private companies relocate or go out of business. Framing service providers as informal allows the state to ignore their existence and hold the power to remove them at any given time. The state has an active role in the production of space, determining what is informal and what is not, and deciding which forms of informality will thrive and which will disappear (Ahlers et al., 2014; Roy, 2005). Formality and informality "are fluid concepts that say more about the authority to legitimate certain practices than describe the condition of that particular practice" (Ahlers et al., 2014, p. 2). So, human actors exert agency but simultaneously depend on circumstances that they can only control to some extent.

When studying social interaction, issues of power and agency influence the evolution of practices; i.e. the politics through which sociomaterial conditions are made and remade. Using a UPE lens, we emphasised how processes of change produce particular future path

dependencies in urban development and water networks. Therefore, the agency of actors should be situated against the background of contexts that influence them: combining an understanding of *how* interaction and change in the structure of societies take place while incorporating *why* social interaction and change are structured in particular ways. In the context of African urbanism, closely related to the concept of everyday urbanism regularly used in this dissertation, Lawhon et al. (2014) suggest moving towards a 'situated Urban Political Ecology' where everyday practices and diffuse forms of power become a central object of analysis. "The base for theorisation here is the ordinary practices of city-making, including how relations are formed and stabilised, how the city is made to work to secure livelihoods and identities and how people scale themselves through their networks to access resources and opportunities" (*ibid.* p. 507). Studying the everyday practices through which people appropriate space offers insights into what people do and how they do it, while showing that they are inseparable from the diffuse forms of power that structure how life is lived.

2.6 Discussion and conclusions

This chapter aimed to understand the role water use practices play in how cities take shape. To understand the interplay between everyday practices and the structuring socio-material environment within which people interact and society takes shape, we used insights from Social Practice Theory (SPT) and Urban Political Ecology (UPE) when studying the practices and politics of urban water in East Africa. The more extensive literature on water and sanitation service provision offers a useful lens to analyse the practices and politics of irrigated urban agriculture that are central in this dissertation. Here, we showed how the (urban) spaces we are part of are not static but instead socially produced. A focus on water infrastructures serves to understand this production of urban spaces better. Society actively produces the sociomaterial space where water use practices occur, but water flows likewise shape urban society. Although dynamic, flexible, and heterogeneously assembled, water infrastructures are simultaneously also context-bound and path-dependent. In the remainder of this chapter, we highlight the main insights from our analysis and subsequently conclude what this implies for the study of and engagement with water use practices in cities.

A focus on practices emphasises what is actually happening (the actual acts of doing) rather than what is technologically or institutionally planned, therefore offering a better

understanding of how people flexibly cope with the opportunities and challenges of day-to-day city life. Studying urban dynamics as a web of interconnected (sociomaterial) practices shows a bricolage or hybrid configuration of water and sanitation service provision unrestricted by artificial divides of what is social and material, what is planned or unplanned, and to move into informality and back easily. Due to the pressure on water supply and sanitation in many East African cities, urban water systems are pragmatically reconfigured by their users to fit local conditions. The patching together of heterogeneous sociomaterial elements creates mixtures that 'work' for their producers. In this way, water infrastructures function as living systems that extend through social practices around them, emphasising how networks are dynamic, flexible, and heterogeneously assembled by the actors involved. Therefore, the notion of infrastructure could also be broadened to include 'people as infrastructure' or 'social infrastructure' (McFarlane & Silver, 2017; Simone, 2004). This patchwork of practices provides urban water and sanitation services to the majority of dwellers in growing cities across East Africa while contrasting with modern discourses of formalisation and centralisation. Although not formally planned or recognised, people appropriate space for the improvement of their lives and thereby co-shape the city.

Since social practices are both the result and precondition of the production of society, these singular moments of doing are also the social interactions that produce society over time in ways that make the opportunities to participate particular. Social differentiation and existing power relations shape the performance of social practices and the reproduction of inequality and injustice in service provision networks of water and sanitation. As illustrated in the literature on different cities in East Africa, water networks carry important historical imprints of how and where access to networks of water provision and sanitation occurs and subsequently evolves. This differentiated access to water and sanitation does not occur overnight; contrarily, it is the product of the specific history of a city (and creates conditions of possibility). Prioritisation and fragmentation create imbalances in urban development and continue to create divergent geographies with inequalities in the access to public services and economic prospects. While actors exert agency by constituting practices that align their interests and convictions, their identities and associated interests may be contradictory and create competition. The production of urban space through webs of practices is therefore differentiated,

contentious, and infused with power relations that shape who will have access to or control over urban spaces and water resources.

Human agency thus operates through the effects of water and its flows, which are often unevenly distributed across the urban landscape. The individual's ability to contest and reproduce practices is situated contextually in a socio-material setting that structures how life is lived. This shows the politically-constituted space in which everyday practices are placed. This conceptualisation of social practices as part of politically-constituted spaces is applied to the case of irrigated urban agriculture throughout this dissertation and further conceptualised in Chapter 1.3. A combination of SPT and UPE understandings – such as used here – is helpful for researchers, policymakers, planners and practitioners to understand water infrastructures in African cities, respectively focusing on the *how* of interaction and change through practices while raising questions around *why* social interaction and social change is structured in particular ways. Combining micro-level studies on how practices are interlinked, mutually shaping, and embedded in extended networks of everyday city life with a broader appreciation of the institutional and political structures enhances the understanding of dynamics around water use and urban living. In order to incorporate alternative forms of organisation around water and sanitation provision as part of urban development trajectories, planning and governance must engage with those who actively participate in urban (water) networks but often remain unrecognised and unaccounted for in their efforts to co-create these systems of service provision.

CHAPTER 3

3

Going with the food flow: The contribution of urban agriculture to a growing African city

"Mchicha ni mali"

Sub-Saharan Africa's rapid urban growth is causing a decline in urban agricultural land, reducing access to healthy local food for citizens. This paper quantitatively and spatially describes the contribution of urban and peri-urban producers to the availability and accessibility of fresh leafy vegetables in the growing city of Dar es Salaam, Tanzania. Based on over 700 surveys with food vendors and consumers, as well as ethnographic research with farmers, we show how a total of 70 per cent of all amaranth consumed in Dar es Salaam was found to be produced within the city. With an average distance travelled from farm to fork of 11 km, leafy vegetables have a strongly localised foodshed. The results show the ongoing significance of urban areas in meeting their own food demands, emphasising the necessity to explicitly integrate food provisioning in the planning of growing African cities.

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Quote: 'Amaranth is wealth'. From an interview with farmer Y5 in Sandali ward on 4 June 2021.

3.1 Introduction

Sub-Saharan Africa's cities are rapidly expanding, reshaping landscapes and societies in a myriad of ways. Increasing poverty and inequality in cities as a result of unplanned growth pose disproportional food security challenges for economically marginalised groups. The urban poor, when compared to rural areas, are believed to be particularly vulnerable to food insecurity given the high dependence on the cash economy in cities (Battersby, 2011; de Zeeuw & Drechsel, 2015; Ruel et al., 2017). The (global) trade disruptions caused by the Covid-19 pandemic have shown that food insecurity increases due to income loss and rising food prices (Nechifor et al., 2021). The FAO's global study on Covid-19 found that urban areas with closer access to agricultural land (thus shorter supply chains) are more resilient to such food system disruptions (FAO, 2020). Nonetheless, food insecurity has long been viewed as a rural, production-based issue that is outside the mandate of city authorities (Crush & Frayne, 2011). As a result, food systems thinking is largely absent in the planning and policy of many African cities despite playing an important role in urban sustainability and resilience (Battersby & Watson, 2018b; Davies et al., 2021).

While local food production can contribute to urban resilience, much of the urban land expansions occur on agricultural land (Barthel et al., 2019; D'Amour et al., 2017; J. van Vliet et al., 2017). The expansion and densification of cities thus go together with the loss of agricultural land and the displacement of farmers; something which is often overlooked in African urban planning (Shannon et al., 2018; Zoomers et al., 2017). The impact of these processes on the availability and accessibility of food is largely unknown and may pose risks to food security. There is a resulting gap in understanding the contribution that urban and peri-urban farmers make to urban food security in Africa. By taking the food system of Dar es Salaam in Tanzania as a case example, the objective of this paper is to assess the contribution of local vegetable production to the food system. We do so by (1) quantifying the contribution of urban and peri-urban agriculture to the availability and accessibility of leafy vegetables in the city and (2) spatially mapping the food supply chain from production to consumption. We use the 'foodshed' concept as a way to geographically map the flow of food from producer to consumer, as if it were a watershed (Peters et al., 2009). Foodshed analyses have proven useful in studying the relationship between people (food) and place (shed) through a study of the flows of food from producer to consumer. However, especially in the Global South, where urban development is expected to have a major impact on both dietary patterns and land use,

there has been limited research into the configuration and functioning of the city region foodshed (Hemerijckx et al., 2023; Schreiber et al., 2021).

The contribution of urban agriculture has generated considerable debate regarding its actual contribution to household food and nutrition security. As urban agriculture provides the most 'local' food to cities, the debate in the literature concerning its importance (Davies et al., 2021; Poulsen et al., 2015; Zezza & Tasciotti, 2010) somewhat mirrors the discussion surrounding the relative benefits of local versus global foodsheds. Proponents of urban agriculture point to its socio-cultural relevance (Battersby & Marshak, 2013; Olivier, 2019), economic opportunities for urban dwellers (Mensah, 2023), and contribution to food system outcomes such as food security (Maxwell, 1995) and dietary diversity (Hemerijckx et al., 2022; Poulsen et al., 2015; Warren et al., 2015). However, others argue that it provides a marginal contribution to food security, if any (Davies et al., 2021; Frayne et al., 2014, 2016; Riley & Crush, 2023), and that farming within cities cannot be the main focus of a sustainable strategy toward just, healthy urban food systems in low-income countries (Badami & Ramankutty, 2015). While it is acknowledged that (peri-)urban agriculture alone will not be able to feed entire cities or fulfil all household food needs, it may constitute a relevant and needed source of food to meet urban food demands. Aside from the debate for or against the continuation or further expansion of urban agriculture in African cities, this study responds to the need to quantify the status quo of urban agriculture and its contribution to the food systems of rapidly growing cities.

With a population rapidly approaching 5.5 million (NBST, 2022), Dar es Salaam in Tanzania is chosen as a case study to exemplify the growing number of large-sized cities in Africa where rapid expansion puts pressure on the urban food system. Urban agriculture has been consistently present in Dar es Salaam over the past several decades (McLees, 2012; Chapter 4). Because of its unique characteristics – including limited space, insecure land tenure, and proximity to markets – which distinguish it from rural agriculture, the cultivation of perishable vegetables is common in Dar es Salaam. This trend is similar to urban agriculture in many other African cities (de Zeeuw & Drechsel, 2015; FAO et al., 2022; Shackleton et al., 2009). The green leafy vegetable amaranth (*Amaranthus* spp., *mchicha* in Swahili) was selected for further study because of its prevalence and known health benefits. Leafy vegetables, as a side dish to starchy staple foods, are an important part of the traditional diet in Africa containing high nutritional value while being easily accessible and affordable, although their consumption is on a reported decline and is often

associated with low social status (Gido et al., 2017; Mwadzingeni et al., 2021). Our analysis is specific to amaranth and indicative for leafy vegetables while simultaneously shedding light on the contribution that urban farmers make to the availability of healthy foods. Previous studies have shown that around 7 per cent of the total food requirements of Dar es Salaam are derived from local urban and peri-urban production (Schmidt, 2012), with 90 per cent of the city's leafy vegetables grown locally (Stevenson, 1996). Although these figures are popularly cited, the population in Dar es Salaam has tripled over the past three decades and a lot of former agricultural land has ceased to exist in its original form. This stresses the need for primary data to provide an in-depth understanding of the current foodshed, as well as to examine how food supply chains are changing over time.

We continue this paper by elaborating on the methods employed to study the foodshed of Dar es Salaam. Following this, we explore the city's foodshed by presenting the perspectives of consumers, vendors, and producers. While presenting these different perspectives, we quantify and spatially map the foodshed. We finish by reflecting on the study's limitations. In our conclusions, we summarise our findings and discuss implications for foodshed research and for practitioners who wish to incorporate food provisioning in the planning of growing cities.

3.2 Material & methods

This study quantitatively and spatially assesses the contribution of urban agriculture to the food system in an African urban context, using leafy green vegetables in the city of Dar es Salaam as a case study. The city is subdivided into five municipalities (or districts) which together constitute Dar es Salaam Region (Figure 6). All agricultural activities within this region can be considered 'urban', although we elaborate in several places on the particularities of these spaces. When referring to peri-urban areas in this paper, we broadly refer to the outskirts of the city towards the region's border where the landscape consists of a mix of urban and rural land uses and livelihoods.

Data collection

To provide a better understanding of the present-day foodshed of Dar es Salaam, a current primary dataset is needed that can provide information beyond outdated quantifications on the significance of urban agriculture (e.g. Stevenson, 1996). Stakeholder interviews and three rounds of surveys (by the first author, supported by three local research assistants) were conducted between September 2021 and April 2022.

This was combined with ethnographic research by the first author in six urban agricultural areas between May 2021 and July 2022. Two rounds of surveys focused on the relationship between producers and vendors, while a third round of surveys focused on the relationship between vendors and consumers. Based on eleven stakeholder interviews, a list of vendor types was created that reflects how urban consumers commonly access leafy vegetables: direct farm access (either by purchasing or own cultivation), markets, street vendors, supermarkets, and fruit and vegetable stalls (this category includes the retail shops where fruits and vegetables, as well as other food items, are sold). Following survey testing, two rounds of surveys were conducted with vendors ($n = 365$), considering the intra-annual variability of food flows. The surveys focused on vendors' food retail and provisioning practices, specifically to understand where amaranth is sourced from. For every municipality included, the two largest markets and the known large supermarkets were selected, as well as one market, vegetable stalls, and street vendors within a random selection of one-tenth of the municipal wards.

The third round of surveys ($n = 358$) focused on the consumers' purchasing behaviour, specifically to understand which of the different food vendor types are most commonly used by households to access amaranth. It was hypothesised that food accessibility, such as purchasing power or market infrastructure, varies across the city. To address this, a pattern of rings based on the distance from the city centre was established to encompass intra-urban, urban, and peri-urban areas (see Appendix). Locations were selected purposively along every ring to cover different areas based on the known socio-economic differences. At every location, 20 surveys were conducted with pedestrians during a transect walk. People were asked from what food vendor, why, and how many bunches of amaranth they purchased every week. Besides this, questions were asked about household characteristics to check the quality of the sample against existing household surveys conducted in Dar es Salaam (URT, 2020b). Since the respondents were not necessarily living in the direct vicinity of where the survey took place, the data was linked to the respective ward of residence. The survey data is shown in Figure 6 and all survey locations can be found in the supplementary materials published online.

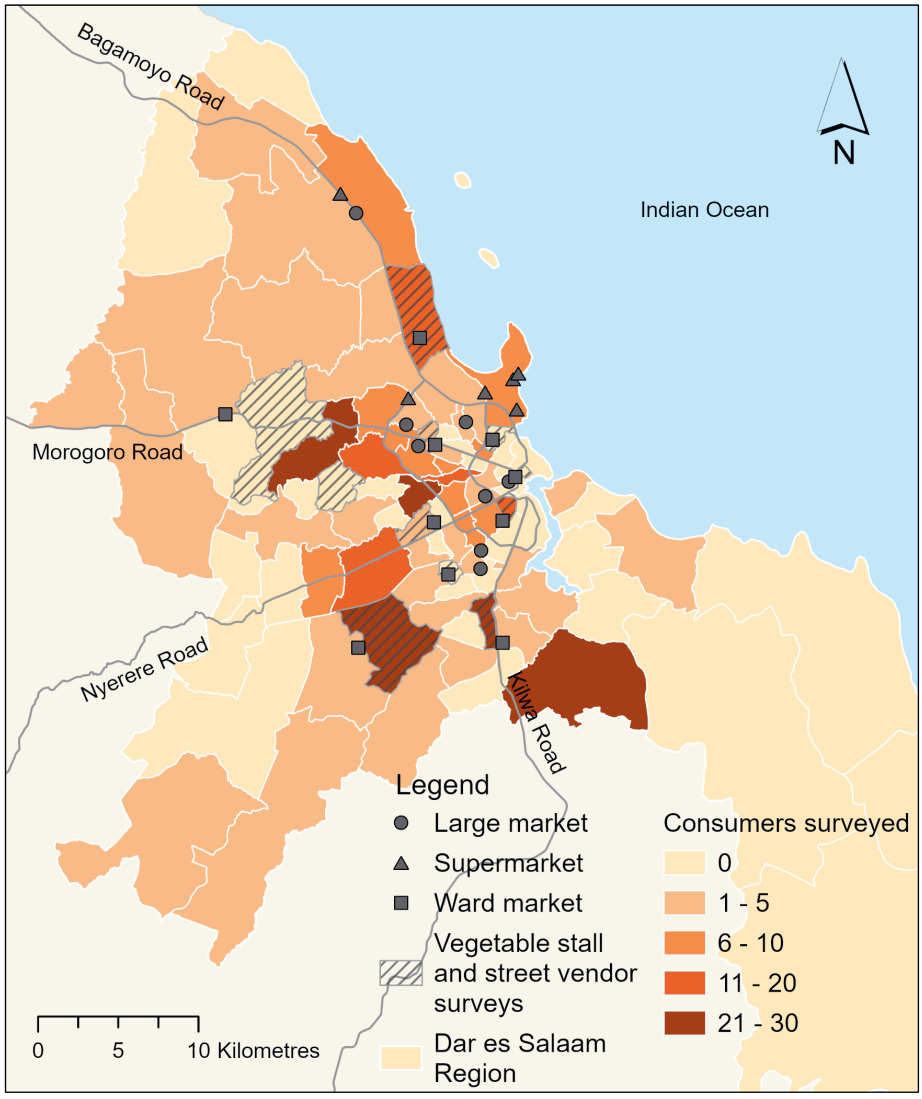

Figure 6. Map of Dar es Salaam Region showing the different survey locations and the number of consumers surveyed per ward.

Foodshed analysis

As this study 'goes with the food flow', we traced the consumed amaranth back from its place of consumption, via the food vendors, to its origin location of production. The analysis (carried out in Python version 3.9.7) presents an extension to the consumer foodshed workflow by Hemerijckx et al. (2023) with the difference that the current analysis quantified the foodshed in absolute quantities (by bunches of amaranth) instead of by its equivalent retail value. In addition, our adapted workflow enables vendor-vendor

interactions to be traced, i.e. when vendors obtain their supply from wholesale markets. The dataset of households (n = 358) and their amaranth consumption was linked to the vendor dataset (n = 365) based on the vendor type where each household indicated they obtained their amaranth supply. The workflow is shown in Figure 7 below. Surveyed households that did not consume any amaranth (n = 12), households living outside the study area (n = 6), and vendors who did not sell any amaranth (n = 4) were excluded from the analysis. Households that did not provide a quantity (n = 67) but could explain where they sourced their amaranth, were given the average number of bunches consumed by a household of that size. We assume households obtain amaranth from vendors within their ward of residence, and if multiple food vendors or origin locations are found, the amount (in bunches) is divided equally. If no vendors were surveyed in their specific ward of residence (72% in our survey), the household was linked to vendors within their respective municipality. The foodshed is mapped by assigning the consumed bunches of amaranth to the production locations indicated by the vendors. Once production and consumption locations are known, the average distance travelled from farm to fork is mapped separately to display the consumer foodshed extent (comparable to the 'food miles' concept). These distances are calculated as the Euclidean distance between the centroids of the urban ward of consumption and the urban ward or rural region where the amaranth was cultivated. Many amaranth vendors sourced their produce not directly from the farm but rather at other markets (at 'wholesale vendors'). As both wholesale and retail vendors were found at markets, surveyed vendors selling over 50 bunches per day are considered 'wholesale vendors'. This value was selected as most market vendors offering a wide array of food items for direct sale to consumers – compared to vendors selling leafy vegetables only – sell below this number on an average day.

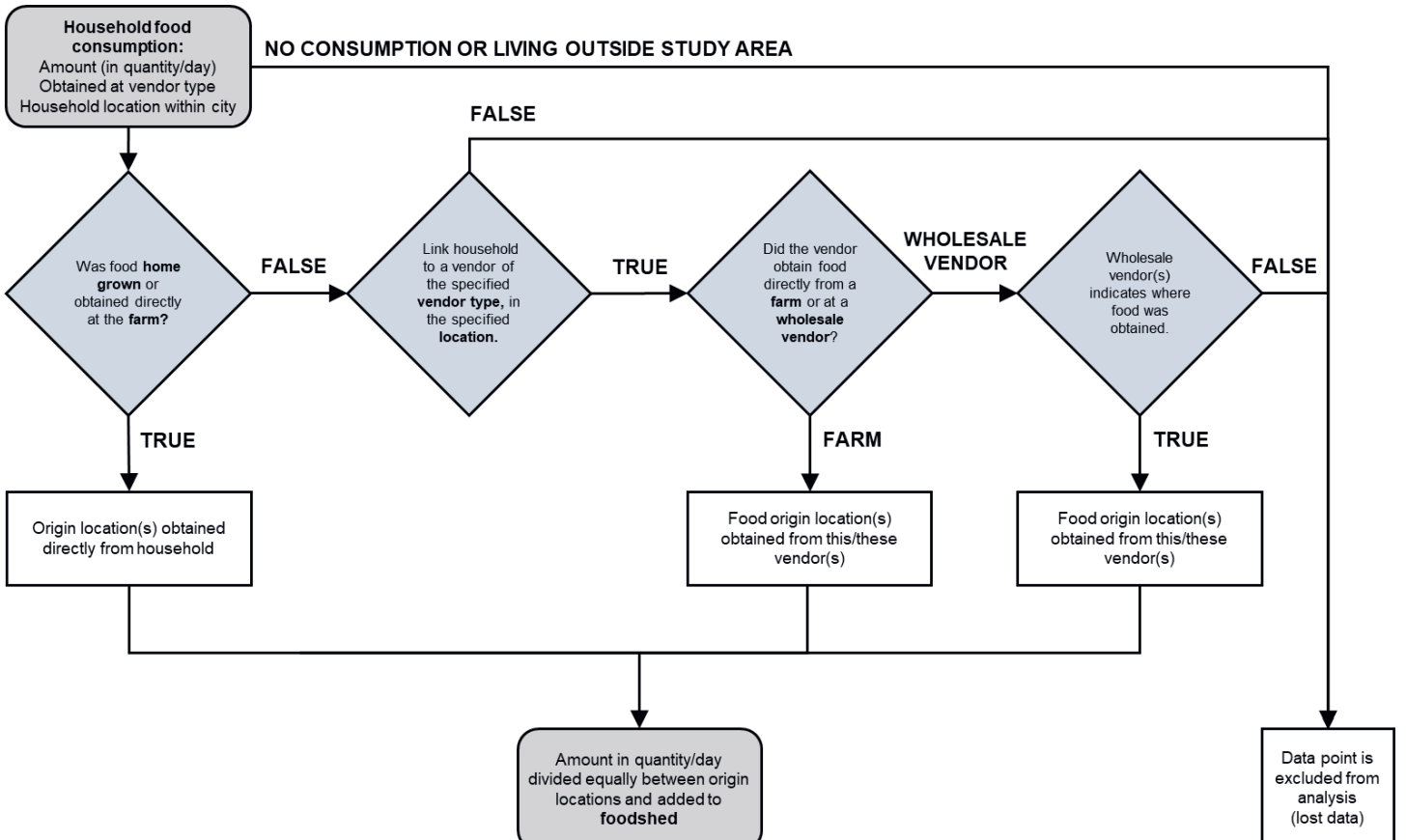

Figure 7. The workflow shows how food consumed by surveyed households is traced back to its origin location. In the context of this paper, the scale of the location is a ward or municipality in Dar es Salaam.

3.3 Results and discussion

The role of consumers and vendors in Dar es Salaam's foodshed

Going with the flow of food within the foodshed gives a comprehensive view of the production locations and the routes taken by the food from farm to fork. For Dar es Salaam, the surveys showed an average household consumption of 4.8 bunches of amaranth per week. As only twelve of the surveyed households did not consume amaranth, this shows how most households regularly consume this leafy vegetable (from daily to several times a week). This is similar to leafy vegetable consumption by urban dwellers in Kenya and Uganda (both about twice a week) (Gido et al., 2017; Hemerijckx et al., 2022). One-tenth of the surveyed consumers directly obtain their amaranth at a farm, either by growing it themselves or by conveniently purchasing leafy vegetables from nearby farmers. The wards where these respondents reside are primarily located in peri-urban areas. This demonstrates that the shortest distances between producer and consumer locations can be found in peri-urban areas where the landscape consists of a mix of urban and agricultural land uses, livelihoods, and lifestyles.

A total of 90% of the surveyed consumers in Dar es Salaam rely on food vendors rather than direct farm access to obtain their leafy vegetables (Table 2(a)). The most important types of food vendors with regard to leafy vegetables are street vendors (36%) and vegetable stalls (31%). These types of informal vendors that are located close to the consumer are a particularly important economic space for women through which food supply reaches the eater's doorstep. Informal vendors play a prominent role in Africa's urban food security despite facing policy neglect or opposition (Battersby & Watson, 2018a; Skinner, 2016; Wegerif, 2017). Ambikapathi et al. (2021) similarly showed the importance of semi-formal and informal vendors in Dar es Salaam, additionally revealing that 78% of these vendors were women, up to 95% for vendors of leafy vegetables. With the expansion of supermarkets into urban Africa, a decline in the presence and importance of these informal food retailers was expected, but the much talked of supermarket revolution has not materialised in Dar es Salaam and many other African cities (Hannah et al., 2022; Nickanor et al., 2021; Wegerif, 2017). Several supermarkets, including Shoprite and Game, have closed their shops in Dar es Salaam over the last few years. The survey and stakeholder interviews show that supermarkets are generally used by a small proportion of citizens, an elite group, as they are more expensive and less

accessible. This corresponds to research by Wanyama et al. (2019) and Hemerijckx et al. (2023) in Kenya and Uganda.

Moving to the vendors' sourcing strategies, they mainly source their amaranth supply directly from farms and by purchasing from wholesale markets (Table 2(b)). More than half of the market vendors (60%) that sell to consumers obtain their amaranth at (other) markets, which shows the difference between wholesale and retail market vendors. It is common to buy leafy vegetables in large bunches (either at markets or from farmers) and split them into smaller bunches later. Other examples of sourcing amaranth are vendors having their own farms, receiving vegetables from farmers elsewhere via telephone orders, or picking up vegetables in the ward of residence before travelling to the location of their vending business. The price per bunch of amaranth sold by vendors (including farmers selling directly to customers) ranges between 200 and 350 TZS (0.09–0.15 USD at the time of research). The prices fluctuate based on scarcity or abundance due to seasonality, location, and size of a bunch. Interviews found that the size of a bunch sold to consumers can differ over the season in order to deal with price fluctuations. Thus, the size of the bunch rather than its price usually fluctuates when leafy vegetables are scarce or abundant (interview 26 May 2021; 9 November 2021). Vendors with vegetable stalls prefer market locations to source their goods, as they offer a larger variety of food items than what is readily available at urban farms. Street vendors primarily source their leafy vegetables directly from farms (64%). With a variety of leafy vegetables grown on urban farms, they move from door to door to sell at affordable prices.

Table 2. Sources where vendors and consumers obtain their supply of the leafy vegetable amaranth.

a. Vendor types where consumers obtain their supply

Vendor source	Count[1]	Proportion (by number of consumers)	Proportion (by number of bunches)
Direct farm purchase (including own production)	33	9.7%	10.9%
Market	79	23.1%	21.6%
Street vendor	123	36.2%	38.6%
Supermarket	1	0.3%	0.2%
Vegetable stall	104	30.7%	28.7%
No purchase	12	-	-

b. Locations where food vendors obtain their supply[2]

Vendor type	Count[3]	Farm	Wholesale market	Middlemen (no location)
Retail market	243	38.5%	60.3%	1.2%
Street vendor	14	64.3%	35.7%	-
Supermarket[4]	2	25.0%	-	75.0%
Vegetable stall	102	23.5%	75.5%	1.0%

[1] n= 352; 6 surveys were omitted before analysis since the respondents did not reside in Dar es Salaam; [2] vegetable stall, street vendor, and supermarket are not shown since vendors do not obtain their supplies here; [3] n= 361; 4 surveys were omitted before analysis since no amaranth was sold at the respective supermarkets; [4] the proportion of sourcing locations here is explained by one supermarket indicating the use of two locations

Urban agriculture in Dar es Salaam

The surveys show that consumers in Dar es Salaam are connected to agricultural areas for the provision of leafy vegetables in different ways. Urban agriculture in Dar es Salaam can generally be divided into two categories. The first category includes backyard farming (home-based gardening), where people cultivate crops for home consumption within and around their residences. A variety of crops can be found here that cater for household needs. The second category is farming in open spaces within the city. This market-oriented form of agriculture takes place in vacant areas that are either awaiting development or are deemed unsuitable for it. Farmers in these open spaces sell the majority of their produce to vendors and a small portion to residents from the direct vicinity. Amaranth is the most common vegetable for commercial farmers to start with, as it has a high market demand. A farmer commented on the benefits of this crop choice by saying that '*mchicha ni mali*' (which can be translated as amaranth having 'significance' or 'wealth'; interview 4 June 2021). Most farmers interviewed during fieldwork indicate that they derive a reliable income and have more employment stability compared to other (informal) jobs. Urban agriculture is also mentioned as compatible with other kinds of employment and therefore offers an opportunity for risk reduction by diversifying income sources. When farmers can obtain sufficient space, they diversify with other (leafy) vegetables to strengthen their marketing position. This is important since there is a reported increase in leafy vegetables from rural areas. Trucks from areas such as Morogoro (which has a good road connection with Dar es Salaam) travel through the night to supply leafy vegetables to several large markets in the city. Urban farmers therefore put more effort into getting permanent customers and securing buyers in order to lower their dependence on markets.

Urban sprawl puts pressure on the limited space available for farming within the city. Farmers find themselves in a position of uncertainty regarding their (often informal) access to agricultural sites, as they have already been forced to move before, have lost land due to construction in the same location, or have been informed about planned development. A farmer illustrates this tenure insecurity by saying: 'There is no hope for this land. There might be construction in the evening and the next morning your land is not there anymore' (interview 16 June 2021). Chapter 4 gives an example of an agricultural area within the built-up areas of Dar es Salaam that transformed into an industrial site. In these processes, it is not only the farmers who must adapt but the entire foodshed as well.

Most farmers try to secure land further towards the urban periphery where the pressure on land is less acute. This implies that food supply chains towards consumers become longer, thereby enlarging the foodshed. Despite the agriculture-to-urban land use transformation, urban agriculture (as a practice) shows persistence to its changing environment, largely without any state or other institutional intervention (Drechsel & Dongus, 2010; Chapter 4, 5).

Quantifying and mapping the foodshed

Knowing the quantities and directions that amaranth travels enables us to provide quantitative and spatial insight into the foodshed. Figure 8 gives a complete overview from consumer to producer. Starting from the consumer and tracing backwards, we found that 11% of all amaranth is directly sourced from farms within Dar es Salaam. For the remaining part, citizens rely on a combination of different types of vendors of which street vendors (38%) and vegetable stalls (29%) are most prominent for the purchase of amaranth (see also Table 2). As shown in Figure 8, when combining all food flows and disregarding lost data, a total of 70% of the amaranth that is consumed comes from agriculture within Dar es Salaam while 30% per cent is supplied by rural agriculture. The rural-to-urban food provisioning comes from regions in Tanzania that have a relatively good connection with infrastructure to supply food to the city. Examples of regions that are found to be sources of amaranth are Morogoro and Pwani. This supply enters the city primarily through the municipalities' main wholesale markets. Comparing these findings with previous research on green leafy vegetables, the percentage of urban production in other African and Asian cities is found to be 70 per cent and above (de Zeeuw & Drechsel, 2015; Orsini et al., 2013). When compared to the previous study in Dar es Salaam that reported a value of 90 per cent (Stevenson, 1996), we observe a decline in amaranth production in the city which can be attributed to the agricultural- to-urban land use transformation within Dar es Salaam Region that pushed agriculture outside of the city's administrative boundaries. Meanwhile, the total amount of amaranth produced by farmers within Dar es Salaam Region has likely increased given the increased demand due to urban population growth. Urban farmers and the city's agricultural officers confirm a trend of agricultural practices switching from staple crops to vegetable production in different parts of the city.

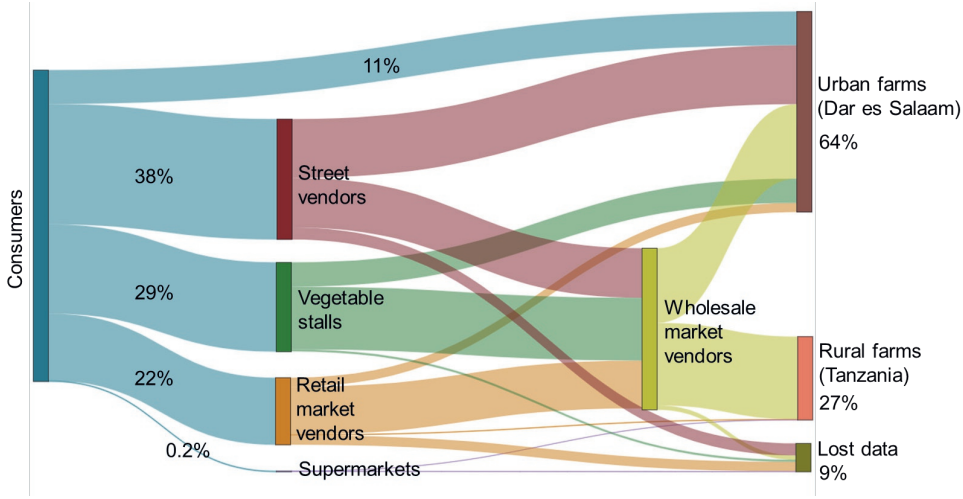

Figure 8. Amaranth flows in Dar es Salaam.

Figure 9(a) portrays the areas where amaranth is grown within Dar es Salaam. Most urban farming activity takes place in wards that can be considered peri-urban. Examples are the wards of Kitunda and Kivule which are important production areas often mentioned by vendors as their source location of amaranth (shown as >10% in the figure). Although all wards within the Dar es Salaam Region have been considered urban in this context, the variation is worth mentioning. Where most urban agriculture takes place on the outskirts of the city, there are also agricultural areas within the built-up areas that continue to contribute to the availability of leafy vegetables while being confronted with urban pressures (e.g. water pollution, see Chapter 6). Also, one can find (leafy) vegetables being produced just outside the urban administrative region (therefore regarded as rural agriculture here) but showing strong urban characteristics due to their interlinkages with the city. Contrary to the production of other food items, leafy vegetables such as amaranth and other fresh food items (e.g. milk) have remained prominently present in the city region. The agricultural land use patterns in and around the city are configured so that high-value, perishable goods are produced closest to the consumer, while other agricultural commodities are produced further away. This aligns with the Von Thünen model about the relation between markets, production, and distance, which creates different food chain configurations for different food items (Moustier et al., 2023).

Regarding the length of the amaranth foodshed (shown in Figure 9(b)), the shortest distances (under 7.5 km) are travelled by the amaranth from the origin locations towards household consumers in the area where the highest share of amaranth is produced. Please note that distances are calculated as the Euclidean distance between ward (or for rural sources, the region) centroids, which may explain why being close to larger wards or rural areas may result in larger average foodshed distances. While the study area spans a distance of over 60 km from north to south, the average distance travelled by the consumed amaranth is just 11 km and therefore shows a strongly localised foodshed.

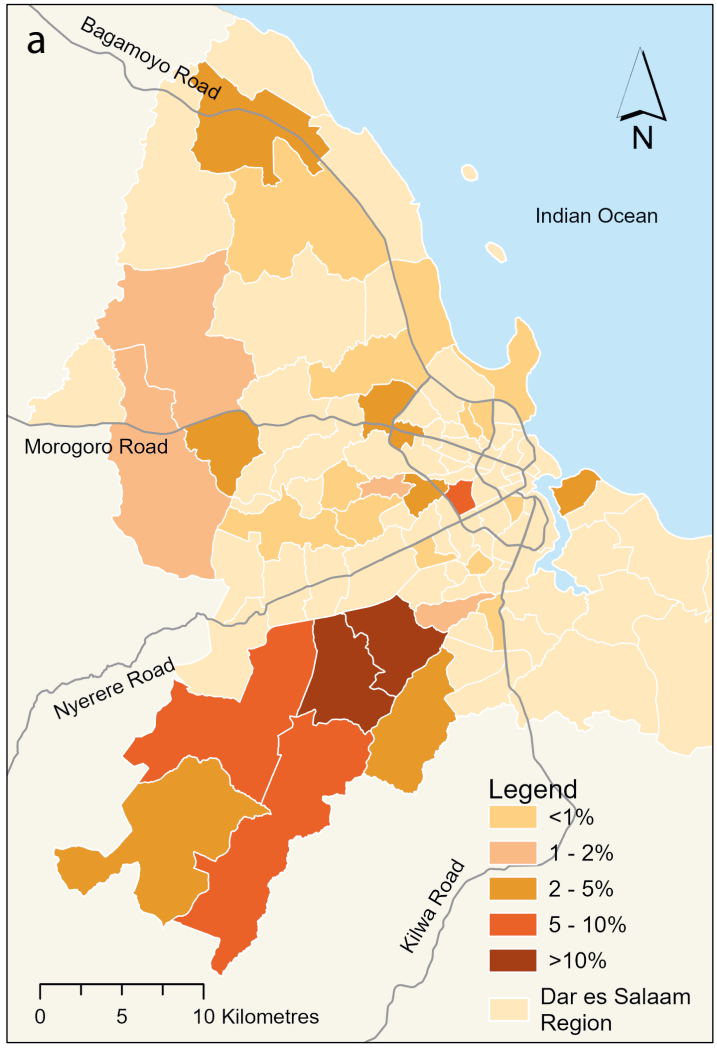

Figure 9(a) Distribution of production locations of amaranth within Dar es Salaam, as indicated by food vendors.

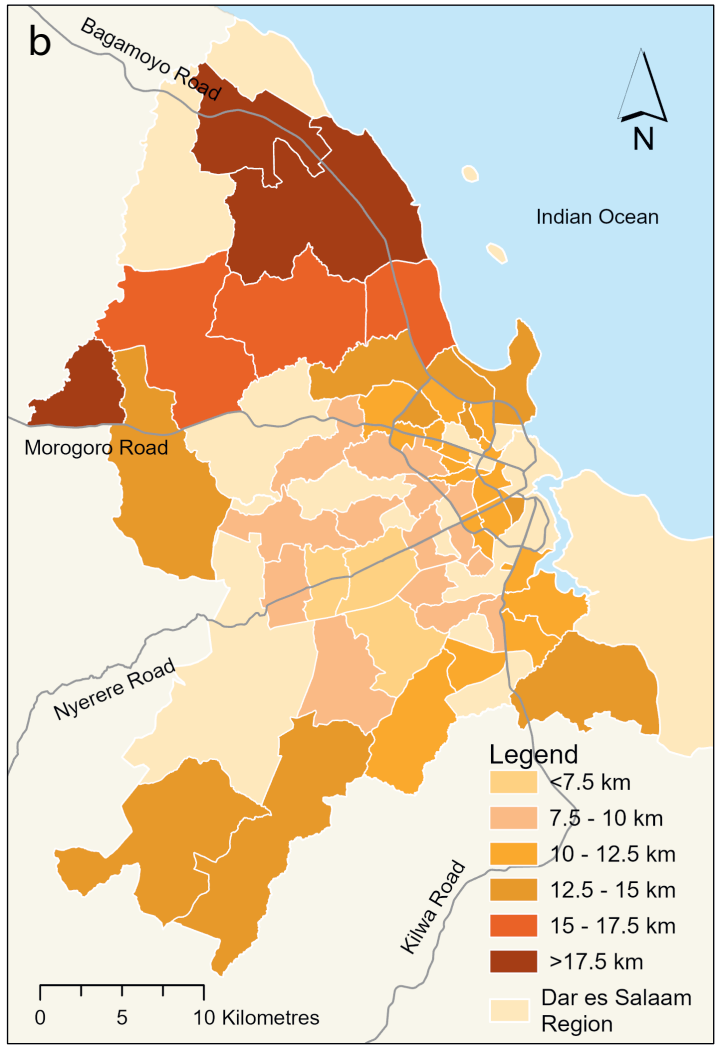

Figure 9(b) Average distance travelled by amaranth from producer (farm location) to consumption location.

Limitations

While this study provides an innovative extension to the foodshed approach by Hemerijckx et al. (2023) to visualise food miles and account for vendor-vendor food flows, there are limitations worth discussing. First, our research approach enabled following a vegetable-specific flow in detail, while simultaneously showing the continued role that urban farmers play in the provision of leafy vegetables to the city. The overall contribution of urban agriculture to the city's food requirements should, however, not be overestimated as compared to what is brought to the city from afar. Future research may

therefore, with a similar methodological approach of following the food flow, focus on other food items to further understand what part of the food consumed is grown within the same area. While Dar es Salaam is used here as a case example, this methodology can used for comparative research between cities or longitudinal studies in different geographical locales.

Second, we rely on the survey responses to indicate the origin locations and have triangulated this data with stakeholder interviews and ethnographic fieldwork in several agricultural areas throughout the city. The consumer survey, however, only focused on household-level purchases and did not incorporate other categories such as local restaurants (e.g. so-called *mama ntilie*). The question remains how the sources of food items of out-of-home consumption compare to household purchases. An additional sampling limitation is that food vendors and consumers were not always surveyed in the same wards, which led to 72% of the consumer-vendor links being made at the municipality scale instead. This may lead to an overestimation in the foodshed size for wards were consumers, but no vendors, we surveyed. Also, a limitation that requires further research is the low number of street vendors (n = 14) surveyed. Their constant mobility within urban neighbourhoods posed challenges in engaging with them. Given the regular engagement of the first author with street vendors while conducting ethnographic fieldwork, the surveys conducted are considered representative of the strongly localised foodshed in which they are embedded. The stakeholder interviews and conversations and observations during urban farm visits also confirm the important role that urban farms play for street vendors but an uncertainty remains regarding the exact figures on where street vendors obtain their supply. Further research on the role of street vendors can enhance this quantitative understanding and illuminate policy support for this predominantly female group.

Third, we used Euclidean distances between production and consumption locations in our analysis and visualisation rather than carrying out road network analyses. This means that the actual distances travelled from farm to fork by the amaranth might slightly differ from what is presented here. We believe that this approach provides key insights into the configuration of the foodshed while simultaneously adhering to a methodological approach that can be used for other case studies without the need to collect data on road infrastructure. Nonetheless, future research efforts could include other distance measurements (Charreire et al., 2010) to assess the urban foodshed size.

3.4 Conclusions

In light of rapid urban expansion in Africa, it is imperative to understand the changing configuration and functioning of foodsheds to increase cities' food system resilience. Urban agriculture in Africa is often mentioned as a contributor to urban food availability and accessibility, although quantifications of its actual contribution are scarce and often outdated. This study showed the contribution of urban farmers to the availability and accessibility of leafy vegetables in the city of Dar es Salaam, Tanzania. More than 700 surveys with food vendors and consumers, as well as ethnographic research in urban agricultural areas, enabled us to quantify and map the food flow of the leafy vegetable amaranth. Our study shows that one-tenth of the consumers have direct access to farms in their vicinity while the remaining part of the urban population depends on food vending networks to obtain their leafy vegetables. Two-thirds of all amaranth purchases occur via informal vendors operating in residential neighbourhoods who create the shortest linkages between producer and consumer.

Our analysis shows that the significance of urban and peri-urban agriculture for the availability of leafy vegetables such as amaranth has remained high despite the city's continued growth. Currently, a total of 70 per cent of all amaranth consumed in Dar es Salaam was found to be produced within the city, while a previous study reported a value of 90 per cent (Stevenson, 1996). The decline in total amaranth production in the city can be attributed to the agricultural-to-urban land use transformation within Dar es Salaam Region which has pushed agriculture outside of the city's administrative boundaries. Meanwhile, the total amount of amaranth produced by farmers within Dar es Salaam Region has likely increased given the increased demand due to urban population growth. The boundaries of what is considered 'urban' play an important role in quantitative analyses, although the foodshed has no regard for administrative boundaries. We therefore also showed the localised character of the foodshed by visualising travel distances from producer to consumer. The average distance travelled by amaranth from farm to fork in Dar es Salaam is found to be just 11 km, indicating a strongly localised foodshed for this food type.

Foodshed analyses – such as used in this study – are essential to understand how the flows of food are changing in light of the rapid urban growth in Africa. Foodshed studies enable comparisons over time and between cities to understand how supply chains are changing

and where action is required to enhance the resilience and sustainability of the food system. Our method provides an in-depth and innovative approach compared to prior empirical foodshed visualisations for cities in sub-Saharan Africa (e.g. Hemerijckx et al., 2023; Karg et al., 2016). We explicitly map urban food consumers and their respective food sources as spatially diffuse across the city, whereas previously food consumption within the city was considered as a general 'endpoint' of the foodshed. Our methodology gives insight into the heterogeneous system of providers that create an accessible supply of fresh vegetables to the city but can moreover show where these linkages between producer and consumer are insecure and therefore require action.

This study has several implications for urban planning and policy beyond the case studied. We conclude that there is a continued role for urban areas in providing for their own food demands. As the presence of agriculture in African cities is under pressure, both physically and ideologically, there is a need for urban authorities to actively envision (and strategise) the position of agriculture in the city, and subsequently plan and preserve agricultural land through land use planning or strengthen food flows from rural areas to safeguard the supply of nutritious green leafy vegetables. An analysis of the foodshed can herein inform goal-setting and scenario planning as part of a broader discussion about the benefits of local versus global foodsheds. Besides the food provision mainly focused on in this paper, urban planners should also consider the other ecosystem services that green productive spaces can provide to its citizens. For instance, local production provides economic opportunities for a range of people and the green spaces provided by urban agriculture contribute to the wellbeing of communities by mitigating urban heat islands due to climate change. Incorporating food and the robustness of its supply and accessibility in urban planning ensures that cities can become more liveable, sustainable, and equitable places for all their residents, including those producers and vendors that informally shape the city and its foodshed.

CHAPTER 4

4

Persist or perish. The dynamics of irrigated agriculture in urbanising Dar es Salaam, Tanzania

"The city is all of us, we make the city"

Dar es Salaam (Tanzania) is one of the fastest urbanising cities in sub-Saharan Africa, which has implications for its food security. Based on ethnographic research that focused on understanding how day-to-day agricultural practices are configured, we study the responses of farmers to a changing urban environment. We describe urban agriculture as an expression of active city-making; something which is uncommon since the agricultural sector is typically presented as passive and helpless in the face of urban growth. This paper shows that farmers, despite not being accounted for in urban narratives, co-shape what the city looks like and how it functions. By crafting networks of provision based on the informal access to land and water, they offer food, employment, and more for the improvement of their lives and the wider citizenry. In opposition to land pressure and water resource degradation, farmers adapt their agricultural strategies to benefit from what they can access while dealing with the uncertainties of changing realities. Based on our findings which reflect the characteristics of everyday urbanism, we discuss implications for theory and governance. With African cities risking to grow hungry, a better representation of urban farmers and their irrigated agricultural production in urban planning and governance reduces uncertainties and risks, both for farmers and the wider city.

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Quote: Sara Nandudu, Deputy Chair of Slum Dwellers International. In Carrizosa (2022, p. 3).

4.1 Introduction

> *Eliza[14] is preparing bunches of vegetables for sale in the surrounding urban areas. She is one of many who have come to the city in search of a better life. Arriving in Dar es Salaam, she first had a business selling clothes and years later turned to farming. She now grows vegetables on the riverbanks in the city. Over recent years, more and more houses have been built on the agricultural land in this area and several farmers she knows have been forced to leave. "It will reach a time that if you want vegetables, you have to use buckets and tins to cultivate your vegetables. This is not just what I think, it is the real situation!" (interview, 8 July 2021). The advancing city makes her worried about her future as a farmer.*

The anecdote above is illustrative of the pressure that urban farmers in Dar es Salaam face due to rapid urbanisation. The largest city and de facto capital of Tanzania recently counted a population of close to 5.4 million and with an annual urban agglomeration rate of 5.0% from 1990 to 2018, Dar es Salaam is one of a few cities of this size and with this growth rate in Africa (NBST, 2022; UN, 2018). Despite countless efforts to plan and direct this rapid growth, the city has experienced urban sprawl without adequate planning for decades. More than 70% of the residential land can be described as informal, "meaning that they were built upon without planning designation, surveying, land titling, provision of services and building permit" (Hill et al., 2014, p. 167; Murphy & Carmody, 2019; Todd et al., 2019). The city's limited capacity to cater for new urban dwellers leaves many with limited economic opportunities, reinforcing patterns of inequality and putting food security at risk.

As Africa urbanises, a growing number of urban dwellers face the challenge of accessing sufficient food to meet their dietary needs. Being food insecure remained for a long time largely ignored since development initiatives primarily focused on eradicating rural hunger and boosting smallholder agricultural production. Acknowledging the global dynamics of growing cities, there is a shifting focus of the global development agenda towards the urban population and their food security (Crush & Frayne, 2010; Crush & Riley,

[14] Pseudonyms are used for all research participants to protect their identities.

2019). The urban metabolism of food systems holds a shaping force in the sustainability and resilience of cities, which means that food cannot remain 'peripheral' to urban planning and governance (Haysom, 2021; Smit, 2016; Sonnino & Coulson, 2021). Cities also do not expand into vacuums but encroach into existing natural and agricultural landscapes that contribute to human well-being. Agriculture in and around cities contributes to urban sustainability in ways that extend beyond more traditional understandings of agriculture. Rather than only contributing to food security through production, examples of other urban functions mentioned in literature are beautification, leisure, resource recovery, and urban greening that reduces heat island effects (Ayambire et al., 2019; Contesse et al., 2018; FAO et al., 2022; Gómez-Baggethun & Barton, 2013; Tapia et al., 2021). The loss of land for food production therefore not only raises concerns about the ability to cater for growing urban food demands but also about the other ways through which urban agriculture contributes to the sustainable growth of cities (Barthel et al., 2019; La Rosa et al., 2014; Tapia et al., 2021).

Despite the growing competition over land, urban and peri-urban agriculture can be found across sub-Saharan Africa (Davies et al., 2021; Lee-Smith, 2013; Orsini et al., 2013; Zezza & Tasciotti, 2010). While a lot of previous research has focused on documenting the existence of urban agriculture, there is a lack of understanding about the actual responses of urban and peri-urban farmers to a changing urban environment. Our objective is to fill this knowledge gap by studying how agriculture is shaped by (but also co-shapes) the growing city. We selected Dar es Salaam as a case example due to its rapid growth and the known presence of agricultural practices in the city over the past decades (Dongus, 2001; Mlozi et al., 2014; Chapter 5). We explicitly describe urban agriculture as an expression of city-making; something which is uncommon since the agricultural sector is typically presented as passive and helpless in the face of urban growth and is often considered as a rural activity portraying failed urban development (Follmann et al., 2021; Shannon et al., 2021). Our study shows that urban dwellers (practising agriculture) play an active role in appropriating urban space for their own ends to make a living. We, therefore, believe that the findings in our paper not only contribute to current debates around the role and significance of urban agriculture, but moreover also show how these agricultural practices exemplify the everyday city-making dynamics that are part and parcel of growing African cities.

This study focuses on irrigated agriculture within the city of Dar es Salaam. We see the case of Dar es Salaam as exemplifying other medium and large-sized cities in sub-Saharan Africa where rapid expansion puts pressure on urban land use planning and the urban food geography. We explicitly refer to the irrigation aspect of urban agriculture because (as we will show later) water plays a key role in shaping the interconnection between agriculture and the city. Water remains rather implicit in studies on urban agriculture as it is often regarded as just one of several inputs. In the field of water management, there is more emphasis on this aspect but often with a particular focus on the quality of the water used for irrigation (Drechsel, Qadir, & Galibourg, 2022; Ricart & Rico, 2019; Wichelns & Drechsel, 2011). This frequently underscores the challenges associated with urban agriculture, while farmers often have limited control over their water supply (Chapter 6). In our selection of study areas, we have primarily focused on practices of irrigated agriculture in urban areas while also supplementing this with fieldwork in peri-urban areas (explained in more detail in the next section). We mostly refer to urban agriculture in this paper without differentiating between the urban and peri-urban, as we consider the urban and peri-urban connected through myriad flows of goods, services, and that these divides are of limited use due to the constant change they are subject to given urban growth.

The paper continues by first describing the conceptual lens and research methodology. We also shortly show the wider sets of ways in which Dar es Salaam's citizens already manage and navigate the city with regard to service provision. After that, we turn to our research outcomes and describe how irrigated urban agriculture is formed by its urban environment and likewise shapes what Dar es Salaam looks like and how it functions. Following this, we describe how farmers respond to processes of urbanisation through flexibility and mobility. To illustrate this, we finish this section with an example of one of the study areas to show how agriculture changes over time (Box 1). In the discussion, we reflect on the city-agriculture relationship and point out implications for theory and governance. We conclude the paper by summarising our findings and thoughts on engagement with farmers as active city-makers in light of urban food security.

4.2 Research approach

Conceptual framework

With urbanisation pathways in Africa showing distinctly different from dominant urban planning theory, there is a growing body of scholarly work focused on new understandings of cities that give better right to the context of the cities of the Global South (Harrison, 2006; Parnell & Robinson, 2013; Pieterse, 2011a; Robinson, 2016; V. Watson, 2009). Watson (2009) describes a 'clash of rationalities' in the domain of planning between the logic of governing and that of survival. Planning efforts by the state are responded to in varied ways by those outside of the state and formal business sector who appropriate the city to their own needs in order to survive. "People in their everyday lives engage with the [state-initiated planning] systems in diverse and unpredictable forms – making use of them, rejecting them or hybridising them in a myriad of ways" (Watson, 2009, p. 2269). Since the efforts of ordinary urbanites play an important role in the construction of the African city, emphasis is given to the theorisation of these bottom-up processes of city building. Simone (2004, p. 407) states that "African cities are characterised by incessantly flexible, mobile, and provisional intersections of residents that operate without clearly delineated notions of how the city is to be inhabited and used" and refers to 'people as infrastructure' to describe how Southern cities are made to work through the efforts of people. Pieterse (2008, p. 109) argues that in order to understand the city it needs to be studied "through the eyes of the majority of poor denizens who appropriate the city for their own ends." Bayat (2000, p. 109) uses the term 'quiet encroachment' to describe "the silent, protracted and pervasive advancement of ordinary people on those who are propertied and powerful in a quest for survival and improvement of their lives". Building on this, Swilling (2011) and McFarlane & Silver (2017) distinguish an urbanism 'in its own right' (i.e. slum urbanism, everyday urbanism[15]) in which urban dwellers construct their ways of living despite a lack of access to formally constructed and managed infrastructures.

Building on this understanding of the African city, the theoretical base we use in our analysis is that the city is made to work through the everyday practices of ordinary people. We apply this conceptual lens of an everyday urbanism to the study of agriculture in the

[15] Others refer to 'southern urbanism' or specifically 'African urbanism'. See Parnell & Oldfield (2014) for considerations when conceptualising (the study of) Southern cities.

city, as we believe that this practice shows similar patterns of urbanity despite often being placed outside of urban narratives. Based on a systematic review of urban and peri-urban agriculture, Follmann et al. (2021, p. 3) describe how farmers are "typically presented as passive and helpless in the face of rapid urban growth" and the active responses of farmers to processes of urbanisation are rarely examined. Before studying these farmers' responses to urban growth using this conceptual lens, we first show how Dar es Salaam's citizens already play an important role in the functioning of the city.

Context of the study

In the interface of state-initiated planning approaches and the everyday lives of a growing urban population largely living under conditions of informality, the reality of urban growth and service provision in many African cities is characterised by diverse and hybrid sociotechnical configurations that act partially within and partially outside state regulations (Hossain et al., 2015; Lawhon et al., 2018; S. Letema et al., 2014). Dar es Salaam has shown similar patterns of urban growth taking place mainly beyond formal planning. The city's growth along the coastline and the four arterial roads has created distinct differences between the inner city and the suburban areas towards the peri-urban and the urban interstices. These differences in growth patterns (see Figure 10) have also resulted in service provision disparities. Koepke et al. (2021) show how electricity grid expansion in Dar es Salaam is largely demand-steered based on the mobilisation of resources rather than through proactive planning. This has resulted in an electricity network that is highly diverse in its composition (with social imbalances in access), yet electrifies the city. These infrastructural configurations embody a creative response to a rapidly growing urban society in need of electricity. Similar processes can be observed in the provision of water, where strategies of multiple-sourcing of water and networks of private water vending have appeared as a response to the absence of reliable central water provision (Bender, 2021; Dakyaga et al., 2021; Pastore, 2018; Smiley, 2013). "As much as 50 per cent of the population relies, at least in part, on private vending to secure water. It provides not only for users in poorly serviced formal and informal neighbourhoods, but also wealthier households dissatisfied with their tap water" (Bender, 2021, p. 55). Service provision networks have emerged through the efforts of people in need of basic services but show high levels of fragmentation that are simultaneously structuring people's lives.

Despite the drawbacks of these network configurations (e.g. issues regarding quality and affordability), the amalgamation of formal and informal service providers effectively

reaches the many residents of Dar es Salaam. Citizens are able to employ a number of strategies to access services to survive, if not thrive. This process of crafting systems of service provision shows how urban dwellers can make a difference to an urban state of affairs. This urban agency is however bound to the ability people have to effectively act in ways that align with their interests and demands, which raises critical questions about who is able to direct (thus benefit from) urban growth and who find themselves in an insecure position (Briggs & Mwamfupe, 2000). Relating this to urban agriculture, Chapter 5 shows how farmers in Dar es Salaam are confronted with the increasing pressure of a particular ideal of 'progress' that threatens their livelihood. In the competition over land as a result of urban development, the loss of agricultural land and the displacement of farmers tend to be often overlooked in conversations concerning the planning of African cities (Shannon et al., 2018; Zoomers et al., 2017). We therefore take a methodological approach, which we will now elaborate on, that emphasises studying the day-to-day reality of agriculture in the city.

Methodology

The data presented in this paper is based on ethnographic research in six areas that represent common types of open space cultivation in Dar es Salaam (Figure 10). The selection of study areas is based on 20 exploratory field visits, a literature study, and expert interviews in the run-up to this fieldwork. The selection of study areas can be subdivided into three categories: open space cultivation in (1) river floodplains; (2) low-lying areas; and (3) developing urban areas. The latter category captures irrigated cultivation in urban areas where plots await development. It was decided not to focus on peri-urban agriculture, as agrarian change is distinctly different there. We also did not consider backyard farming (or home gardens) in our study since, although it is also a common type of urban agriculture, this is more household-oriented rather than related to a more extended urban food system.

A period of fieldwork (by the first author, accompanied by a local research assistant) was conducted between May 2021 and February 2022. Informal conversations, semi-structured individual interviews, and participant observation were combined in all areas. This combination of research methods allowed to experience in-depth how agricultural practices are configured, as well as how these practices are embedded in bigger networks of occupying space, using water, and producing food. Regular visits to the study areas created opportunities to conduct individual farmer interviews and the generation of a

shared understanding of how agricultural practices take shape in the city. More than 50 farmers within the six study areas were interviewed at least once, and 37 of them were visited regularly and interviewed several times throughout this period. The fieldwork period was subdivided into three stages with different focuses. The first period aimed to generate a general understanding of the people, practices, and places (e.g. crop choices; irrigation routines; social organisation), while particular attention during interviews was given to changes that had taken place over time. The second period of interviews and field visits zoomed in on marketing strategies and water use arrangements, while the third focused on more sensitive issues such as contamination of irrigation sources, forced relocation, and the public perception of the desirability of agriculture. To better understand the farmers in the urban areas, an exploratory follow-up was conducted in two peri-urban areas using field visits and undertaking 20 interviews. Most interviews were conducted at the farm plot while interviewees were doing activities such as soil preparation, harvesting, or waiting for customers. This strategy of meeting farmers at work (several farmers referred to their plot as their office) helped to better understand the farmers' realities (benefiting from 'show and tell', which adds depth and reliability to the data) and minimised disruption to the farmers' routines. Data analysis was based on a combination of coding and memo writing in the different stages of data collection. This method allowed the design of subsequent data collection based on active engagement with the data already collected. The fieldwork data was supplemented with content analysis to contextualise the research findings.

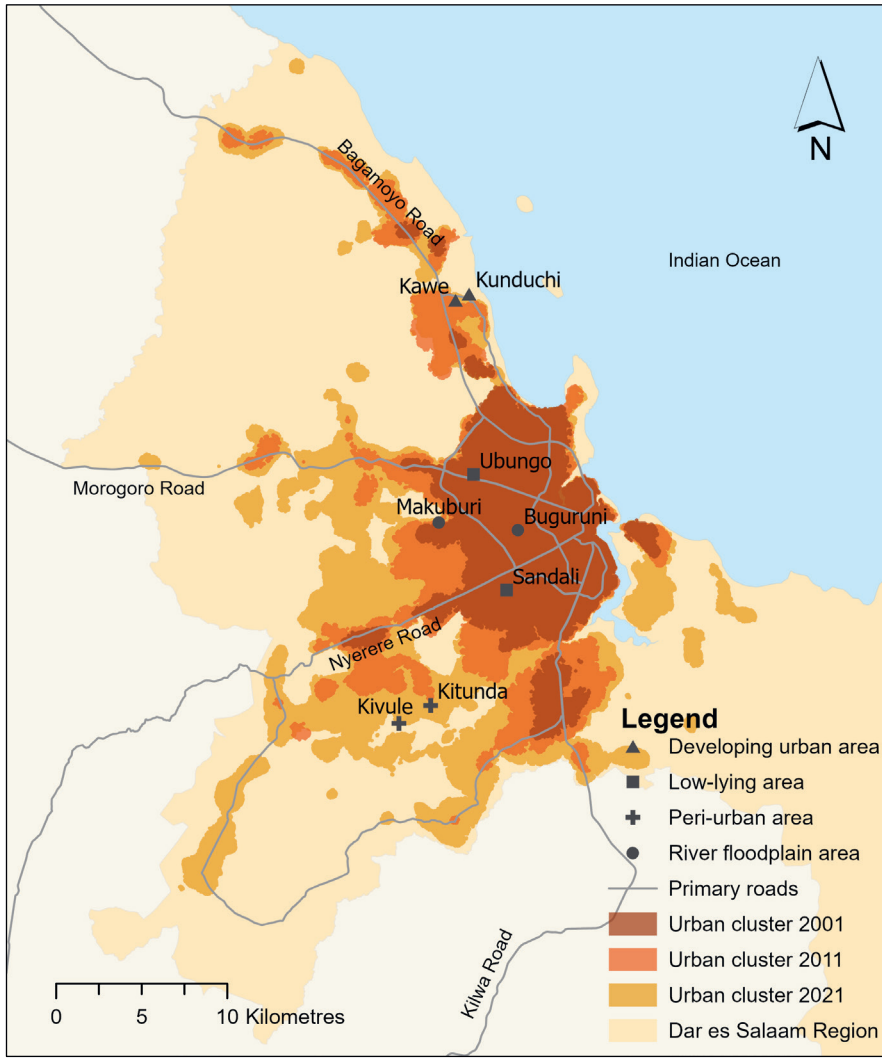

Figure 10. Study area locations with names of the respective wards. The urban clusters show the expansion of Dar es Salaam between 2001 and 2021, see Chapter 5.

4.3 Results

The socio-material context in which agriculture takes place plays an influential role in its configuration, as farmers actively appropriate the urban space around them in order to make a living. The following section describes (1) how irrigated urban agriculture shows clear imprints of the city in terms of its shape and the services it provides and (2) the active responses to urbanisation that have enabled its persistence. By doing this, we show how agriculture is an intrinsic part of the contemporary urban fabric through the everyday interactions of people around land, water, and food.

Irrigated agriculture in the city

The commercial production of leafy vegetables is common in open spaces within the built-up areas of Dar es Salaam. Leafy vegetables (especially *mchicha*, i.e. amaranth) are in particularly high demand since they are part of local traditional diets and need to be grown close to local food outlets to be supplied fresh. Farmers contribute to urban food availability by selling from the farm to street vendors and business(wo)men, with a small part sold directly to consumers. Doing this, they are part of a (largely informal) network of food provision that is adaptive to the urban ecosystem they are part of. This (social) infrastructure of provision not only contributes to the accessibility of food but also provides economic opportunities for a range of people, farmers included. Cultivation on a small patch of land is already financially profitable, especially during the dry season when the supply declines due to water scarcity. Given the short growth periods of leafy vegetables (mchicha has an average growth period of just over three weeks), some farmers describe their income cycle as similar to the monthly salaries from other urban jobs. Studies conducted in Dar es Salaam show that urban agriculture contributes to a reliable household income given low start-up costs, high productivity, and short production cycles (Kifunda, 2019; Lee-Smith, 2010; McLees, 2012; Mlozi et al., 2014; Victor et al., 2018).

To access open spaces within the built-up areas, farmers approach those who own or supervise these unused areas. The farmer that turns the area into productive use – for example by clearing bushes and tilling the land – becomes the right-holder of the land. Tenure arrangements are based on the right to use rather than the right to own; customary rights that can be transferred from person to person. Plots can be sold or rented to others while knowing that the opportunity to use the land can be terminated at any moment. Land governance shows to be a complex system with overlapping formal and customary land rights that can also be seen in other urban regions in Africa. Urban densification and expansion go together with land planning and formalisation whereby these formalisation processes enter (peri-)urban interstices or rural areas with existing tenure structures (van Noorloos & Kloosterboer, 2018)8). In the case of this study, there is a similar intermingling of formal and informal land use plans where farmers make use of urban land based on agreements between the owner and the user (i.e. farmer) to keep the area looked after until development plans materialise. While the number of male and female farmers in this research was found to be fairly evenly balanced, men generally have

a stronger hold over land; they are more often first-time users and have access to larger plots

Most of the urban farmers (92% in this research) are first-generation migrants from different regions of Tanzania. People come to Dar es Salaam in search of opportunities for a better life (many interviewees refer to their motivation as '*kutafuta maisha*', i.e. 'to find life'). New urban citizens, such as farmers here, require time for experimentation and establishing social ties from which effective connections (although often fragile) with the city emerge. On average, the interviewed farmers have lived in the city for 23 years and relied on farming for 17 years, which implies that it is not an activity that is immediately taken up by recent arrivals nor a short-lived activity. Many farmers worked in the informal economy upon their arrival in the city and turned to farming (leaving other jobs) in order to generate more income and have more stability in their employment. This contradicts the popular notion that taking up agriculture is an act of despair in response to urban unemployment (Hovorka, 2004; McLees, 2011; Schmidt, 2012). Urban farmers do come from vulnerable jobs (insecure, informal), but their turn to agriculture can likewise be described as a move towards better employment conditions and prospects.

Social organisation is generally limited in the different agricultural areas studied. Wesselow (2019) describes how social heterogeneity and the temporary nature of agricultural locations limit the establishment of solidarity-based interactions among farmers. Existing social organisation revolves around occasional matters, such as collective responses to land being taken (also see Box 1) or the use of irrigation sources. While irrigation, which takes place with petrol pumps and/or by using buckets and watering cans, is generally allocated on a first come first service basis, farmers can negotiate irrigation scheduling and the use of particular sources when water is scarce. These sources often have customary ownership based on the contribution to construction or maintenance; making use conditional at times. The only situation in which collective organisation takes place is around the use of the piped water system. In some agricultural areas within the developing urban areas, farmers make use of metered water points. The amount of water used per individual is recorded in a book and the bill is paid collectively at the end of the month.

The water supply for farmers is woven into Dar es Salaam's water system, which exposes farmers to changes occurring elsewhere in the water system (we return to this point in the

next section). Besides (seasonal) rain, different types of water feed the farmers' irrigation sources: groundwater, piped water, and wastewater. Groundwater is drawn from the coastal aquifer, which also supplies water for domestic use through boreholes in the residential settlements. Piped water can be either directly drawn from a tap or indirectly benefited from when water is lost during transmission. There are also different types of wastewater, which can come from domestic or industrial sources (or a mixture) and be raw, partially, or fully treated. The main irrigation sources fed by these different types of water supply are rivers, canals, shallow wells, and water taps. Rivers are a common source of irrigation since food risks during the rainy season prohibit housing in the adjacent areas; offering opportunities to cultivate. The larger the river system, the more complex the understanding of what types and proportions of water supply it is fed by. Water in the canals is often excess water draining away from residential settlements (mostly rainwater and domestic wastewater). The canals are unlined waterways with in-stream reservoirs that hold back excess flows before draining into the rivers. These reservoirs allow for irrigation when the water supply is limited, increasing the buffering capacity of the irrigation systems. For shallow wells, they fill up with surface run-of during the wet season and return to their natural groundwater level after the rains stop. Finally, water taps are used for irrigation in some areas. Farmers can benefit from the convenience of clean and pressurised water that is available (almost) anytime. However, this is the only source of irrigation for which farmers must pay. This means that the use of this source is strategically chosen and the costs can inhibit cultivation.

In this section, we have shown how unused open spaces within built-up areas are temporarily used as an opportunity for cultivation; thereby contributing to the improvement of the lives of the farmers as well as the wider urban citizenry. These practices provide locally grown food for the city, offer employment, and contribute to keeping unused land looked after. Agricultural practices are not only shaped by the urban context, but the farmers themselves also construct the urban in this way by establishing employment opportunities, utilising urban land and water resources, and contributing to the city's food geography. Despite the rapid growth of the city which puts pressure on agriculture within the city, agriculture continues to exist and people still turn to farming for their livelihood security. In the following section, we show how urban agriculture responds to urban development in order to survive and stay of relevance.

Agricultural responses to urban growth

The expansion and densification of built-up areas comes at the cost of the diminishment of existing agricultural areas in and around Dar es Salaam. Houses are built on agricultural fields or companies come in and redevelop the land for commercial purposes. For some farmers, beacons that demarcate planned property have already been placed in the middle of their fields; a reminder to them of the temporary nature of their land use (see Figure 11). As we show in Box 1, complete areas can be taken for development purposes; leaving farmers landless and looking for new opportunities. Farmers do not have the power to oppose land acquisition, are not entitled to compensation in this process, and are confronted with modernist convictions about how urban agriculture is regarded as backward urban development (Bourque, 2000; Halloran & Magid, 2013a; McLees, 2012; Mkwela, 2013). Chapter 5 shows a disconnect between agricultural planning ideals and the embodied reality of agriculture in Dar es Salaam. A broader antagonism towards urban agriculture has "rendered urban farmers largely invisible amidst the growing global competition for Africa's urban land" (Shannon et al., 2021, p. 735). As the city becomes denser, the right to use land is withdrawn. Farmers lose the opportunity to tap into the urban food system through cultivation, so they search for new areas to reactivate their practice. By relocating to new urban or peri-urban locations for production, they reconfigure their practices to stay connected to the opportunities that are present.

With the reduction of arable land, the urban food geography changes and shows a stronger dependency on long-distance food relations. Leafy vegetables have become one of the few crops that are still attractive for urban cultivation. Staple crops (e.g. cassava, maize) used to be common in the past, but it is nowadays necessary to focus on high-value (and fast-growing) crops in order to gain a livelihood from smaller plots. Fruits and vegetables (even to some extent leafy ones) are increasingly imported from outside the city. While there has always been a supply of fruits and vegetables from other regions, interviewees indicated that the import of (leafy) vegetables has become more significant and constant over the years. Trucks come from other regions of Tanzania to sell at the market at low prices and urban farmers are forced to lower their prices if they want to sell at the market. Despite more fruits and vegetables being brought to Dar es Salaam over larger distances, leafy vegetables remain a profitable crop choice. Their perishability requires the supply chain to be short and is therefore more persistent compared to other fruits and vegetables.

Figure 11. Field with a concrete beacon placed by surveyors to demarcate the boundaries of a property, exemplifying the temporary nature of the area as agricultural land (photo taken by the first author, 29 July 2021)

Besides the impact of urbanisation on land use and the food system, access to water for irrigation is also subject to change. During the wet season, increased direct runoff (caused by the soil being sealed by construction) results in agricultural land along the banks of rivers or in low-lying areas being submerged for longer periods (thus prohibiting cultivation). During the dry season, farmers benefit from an increase in water availability when their agricultural areas are directly fed by water from residential areas (i.e. reusing urban water). These flows become more reliable because domestic water use (and therefore disposal) increases. Leakages from piped water networks, which have increased due to a lack of maintenance or network ageing also contribute to these flows. At the same time, infrastructure or development projects can reduce access to water. For example, there are areas where leakages have decreased because of piped system upgrading. Likewise, there are examples in several areas where water supply has been cut of or redirected due to construction projects. Farmers in these areas switch to alternative irrigation sources, are forced to reduce the number of irrigated plots, or relocate to new areas.

Although the extent to which the water quality has changed is context-specific, the water quality overall has deteriorated due to an increase in the number of industrial and domestic discharges upstream. These water quality changes are generally not described as detrimental to growth, but farmers do voice their concerns about how the general public perceives their practices. Publicity in the past around water contamination has damaged the image of urban farmers, who have been unable to object to the conclusions drawn (Chapter 6). Farmers are rarely in a position to express their concerns about upstream water pollution, since their use of these water flows is not formally acknowledged. This creates a hesitancy to talk about these concerns or raise them at the local government level, because local government authorities hold the power to respond in ways that may not align with the needs of the farmers. This reflects the situation in many cities in the Global South, where residents have little confidence in the provision of public authorities, benefit from the state's inability to provide, or are afraid that state interventions will lead to the loss of existing opportunities. The capacity of urbanites for self-help often eclipses the role of the state and renders it unnecessary (Jaglin, 2016; Roy, 2005; Simone & Pieterse, 2017). In this case, minimising nuisance in order to continue irrigation means accepting the additional risks due to the upstream intensification of water use.

Although farmers indicate that they are flexible to take up other employment opportunities if and when they arise, most feel that the commercial production of vegetables gives them (and their families) security that they have not found in other types of urban employment. This characterises how urbanites are constantly on the lookout for opportunities while bearing the uncertainties that characterise Southern cities. Only when agricultural land is taken for construction are urban farmers forced to reconsider their options. When this happens, some turn to other (often agriculture-related, such as vegetable selling) jobs while searching to secure a new plot. Others can directly move to agricultural areas on the urban periphery or just outside Dar es Salaam region. Most of the urban farmers we interviewed expected to continue farming although not in the same location.[16] This shows how farming persists but moves outwards in order to do so. When losing their land, farmers relocate to areas where the pressure on land is less acute. This

[16] The existence of an inter-generational transition from agriculture into more formally-constructed parts of the city's economy have not been explored.

can be in the peri-urban areas of the city or in the adjacent rural districts that have good road connections with markets in the city. Besides this, the process of 'moving outward' can also mean that farmers move into more marginal spaces within the city.

Access to land and (irrigation) water is key to the survival of the practices and prosperity of farmers facing the pressure of urban growth. In opposition to land pressure and water resource degradation, farmers adapt their agricultural strategies to maintain their position in the city. When farmers lose access to land, they are mobile and search for new locations to reactivate their practices. They are also flexible and switch to alternative water sources or are sometimes confronted with the consequences of water use by others. Urban growth reconfigures agricultural practices according to the availability of land, water, and markets; all of which bring new balances of benefits and risks. This shows how infrastructures of provision (e.g. food, incomes) are pragmatically built by urban individuals. The attractiveness of agriculture as an urban livelihood practice – as well as the demand for its services – results in an 'infrastructure' that is constantly reconfigured to be made ft to the urban ecosystem.

Box 1. Example of dynamic reconfigurations in a growing city: TAZARA-Mchicha. The same case is presented in the Supplementary materials means of a research story.

TAZARA-Mchicha is a well-known agricultural area in Dar es Salaam that has existed since the 1980s (see Halloran & Magid (2013a) and McLees (2011)). The area (located in Sandali Ward, see Figure 10) is owned by TAZARA, the railway authority linking the seaport of Dar es Salaam with Zambia. The total area has decreased over time because of construction, but approximately 12.5 ha was under cultivation in early 2021 (own calculations). Early mornings (as well as *jioni*, i.e. the end of the afternoon until sunset) a lot of activity can be seen in the area. Farmers irrigate and harvest their plots while customers (especially women) come to buy vegetables to sell either in the direct neighbourhoods or at the market. A wholesale and smaller retail market can be found nearby attracting business purchasers to the area. Three streams (with in-stream reservoirs) and a small number of shallow wells provide sufficient water for farmers to irrigate their leafy vegetables. The streams pass through the upstream residential areas and are described as having different reliabilities and qualities.

In June 2021, a contractor arrived and started excavating trenches for the construction of a wall. Although the local government office received prior notice, the news was not yet relayed to the farmers. TAZARA had come to an agreement with a large energy and transportation company wanting to construct a dry port. This came as a surprise not only to the farmers, but also to the surrounding community (the valley connects two neighbourhoods, and many people pass through it every day). The community (where farmers are a part of) showed resistance by backfilling the trenches and demolishing the stacks of delivered building blocks. Construction came to a halt, but the farmers realised that this would only be temporary. They organised as a group and requested compensation for land to be lost and prior notice of construction to be able to harvest their last crops.

A month later, construction of the dry port restarted. Agriculture slowly ceased to exist in this valley, leaving farmers with mixed emotions. Some farmers acquiesced and emphasised that they knew about the temporary nature of the agreement from which they had reaped benefits over the years. Others felt let down by the loss of the land and their livelihood security. The interests of high-value development outweigh the agricultural function of an area like this. Farmers cannot claim any legal rights from their histories of agricultural production when the land owner decides to develop the area. As a local leader from the area described: 'It is not easy to stop a person with money if you don't have anything in your pocket' (interview, 27 July 2021). The only option for farmers is to accept their losses in one place and start looking for another location. This is what most farmers have done: moving to the peri-urban areas of Dar es Salaam or to rural areas along the main roads heading towards the city. In a matter of five months, the area had been transformed into a fenced commercial property with no signs of the agricultural activities that had once taken place there.

Juma is one of several farmers we followed through this process. He got access to a plot through his father in 1998 and has been farming it ever since. Every morning he arrived at his field by bike and worked on the farm while waiting for customers. Water for irrigation was taken from a canal that used to be connected to the drainage system of the nearby main road. This stormwater supply was cut off in

2015 because of the construction of a smaller dry port between his plot and the main road. Since then, most of the year he took water from a shallow well that was collectively constructed in response. With eviction approaching, he started looking for a plot in one of the peri-urban areas of Dar es Salaam. After losing his plot, he relocated to this new location. This shift resulted in a change of location (more than 25 km further outward), a different source of water (a small spring), and a new market location. While his agricultural practice has changed, his contribution to urban food security remains.

4.4 Discussion

In the previous section, we have offered an empirical account of agriculture as part of a growing city. We have shown how irrigated agriculture is embedded in the urban ecosystem and dynamically moves along with urban growth in order to 'stay alive'. Changes in access to land, water, and markets create different embodiments of a practice that proves persistent, despite not being formally planned for as part of the city. In this section, we draw conclusions on the responses of urban farmers to processes of urbanisation and indicate the respective implications for theory and governance.

First, this research has shown that farmers take an active role in the urban (food) geography through the production of perishable vegetables, income generation, and maintaining open spaces. The mobile and non-destructive character of irrigated urban agriculture (no on-site infrastructure needed and crop production with short growth cycles) provides different services by utilising food-buffering and to-be-developed areas. In this way, farmers actively participate in the configuration and reconfiguration of a growing city. The presence of urban agriculture shows not to be a transitional phase, but rather a continual part of what the city looks like and how it functions. People continue to turn to agriculture and urban agriculture is responsive to processes of urbanisation by reconfiguring their practices and relocating in order to persist. In this way, the locations where urban agriculture can be observed might perish due to urban growth, but the practice itself shows persistent (see Box 1 as an example). Agriculture and the growing city interact in a symbiotic way where farmers continue to find urban and peri-urban land to provide for the city in different ways. Although we have shown the agency that farmers have in the configuration of agricultural practices and their responses to urbanisation, this

agency is bounded contextually. Farmers take part in an urban space where the changes that occur (e.g. upstream water pollution or forced relocation to marginalised spaces) result in a redistribution of benefits and risks over which they often have limited control. As such, these agricultural practices are best understood as interlinked with other forces of city-making, be they physical or political.

Second, agriculture has stayed largely 'peripheral' to the understanding of cities as it opposes popular convictions about the modern city (Bourque, 2000; McLees, 2012; Shannon et al., 2021). This paper, however, offered a detailed empirical account of how agriculture is intrinsic to the city of Dar es Salaam, actively contributes to the production of the city's socio-material space, and is expected to continue to do so by finding value in vacant spaces. Despite generally not being accounted for in urban narratives, this show how farmers actively co-shape the city in the way it looks and functions. By constructing (and reconstructing) networks of provision, they offer food, employment, and more for the improvement of their lives and the wider citizenry. These social infrastructures (and their associated flows) are important constitutive parts of how urban life is structured and evolves. In this way, farmers effectively find their security of living in the opportunities that can be found beyond formalised systems and the state's reach. This paper therefore argues that these agricultural practices can be regarded as an example of everyday urbanism. In light of Africa's urban future (specifically how future cities are going to be fed), agricultural dynamics should be studied (and theorised) as an urban phenomenon in its own right in order to better understand the role food production plays in the sustainability and resilience of cities.

Third, the dynamic character of irrigated urban agriculture enables the practice to endure but also creates difficulties regarding governance engagement. Mobility (making way when needed) and informality (limited engagement with state actors) are strategies adopted to survive, but also make it hard to capture (i.e. describe in its appearance or quantify) and regulate these agricultural practices. This quasi-invisibility can be regarded as part of the farmers' strategy of persistence. Concealment and continual mobility are effective strategies to survive for a diverse array of practices in the informal sector. Since urban agriculture is merely tolerated in many African cities (including Dar es Salaam) as long as it does not become a 'nuisance' (Chapter 5), limited engagement with authorities is a way to be of limited disturbance while continuing agricultural production and income generation. Although we support existing policy recommendations to formally

incorporate agriculture in urban planning, formalisation and regularisation of urban agriculture have shown to be a challenge for a long time already (Chapter 5). As a result, irrigated urban agriculture persists (and will likely continue to do so) by informally and temporarily filling up the voids of urban space. In this light, incremental approaches of tenure (e.g. assigning interim tenure rights to farmers as part of urban planning approaches) might be better suited to address the diversity of demands of the city (today and in the future). Also, the recognition and involvement of informal actors in urban planning and governance can strengthen the collaboration around service provision in the city in order to balance benefits and risks that also exist around the use of urban land and water for food production. Embracing the informal into planning and governance implies the acknowledgement that cities and urbanisation processes are shaped by a bricolage of top-down and bottom-up forces of development.

This paper has provided insight into how farmers are embedded in and respond to the growing city. Foregrounding the agricultural identity of the urbanite here has automatically resulted in backgrounding other identities farmers carry. Farmers are also urban dwellers who have a multitude of other connections regarding urban living, consumption, recreation, etc., that we have not touched upon. In some cases, farmers in this research were even participating in other types of jobs that could be seen as conflictive (e.g. farming and working as a day labourer to do masonry in the same area). Urban actors have multiple identities, which makes the understanding of urban space non-monolithic and, at times, divergent. This means that urban practices may be surrounded by negotiations and contestations about what the city does (and should) look like that cannot be understood by only looking at one of these identities. Studying these (interaction of) multiple identities and how they direct people's connection to agriculture (or perhaps the transitioning out of agriculture) needs to be studied in further detail and is therefore recommended as a relevant field of further research.

4.5 Conclusions

Urban growth puts pressure on the future of agriculture as an urban land use practice. This paper studied irrigated agriculture in Dar es Salaam, Tanzania, to understand how these practices respond to urban growth. Where the disappearance of agricultural sites can be observed, we showed how irrigated urban agriculture persists due to its flexibility and mobility. Farmers build on temporary land use agreements, tap into different urban

water sources, and cultivate short-cycle crops for the surrounding urban areas. Doing this, farmers claim their (informal) right to the city and commercially cultivate open spaces until the city (i.e. construction) takes over. The changes in access to land, water quantity, water quality, and markets have obvious implications for farmers both practically and in normative terms. Since agricultural land use and urban irrigation are not planned for and not formally acknowledged, farmers benefit from what they can get access to while dealing with the associated uncertainties of changing realities. These agricultural configurations represent a network of (service) provision that functions independently from systems of the state and is responsive to urban advancement. In this respect, this study of irrigated urban agriculture is valuable in showing the everyday dynamics of urban living and the heterogeneity of the African city; reflecting the characteristics of everyday urbanism. Ordinary people continue to find ways to access land and water for the improvement of their lives and that of the wider citizenry. The continuation of the practice shows that it is not a 'passing phase' towards the modern city, but rather an informal practice in its own right. Practices are built (and re-built) based on its socio-material environment and form dynamic infrastructures that supply food for the city. With African cities risking to grow hungry, an active scholarly engagement with urban agriculture as an expression of urbanity is important. To support these social infrastructures in light of urban sustainability, we recommend recognising farmers as active city-makers (which also implies integration in urban planning, possibly through incremental approaches of tenure) and acknowledging the temporal presence of agricultural configurations as a continuous contribution to the (social and spatial) fabric of African cities.

CHAPTER 5

5

Agriculture and the ideals of urban modernity: The case of Dar es Salaam, Tanzania

"The ruralization of urban areas through the invasion of cities and towns by subsistence agriculture and rural poverty euphemistically called urban agriculture symptomizes (…) economic decay."

This article studies the policy dynamics of irrigated agriculture in Dar es Salaam, Tanzania, based on stakeholder interviews and a literature review. We found that irrigated urban agriculture receives a positive reception supported by a discourse that values productivity, but this is increasingly challenged by a discourse that focuses on health and modernity. Whereas authorities aim for modern farming models, most urban farmers contribute to the city's economy and food system based on informal and insecure access to land and water. These two types of urban agriculture exemplify the tension between planning ideals and urban reality.

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Quote: In Bigangambah (1992, p. 303).

5.1 Introduction

Sustainable urban growth features prominently on policy agendas in Africa, where rapid urbanisation poses both challenges and opportunities. The role of agriculture in these urbanising landscapes has been disputed for decades. Critics have often referred to this as a 'backward' practice that detracts from what African cities are supposed to look like (Battersby, 2013; de Neergaard et al., 2009; Smit, 2016), whereas others see urban agriculture as progressive due to the different ecosystem services it provides (Langemeyer et al., 2021; Tapia et al., 2021). In Dar es Salaam, Tanzania, contrasting views about urban agriculture and its value are reflected in two distinct Swahili expressions that are each a translation of urban agriculture. There is *'Kilimo cha Maghorofani'* ('apartment agriculture'), which refers to agriculture practised near people's houses or apartments in the form of hydroponics, vertical farming, greenhouses, or container-based types of agriculture, all of which use piped water. This type of agriculture is welcomed and actively supported as having a place in the city. However, most urban farmers practice *'Kilimo cha Mjini'* ('city agriculture'), which is open space cultivation in vacant areas that uses mixed urban water flows for irrigation.

Agriculture is an integral and well-established part of urban society, yet in many African cities, including Dar es Salaam, it is not formally recognised or even considered illegal (Follmann et al., 2021; Orsini et al., 2013). This raises questions about how planning and governance are constructed in such ways that it enables the continued presence of agriculture in these growing urban centres. To answer this question, this paper studies how policy practices shape and direct irrigated agriculture in Dar es Salaam. Irrigation is often implicit in studies on urban agriculture, but we explicitly address it in this paper because water plays a key role in the relation between agriculture and the city. We use 'city agriculture' and 'apartment agriculture' throughout this paper to refer to the different forms of (and ideas around) urban agriculture to show the presence of contrasting discourses around the desirability of agriculture in the city. By using these two expressions, which both translate as 'urban agriculture' in Swahili, we show why, and how, certain agricultural practices are screened out from the imagined future of the city, which raises questions about who is granted the right to participate in the city's future.

This paper shows modernist convictions around the desirability of urban agriculture, which should first be contextualised. Modernity has played a pivotal role in the pursuit of

progress since the beginning of the industrial era. The images and dreams of modernity (in which the state was attributed a position of power) were inter alia materialised in the construction of cities and infrastructures (roads, water, energy, waste, communications). As Europe expanded its imperial power over the southern hemisphere, so did modernity. The dialectic of 'becoming modern' posited ideas about what is 'traditional' and 'primitive', or the opportunity 'to catch up'; cultivating a sense of superiority and legitimising a developmentalist relationship (Arce & Long, 2003). Modernist discourses in urban development have been widely critiqued by post-colonial scholars, who argue that urban theory should be developed in direct relation to the lived experiences of city dwellers (Pieterse, 2008; Robinson, 2002). However, as we also show for the case of Dar es Salaam, Western conceptualisations and representations of modernity continue to be embraced in the planning and governance of African cities (Parnell & Pieterse, 2014). In the context of this paper, we show how modernist ideas appear in (1) discourses about the functioning of urban society and what it should look like, as well as through (2) the integration of 'modern' elements in existing agricultural practices.

By referring to policy practices and dynamics in our writing, we emphasise the critical role of human agency in shaping and reshaping policy impacts. The policy domain is a space where there is constant interaction between different societal actors who – with varying levels of influence and power – defend or contest the way society is constructed. To study this, the policy arrangements approach (which we introduce in more detail in the following section) is used to link people's day-to-day policy interactions to the broader, structuring elements of urban society. Our study focused on Dar es Salaam, as this city exemplifies the rapid growth of urban centres in Africa and the presence of urban agriculture here has been well-documented over the past few decades (Drechsel & Dongus, 2010; Jacobi et al., 2000; Kiango & Likoko, 1996; Kyessi, 1997; McLees, 2012; Mlozi et al., 2014; Sawio, 1994; Chapter 4). Data collection for this paper took place between May 2021 and July 2022, but with a particular policy focus in the first half of 2022. As most of the initial ethnographic research focused on irrigated cultivation in open spaces within the built-up areas of the city, less attention has been paid to backyard farming and peri-urban agriculture. Nevertheless, we believe that our findings also give insight into the policy context of urban agriculture more generally.

In the subsequent section, we elaborate on our research approach by explaining the policy arrangements approach and the methods we employed to study such

arrangements. After that, we present the results in two sections. We first look at the historic position of agriculture in Dar es Salaam and characterise contemporary agriculture in the city. We then describe the current-day policy dynamics that we found in our research and specifically zoom in on the role that discourses play in the interaction with actors, resources/power, and rules. In our discussion, we reflect on the discrepancy found between modernist ideas about how cities should work and what they should look like and the 'everyday city' that gets by on its own. We conclude by summarising the findings and highlighting two points of consideration when it comes to both the engagement with and the planning of urban agriculture.

5.2 Research approach

Urban agriculture can be found in different configurations of production, in different areas with particular characteristics, and aiming for different destinations (Mougeot, 2000). This paper studies city agriculture in Dar es Salaam and the opposing views found in apartment agriculture. We study these using the policy arrangements approach which, together with the research methodology applied, we elaborate upon below

The policy arrangements approach

The policy arrangements approach studies policy dynamics by being positioned between two continua: actor–structure and discourse–organisation (Arts & Leroy, 2006). The first describes the extent to which human agency is guided by social structures and how it (re) produces these structures over time. The second relates to how social stability and change can be attributed to either ideational mechanisms (discourses) or material circumstances (materiality). In this way, the approach acknowledges the interplay between everyday policy practices and more structural societal and political processes. This approach has been extensively used for the study of environmental policy and, increasingly, of urban governance (Basile, 2022; Contesse et al., 2018; Majale-Liyala, 2013).

The policy arrangements approach is not exclusive or unique to studying policy dynamics, but we have used it in this context for two main reasons. First, the approach acknowledges the instability of the policy domain and studies the domain in a momentary stabilisation of rules, actors, resources/power, and discourses (Arts & Leroy, 2006; Tatenhove et al., 2000). These dimensions are often depicted as a tetrahedron to emphasise the interrelatedness and how changes in one dimension can reconfigure the policy arrangement as a whole (Figure 12). This is useful when studying the institutional

dynamics of cities in the Global South, because urbanisation and fragmented growth create diverse socio-material spaces of living that function partially within, and partially outside of, the state's reach. As people can assemble or reshape policy arrangements in a myriad of ways – drawing on whatever materials and resources (including power) that are available to them – it is important to acknowledge the constant tension in the policy domain that influences the actual effects that policy has; effects that can differ across space and time. The emphasis on the interrelatedness (as illustrated in the tetrahedron) is the second reason why this approach is useful, as this is believed to give better insight into policy dynamics than providing a mere analysis of different policy aspects. By specifically looking at relations, this paper studies how discourses interact with actors, resources/power, and rules. This is relevant because, during the initial research period, we found that particular ideas about the relation between agriculture and the city are influential on the thinking and actions of different actors, the allocation of resources, and the rules (formal and informal) that shape and direct urban agriculture.

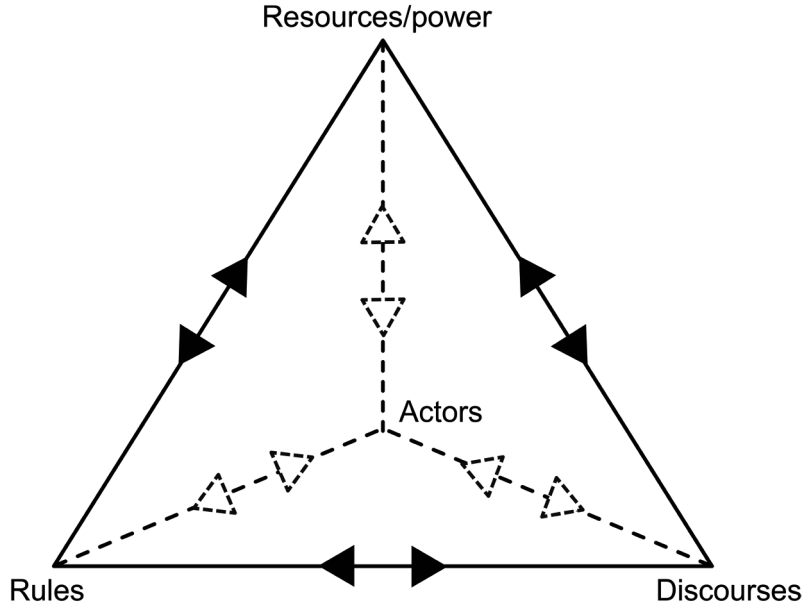

Figure 12. Policy arrangement visualised as a tetrahedron of interconnected policy elements. The arrows emphasise how changes reconfigure the arrangement as a whole. Based on Arts and Leroy (2006).

Methodology

Empirical data collection for this paper took place in Dar es Salaam between May 2021 and July 2022. The initial research period (until the end of 2021) focused on an ethnographic study of urban agriculture in Dar es Salaam based on regular visits (every other week, except for two intermissions for data analysis) to six agricultural areas that represent common types of agriculture in the city. Semistructured individual interviews and participant observation allowed the development of a detailed understanding of how agricultural practices are configured in the context of using urban land and water while producing food. By systematically going back and forth between data gathering and analysis, it became evident that there was (and is) a gap between urban planning intentions and urban reality. This formed the basis for further research. From the beginning of 2022, we used a combination of methods to better understand the policy dynamics that shape the relation between agriculture and the city. We interviewed 31 respondents from relevant ministries at the central government, different departments of the local government authorities, and people from relevant government-related, private, community-based, and research organisations, all of whom work on urban planning issues or urban agriculture in particular. This was combined with 16 additional farmer interviews at the agricultural sites that had been regularly visited since the beginning. We also conducted a desk study of the available policy and research documents around agriculture and urban planning in Dar es Salaam. The combination of methods (interviews and literature) and sources (including interviewing a wide range of stakeholders) has allowed for data triangulation. The tetrahedron with its four dimensions and their interrelations (Figure 12) was used for guidance during the interview design and desk study (analytical considerations are explained in more detail by Liefferink, 2006). For example, when studying the actors involved in urban agriculture, an analysis was done of the actors (and the existence or absence of coalitions), their power position, the interaction with rules, and their views (discourses) about the relation between agriculture and the city. The interview data and available documents were analysed through coding and memo writing and resulted in a comprehensive policy overview, on which this paper has been written. However, we do not give an exhaustive overview of all policy aspects found, but rather focus on understanding discourses and how they interact with other policy elements.

5.3 Contemporary Dar es Salaam in context

Although the city of Dar es Salaam exemplifies a wider trend of rapid and continuing African urbanisation, it also is the product of its own history. We therefore shed light on the city's geographical and political evolution, as current-day policy practices (which we describe in the next section) are inseparably linked to societal and political trajectories (Arts & Leroy, 2006; Tatenhove et al., 2000). We pay specific attention to the historic position of agriculture in the city and finish this section by characterising contemporary agriculture within the city of Dar es Salaam.

Geographical development

What started as a small fishing village on the East African coast in the mid 19th century has grown to be one of the largest cities in Africa. The population of Dar es Salaam was recently counted at close to 5.4 million and is expected to continue to grow over the coming decades as a result of natural growth and rural–urban migration (Moshi et al., 2018; NBST, 2022; UN, 2018). Although the latter is strongly driven by people's expectations of a better life in the city, the benefits of living in the city do not uniformly trickle down to improved living conditions for all. The inadequacies of urban planning and service provision due to rapid urban growth have contributed to increased socioeconomic inequality in the city (Moshi et al., 2018).

The urban structure of Dar es Salaam resembles a finger-shaped model pointing from the Indian Ocean into the country's interior. Our spatial analysis of urban expansion, presented in Figure 13, clearly shows the important role of the arterial roads in directing the city's growth. Differences have also been found between settlement types and service provision along the roads compared to the interstitial areas (Schmidt, 2012). Informal urban sprawl is prominent in these interstices and towards the peripheral areas. The city is subdivided into five municipalities and the overarching Dar es Salaam City Council. The latter used to be responsible for the coordination and performance of key services for which interdependencies across the municipalities exist (Moshi et al., 2018), but was removed in 2021 to prevent ambiguities in the authorities' responsibilities on the ground; leaving uncertainties about how this affects intermunicipal coordination (e.g., future city planning).[17]

[17] One of the municipalities (Ilala Municipal Council) is nowadays referred to as Dar es Salaam City Council.

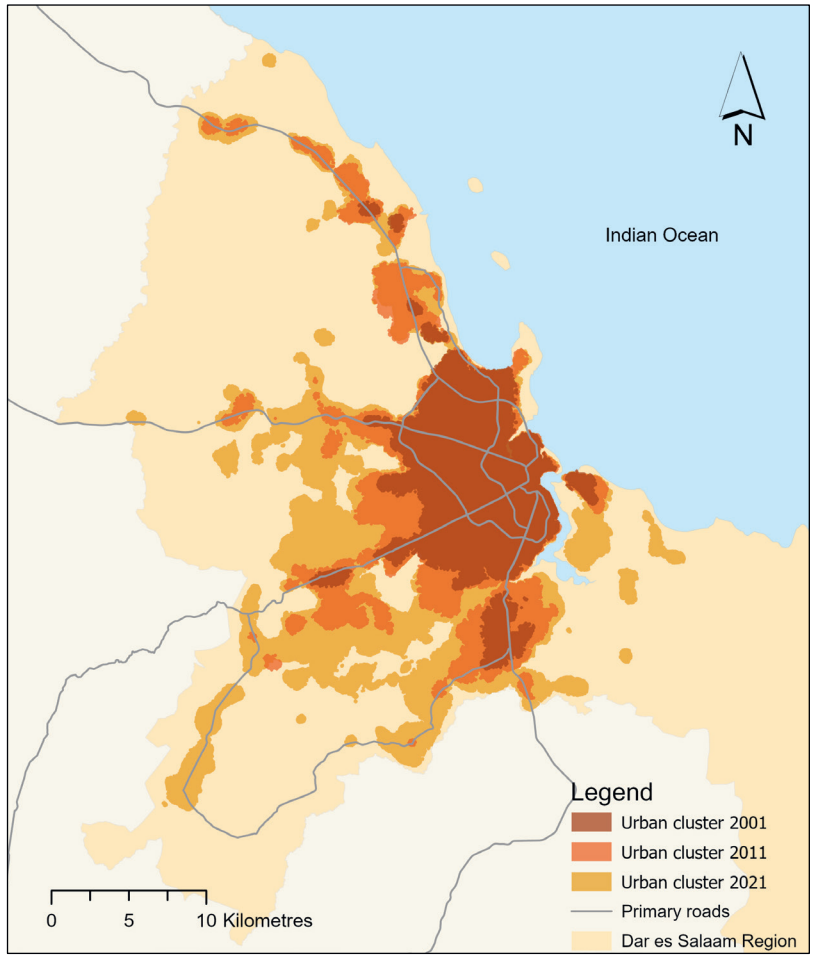

Figure 13. The expansion of Dar es Salaam between 2001 and 2021, largely influenced by the primary roads. The urban clusters here contain (sub)urban areas together with urbanized open spaces, as defined by Angel et al. (2016).

More than half of all households in Dar es Salaam (58.0% according to URT (2020c)) rely on self-organised (informal) employment. Despite the importance of the informal economy for service provision and income generation, colonial and post-colonial (or post-independence) authorities tried (and continue to try) to remove informal living and self-organised economic activities and formalise them (Brennan et al., 2007; Brownell, 2016). During our fieldwork in 2021, consolidated efforts to formalise informal activities took place by removing so-called *machingas* (petty traders) from the streets and relocating them to designated market areas. In conversations with the first author, people raised their concerns about having to travel further for their food and other goods, the loss of employment for vulnerable groups, and the fear of an increase in crime, given higher rates

of unemployment. Others supported the government's decision because 'it [petty trading] does not show the progress that Dar es Salaam is going through' (personal communication K7, 3 November 2021).[18] As with urban agriculture (which we show later), normative ideas about the city are influential in determining people's ideas about which parts of the economy should thrive or are in need of 'progress'.

Political development

The growth of Dar es Salaam started to get planned and regulated under colonial rule through the development of master plans (Armstrong, 1986). Foeken et al. (2004) and Brownell (2016) describe how colonialism brought along Western perceptions of what constitutes 'urban', with a strong divide between the countryside and the city. The first urban agricultural by-laws (enacted by the British and abandoned after independence) aimed "(i) to prohibit people of African descent growing crops and raising livestock in urban areas; (ii) to prevent urban agricultural activities, especially the growing of crops taller than one metre, in urban areas because they were thought to increase the presence of malaria-carrying mosquitoes; and (iii) to maintain a cleaner urban environment and sustain urban aesthetics by preventing people of African descent from growing crops on most open spaces in town" (Foeken et al., 2004, p. 121). Colonial authorities tried to keep agriculture (i.e., the countryside) out of the city through these by-laws.

Following independence, Tanzania's first president Julius Nyerere implemented his development vision (*Ujamaa*, i.e., 'familyhood') that focused on an egalitarian and cooperative society with a strong focus on communal villages rather than urban centres (which was also a critique on industrial capitalism and urban elitism; Brownell, 2016; Hyden, 1980; Owens, 2010). This villagisation policy failed to promote agricultural development and gave rise to famine and rising food prices, which led the authorities to encourage urbanites to engage in farming within urban settlements (Foeken et al., 2004; Mlozi, 1995; Owens, 2010). Brownell (2016) describes how this tactic also sought to portray urbanites as producers and diminish their urban privilege. Irrespective of the productive or moral rhetoric behind it, the opportunity was used by urbanites to engage in farming as a way to become more food secure and supplement their incomes from the

[18] The names of all interviewees are coded to protect their identities.

(nationalised) industries in Dar es Salaam. Agriculture became an integral part of urban space and the city's economy.

From the end of the 1980s, the Tanzanian government started to welcome liberalisation and privatisation of the economy. Reforms towards market economics and capitalism meant the end of state-based structures based on socialist values (Briggs & Mwamfupe, 2000; Owens, 2010). The city expanded, both physically and economically, in an increasingly informal way (Brennan et al., 2007). Rising land prices resulted in outward growth and difficulty to protect the city's open spaces from encroachment, which put increased pressure on agriculture. For example, Msangi (2011) and Mkwela (2016) both studied the '20,000 Plots Projects' in Dar es Salaam, where peri-urban land was incorporated for residential, commercial, and communal use. Farmers experienced severe disruptions to their livelihoods as their customary land rights (rights granted through customary practice rather than statutory tenure) were inferior to the formal planning procedures and exposed them to urban land grabs. In this way, development (master) plans redefine 'undeveloped' hinterlands based on long-term and large-scale ideologies for human improvement that are reminiscent of previous colonial and socialist strategies, albeit now based on neoliberal principles.

Agriculture and the city

Urban dwellers who rely on agricultural practices for their livelihood are confronted with both political and physical pressure on their land, despite the periods when the authorities actively stimulated agriculture in Dar es Salaam. Contemporary agriculture in Dar es Salaam mostly exists in backyards and open spaces. Interviewees describe that urban agriculture contributes to locally grown food, creates urban employment, and keeps vacant areas safe and secure through the daily presence of farmers. Our research in Dar es Salaam found two distinct Swahili expressions that are each used as a translation for 'urban agriculture'. These different translations cannot be directly linked to commonly used classifications, but they do represent particular types of agriculture found in the city.

Most urban agriculture in Dar es Salaam can be referred to as 'city agriculture', which is open space cultivation in vacant areas – both within and on the fringes of the city – that are awaiting urban development or are deemed to be unfit for development (e.g., being flood-prone), using mixed urban water flows for irrigation. Leafy vegetables are popular here because they are in high demand and their perishability means that there is less

competition from outside the city. This allows for the commercial cultivation of these vegetables, which are distributed throughout the city via a network of vendors. Access to land is based on informal land-use agreements between the owner and user. Without legal land rights, farmers have no formal right to compensation in the case of land acquisition (Chapter 4). This lowers their incentive to make long-term investments, such as planting perennial crops or installing permanent (irrigation) infrastructure. Although insecure land tenure clearly has an impact on these farming practices, McLees (2011) describes – through a focus on access rather than property or tenure rights – the multiple benefits that farmers (but also land owners) derive from this agricultural land use.

At a smaller scale but given particular attention is the so-called 'apartment agriculture'. Apartment agriculture refers to agriculture practised near people's houses or apartments in the form of hydroponics, vertical farming, greenhouses, or container-based types of agriculture. Although apartment agriculture generally takes place on private property, it is not the same as backyard farming but specifically refers to technology-based types of cultivation. The efficient use of land and safe water plays an important role but requires capital investments and land security, which are not available to the majority of farmers in Dar es Salaam. The consequence is that apartment agriculture is practised by a smaller group of citizens who are, using different techniques, able to produce a range of vegetables for both subsistence and commercial purposes.

Because the water requirements of vegetables cannot be fulfilled by the limited and/or irregular rainfall received, access to water for irrigation is a prerequisite for both types of urban agriculture. For city agriculture, water for irrigation is taken with buckets, watering cans, or mobile petrol pumps from rivers, canals, shallow wells, reservoirs, or taps. Rapid urban growth has resulted in residential and industrial discharges, which can create problems for farmers reusing water downstream (Wesselow et al., 2020; Chapter 6). Apartment agriculture is not experiencing this issue because there is a strong emphasis on the use of clean, piped water for cultivation. Drip irrigation is common here to achieve high water-use efficiencies. As we further explore in the next section, the different forms of agriculture present create tension around what is deemed fitting in the city. Where city agriculture is recognised for its potential to provide food and incomes (and add value to vacant space), this is challenged by water quality concerns and the perception that agriculture is not a principal function within the modern city.

5.4 The policy arrangement for irrigated urban agriculture in Dar es Salaam

Agriculture in Dar es Salaam has been alternately prohibited and stimulated and today it is likewise impacted by policy dynamics that both constrain and enable its presence. Here, we use the policy arrangements approach to analyse the policy dynamics surrounding agricultural practices in Dar es Salaam. We first elaborate on city agriculture and apartment agriculture and we show how these agricultural configurations are surrounded by different actors, discourses, and associated resources. We then continue by describing the planning and regulation of urban agriculture in general. In this way, we show how competing discourses (visible in the different types of agriculture) pose a challenge to the continued presence of the majority of farmers in the city.

City agriculture: actors and discourses

Those who are directly or indirectly engaged in city agriculture emphasise the productive benefits and present a discourse that favours the continued (informal) presence of agriculture in the city. A large majority of interviewees in our study (from residents to central government officials in different ministries) feel that city agriculture should be given the space to exist, given that it is important for the people engaged in it. Similar to the example of *machingas* in the previous section, our interviewees pointed out the importance of food availability (nearby and at affordable prices), employment for vulnerable groups, and the maintenance of open spaces (which increases safety). However, many interviewees also emphasised the use of 'proper' and 'good' farming methods in order to minimise health and environmental risks (a point which is also found in the agricultural regulations described later). During informal conversations with residents, farming was commonly referred to as an activity that people take up when unable to secure employment, which illustrates how being engaged in city agriculture is seen as inferior to many other urban jobs. Farmers themselves, however, compare their harvesting cycles (most leafy vegetables have a growth cycle of less than a month) and the income that they bring as similar or superior to the monthly salaries available from other urban jobs. Turning to farming (and leaving other jobs in the informal economy) is motivated by the prospects of generating more income and having more economic stability.

Health concerns associated with vegetables irrigated with urban water (especially in the denser built-up areas) are a big challenge to farmers in the city. Although there is a diverse range of water flows available to farmers, there is a high dependence on flows of urban water originating from adjacent or upstream urban areas. Chapter 6 describes how farmers are concerned about how water quality issues undermine the social acceptance of their practices and produce. Farmers emphasised during interviews that the water they use in their respective areas is safe for irrigation purposes, although some also acknowledged that it is hard to find clean water in an urban landscape such as Dar es Salaam. As one of the farmers explains: "I usually reply with a 'sorry', as we do not have any other choice for water. There is no way to prevent discharges from getting into the canal". The Msimbazi River is regularly mentioned as a prime example of how agriculture in Dar es Salaam got its bad image. Research focusing on the river's water quality and media coverage about agriculture in the river valley have contributed to this negative perception (Halloran & Magid, 2013b; Mwegoha & Kihampa, 2010; Sylvester, 2018; Chapter 6). This example is often used to challenge the agricultural and economic benefits of city agriculture in Dar es Salaam more generally.

Almost all the farmers practising city agriculture in open spaces within the built-up areas indicated that they did not receive extension services and agricultural officers themselves particularly emphasised on their involvement with off-farm trainings and demonstrations (focused on apartment agriculture). We also noted a shift in the municipalities' focus towards supporting agriculture in peri-urban areas rather than urban areas. Agricultural officers struggle with ambiguities around the formal recognition of farmers using land and (polluted) water for agriculture in the city. This is reflected by a hesitance to offer extension services in 'unauthorised areas' or in areas where irrigation water is polluted (personal communication Z5, 1 February 2022; Y7, 12 April 2022). Some farmers criticise the municipality for this lack of support, although others realise that the agricultural officers face similar challenges in trying to protect agriculture in the city. A farmer recalls: 'the agricultural officer visited us and we discussed how to get another farm, but she also struggles as she does not have any unoccupied farms' (personal communication T3, 14 June 2021). This leaves most farmers in the built-up areas practising city agriculture without support (a similar observation was made by Kyessi, 1997; Magigi, 2008). The agricultural extension officers we spoke with denied that farmers in the urban areas do not receive extension services, although they admitted that most capacity development

is done through funded programmes at the agricultural centres and that the capacity to visit farmers is limited, because all extension officers render services to multiple urban and peri-urban wards at once.

Apartment agriculture: actors and discourses

The dominant discourse around productivity (i.e., agriculture provides food and income, and therefore should be maintained) is increasingly challenged by newly emerging discourses around health and modernity. Health issues related to irrigation with urban water flows are increasingly presented as a reason to enforce strict rules or remove agriculture from the city, as 'the health of citizens cannot be jeopardised over agricultural productivity' (personal communication urban agriculture researcher P2, 24 January 2022). As the city urbanises and land values rise, agriculture in the city is also regarded as an improper use of land, which makes the city look undeveloped and backward. This results in a stronger push to either modernise existing agriculture or remove agriculture in order to 'clean the city' from practices that are regarded as portraying failed urban development (this shows similarities with the actions taken against *machingas*) (personal communication regional town planner E4, 25 July 2022; Halloran & Magid, 2013a; McLees, 2012; Mkwela, 2013).

Urban specialists from government, academia, private and donor organisations seek to restructure agricultural practices in ways that (in their view) better fit the metropolitan city. These new farming models (referred to as apartment agriculture) emphasise the need for the efficient use of land and safe water, as well as the importance of making agriculture more attractive to the ever-growing young population. Technology, little physical labour and the entrepreneurial nature of agriculture are all emphasised in a bid to attract people to engage in this type of farming. One of the directors at the Ministry of Agriculture described: 'We are making agriculture "sexy" so that people will love it. Youth will be involved in agriculture instead of driving *bodaboda's* [motorbike taxis]' (personal communication L8, 23 June 2022). In the same vein, an agricultural advisor working for a foreign donor commented that 'you need to put in technology to make it appealing, agriculture of the 21st century!' (personal communication U2, 13 May 2022). The introduction of container-based farming, vertical farming, and drip irrigation aims to utilise technology to deal with smaller plot sizes and the efficient use of clean tap water. Also, greenhouses and hydroponic systems are promoted as advanced types of agriculture that are attractive to urbanites. The coordinator of a grassroots organisation

on urban agriculture in Tanzania critically pointed out how bilateral development has led to a fixation on technology within the authorities that only serves a small minority of farmers in Dar es Salaam (personal communication D3, 17 May 2022).

The emphasis on progress and innovation seeks to distinguish agriculture in Dar es Salaam from that in other rural regions in Tanzania. This is used as a way of legitimising the work of the city's agricultural departments, which struggle to get recognition for their work. Agricultural officers are often challenged by their colleagues about the contribution that they make to the development of the city. Several interviewees (both within and outside the municipality) indicated that the municipalities' agricultural officers are fighting for their right to exist within the city. The coordinator of a grassroots organisation on urban agriculture noted: 'A big challenge that they [the agricultural officers] have is that the people in the municipal council don't think agriculture can be done in the city. If agriculture cannot be done, that means they don't have work here' (personal communication D3, 17 May 2022). Similarly, the value of urban agriculture is not recognised as contributing to food security at the central government level, because agriculture is generally associated with large tracts of land rather than with small urban agricultural areas (personal communication M4, 20 April 2022; Magigi, 2008; Schmidt, 2012). As an example, one of the agricultural directors recalls a meeting at the Ministry of Agriculture where the chairperson noted during a plenary introduction round: 'I see some people from Dar es Salaam, but I don't know what they are doing here' (personal communication B3, 12 May 2022). Dar es Salaam's agriculturalists actively promote apartment agriculture through presentations and field demonstrations in order to show that agriculture is present within the city, fits the growing city, and requires continued support through funding and planning to secure its economic impact (emphasising the benefits to women and youth) and the contribution it makes to food availability and accessibility.

Planning, rules, and their regulation

The central government in Tanzania, through its ministries, formulates policy and provides regulatory frameworks, while local government authorities (i.e., the municipal council in this urban case) are responsible for the implementation, regulation, and enforcement of these policies. On a local level, agricultural officers do not feel heard in their calls to reserve (and maintain) land for agriculture in urban planning. Urban planners themselves emphasise the needs of the urban poor to justify the loss of agricultural land

in favour of housing and public services (personal communication Z7, 21 April 2022; P5, 15 June 2022; focus group discussion, 22 April 2022). This shows the competition over urban space and which functions and interests should be accounted for.

There are initiatives to maintain green, productive spaces as part of the growing city of Dar es Salaam, but these risk being side-lined in visioning the city's future. In 2012, the city's municipal councils collectively approved a city-wide strategic plan to formally incorporate agriculture as part of the city. Areas were selected for urban agriculture (including plans for financing and regulation) and these ideas served as a direct input for the development of the Dar es Salaam City Master Plan 2016–2036 (Halloran & Magid, 2013a; IMC et al., 2012; SCINAP, 2012; URT, 2020a). Although this achievement was applauded by policymakers and researchers as an important breakthrough in the formalisation of agriculture in African cities, the results from this collective bottom-up initiative are yet to appear in the plans that envision the future of Dar es Salaam. The initiative is referred to in the latest Master Plan, but excluding the zoning of the agricultural areas originally and explicitly proposed. Agriculture gets a mention as a landuse type but largely shows to be a left-over category (declining in direct relation to the planned growth of the city; (see URT, 2020a, Technical Supplements Volume II) waiting for 'possible future urban growth' (URT, 2020a, Main Report, p. 257–259) rather than a basis for concrete action to secure the position of agriculture in the city.

The continued presence of agriculture in Tanzanian cities is described in various policy documents (Kyessi, 1997; Mkwela, 2013; Mlozi et al., 2014; URT, 2000, 2013, 2017, 2018). As part of these, the Urban Planning Act stipulates the conditions under which urban farming is allowed (URT, 2018). This regulation, as well as other regulations that refer to urban agriculture, recognise agriculture as an important component of urban sustainable development, although they also state that agriculture is not a principal function of towns (see the policy analysis by Mkwela, 2013), is only allowed when it does not "create nuisance within the urban area" (URT, 2018, p. 3), and when "improperly practised, conflicts with other urban land uses and leads to land degradation, water pollution, and is a threat to health and safety" (URT, 2000, p. 48). The ambiguities and conditionalities outlined in these policy documents leave room for differing visions because by-laws for urban agriculture are largely non-existent. These ambiguities (and the absence of bylaws) should not just be seen as problematic, as they also offer direct opportunities for the

continued presence of farmers in the vacant spaces within the city who make a living while bearing the uncertainties of these informal (non-regulated) economies.

In order to deal with the possible health effects as a consequence of water pollution, environmental guidelines are in place to prevent the uncontrolled discharge of wastewater (Nyanda & Mahonge, 2021; URT, 2004, 2009). Water reuse is acknowledged as a possible 'alternative water source' (URT, 2002, 2022), but specific interventions and regulations have not yet been implemented. A guideline on the reuse of treated wastewater in agriculture has been prepared, but how the implementation of the guidelines in small-scale irrigation systems is supposed to take place remains unclear (TBS, 2021). Given the absence of ways to enforce such regulations, farmers cannot be forced to stop using such water for agricultural practices. Extension officers can only decide to stop offering services to areas that are known to experience problems related to water pollution (personal communication Z5, 1 February 2022; Y7, 12 April 2022).

Local authorities hold the power to decide which agricultural practices they provide support to (or not). In making these decisions, they render some areas institutionally invisible (no extension services to support them) while condoning its continuance (no enforcement against it). Both the existing regulations and their day-to-day enforcement create an ambiguity where urban agriculture is conditionally condoned: farmers are allowed to use space to contribute to the city's economy and food geography but with no support and uncertainty as to whether they can maintain this place in the future city.

5.5 Discussion

The preceding sections described the policy dynamics of urban agriculture (as found in city agriculture, apartment agriculture, and urban agriculture more generally) in Dar es Salaam. The policy arrangements approach has proven useful as a tool to understand how discourses work in interaction with actors, rules, and resources/power. With the growing dominance of a discourse around health and modernity as compared to the existing discourse that values agricultural and economic benefits, we show how a change in one dimension of the policy arrangement (i.e., the discourse) also influences other policy elements. Table 3 summarises the different policy elements discussed in this paper.

Despite an antagonism between agriculture and the city, which originates from colonial ideas about what constitutes the 'urban', there is a continued space for agriculture in urbanising landscapes to offer economic benefits and food by utilising idle resources.

Supplying food and jobs – something the state or the formal private sector cannot fully cater for – means that agriculture is embraced as an urban practice. However, as the city grows, this prominent discourse around agricultural and economic productivity is challenged by newly emerging discourses around health and modernity. Health issues related to irrigation with urban water are increasingly presented as a reason to enforce strict rules or remove agriculture, and agriculture is more and more regarded as an improper use of urban land. Farmers have limited control over the consequences of these changes and find themselves in a position where they are reactive to opportunities that arise within the city.

The introduction and support of new farming models (apartment agriculture) represent the materialisation of urban ideals and seeks to integrate modern elements into existing agricultural practices. In this way, the existing ideas around agricultural realities (associated with traditional, untransformed ways of life) are reconfigured to fit modern narratives of 'being urban' that embody ideas around efficiency, cleanliness, innovation, and entrepreneurship. However, most of these capital-intensive methods imply requirements (e.g., financial resources, legal land rights) that cannot be met by the far majority of people currently practising conventional urban agriculture in the city's open spaces (city agriculture). While apartment agriculture legitimises the presence of agricultural support and (to some extent) urban agriculture more generally, it simultaneously strengthens the divide between what is transformed and untransformed; leaving the majority of farmers in Dar es Salaam in a delicate space.

Ambiguities concerning the planning and regulation of the use of land and water for agriculture in Dar es Salaam pose direct risks, but also offer opportunities for the continued presence of those who make a living as part of these informal economies. Farmers are exposed to urban land grabs, as well as the deterioration of their irrigation sources because they lack the ability to contest urban water pollution. Meanwhile, they provide for the city by informally utilising urban land and (polluted) water. Where local authorities hold the power to decide which agricultural practices they provide support to (or not), they can render agricultural areas institutionally invisible (no extension services to support them) while condoning its continuance (no enforcement against it). In this day-to-day governance of urban space, we observe the interplay between top-down forces of control and bottom-up forces of city-making through which people shape the city according to their own demands and interests (Veldwisch et al., 2024a; Chapter 4).

Table 3. Summary of policy elements found for both city agriculture and apartment agriculture.

	City agriculture	Apartment agriculture
	Agriculture in urban open spaces that uses mixed urban water flows for irrigation. Contributes to the city-wide availability of leafy vegetables	Technology-based types of agriculture near people's houses that use piped water for irrigation. Contributes to the availability of vegetables on a local scale
Discourse	Emphasis on the contribution to food availability and employment	Emphasis on food safety and (technological) progress that exemplifies the modern city
Actors	Farmers in coalition with (mostly informal) actors in a city-wide food distribution network. Limited or no coalition with state actors	Farmers in coalition with actors in a small food distribution network. Coalition with local government authorities around the promotion of new farming models
Resources/ power	Farmers rely on the informal use of open spaces to build profitable networks of food provisioning. They have limited control over access to land and the quality of water and have limited power to defend their interests	Farmers have financial capital that enables securing land and investing in agricultural technologies. Knowledge exchange around these farming types takes place during trainings funded by the government and development partners
Rules	At the national level, there is the Urban Planning Act. On a local level, by-laws concerning urban agriculture are largely non-existent. This creates ambiguities and conditionalities around what is allowed	
	Land insecurity and issues of water quality pose risks of enforcement and/or removal. On the other hand, policy ambiguities create room for continuance so long as it is not regarded a nuisance	Security of access to land and clean water, combined with the characteristics of the agricultural practice, makes it regarded as aligning with the city's plans and regulations concerning urban agriculture

5.6 Conclusions

This paper has shown a disconnection between planning ideals and the embodied reality of agriculture in Dar es Salaam. While authorities aim for modern technologies that legitimise the presence of agriculture in the city (*Kilimo cha Maghorofani*, i.e., 'apartment agriculture'), the majority of urban farmers rely on self-organised types of agriculture that are built on informal agreements over access to land and water (*Kilimo cha Mjini*, i.e., 'city agriculture'). Farmers have limited control over the dominant visions about agriculture in the city, but their presence is simultaneously legitimated through the contribution they make in providing food and incomes to the urban citizenry. This results in a state of laissez-faire, where agriculture is embraced as an urban practice so long as its presence and proximity are useful and not intrusive.

As the city grows, the presence of urban agriculture is increasingly challenged, both physically and ideologically. By studying policy dynamics using the policy arrangements approach, we showed how urban agriculture in Dar es Salaam is moving in two directions as a result: one that reflects an attractive model of agriculture that fits modern urban ideals ('apartment agriculture') and one that satisfies everyday demands for food and employment by making use of institutional ambiguities around the use of urban land and water ('city agriculture'). Although these two types of agriculture co-exist in the city, it simultaneously reinforces the divide between planning ideals and urban reality. Authorities promote ideas on progress and development that implicitly position the majority of the current agricultural practices 'outside' of the city's future. This not only applies to those urbanites who have found livelihood security through agriculture but also to other types of informal employment and informal living arrangements.

Based on the findings in this paper, we highlight two points of consideration that are relevant for researchers, planners, and policymakers when engaging with urban agriculture. First, initiatives that are 'making visible' or are 'giving voice to' the continued presence of urban farmers can help to secure the political and material interests of those that are often not considered in development planning. Mapping, quantifying, and describing urban agriculture strengthens the understanding of the sector's dynamics and its impact and, in this way, can support an informed dialogue about what role agriculture can play in light of urban sustainability. Second, we have shown the interplay of top-down (state-initiated) approaches of urban development and bottom-up forces of city-making

through which people shape the city. As state and society have different capacities to develop urban space (including the services it requires), a collaborative approach to urban planning is recommended to strengthen the state–society engagement around city-making. A co-production process could be a useful approach here, where diverse types of expertise, knowledge, and actors collaboratively produce context-specific knowledge and pathways towards a sustainable future for the city.

CHAPTER 6

What's in a name? Politicising wastewater reuse in irrigated agriculture

"Water is not about water. Water is about building people's institutions and power to take control over decisions."

Wastewater is increasingly being reused as a solution to water scarcity in agriculture. This article combines a literature review with an ethnographic study of water reuse in Dar es Salaam, Tanzania, to explore the field of wastewater reuse and what it is made to represent. The academic literature largely focuses on the practical challenges of wastewater treatment, while underlying political dynamics that contextualise the planning of, and control over, water flows remain largely unaddressed. Because people seek to take control over water through the manipulation of flows and qualities, wastewater reuse is inherently political. The study of water reuse practices in Dar es Salaam shows how water quality decline is co-produced with processes of urbanisation that cause inequalities in the urban waterscape. Farmers are subject to changes in the physical characteristics and normative understandings of the urban water system, yet do not have the power to reconfigure these to their own ends or challenge the way that their practices are portrayed. This paper shows the importance of politicising wastewater reuse and calls for a more diverse and emancipatory understanding of, and response to, water reuse in agriculture through interdisciplinary research and the collaborative production of knowledge and interventions.

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Quote: Sunita Narain, director of the Centre for Science and Environment. From the acceptance speech after being awarded the Stockholm Water Prize for the work of the Centre for Science and Environment (26 August 2005).

6.1 Introduction

Cities are growing worldwide, especially in those areas where the effects of climate change are expected to be most severe. The adverse effects of historic growth and industrialisation fall onto cities in Africa and Asia that have lower capabilities to adapt to these climatic changes (IPCC, 2022a; Maplecroft, 2022; UN, 2018). In the context of this growing future uncertainty, agriculture faces the challenge of producing more food with less water. A combination of the physical challenges related to unpredictable rainfall, higher crop water demands, and the political negotiations around the reallocation of water put increasing pressure on food production (Garrick et al., 2019; Hommes et al., 2019). It is expected that conflicts between the urban and agricultural sectors will become more pronounced in an increasing number of watersheds (Flörke et al., 2018). When handling these conflicts, allocation generally prioritises uses with the highest returns per unit of water. Cities hold a powerful position in this regard, since agriculture is often seen as inefficient in both technical (large water withdrawals at low irrigation efficiencies) and economic terms (low economic productivity compared to non-agricultural sectors) (Komakech et al., 2012; Molle & Berkoff, 2009). Irrigation modernisation can only partially offset agricultural water losses; this is driving a search for nonconventional solutions to water availability in agriculture.

Over the last decade there has been a growing interest in the potential for wastewater reuse as a solution to water scarcity. The attractiveness of wastewater (which contains water, nutrients, organic matter, and energy) as a resource comes hand in hand with risks (to human health and the environment) and this dichotomy contributes to wastewater featuring prominently on international policy agendas. Wastewater reuse has the potential to be an important economic asset in a largely publicly-funded sector (Drechsel et al., 2015; Hernández-Sancho et al., 2015) and plays a central role in the water-energy-food nexus that focuses on resource streams, their interconnections, and the need to move towards circularity and the closing of resource loops (Gremillion & Avellán, 2016; Kurian & Ardakanian, 2015; Qadir et al., 2020). The interest in wastewater as a resource was highlighted and extensively discussed when UN-Water addressed this water type as its 2017 theme. The World Water Development Report of UN-Water, entitled Wastewater: The untapped resource, argues for a paradigm shift towards seeing the potential for wastewater as part of a circular economy (WWAP, 2017). This line of thinking (which emphasises the optimisation of cross-sectoral resource use) is particularly relevant in the

context of urbanisation, as interconnected resource pressures are concentrated in cities and urban growth is reconfiguring the urban – rural interactions around water and food (Scott et al., 2016). The urban use and subsequent disposal of water affect physical flows and water qualities in ways which are not only material but also symbolic. This reconfigured water is relatively stable as a resource (as there is no seasonality in wastewater production) and contains valuable nutrients (although these are not easily separated from the hazardous elements it also contains), which makes building links between cities and agriculture an attractive option.

Wastewater reuse, however, cannot be seen as having uncapped and untapped potential yet to be fully embraced. Wastewater reuse is already widespread, particularly in low-income countries where small-scale farmers rely on urban return flows for irrigation (Drechsel et al., 2010; Scott et al., 2004). The majority of these reuse practices take place without planning or regulation and are not acknowledged for their contribution to the circular economy and local food production. This raises questions about which types of wastewater reuse are accounted for and which practices are deemed to be either appropriate or unfit for the purpose. By posing the question 'What's in a name?', this article explores the meaning of 'wastewater reuse in agriculture' and what it is made to represent, both in academic literature and in the governance of day-to-day reuse practices. The analysis is guided firstly by the question of how end-users' (i.e. farmers') perspectives on wastewater reuse compare to and interact with dominant (expert) knowledge in the same field. And secondly, how this interplay of different understandings influences governance and actual reuse practices. Based on literature and my own experiences in the field, I start from the hypothesis that this expert perspective approaches water pollution and reuse predominantly as a biophysical challenge that can be resolved using technical solutions and good governance. Rendering these issues as technically solvable largely conceals the political nature of access to water quantity and quality. By studying water reuse practices in the rapidly-growing city of Dar es Salaam, Tanzania, this paper shows the value of a socio-political study of wastewater reuse to supplement these expert understandings. An interdisciplinary research engagement, in which both the biophysical and socio-political processes that configure wastewater reuse are studied complementarily, would thus contribute to a richer description of how water reuse takes shape and thereby allow us to engage with water reuse in more diverse and emancipatory ways.

Many cities' water supplies are characterised by heterogenous infrastructure configurations that result in differentiated conditions of access (Crow-Miller et al., 2017; Graham & Marvin, 2001; Lawhon et al., 2018; Rusca & Cleaver, 2022). These features shape the ways in which urban dwellers manage and navigate their way through the city. Urban political ecology has advanced the understanding of cities as interactive socio-ecological spaces that are shaped by social relations of power. Urban dwellers exercise their power to appropriate the city for their own ends through, for example, finding ways to gain access to scarce land and water resources. The capacity to mobilise power is contextualised both geographically and historically, which creates divergent socio-material geographies and social marginalisation (N. Heynen et al., 2006; Lawhon et al., 2014). Whilst urban political ecology scholars have focused extensively on access to water quantities and timing, little attention has thus far been paid to issues surrounding water quality decline (Karpouzoglou et al., 2018; MacAfee, 2022; Rusca et al., 2017). Rusca et al., (2017, p. 139) describe how water quality "continues to be entrenched in disciplinary studies in micro-biology focusing on physico-chemical and microbiological quality and in studies in public health focusing on risks associated with contaminated water". Just as access to water can be a contested resource over which people seek to exert agency in order to maintain or upset control, water quality can be similarly contested. By applying a political ecology lens to understanding wastewater reuse practices, this paper shows how water quality is instrumental in understanding the varying levels of control that water users have within the urban waterscape.

First, this paper provides a literature review of the past decade of publications on wastewater reuse in agriculture. The research field is studied from three different angles: an analysis of the academic corpus, the global scale, and the most common descriptors. It shows that the academic engagement predominantly revolves around the biophysical aspects of wastewater and its reuse in formally structured schemes. This paper then describes the results of ethnographic research into water reuse practices in Tanzania's largest city, Dar es Salaam. Although this paper explores 'wastewater reuse in agriculture', it refers to 'water reuse in agriculture' in the case description, as the farmers' vocabularies deviate from commonly-used terminology to describe these reuse practices (I will come back to this in more detail). The case analysis shows the value of integrating a socio-political approach into the study of water reuse. The study employed participant-led research in six urban agricultural areas between May 2021 and July 2022, with regular field

visits and active farmer engagement, in order to learn more about the everyday lives of urban dwellers who cultivate and irrigate and to understand how their practices are embedded in the wider urban context. This article mainly relies on regular interactions with sixteen farmers in one particular agricultural area. In addition, stakeholder interviews and documentary analysis were used to relate the field observations to the broader dynamics around access to land and water in a rapidly growing city. Finally, three insights from the analyses highlight the importance of politicising wastewater reuse and point towards a more diverse and emancipatory understanding of, and response to, day-to-day reuse practices.

6.2 Exploring uncharted waters

Three steps were taken to navigate through the academic field of wastewater reuse in agriculture. First, a bibliometric analysis was conducted to study the intellectual structure of the research field over the past decade (Donthu et al., 2021). Bibliometric techniques are increasingly used as a literature review method to map the conceptual and performative structures within a (broad) research field. In the field of water management this has, for example, been done by Zare et al. (2017), Velasco-Muñoz et al. (2018), and Durán-Sánchez et al. (2020). The resulting insights into the thematic and geographical characteristics of the research field are presented in this section. Second, the scale of wastewater reuse in agriculture is discussed in order to show the role that reuse plays in meeting water and food needs around the world. Third, and building on the previous steps, this paper shows a classification of wastewater reuse in agriculture based on influential publications in the field. Additional information about the literature review can be found in the Supplementary materials to this dissertation.

There has been a growing academic interest in wastewater reuse in agriculture over the past decade, undeniably a result of increasing stress on global water supplies. Academic contributions are diverse in their focus, as the chain of water production leading up to agricultural reuse passes through different fields of attention, but most published articles (68%) belong to the physical sciences (Figure 14), with the environmental sciences being the largest field represented. Meanwhile, the social sciences make up the smallest contribution (4%), which shows a limited focus on the societal dynamics that surround water reuse. Publications predominantly centre around treatment processes and the biophysical effects of water reuse (both beneficial and harmful) for agricultural

production systems. Close to half of all publications don't refer to a specific geographical context and apply research approaches that are not specific to a particular location (e.g. experimental set-ups or modelling-based approaches). Most publications that do refer to a geographical context (country or city) take place in North Africa and the Middle East (Figure 14). Three quarters of all publications about wastewater reuse in a particular location take place in upper-middle- and high-income countries. This shows a relatively low representation of research work in regions that have a lower capacity to adapt to climate change. An increase in urban vulnerability and scarcity-induced economic losses in those areas puts more pressure on the competition over available water resources (IPCC, 2022b, 2022a). The absence of research work on wastewater reuse in these climate-vulnerable countries should not, however, be interpreted as an absence of reuse practices; rather, it shows how water reuse is neither monitored nor accounted for.

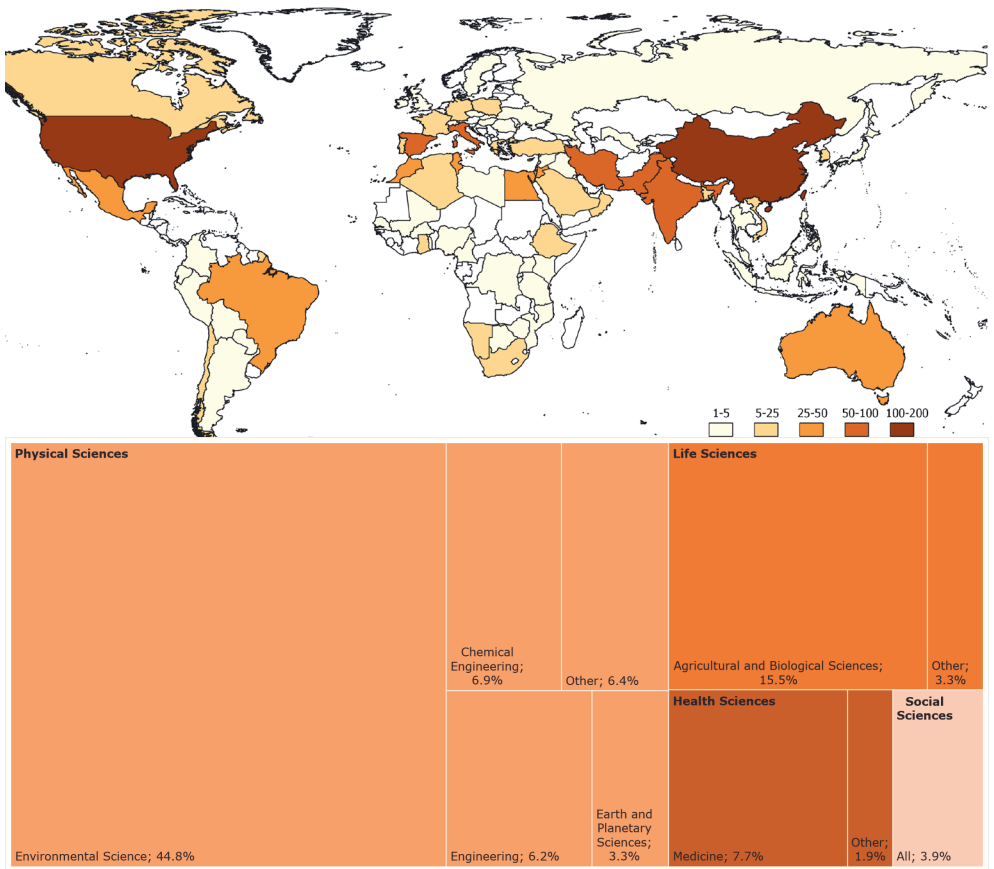


Figure 14. (a) Geographical distribution of location-based publications. (b) Thematic distribution of publications based on the All Science Journal Classification. More details are provided in the supplementary materials.

Non-conventional sources such as wastewater are believed to hold the potential to reduce the pressure on the global water budget – especially in the agricultural sector, which accounts for 72% of all freshwater withdrawals worldwide (FAO, 2021). Incorporating these 'new' sources into agriculture enables freshwater to be transferred to higher-value uses (such as growing cities) and contributes to the balancing of competing water demands among various users (Drechsel, Qadir, & Baumann, 2022; Murray et al., 2019; Reznik et al., 2017). Thebo et al. (2017) calculate that around 35.9 million hectares of irrigated cropland have high levels of dependence on urban wastewater flows, which is at least 50% higher than previous estimates. 82% of this cropland is located in catchments with low levels of wastewater treatment. Such settings are often described as unplanned wastewater reuse or wastewater irrigation (see below), and they are poorly accounted for in traditional water accounting approaches. Global or regional assessments of wastewater reuse often focus on the planned reuse of treated effluent and do not capture the significantly larger share of indirect reuse of untreated or partially treated wastewater flows, widely used in low- and middle-income countries (Drechsel et al., 2015). The scale over which the planned reuse of treated wastewater takes place is estimated to be between 0.7 and 1.35 million hectares and is particularly focused on the Middle East, North Africa, and Western Europe (Drechsel, Qadir, & Galibourg, 2022; Jones et al., 2021).

Quantifying the scale of wastewater reuse in agriculture is a challenge given the different types of water use configurations. The practice has often been referred to as 'wastewater irrigation' (particularly in the unplanned setting) (Zhang & Shen, 2019), which creates uncertainty over whether it captures the diversity of water uses that have an impact on agricultural productivity, human health, and the environment. Wastewater itself already consists of a number of 'used' water flows that have been produced by households, businesses, or in industrial settings. Wastewater reuse is generally clustered into four categories: direct and treated, direct and untreated, indirect and treated, and indirect and untreated (Huibers & Van Lier, 2005; Jiménez et al., 2010; Mateo-Sagasta et al., 2015; W. van der Hoek, 2004). With direct use, wastewater (treated or untreated) is used in agriculture without being mixed with other water flows. In the case of indirect use, wastewater is first discharged into a water body and used downstream. This indirect use dilutes the wastewater, as well as the meaning attributed to it. Linked to these clusters – which strongly focus on the treatment and disposal/reuse component of the wastewater management chain – there is often reference to the level of planning involved. Drechsel,

Qadir, & Galibourg (2022) expand on earlier work by Scott et al. (2004) and differentiate between planned and unplanned wastewater reuse. Planned wastewater reuse is generally linked to the direct reuse of treated wastewater, with strict regulation and high levels of formal recognition. These reuse configurations generally move away from pointing at the waste character of the water used by referring to 'reclaimed' or 'recycled' water. Such changes in semantics have a proven positive impact on the perception of risk involved in wastewater reuse (McClaran et al., 2020; Mikhailovich, 2009). Unplanned wastewater reuse, meanwhile, is mostly associated with the indirect use of (partially) untreated water in an informal setting. These practices are typified by other descriptors, such as wastewater reuse or wastewater irrigation – terminologies that do not necessarily match the perspectives of the end-users themselves, as I will show in the next section.

This section demonstrates the prevalent academic focus on the biophysical aspects of wastewater reuse in the context of the planned (and regulated) connection between wastewater management and irrigated agriculture. The deterioration of water quality due to prior use is controlled by treatment set-ups and the monitoring of quality parameters in order to minimise any negative impacts on crops, human health, or the environment. Planned reuse schemes allow for a controlled environment that seeks to optimise the productive and economic benefits of transforming this waste stream into a resource. However, the socio-political dynamics that contextualise the planning of, and control over, water flows remain largely unaddressed. Beveridge et al. (2017) describe how social science studies in the field of water reuse only focus on particular problems around implementation and largely overlook the politics of water reuse. Whereas research approaches show a dominant focus on water quality control backed by technical expertise, this paper rather continues by giving insight into the socio-political processes that configure access to water flows and qualities.

6.3 Water reuse in Dar es Salaam

Wastewater reuse in agriculture takes place around the world, but research is largely focused on planned reuse, the associated water treatment, and regulative institutions. State authorities play an important role in these water systems, whereas farmers participate with varying levels of control. Meanwhile, a far greater share of water reuse takes place on a more informal basis where farmers (consciously or unconsciously) make use of urban water flows for irrigation in urban, peri-urban, or rural areas downstream of

cities. Although commonly classified as 'unplanned', farmers actively and intentionally plan their use of water for agricultural purposes – though largely without any state involvement. This section examines such cultivation and irrigation practices in Dar es Salaam and shows the multiple ways of knowing and doing that surround water reuse. By taking day-to-day reuse practices as an entry point, I show how the farmers' perspectives on water reuse compare to and interact with dominant (expert) knowledge. A focus on the farmers' everyday dealings with water thus widens and pluralises the understanding of water reuse.

Irrigated urban agriculture is a long-established part of Dar es Salaam, is responsive to urban growth, and functions independently from the state. Open spaces – such as river valleys, flood-prone areas, public open spaces, or to-be-developed private plots – serve as (often temporary) opportunities from which networks of food provision are built. Leafy vegetables are commonly found in these areas, as they are in high demand, quick to grow, and perishable (which favours short distances between producers and consumers). Wegerif (2017) describes how urban farmers are part of a symbiotic food system that provides economic opportunities for a range of people and an accessible supply of fresh vegetables for consumers. The ability to construct (and reconstruct) a network of food provision that fits the urban ecosystem has enabled its continued presence, but farmers are also subject to the changes that occur around them. The densification and expansion of the city pose a constant risk that the opportunity to use land will be lost. Since agricultural land is regarded as inferior to other uses, zoning urban land for agriculture is uncommon. Urban farming persists in Tanzanian cities as long as it is deemed appropriate, but it is seen as subservient to other uses when they present themselves (Foeken et al., 2004; Mkwela, 2016; Mlozi et al., 2014; Msangi, 2011; Namwata et al., 2015; Thomas et al., 2021). "Urban agriculture is placed at the bottom of the pile as a land-use priority. The best land is often covered in concrete whereas the poor land is rehabilitated for food production" (Hallett et al., 2016, p. 94). Farmers in and around African cities often have a limited say in the urbanisation agendas that are imposed on them (Zoomers et al., 2017). Since the majority of agriculture in Dar es Salaam relies on informal agreements for land access, farmers are constantly exposed to urban land grabbing.

The Msimbazi River is the city's largest river and is also known for the agricultural production in its floodplains. The river originates in the city's adjacent rural region and is joined by a number of tributaries before flowing into the Indian Ocean. It receives effluent

discharges from residential areas and several industrial sites as it passes through the city (Chanzi, 2018; Leonard et al., 2012). During the dry season, the baseflow from the hinterland is low, and the supply of water is believed to be largely return flows from human activities. Some of these return flows are treated (the river receives effluent from several wastewater treatment plants), but other wastewater flows are discharged directly into the river. The best-known agricultural area along the river is called Sukita (around 45 hectares, and largely used for agriculture). Sukita is named after the business arm of Tanzania's ruling political party, which previously managed the area as a coconut plantation and allowed farmers to grow vegetables under the palm trees as a way to keep the area clean and looked after (a common reason for urban landowners to allow agriculture on their land). The agricultural area – enclosed by high-density informal settlements – has remained part of the city for over 40 years, as annual flooding prohibits construction in the area. However, urban development is still occurring: several warehouses have been built there over the last decade, eating up agricultural land, and the placement of beacons by land surveyors in more recent years has given farmers reason to fear imminent eviction. Since there is no formal recognition of agricultural land use in the city, land pressure is slowly forcing farmers to relocate to the edges of society, both physically and ideologically speaking (Bersaglio & Kepe, 2014). This means that farmers in Dar es Salaam who lose agricultural land to urban development move towards the peri-urban areas or into marginal areas such as Sukita.

The urban dwellers who practice farming in Sukita and other agricultural areas in Dar es Salaam rely on informal land use agreements. Men generally have a stronger hold over the land, although this does not reflect the important role that women play in food production and provisioning. When visiting Sukita in the early morning, one finds female farmers and groups of women harvesting and preparing vegetables (washing, sorting, bundling) and leaving the area to sell at markets and vegetable stalls or to go from door to door in the surrounding neighbourhoods. A small portion of the vegetables is sold directly to consumers who visit the area. This small-scale, commercial agriculture provides a reliable household income, and only a small number of farmers combine their farming activities with other jobs (e.g. security or construction). Nearly all farmers in the area are rural migrants who spent, on average, 6 to 7 years in the city engaged in other types of employment before starting agriculture. Social organisation among farmers remains low due to their social heterogeneity; their different ethnic backgrounds, socio-economic

characteristics, areas of urban residence, and agricultural aspirations make it difficult for urban farmers to organise themselves as a group. The sparse social organisation that is present generally revolves around occasional matters that endanger farming practices, such as conflicts around access to land and water or water scarcity during the dry period. The mobile petrol pumps that are used for irrigation are generally individually owned, as farmers are afraid of the potential conflicts that collective ownership might cause. It is more common for women farmers to lend out a pump (on the condition that their own plots are also irrigated), as pump irrigation is regarded as a physically demanding job that should be done by men.

Over time, Sukita has become symbolic of the conflictive relations between agriculture and the city. Water quality studies have shown pollution in the Msimbazi River, with specific focus on the concentration of heavy metals, which exceeds permissible limits (Chanzi, 2018; Harieth, 2017; Leonard et al., 2012; Mwegoha & Kihampa, 2010). Heavy metal contamination has also been found in the vegetables grown along the river (Kihampa & Mwegoha, 2010). An increase in the number of uncontrolled industrial and domestic discharges has led to this deterioration. Over two million people in the city were estimated to be possibly exposed to severe health risks given the river water pollution and the fact that the leafy vegetables grown in the river valley are consumed by nearly all citizens (Leonard et al., 2012). Such figures and other research outcomes have been widely picked up and have resulted in a number of newspaper articles with alarming titles such as "Dar's river pollution threatens millions" and "Vegetables in city gardens declared as silent killers" (Andrew, 2008; Sylvester, 2018). Farmers in Sukita – as well as in other agricultural areas – contest these statements and indicate that these articles have raised disproportionate concerns about vegetable production in Dar es Salaam. However, a shut-down of urban farming as a consequence of this uproar is uncommon, given the significant number of urban dwellers that either directly or indirectly benefit from local vegetable production. Local government authorities have only decided to shift their focus to other areas that don't face the detrimental effects of urbanisation and are therefore more popular (or less sensitive) to engage with. This can be seen in the side-lining of Sukita during discussions about the formalisation of urban agricultural areas (McLees, 2012), a municipal council that indicates not to provide extension services to agricultural

areas facing problems with water pollution (p.c. L6[19]; 23 July 2021; Y7, 12 April 2022), and an observed shift of extension services towards peri-urban agriculture and more advanced agricultural set-ups.

Most research thus far has been conducted on the biophysical characteristics of the Msimbazi River, linking them to the farmers present in the river's vicinity without studying actual farmers' practices. However, active farmer engagement and field observations have revealed that the understanding of water flows and qualities in Sukita is more diversified than previously documented. Farmers do not rely solely on the Msimbazi River for their water, but also make use of a network of canals and a number of shallow wells. The (unlined) canals play a particularly important role for the majority of farmers whose plots are not directly adjacent to the river. These canals originate in the residential areas and feed reservoirs that increase the buffering capacity of the local water scheme for times when irrigation demand exceeds water supply. The canals from the urban areas drain a combination of water flows, which reflect the composition of the area. Observations and interviews indicate that most water drained into the area is domestic wastewater, stormwater, and water leakages from the piped water system. Some of these leaks get repaired, while other background leaks are hard to identify or contain and are a possibly significant contributor to a stable base flow into the area.[20] Industrial wastewater (which is often cited in the case of the Msimbazi River) is not a significant source for most of the canals that the farmers use. The other source is a number of shallow wells supplied with water from the shallow groundwater table in the area; these also fill up during rainfall events. The latter is a known challenge in terms of water quality, as floods flush waste towards low-lying areas.

When asked to characterise their own irrigation sources, farmers described them in terms of quantity and reliability, and (upon further probing) the majority indicated that they did not experience problems with water quality. Three farmers referred to quality-related problems with the Msimbazi River (skin irritation and two cases of detrimental crop

[19] P.c. refers to 'personal communication'. The names of all interviewees are coded to protect their identities.

[20] 38.8% of all water produced by DAWASA (Dar es Salaam's water utility company) is lost through a combination of physical and commercial losses and becomes (partially) available in the catchment (EWURA, 2022).

growth) (p.c. C6, 20 July 2021; J7, 19 August 2021; W2, 19 August 2021). When asked about changes in water quality, farmers indicated that the increase in the numbers of households and industries discharging wastewater into the river has affected the water quality compared to when they started using the area. Changes in the quality of water from canals and shallow wells were not mentioned during these interviews. Observations in the area indicate that the water from these different sources can have different colours and can sometimes smell when pumped but does not seem to be detrimental to plant growth. The vegetables grow well across the whole area and show no visual abnormalities. Interviews and observations in other urban agricultural areas in Dar es Salaam also show deterioration in the quality of available water, but no visible problems with crop growth. It is uncommon for farmers to raise concerns around the quality decline of their irrigation sources, because the use of urban water flows is not formally acknowledged and has already contributed to controversy around the presence of agriculture in the city. Since farmers are unable to advocate for the preservation of their irrigation sources (or land security), they employ a strategy of persistence in which they limit their engagement with authorities as a way to be of limited disturbance while continuing with their irrigated cultivation practices. Farmers only raise concerns when there is a risk of losing access to water quantity (or to the land itself), but they tend to accept the water quality decline they are confronted with.

Research and media attention has contributed to a public perception that farmers are putting consumers at risk. Fifteen farmers in different agricultural areas throughout the city were asked to respond to this issue (phrased as, "Farmers are putting the people of Dar es Salaam at risk because of their use of wastewater for irrigation"). Three types of responses were given. The first and largest group of farmers responded by saying simply that their water is clean and safe to be used for irrigation. Their position is derived from the fact that they have not experienced problems with their cultivation nor received complaints from their buyers. The second group acknowledges pollution in their respective areas but argue that they are unable to switch to alternative sources. One of the farmers explained: "I usually reply with a 'sorry', as we do not have any other choice for water. There is no way to prevent discharges from getting into the canal" (p.c. B8, 9 July 2022). Another farmer similarly responded that "there is no such thing as clean water in Dar es Salaam" (p.c. S1, 7 July 2022) and that he and his fellow farmers have no option other than to use the water that is available. Finally, a few farmers argued that these

rumours are spread by those who wish to discredit their activities, as they don't like to see agriculture in the city or have a commercial interest in importing vegetables from outside the city. There is a strong feeling among farmers that it is wrong to blame them for water quality problems and that instead of criminalising the cultivation of vegetables, local government authorities should stop unlawful wastewater discharges upstream (see Figure 15).

Figure 15. Illustration based on research conducted in the area. Farmers feel that the government is criminalising the cultivation of vegetables rather than responding to unlawful pollution upstream.

Farmers do not deny that water pollution is affecting their water sources, but at the same time, they don't like to refer to their irrigation sources as 'wastewater'. They don't experience the water they use as harmful for production and believe that the term 'wastewater' is pejorative and problematic for their business. Examples from field work, though anecdotal, show that farmers use different descriptions for their water sources. When asked where the water from their canals originated, several farmers used the term *chemchem*, a Swahili word that refers to a natural spring. While this protects them from disclosing further information about the source, it also has interesting linguistic overtones. In the urban context, it is an anthropogenic, rather than a natural, source that supplies farmers with a stream of water. Irrespective of a rural or urban setting, *chemchem*

refers to a place where water wells up that can be used for irrigation (p.c. N1, 29 July 2021; W2, 19 August 2021; A4, 28 June 2022; informal conversations 16 June 2021, 19 August 2021). Another farmer consistently referred to his irrigation water as *maji ya Bongo* (Bongo is a nickname for the city, so this translates as 'water of Dar es Salaam') during our regular interactions in the field throughout the research period (p.c. B2). He justified this by explaining that there was no other way of knowing or describing the water he used, since it is urban water constituted by a multiplicity of upstream uses (and misuses).

Taking the farmers' everyday dealings with water as an entry point, this section shows how farmers' practices are persistent despite being suppressed, and why governing water reuse practices is not a technical, apolitical challenge. The availability of leafy vegetables for consumption in Dar es Salaam largely relies on self-organised systems of irrigated urban agriculture based on the (temporary) use of vacant land and a variety of urban water flows. Empirical data from Sukita shows how irrigation is deeply entrenched in this urban water system and subject to changes that occur elsewhere in this system. Farmers make use of different irrigation sources that are fed by a combination of urban water flows. Different vocabularies are used to describe these water flows compared to common expert perspectives, as farmers believe that the term 'wastewater' is pejorative and problematic, particularly while they have no control over changes in water quality that occur. Although they are actively responding to the opportunities of urban land and water, farmers have limited agency in setting the conditions of their (hydraulic) citizenship, since the presence of agriculture in the city is disputed. They are subject to relocation towards more marginal areas and face a deterioration in the quality of their irrigation sources due to upstream uses. Moreover, they have little or no control over either of these factors, both of which marginalise them and their livelihoods. This shows the inherent political nature of water reuse, as people have varying levels of control over, and access to, water – both flows and qualities – and the associated normative understandings of this water use. The following section reflects on the lessons that can be learned from studying the politics that surround such water reuse configurations.

6.4 Discussion

The preceding sections studied wastewater reuse in order to better understand what it is made to represent, both in academic literature and in day-to-day practices in Dar es Salaam. Linton (2010) introduces his writings with the assertion that "water is what we

make of it", which is helpful here in discussing what is made of wastewater (and its reuse). Although wastewater holds the potential to reduce urban vulnerability and scarcity-induced economic losses in areas that are prone to climate change, this attractive narrative risks boiling water reuse down to a managerial task that does not acknowledge the tensions intrinsic to water control. Based on the previous sections, I highlight here three insights that show both the importance of politicising wastewater reuse and also how this politicisation can contribute to more diverse and socially just responses to water reuse in urbanising landscapes.

Firstly, the literature review of the academic field shows a dominant focus on the physical processes that surround water quality. Wastewater reuse (and the associated control over water quality) is approached as a phenomenon that can be measured and managed in order to optimise its allocation. The exclusivity of this discourse can make the control of water (both in terms of quality and quantity) appear to be a politically neutral issue that can be solved through technical knowhow, rational water use, and good governance, rendering the role of power and politics invisible (Boelens et al., 2016; Karpouzoglou et al., 2018; T. Li, 2007; Wessels et al., 2019). However, water is more than its biochemical constituents that can be regulated through problem-solving interventions. It is surrounded by "valuations, knowledge and classifications that are contextual, complex, contested and/or sometimes ambiguous" (Berry et al., 2018, p. 40). Wastewater reuse is inherently political, as people seek to take control over water through the manipulation of physical flows and qualities. These reconfigured flows and qualities subsequently guide human behaviour and provide the conditions for management and regulation (Beveridge et al., 2017; Mollinga, 2008). Stakeholders do not only have differing perspectives and interests that can be subject to negotiation and conflict, they "are also drawing on different resources, norms and legal repertoires to articulate, frame, and defend their positions" (Zwarteveen et al., 2017, p. 6). The case analysis in this paper complements common academic focuses by shedding light on the socio-political processes that configure water reuse practices. Urban agriculture in Dar es Salaam serves as an (informal) food and job provider in a changing urban landscape, but those who practice farming are limited in their power to configure the socio-material environment according to their own needs. Lacking formal recognition of their presence, farmers are slowly relegated to fringe areas and forced to use marginal water sources. In order to continue their activities and provide the city with vegetables, they minimise the voicing of their concerns whilst, at the

same time, bearing the public disapproval associated with water quality decline, which they cannot control. Studying the farmers' everyday dealings with water clearly shows the deeply political processes that shape what the city looks like or how water flows (and with what quality). To contribute to the understanding of water reuse in agriculture, this paper calls for an interdisciplinary research engagement in which both the biophysical and socio-political processes that configure wastewater reuse are studied complementarily. Besides this, pluralising the scholarship by looking beyond accepted science-based expertise to learn from the many other voices, experiences, and stories associated with wastewater reuse can help us make sense of, and engage with, day-to-day water use (Zwarteveen et al., 2021).

Secondly, the empirical case on which this paper is based shows how urban farmers have limited control over the quality of the water that they tap into. This limited control over the conditions of their (hydraulic) citizenship is not unique for Dar es Salaam; farmers in other African cities face similar contestations around their presence and practices. Governments and international donors play an important role in foregrounding ideas on progress, modernity, and development, which depoliticise underlying questions about who has a right to the city (and under what conditions) (Côté-Roy & Moser, 2019; van Noorloos & Kloosterboer, 2018; V. Watson, 2014). Urban political ecology has convincingly shown that urbanisation trajectories are infused with power relations which shape who has access to, or control over, urban water (e.g. N. Heynen et al., 2006; Lawhon et al., 2014; Swyngedouw, 2004). While urban political ecology work has largely focused on access to water quantities and timing, this paper shows how water quality can be similarly studied as a measure of uneven access to water. Rusca et al. (2017, p. 140) describe how water should be recognised in "the sets of social relations that produce water as a commodity (thereby shaping uneven access to that commodity) but also on the socio-ecological relations that give rise to wide variations in water quality and to the exposure of certain groups to poor quality water". Water quality can be instrumental in the study of inequalities in the urban waterscape but requires a comprehensive understanding of both the biophysical and socio-political characteristics of water reuse. Addressing these inequalities in planning and regulation will mean recognising farmers as active participants in the urban water system (with the privileges and responsibilities involved) rather than mere recipients of water 'wasted' elsewhere. However, having farmers actively partake in the planning of urban land and water also requires recognising agriculture as

part of the city's future – something that is contested. By co-producing knowledge and interventions, participative governance can contribute to improving urban food safety and security, which benefits both producers and consumers.

Thirdly, this paper shows the knowledge and values that farmers attribute to the water that they use and how this compares to dominant expert framings. Where these types of water reuse configurations are often referred to as 'wastewater irrigation', this case study shows how this terminology is arbitrary compared to the multiplicity of water flows being reused. Farmers make use of different sources, which are fed by a combination of urban water flows. Although the importance of wastewater flows (including untreated) should not be rendered insignificant, the use of 'wastewater' as an all-encompassing term does not give recognition to the diversity of the flows nor the perspectives of the users themselves. Water is not universally understood: different actors mobilise different ways of thinking and understanding that lead to differing representations and discursive constructions of water. In the case of Dar es Salaam, farmers refer to their irrigation water as a resource rather than a waste product, despite being aware that the water has often been used before. The reference to 'wastewater reuse' or 'wastewater irrigation' by experts to describe these water use practices marginalises farmers and their views on water, which contributes to the persistence of knowledge inequities. Related to this is the common classification of the great majority of water reuse worldwide as 'unplanned'. In actuality, the farmer-led irrigation development that takes place is intentional and requires hard work and investment. Referring to this farmer-initiated development of water reuse as informal, unofficial, or unplanned "labels them as inferior, and often indirectly calls for an intervention to regulate it" (Veldwisch et al., 2019, p. 4). A richer and more nuanced description of water reuse – for example, that dissects the diversity of the urban flows that feed irrigation sources, recognises end-users' views on irrigation sources (by, for example, taking the 'waste' out of 'wastewater'), and acknowledges the intentional efforts of farmers to reuse water – better captures day-to-day realities and thereby allows a more emancipatory engagement with water reuse.

Summing up, this article shows the value of politicising wastewater reuse by studying the biophysical and socio-political processes of water as complementary. While water is a single compound, understandings of it are plural. This means that there is no consensus among actors as to what wastewater reuse represents. Multiple knowledges about wastewater reuse co-exist, but the knowledges embedded in the experiences of day-to-

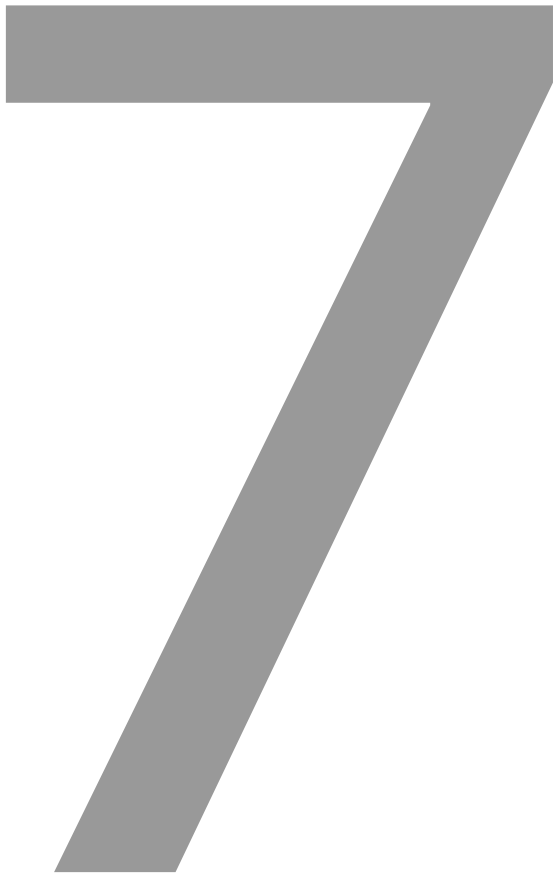
day water users are generally subordinated to the understandings of experts that prevail in research and governance. From an expert perspective, wastewater reuse predominantly revolves around the management of physical water flows and qualities through technical knowhow and regulatory guidelines. Showing the farmers' knowings and doings pluralises the understanding of water reuse in agriculture. Farmers actively and intentionally plan their use of water for agricultural purposes, but they are limited in their control over the physical quality of the water as well as the normative attributes associated with the practice, i.e. they have no control over 'what is made of water'. The call for an interdisciplinary research engagement and the pluralisation of wastewater reuse scholarship is not bound to the particular sphere of water reuse described here but also extends to the other water reuse typologies, regardless of the fact that the politics elsewhere may be configured differently. Wessels et al. (2019) and Tawfik et al. (2023), for example, show how farmers in South Africa and Jordan, respectively, exert power to align the biophysical and socio-political arrangement of water reuse according to their own interests (with varying levels of success). By considering the power-laden context of water reuse, planning water reuse as a solution to growing water scarcity can also serve as an opportunity to reduce socio-economic inequality and political exclusion.

6.5 Conclusions

This article poses the question 'What's in a name?' to explore what wastewater reuse in agriculture is made to represent, both in academic literature and in farmers' everyday dealings with water reuse. The academic field largely focuses on the biophysical control of water in order to optimise reallocation for subsequent use. The use of nonconventional waters herein answers to allocation gaps that cause economic losses to society. Wastewater flows are approached as a practical challenge that can be managed by designing adequate treatment and good governance. However, the control of water can be subject to negotiation and conflict, as various actors exert their power to align water use and quality with their own interests and convictions. This power capacity results in inequalities in the waterscape that are insufficiently addressed in the field of wastewater reuse. Studying the socio-political processes that configure water reuse in Dar es Salaam, Tanzania, highlights the different water knowledges, values, and interests that surround water flows and qualities. Farmers tap into a variety of urban water flows and attribute different types of knowledge and values to the water they depend on than compared to the expert framings prevalent in research and governance.

Since the presence of irrigated agriculture is not formally acknowledged in the city, farmers are the mere recipients of waters 'wasted' elsewhere. They are subject to changes in the physical characteristics and normative understandings of the urban water system, without holding the power to reconfigure these characteristics to their own needs or to control how their practices are portrayed. This paper calls for an interdisciplinary research engagement in which the biophysical and socio-political processes of water reuse are studied complementarily, as well as pluralising the wastewater reuse scholarship by looking beyond expert understandings of water to learn from the knowledges and interventions that farmers have devised. Putting the end-users central to the study of, and responses to, water reuse contributes to a richer and more meaningful description of everyday reuse realities and thereby allows water reuse to acquire a more emancipatory nature. The collaborative production of knowledge and interventions could empower those who, though generally not regarded as professional experts, are already developing solutions on a day-to-day basis to productively reuse water and strengthen horizontal and collaborative relationships within the city.

CHAPTER 7



Discussion and conclusions

As we observe the continued growth of cities across sub-Saharan Africa, landscapes change in different ways. These changes influence the opportunities present for urban dwellers to access the amenities of living in the city. While people have agency to co-produce the city, urban dwellers are also part of a society they can never fully control. This dissertation described the position of farmers as part of such urbanising landscapes and showed the both symbiotic and ambivalent relationship between agriculture and the city. Networks and flows of food are inextricably bound up with land and water use interactions that altogether play an important role in the sustenance of the urban population and the sustainability and resilience of cities. Irrigated urban agriculture exemplifies the everyday dynamics of urban living and the heterogeneity of the African city. Meanwhile, it also shows tensions around modern narratives of 'being urban' which not only apply to agriculture but also to the wider informal city.

This final chapter elaborates on the research lessons and reflections that arise from the different empirical chapters (summarised in Table 4). First, I highlight the empirical and conceptual lessons from this study. Following this, I reflect on the research process. Building on these research lessons and reflections, I explore three ideas around a more effective engagement by researchers and practitioners with the bottom-up appropriation of space (of which irrigated urban agriculture is an exponent). In the final section of this concluding chapter, I answer the main research question by both concluding on the presence and contribution of irrigated urban agriculture in Dar es Salaam and reflecting on contestations around space and citizenship.

7.1 Drawing lessons of the research

Despite an antagonism between agriculture and the city which originates from ideas about what constitutes 'the city', there is a continued informal presence of agricultural practices in many African cities. Groups of people make use of vacant land and urban water to provide food and incomes for the city. These informal networks of provision – which can similarly be found in urban water supply or sanitation – craft the city's functioning. However, contestations around land and water use for agriculture make that farmers find themselves in marginalised positions with limited control over their livelihood. This research studied how practices of irrigated urban agriculture take shape and contribute to livelihood security in the growing city of Dar es Salaam, Tanzania. By showing the interlinkages of different disciplines and considering the multiple

perspectives among different stakeholders, irrigated urban agriculture forms the connecting tissue between agriculture and the city given the locality of land (i.e. urban) and the collective use of water (i.e. irrigated) for food production (i.e. agriculture). As such, irrigated urban agriculture has been defined as the irrigated production of food crops on land located within cities or as part of urbanising landscapes, interacting both quantitatively and qualitatively with other urban water usage, surrounded by policies and other institutions, while serving multiple functions.

To understand how and why practices of irrigated urban agriculture are constituted in particular ways, irrigated urban agriculture was conceptualised in this dissertation as a social practice that is part of a politically-constituted space. While urban farmers build their livelihood practices in novel ways, these practices are surrounded by a sociomaterial context that influences them in ways that they do not always have control over (Chapter 2). This research thus complements the study of how practices are interlinked, mutually shaping, and embedded in extended networks of everyday city life (Chapter 4) by a broader analysis of the institutional and political structures that direct processes of social change (Chapters 5 and 6). Institutions shape and get shaped by everyday social life while inseparably linked to (historical) societal and political trajectories and take shape based on the interplay of formal and informal, traditional and modern, bottom-up and top-down forces of city-making, and the power relations that animate them. Given the absence of recent and reliable data regarding the contribution of local production to food security in Dar es Salaam, this study also quantified the status quo of urban agriculture to show how the relationship between agriculture and the city (Chapter 3). The research outcomes are primarily based on eighteen months of multisite ethnographic field research conducted within Dar es Salaam between March 2021 and August 2022 while complemented by the analysis of literature, spatial data, and over 700 surveys with vendors and consumers. A process of going back and forth between data and theory and alternating between a zoomed-in and zoomed-out research lens allowed to form a comprehensive understanding of irrigated urban agriculture in Dar es Salaam.

Farmers actively adapt their practice to the urban context, drawing on previously acquired skills, knowledge on land acquisition and market accessibility, what to grow best, and when, and where to access water for irrigation. While irrigated urban agriculture appears temporary at specific locations, the practice endures and constantly re-emerges in different forms and at new locations. This shows how irrigated urban agriculture (as a

practice) is persistent to endure by dynamically adapting to a changing society. Interwoven in urban space and its water networks, agriculture contributes to the informal economy of food supply and employment and can be understood as part of an everyday urbanism through which the takes shape. Actors are active agents in constituting everyday practices, while structural (socio-material) arrangements of how space is organised can create path dependencies that mould the options available to farmers. Practices are conceptualised in this dissertation as the 'in-between' where agency and structure intertwine. Although inseparable and complementary as two sides of the same coin, the dynamics of city-making are analytically studied from the different angles of agency and structure. Like any other urban dweller, farmers interact and adapt their practices in novel ways, but these social interactions exist in the contexts that influence them. The individual's ability to configure practices is situated contextually in sociomaterial settings, and practices have a distinct power dimension as power shapes how people develop and maintain the configuration of space. For this reason, understanding processes of social change benefits from complementing micro-level studies on how practices are interlinked, mutually shaping, and embedded in extended networks of everyday city life by a wider appreciation of the institutional and political structures.

Given the conceptual understanding that society takes its form through a web of social interactions, practices constitute what the city looks like, how water flows, and where food travels and is consumed. The complexity of these social dynamics necessitated an interdisciplinary research approach. Agriculture has remained largely peripheral in *urban planning* since it is generally associated with rural areas. Farmers are typically not recognised (and studied) as urban land and water users. This research described irrigated urban agriculture as an explicit expression of city-making given its embeddedness in and contribution to the city's functioning. In *water resources management*, a growing body of work focuses on using urban water flows in irrigated agriculture. Its focus is mainly on biophysical aspects and planned reuse, however, while the understanding of social elements, power dynamics, and the informal nature of the majority of water reuse practices has remained limited. This research specifically focused on these latter aspects to show the importance of complementing current academic engagement with the socio-political aspects of water reuse. It also showed that putting the end-user central in the study of, and responses to, water reuse contributes to a richer and more meaningful

description of everyday reuse realities. In *food and agricultural science*, food systems (and their producers) are of growing interest in light of urban sustainability. The contribution of agriculture in the city has generated considerable debate about its actual and potential contribution to food security. The particular impact of urban development on food systems has mostly been studied at a system level, and recent data on the role of local food production in African cities is limited. This research combined a detailed account of actual agricultural practices with ethnographic research and a foodshed analysis based on recent primary data to show the continued role that farmers play in the city.

Table 4. Schematic overview of all elements of this research

Specific research questions	Motivation & methods	Outcomes
Q1. How can the crafting of water use practices be understood as part of growing cities in East Africa?	In light of the growing pressure on cities, reveal and discuss the role water use practices play in how cities take shape. Literature review of water supply and sanitation in urban East Africa using two research lenses (Social Practice Theory; Urban Political Ecology).	**Chapter 2.** Using two different theories to study urban water supply and sanitation, we conceptualise the politically-constituted space in which everyday practices are placed. Combining **micro-level studies on how practices are interlinked, mutually shaping, and embedded in extended networks of everyday city life** (Ch. 4) with a broader appreciation of the **institutional and political structures** (Ch. 5) enhances the understanding of dynamics around water use and urban living.
Q2. How does irrigated urban agriculture contribute to urban food availability and accessibility, and to what extent is this subject to urban growth?	Absence of recent and reliable data regarding the actual contribution that urban farmers make to food security in rapidly growing cities in Africa. Foodshed analysis based on surveys with vendors and consumers in Dar es Salaam, complemented by ethnographic fieldwork in several agricultural areas within the city.	**Chapter 3.** The quantification and visualisation of the foodshed shows the **continued role that urban farmers play in the provision of leafy vegetables for the city** (Ch. 4). Although urban growth changes the configuration of the foodshed, urban farmers stay of relevance by providing for consumers through short-distance linkages. A total of 70 per cent of all amaranth consumed in Dar es Salaam was found to be produced by farmers within the city. It is

		imperative to acknowledge the contribution of urban areas in providing their own food demands.
Q3. How do farmers respond to the impact of urban growth on their irrigated agricultural practices?	Previous research has focused on only documenting the existence of urban agriculture or presenting farmers as passive in light of urban growth, so there is a lack of understanding about the actual responses of urban and peri-urban farmers to a changing urban environment. Ethnographic fieldwork in six agricultural areas within the city for an in-depth study of how farmers' practices are configured as part of bigger networks of occupying space, using water, and producing food.	**Chapter 4. Farmers take an active** (yet insecure, see Ch. 5) **role providing food and incomes to the city.** They are part of networks of provision (for foodshed, see Ch. 3) that function independently from systems of the state and play an important role in the day-to-day functioning of the African city. Farmers adapt their agricultural practices in response to land pressure and water resources degradation as a result of urban growth. In this light, **irrigated urban agriculture can be regarded as a phenomenon of everyday urbanism.** Concealment and mobility are strategies to persist but also explain difficulties in governance engagement.
Q4. What is the influence of institutional and political structures on the configuration of irrigated urban agriculture?	Urban agriculture shows persistence despite not being formally incorporated or even considered illegal in African cities. It is unclear how governance is constructed so that it still enables the continued presence of agriculture in growing cities.	**Chapter 5.** Irrigated urban agriculture is increasingly under pressure due to emerging health and modernity discourses. Urban agriculture is moving in two directions as a result: one that reflects an attractive model of agriculture that fits **modern urban ideals** ('apartment agriculture') and one that satisfies **everyday demands for**

	Policy analysis based on both interviews with stakeholders (farmers included) who work on urban planning or urban agriculture and a desk study of the relevant policy and research documents.	**food and employment** by making use of institutional ambiguities around urban land and water use ('city agriculture'). The policy domain is constructed so that **agriculture is embraced as an urban practice so long as its presence and proximity are useful and not intrusive.**
Q5. What are the contestations surrounding the reuse of urban water for irrigated agriculture in cities?	The majority of (waste)water reuse worldwide takes place without formal planning or regulation. It is unclear which types of reuse are deemed either appropriate or unfit to contribute to water availability in agriculture. Systematic literature review of the last decade of academic engagement with water reuse in agriculture combined with ethnographic fieldwork in Dar es Salaam focused on water reuse for irrigation.	**Chapter 6.** Academic engagement in the field of wastewater reuse shows a dominant focus on the biophysical of (planned) water reuse. The so-called 'unplanned' reuse (which is the far majority worldwide) and the socio-political dynamics surrounding these flows remain largely unaddressed. These farmers, however, actively and intentionally plan their (re)use of water for agricultural purposes while being limited in their control over the physical quality of the water as well as the normative attributes associated with their practices. **Water reuse in agriculture is surrounded by different interests, making it a politicised space.**

7.2 Reflections on methodology and positionality

As all researchers carry certain assumptions about the phenomenon being studied, situations to be observed, and people to be interviewed, it is important to reflect and draw lessons from these experiences throughout the research process. I have therefore complemented the different empirical chapters by paying attention to 'the self' within the context that is studied (Butz & Besio, 2009). The introduction of this dissertation described how the research design aimed to promote the generation of a shared knowledge and create a more egalitarian connection between the researcher and the research participant. A selection of research methods in a limited number of study areas over an extended, consecutive period of time allowed the in-depth study while taking time to develop relationships, acquire research consent, and become accustomed to the research context. The introductory chapter also elaborates on my positionality by means of my research motives, fieldwork experiences, and role as a researcher. Here, I conclude with four lessons based on personal experiences as a Northern researcher doing research in the South.

Coming from a place of difference (e.g. culturally, academically), I have tried to understand better and find places of sameness in the context studied. The stories and narratives of farmers and their 'private spaces' have become the basis of this dissertation (Bridges, 2001; Millora et al., 2020). This information contributes to a more extensive debate on how we relate to the food we consume, the water we use, the ideas we have about the city, and moreover to a reflection on who is granted right to this city. However, it does not directly respond to the immediate needs of farmers who find themselves building their livelihoods on the insecure access to land, water, and food networks. Although I believe that research engagement should not depend on a transactional exchange, I do believe that it is essential to consider imbalances of benefit. Millora et al. (2020) discuss how these ethical considerations often remain implicitly part of the research process without clear guidance on how to engage with possible issues that arise. The research story (see Supplementary materials) also describes the personal struggle of role a researcher should take when research participants experience a crisis. An open culture of sharing our dealings with such ethical challenges would be valuable for fellow PhD students and other researchers to engage with and continue conversations on how to deal with the 'imbalances of benefit' in order to unpack these situated issues and debate potential solutions together.

In operating according to common scientific ethical codes, respondents were promised anonymity when agreeing to participate. This anonymity was deemed necessary as the visibilisation of their practices could potentially confer power to control and react to these in unpredictable ways.[21] Therefore, the knowledge in this work is based on a dialogical enquiry of which I decided that 'the other' needed to be anonymised. Anonymising participants thus resulted in the erasure of the identities (and thus in some way the voices) of those with whom the knowledge in this dissertation was developed and has left this work with only my name. This has raised an issue for me regarding the ethics of representation. The fact that the researcher can articulate the views and experiences of others in an anonymised manner could in a way be regarded as disempowering, especially when engaging with marginalised groups. I point several times throughout this dissertation towards the co-production of knowledge, but (looking back) believe that the terms of research consent could also have been negotiated more explicitly at the onset of the research. Rather than promising anonymity as a common ethical practice, I argue that research participants should be given the opportunity to decide if and how they want to undergo anonymisation. This allows those who wish to be identified by their names to have that choice and thus remain identifiable. People involved in research may still prefer anonymisation, and a researcher could still consider anonymisation based on concerns regarding impacts that are difficult for the research participant to assess. Nevertheless, the point here is to challenge the promotion of universal anonymisation and how this relates to proper human respect and care which ethical codes focus on.

While the research participants have been anonymised, my own voice as a researcher is also largely distanced (or perhaps even silenced) in the published accounts of this dissertation. As I consider this research a dialogical inquiry (explained below), I feel a similar discomfort here related to the ethics of representation (described above). Reflexivity is supplementary (i.e. added through the inclusion of an introduction and conclusion) to the main body of this dissertation, which requires to be a distinct scientific treatment. The scholar's invisibility in one's scientific work creates a misconception about 'neutral' science, as distancing one's own voice increases a sense of objectivity and neutrality in the eyes of the reader (England, 1994; Heikkilä, 2020; Turnhout, 2022).

[21] The extent to which full anonymity can be guaranteed in research is also subject to discussion, but this is not the point I want to address here.

Charmaz and Mitchell (1996, p. 193) state that "authors are urged to restrain and regulate their voices in deference to disciplinary expectations" and instead advocate for an 'audible writer's voice'. This touches upon the research debate as to what can be counted as scientific knowledge. I do not want to elaborate on this here, but argue in Chapter 6 (following the call of Zwarteveen et al. (2021)) to pluralise the scholarship by looking beyond accepted science-based expertise to learn from the many other voices, experiences, and stories around day-to-day water use. What knowledge is deemed relevant for our understanding of the world should be part of a discussion in science, also in light of the decolonisation of science and the role of indigenous methodologies and epistemologies (Chilisa, 2020; Turnhout, 2022).

Following this, I wrote a research story (see Supplementary materials) which provides a different academic understanding of irrigated urban agriculture. Scientific storytelling can serve as a research method or product to augment our understanding (or perhaps present a 'different' understanding) of a particular phenomenon (Koch, 1998; Usher, 2005; Krauss et al., 2022). The research story 'Fields of friction' – ironically added as a supplementary section to this dissertation – is a non-fictional, reflexive research story that gives a primary account of empirical insights that is closer to the studied reality and keeps the researcher as part of this reality. Especially given that ethnography is characterised by the researcher sharing everyday experiences with his or her research participants to understand how life is lived, the researcher is invested in the context studied. As a means of science communication, using a story can bring the research to life for its audience. It engrosses our imagination and prompts emotion, which bolsters engagement with the research topic. I consider the research story an experiment of presenting a different kind of scientific knowledge and believe there is more room to explore here, although I also realise that (especially early-career) scholars are susceptible to the politics of and within science.

Although effort has been put into acquiring an insider's conception of the social reality studied, performing these actions as part of a research strategy does not make that this dissertation 'simply presents' the lived experiences of farmers in Dar es Salaam. The writings about the efforts and voices that often remain unseen and unheard in urban society have ultimately become my understanding and interpretation. In discussions on the ethics of engagement, there are arguments to withhold outsider researchers from engaging with disempowered communities as they cannot accurately understand a

particular context or can be exploitative to the research context (Bridges, 2001). The boundaries between two positions (insider-outsider), however, are not all that clearly delineated or might actually be a continuum that researchers move along (Dhillon & Thomas, 2019; Merriam et al., 2001). The researcher will always remain an outsider to an extent by (at the minimum) taking the stance of a researcher and more often being an outsider to the research context in multiple ways. "There is a real danger that if we become persuaded that we cannot understand the experience of others and that 'we have no right to speak for anyone but ourselves', then we will all too easily find ourselves epistemologically and morally isolated, furnished with a comfortable legitimation for ignoring the condition of anyone but ourselves" (Bridges, 2001, p. 381). Considering this and looking back at my research experiences, I consider my role as a researcher that of a 'dialogical outsider'. The dialogical position is central here, as listening to people is to empower them, you have to be the person someone else can talk to, and you have to be willing to hear what someone is saying even though you might not be familiar to it. The characteristics that I typify here emphasise building a relational connection with the other, which is also increasingly important in a polarising society. I realise that while the pressure of 'knowledge production' can hinder building relational connections, fostering a dialogical relationship with research participants – especially in unfamiliar contexts – ultimately enhances the research understanding.

7.3 Exploring new engagements

Irrigated urban agriculture shows to be persistently present in a dynamic landscape full of socio-material diversity. This is not to say that farmers are able to secure their right to the future city. On the contrary, the presence of agriculture is increasingly contested when the physical and ideological pressure on urban spaces rises. This leads to an ambivalent relationship between agriculture and the city that also has future implications. Drawing from the body of knowledge of this research, the question therefore arises: what viable solutions and recommendations emerge that transcend this particular case? Generalising and universalising the research insights from Dar es Salaam with other cities across sub-Saharan Africa can potentially bring forth a stereotypical 'Africa talk' (Ferguson, 2006, as described in Myers, 2022) of how cities (should) function as if there is one Africa or one African city. I have no ambition to present an 'ought to be' through recommendations about infrastructural or legislative interventions, as effective planning and governance cannot be reduced to rely on scientific input but require much more. Nonetheless, I want

to explore three thoughts around the engagement of researchers and practitioners in the complex domain of water and food in the city. I start by discussing the 'urbanness' of agriculture, then explore how to account for different types of city-making in planning and governance, and finish by showing the value of changing towards an end-user perspective and a more active engagement with the institutional dynamics of water reuse.

The urbanness of agriculture

The cities we live in and see around us are not fixed spaces but rather dynamically-produced, socio-material spaces of interaction. Chapter 2 takes water infrastructures (and their associated flows) as a starting point to explore how this urban life is structured and evolves. These infrastructures – which often become hidden underground, sectorised, and taken for granted (Graham & Marvin, 2001; Swyngedouw, 2004) – have an important impact on social life. These water systems are not only shaped by but also themselves shape social relations (Mosse, 2008). As water infrastructures are crafted over time, it is important to understand how aspirations in planning and financing these infrastructures rely on notions of a desirable type of urbanism. Based on the work of several prominent urban scholars, Swilling & Annecke (2012) distinguish four different notions of urbanism: inclusive urbanism, splintered urbanism, slum urbanism, and green urbanism. Although none of these types of urbanism exists in a pure form, they do show how different urban visions direct the configuration of urban space. Besides types of urbanism favouring state-led, centralised systems or a neoliberal shift towards opening up service provision to private entities, a type of urbanism particularly talked about in this dissertation is the everyday dynamic of slum living seen worldwide.

Ideals around what the city is supposed to look like play an important role in what is focused on (and who is attributed the opportunity to exert power or participate) in the planning and development of cities. This relates to the above example of urban infrastructures but also applies to the ideas around the relationship between agriculture and the city that have been further explored in this dissertation. Dominant ideas around the city's functioning stand in contrast with processes of city-making in which ordinary citizens play a prominent role. The theoretical and philosophical appreciation of an urbanism 'in its own right' gives human agency to the urban majority that is often not accounted for in dominant development discourses (Pieterse, 2011b; Swilling, 2011). Urban scholars herein turn away from Eurocentric types of urbanism (with associated

prescriptive understandings of what is good and modern) towards an urbanism that appreciates unique lived dynamics of an urban logic that is (be-ing), yet is also in constant motion (becoming).[22] There is thus no finality (i.e. clearly defined, demarcated) in what constitutes the urban, as the city is continuously crafted by its people. This relates to the work of Lefebvre discussed in Chapter 2 on the production of space: space does not exist 'in itself' but is produced in a synchronic and diachronic way. In these processes of production, agriculture, for example, is persistently present in Dar es Salaam (but also in many other African cities) as an employment provider and an important part of the foodshed.[23] Agriculture could, therefore, be regarded as a form of 'urbanness', despite not fitting the particular ideas around the state or condition of the city (i.e. urbanity) which creates a dichotomy between agriculture and the city. Rather than the dichotomy of urban-rural as absolute entities of their own, this research shows a symbiosis of different functions (including agriculture) within urban society.

When thinking about the future city or sustainable development, we rely on political and ideological standpoints that are diverse and performative, i.e. the notions that we have about the world make us think and act in certain ways. As described in this dissertation, these ideas differ for several consecutive developmental eras in Tanzania. Tanzania's first president, Julius Nyerere, strongly critiqued the city as an example of the colonial disruption of African society that had brought more selfishness and less equality. While he emphasised a communitarian society, the neoliberal vision that became influential in Tanzania after him emphasised the individuals' freedom to pursue their interests in an exchange economy (privatisation and free trade are central here). The dichotomy portrayed here between a neoliberal or communitarian structuring of society helps point at the guiding principles of (urban) planning and governance: whether it should be directed solely at (economic) efficiency (reinforcing the current distributions of wealth and power) or whether it should be redistributive (creating a minimum standard for quality of life for all its residents) and therefore offer people a right to the city. For example, when looking at the efficient use of land, agriculture will always hold a lower monetary land use value than industrial or residential land use. However, when valuing

[22] I linguistically lend from the work on Ubuntu by Ramose (1999).

[23] The services that urban agriculture provides are often listed as more than these, but this research has found these as most prominent in daily life.

(ideologically rather than sole economically) access to jobs for vulnerable groups, climate resilience, and food accessibility, agriculture contributes to the quality of life in the city and the wellbeing of its citizens.

The dominance of particular modern ideals about the city plays a formative role in the room that agriculture is given as part of the city. The 'right to development', the right to 'shiny new cities', and the notion that Africa is 'rising' (see Côté-Roy & Moser, 2019; Watson, 2014; also discussed in the Introduction) depoliticises questions around who these narratives account for and its impact on the livelihoods and the citizenships of the urban poor. "It challenges the possibilities of urban citizenship and belonging. It creates regimes and hierarchies of valued and unvalued spaces and, in the end, of the citizens that inhabit them" (Bhan, 2014, p. 235). This relates to the point at the start of this dissertation about what development is, 'to whom' the city belongs, or 'for whom' the future city is planned. Agriculture and the livelihoods of farmers are generally not accounted for (or only in a narrowly defined way) in the visioning of Africa's future cities (Shannon et al., 2018; Watson, 2014; Zoomers et al., 2017). Despite not fitting the strictly-defined ideas around the state or condition of the city, the continued presence and contribution of agriculture in urban settings makes that agricultural practices could be regarded a form of 'urbanness'. This dissertation has shown that agriculture exemplifies as a form of city-making. However, formally acknowledging the role of agriculture as part of urban futures might require the appreciation of other notions of development. More so, as we experience new questions around the liveability and sustainability of cities that relate to climate change, agriculture could potentially contribute to developing a more robust city regarding reducing heat island effects and managing floods. The following section therefore explores how to relate to such questions of planning and governance.

Planning the unplannable

Development is central to this dissertation. Development happens incrementally but moves towards specific ends, as people exert power by making more room for 'the good' and less room, or no room, for 'the bad' in urban development (see Chapter 1.7). Agriculture in the city is often considered a backward, survivalist practice that is a regression from (both urban and agricultural) modernisation that therefore cannot fit a trajectory towards sustainable development. For this reason, urban farmers often find themselves disconnected from city planning. The informal utilisation of urban water and land creates opportunities for those involved but at the constant risk of removal. Farmers

in and around African cities are prone to urban land grabs without following the usual procedures or appropriate compensation, often with claims about underutilisation of land based on modernist conceptions of space (Shannon et al., 2018; Watson, 2014; Zoomers et al., 2017). This not only pertains to farmers, informality (of which irrigated urban agriculture is an exponent) is in a similar way limitedly accounted for given the prominence of development discourses that emphasise the role of state control. Yet, the blending of formal and informal practices plays an important role in African cities. Examples in this dissertation are the networks of water and food provision that are heterogeneously-assembled by the actors involved. People in their everyday lives engage with the formally-constructed and controlled systems of service provision in diverse ways by using or hybridising them. In large parts of cities across the South, informal dwellers, in one way or another, effectively build and extend a wide range of networked infrastructures (Swilling & Annecke, 2012). Although not formally planned nor accounted for, people appropriate space for the improvement of their lives and thereby co-shape that of the wider citizenry. It is therefore important to consider how planning and governance can be reframed so that all who engage in this process of city-building have a right to participate in urbanisation agendas.

The relationship between informality and planning is complicated. On the one hand, informality is perceived as 'the unplannable' (lying outside the realm of control) while, on the other hand, there are continuous efforts to integrate informal spaces and livelihood practices (Roy, 2005). The formalisation of "informal, unruly and messy situations" towards a situation of order and optimal functioning plays an important role in the justification for urban development plans (Ahlers et al., 2014; Koster & Nuijten, 2016, p. 284; Pieterse, 2008; Watson, 2003). "The formal is identified as that which is modern and necessary, and the informal as that which is backward, undesirable, to be eliminated or incorporated in the formal through formalisation and state regulation" (Ahlers et al., 2014, p. 4). For many urban spaces across the Global South, however, it is the 'informal city' where people assert their rights (Koster & Nuijten, 2016; Pieterse, 2011a; Simone, 2004). Urban space is produced through a meshwork of different practices, while notions of informality and formality serve as a system of norms. Power is reproduced through the capacity to legitimise particular urban practices or to delegitimise them in order to enact their suspension (McFarlane, 2012; Roy, 2005). In this dissertation, irrigated urban agriculture shows an integral part of Dar es Salaam and actively co-produces the city by providing

employment, producing food, occupying land and (re)using water. Claiming their (informal) right to the city, farmers are condoned as long as their presence does not become a nuisance; leaving farmers exposed to threats of displacement, lack of clarity about land ownership, and adverse health impacts. This shows a tension between leaving room for the delicate networks and strategies of everyday life in the city that rely on informality and a form of governmentality – the exercise of control and regulatory action – that intervenes in the lives of those who live in the city in order to progress towards a 'proper' city based on (Western) ideas of modernity and progress (Watson, 2003). Watson (2009) refers to this as a 'conflict of rationalities' between the rationality of governing (governmentality) and a rationality – shaped by efforts of survival – which in turn operates with its own logics and imperatives.

Finding a way in which planning can account for the informal appropriation of urban space is essential when wanting to play a meaningful role in the everyday reality of growing cities in the South. The systems of governing which operate in many Southern cities have embedded within them rationalities which are closely linked to ideas of modernity inherited from often Northern contexts (Graham & Marvin, 2001; Robinson, 2006). Both Chapter 2 and 5 explore how modernity (in which the state is attributed a position of power) materialised in the construction of cities and their embedded infrastructures. The point to highlight here is that normative value systems get routinised in planning and governance. Arce & Long (2003) explore the contrasting interpretations of modernity, the countering of dominant development trends, and the intermingling of different types of modernity which lead to 'mutant' or hybrid modernities. Notions of what it means to be modern and how to get there through modernising can be diverse, which means that modernity itself should perhaps be considered in the plural. Robinson (2006) argues that urban modernity should be more cosmopolitan and account for a greater diversity of urban experiences. "This means disconnecting the social transformations and cultural valorisations indicated by theories of modernity from assumptions about progress, and from any fixed geographical referents" (ibid, p. 18). This does not imply that there is no need to strive for progress or to not have the 'right to development' but rather to recognise that development trajectories are formed by particular ideals of the urban. Thus, we must look at African cities on their own terms and not through the looking glass of development models derived from the experience of

other societies (Harrison, 2006; Parnell & Pieterse, 2014; Parnell & Robinson, 2013; Pieterse, 2011b; Robinson, 2006; Watson, 2009).

The notion of a 'good' city differs depending on who is asked or calls the shots, leading to the prioritisation of different planning and governance practices. Participatory planning approaches offer possible avenues for fostering development in a way that recognises the different forces of city-making present. The concepts of co-creation (or co-production) are examples of participatory planning approaches in which different actors are invited to develop solutions that reflect the needs and aspirations of the community. An example is the widespread work done by Slum Dwellers International who work on a bottom-up change agenda for inclusive and resilient cities through the gathering of local knowledge and advocacy for the role that slum dwellers play in cities (SDI, 2023). It is not my aim to dictate what these co-creation processes should look like[24], but rather point out here that such approaches and organisations challenge the conventional image of the state as the sole authority in expert knowledge production and city planning. Emphasising the role that non-state actors play in the appropriation of urban space and the embedded provision of services makes it possible to generate knowledge from a different set of experts: those urbanites that reside in settlements, derive income from economies, and access services through systems that are (partially) based on informal arrangements. It is important to acknowledge that such multi-stakeholder engagement and the ambition for a more inclusive and equitable environment can be done in many ways and for many reasons. It therefore does not automatically do away with power imbalances in who has a say about the city. However, urban planning can potentially move away from binary categorisations (of what is formal and formal, planned or unplanned) and embrace hybrid service provision modalities that respond to the diverse needs and aspirations of African cities' populations. Planning *with* rather than planning *for* recognises the agency of those who appropriate the city on a day-to-day basis. Co-production between state agencies and communities can potentially positively impact service delivery patterns (Ahlers et al., 2014; Alfaro d'Alençon et al., 2018). These actors have different capabilities and responsibilities. For example, informal actors that partake in service delivery configurations are acknowledged for their capacity to be flexible and adaptive

[24] The design of co-creation initiatives and lessons learnt from these are increasingly discussed, see for example ICLEI (2024) and Rikolto (2024).

(abandoning the survivalist, temporary notion of informality) while the state is acknowledged for its ability to forward large-scale infrastructure roll-outs.

This section addressed the intermingling of top-down and bottom-up forces of city-making. Planning efforts by the state are responded to in varied ways by those outside of the state and the formal business sector who (informally) appropriate the city to their own needs in order to survive. Urban informality is a state of affairs often regarded as difficult to relate to, as it represents a state of exception from the formal order of planning and control. Given these different forces of city making that can also be conflictive, urban planning and governance raise fundamentally ethical questions about what should be done, for whom and by whom, and with what benefits or losses (Watson, 2003). Rather than regarding informality as a nuisance to urban development, this dissertation shows how urban farmers co-produce urban space and hold a right to the city. Given the mutual and interactive appropriation of the city (which is, but also constantly unfolding), the concept of co-creation is suggested as a way to restructure the power relations that underlie the production of the city and shift control towards the everyday city-makers, i.e. the urban inhabitants that (through formal, informal, or often through hybrid networks of practices) govern the city.

Thinking through water reuse

A combination of my own engagement with farmers practising water reuse, a literature study of the academic field (Chapter 6), and discussions around students' research have made me more conscious over the past years of the descriptors used to describe practices of irrigated agriculture in and around cities. Vocabularies used by farmers in Dar es Salaam to describe their water flows differ from dominant expert perspectives. Describing these practices as 'wastewater reuse' and 'wastewater irrigation' is common practice in the field of research and water management, while farmers believe that these terms are pejorative and problematic. It may be possible to rethink reuse typologies so that the widespread practices of water reuse are acknowledged and characterised in a more meaningful way. This refers not only to the type of water flows, but also to the institutions surrounding them and the diverse ideas that stakeholders have concerning the reuse of water flows in agriculture. First, I suggest changing the point of reference from the source of production to the end-user and looking at the water reuse from this angle. Second, I show the room for a more active engagement with the institutional dynamics surrounding water reuse which play a major role in the acceptance and adoption of wastewater flows in agriculture.

Chapter 6 of this dissertation – published as part of a special issue on 'unconventional waters' – explores the characterisation of wastewater reuse in agriculture. The classification of different types of wastewater reuse shows how this practice is defined based on the biophysical impact of wastewater production and subsequent treatment following a conventional upstream-to-downstream water use chain. Consequently, the focus and terminology around reuse strongly emphasise the managerial task of controlling these water flows and qualities. Little attention is paid to other types of sources that influence irrigated agriculture, nor the socio-political aspects that are formative for irrigated agriculture. Regarding the latter, the only distinction often made here refers to water use practices as planned or unplanned (or formal or informal). The water reuse generally referred to as unplanned is a multitude larger when compared to planned reuse and is playing an important role in reducing the pressure on freshwater availability. As the majority of smallholder farmers that use urban water flows do not conform to expert ideals of reuse schemes, their practices are often regarded controversial despite their contributions to food, incomes, and overall circularity. Although referring to this water reuse as informal, unofficial, or unplanned, this farmer-initiated development of water reuse is actually intentional and requires hard work and access to capital. Farmers need to be flexible in responding to the opportunities that the city offers regarding access to land, water, and markets, which implies configuring their practices or relocating when needed.

This case study shows that an emphasis on wastewater is arbitrary compared to the diversity of water flows being reused. Farmers use different sources fed by a combination of urban water flows. The emphasis on wastewater is not to their liking, as it contributes to a negative perception around irrigated urban agriculture, which threatens the continuance of their presence. The emphasis on wastewater (by the way it is named and the labelling of either directly or indirectly linked to a wastewater-producing source) and the way that these practices are described as informal or unplanned by experts (despite intentional efforts by farmers while having limited control over the deterioration of their water source) hinder a meaningful interaction between stakeholders to deal with issues of water quality or water scarcity while maintaining the opportunity for farmers to have access to water for agricultural and economic productivity.

If we take the end-user as the point of reference in the understanding of, and engagement with, water reuse, the way to look at the social and material components of these practices

becomes different. While it remains important to follow the flow of water to distinguish the sources, most farmers use irrigation sources fed by flows that are more diverse (both in composition and meaning) than being either directly connected to a wastewater source or not. The water farmers receive can be based on a single source or multiple sources that all have their particularities regarding flows and qualities that influence what a farmer has access to. These flows might even be subject to change in different ways while practices of irrigated agriculture remain unchanged. When accounting for a combination of different flows, wastewater might be just one of these and its composition could most likely even be differentiated to pinpoint beneficial and harmful flows. In Dar es Salaam's case, water available to farmers originates from several different sources ranging from raw sewage to piped water leakages. This shows the diversity in flows and qualities that needs to be accounted for not only in a descriptive way that acknowledges this diversity but also by considering how farmers view these sources.

This research also shows how the institutional aspects of water reuse often remain largely unaddressed or are referred to using classifications of the institutional context as either formal or informal, planned or unplanned. While these typologies give limited insight into the institutional dynamics that shape and direct reuse configurations, they also portray a dominant view of the need for bureaucratic and technological interventions. Essentially, the farmers' water reuse and irrigation initiatives that take place largely without any state or other institutional intervention and based on the effective crafting of social practices based on the modalities of water and land within the city (no investment in permanent infrastructure, short-cycle crops) are deemed inferior and in need of improvement. Chapter 5 shows how urban agriculture in Dar es Salaam is under pressure given particular ideals around what agriculture and the city should represent which challenge the presence of irrigated urban agriculture in its current form. This is not unique to the urban context but can also be found outside cities. The widespread presence of farmer-led irrigation development (FLID) processes contributes to food security and economic activity but is quickly overlooked and often perceived as backward and in need of modernisation through external expertise (de Bont & Veldwisch, 2020; Izzi et al., 2021; Veldwisch et al., 2019; Venot et al., 2021). It is therefore important to question who determines what agriculture, irrigation, or the city should look like, and who can maintain or upset these ideals.

An alternative and more detailed understanding of institutions is needed to look beyond the formal organisation of water reuse and give more insight into the social relations that shape and direct the configuration of water reuse irrespective of its context. A lens from institutional theory that could be of value is to use the terms 'bureaucratic' and 'socially embedded' to distinguish between different forms of institutions. "Bureaucratic institutions are those formalised arrangements based on explicit organisational structures, contracts and legal rights, often introduced by governments or development agencies. Socially embedded institutions are those based on culture, social organisation and daily practice, commonly but erroneously referred to as 'informal'" (Cleaver, 2002, p. 13). These forms of institutions should be seen as interdependent and interactive, sometimes making it difficult to distinguish between them. Bureaucratic institutions may also be socially embedded and the bureaucratisation of cultural and social arrangements can also take place over time. The state of solidity and fixedness can say something about the stability of an institution in a particular social context (Cleaver, 2002; Cleaver & De Koning, 2015). The planning of water reuse which relies on universalised 'design principles' may therefore result in inadequate institutional solutions, as they fail to recognise the depth of social and cultural dynamics.

Following water flows serves as a valuable tool to describe the linkages between different water use practices, the actors involved, and the various institutional spheres it flows through. Whether we conceptualise the water reuse chain based on an upstream-to-downstream pathway of flows and qualities (i.e. contamination pathways) or reversing it by starting from the end-user does make a difference in how we talk about water reuse. Current terminology used for water reuse in agriculture particularly focuses on formalised (planned) systems with controllable linkages between wastewater production, treatment, and ultimate reuse. For most water reuse practices worldwide, however, this is much more diverse and requires a more detailed understanding. Farmers benefit from the multiple flows that are available in city regions while being institutionally considered unplanned and informal. A more detailed understanding of institutions allowing us to look beyond the formal organisation of water reuse and give more insight into the social relations that shape and direct the configuration of water reuse irrespective of its context. The institutional context of water reuse is a constant interplay of formalised arrangements based on explicit organisational structures, contracts, and legal rights, with cultural and social arrangements in which the two form the ultimate space where water reuse takes

shape from day to day. Dissecting the diversity of water flows that feed irrigation sources, recognising end-users views on irrigation sources, incorporating institutional dynamics, and involving farmers in knowledge production and design (also discussed in the previous section) can contribute to creating an environment in which different stakeholders collectively balance the burdens and benefits of using and reusing water.

7.4 Conclusions

The gravitation towards cities – particularly prominent in the regions where most population growth is expected – reshapes our relation to water and agriculture in multiple ways. Meanwhile, agriculture is an urban reality in many cities across the Global South despite not receiving popular attention. The central question this dissertation engaged with is: *How do the practices and politics of irrigated urban agriculture configure urban space in the growing city of Dar es Salaam, Tanzania?* Irrigated urban agriculture is defined here as *the irrigated production of food crops on land located within cities or as part of urbanising landscapes, interacting both quantitatively and qualitatively with other urban water usage, surrounded by policies and other institutions, while serving multiple functions.* The study provides a detailed description of irrigated urban agriculture in Dar es Salaam, Tanzania, which simultaneously exemplifies the larger trend of urban growth across sub-Saharan Africa and its impact on the agricultural land and water that is feeding it. This dissertation showed insight into the *Fields of Friction* that surround the role that practices of agriculture and water use play in the context of urbanising landscapes. These fields represent more than just the spaces for growing food; they are spaces where issues of access, equity, and sustainability are contested. By reversing the tone of the subject, the urban development that we see across sub-Saharan Africa has been studied from the perspective of farmers who respond to the effects of urban development on their livelihoods.

Practices of irrigated urban agriculture are embedded in bigger networks of occupying (urban) space, using water, and producing food. Farmers build on temporary land use agreements, tap into different urban water sources, and cultivate short-cycle crops for their surrounding urban areas. By crafting networks of provision, farmers offer food, employment, and more to improve their lives and that of the wider citizenry. Doing this, they claim their (informal) right to the city and commercially cultivate open spaces until the city (i.e. construction) takes over. Since agricultural land use and urban irrigation are

generally not planned for and not formally acknowledged, farmers benefit from what they can access while dealing with the associated uncertainties of changing realities. This includes the changes in water access that have received particular attention in this work. Especially in urbanising landscapes, the growing competition between stakeholders with different water use demands relates not only to water quantities and its timing but also to water quality. Water quality can be studied as a measure of uneven access to water in which urban and agricultural water users compete over water flows. The impact of urban water use on the physical flows and the quality of water available in agriculture is both material and symbolic. Access to and exclusion from water (of a particular quality) lay bare power relationships, particularly in cities confronted with intensive and contested water usage while facing external influences by weather shocks and climate change. Urban (domestic and industrial) water users hold a powerful position in this regard as compared to agricultural water users who often act in response to the reallocation of freshwater to cities or the discharge of wastewater from cities.

The pressure on access to land, water quantity, water quality, and markets has implications for farmers both in practical and normative terms. Irrigated urban agriculture relocates and gets reshaped rather than disappears from the urban landscape. Short (or even direct) linkages between producer and consumer remain for particular food items (e.g. leafy vegetables), while the definition of what is considered 'urban' plays an important role when quantifying the actual significance of urban producers in this regard. Farmers face a deterioration in the quality of their irrigation sources due to the intensification of upstream uses. Besides being unable to control the health risks associated with these changes, they cannot control the risks to their livelihood concerning the public perception around their irrigated agricultural practices. Farmers have limited agency in setting the conditions of their (hydraulic) citizenship given that the presence of agriculture in the city is disputed. This is also seen in the tensions between planning ideals and the embodied reality of agriculture in the city. The policy dynamics in Dar es Salaam show how urban agriculture is moving in two directions: one that reflects an attractive model of agriculture that fits modern urban ideals ('apartment agriculture') and one that satisfies everyday demands for food and employment by making use of institutional ambiguities around the use of urban land and water ('city agriculture'). Although these two types of agriculture co-exist in the city, they simultaneously reinforce the divide between planning ideals and urban reality. Authorities and development partners

promote practices that fit within and reinforce ideas on progress and development that implicitly position the majority of current agricultural practices 'outside' the city's future.

Farmers co-shape what the city looks like and how it functions despite largely not being accounted for in urban development narratives. This dissertation shows the ingenuities (emphasising the entrepreneurial rather than survivalist characteristics of these informal livelihoods) with which these practices come into being while also showing how this urban agency is bounded by both physical and ideological pressures that become more influential in peoples' daily lives as the city grows. When considering alternative urban development pathways (i.e. alternative to dominant Western urban theories), informal practices are believed to play an important role as bottom-up forces of city-making. In this light, irrigated urban agriculture can be considered a type of 'urbanness' and offers a way forward to think about the symbiotic relationship between agriculture and the city. These spaces of informality and bottom-up forces of city-making are not a residual category or 'odd one out' but should instead be accepted as a "generalized mode of metropolitan urbanization" (Roy, 2005, p. 147). The interplay between top-down and bottom-up forces of city-making construe a colourful mosaic of diverse people, places, and practices that altogether form the city as we experience it. Although appreciating informality in its unique dynamics is no shortcut to addressing the challenges that cities such as Dar es Salaam face, acknowledging different forces of city-making can be a valuable lens to further our thinking concerning ways of engagement. A possible way forward is a collaborative process (popularly referred to as co-creation or co-production) that brings together different stakeholders that – regardless of their background or position – produce situated knowledge and identify, design, and implement solutions to common challenges within the city. The state and civic society can collectively play a complementary role in urban development by having different and unique city-building capacities (including inabilities).

Where a lot of science and policy attention points towards an appreciation of Africa's urban potential, the point of departure for many urbanisation agendas is that of a tabula rasa urbanism (i.e. assuming starting with a blank slate). However, urban development often comes with the disruption of existing livelihoods – such as agricultural land loss and the dislocation of farmers – which are not sufficiently addressed in building Africa's urban future. The symbiosis between agriculture and the city is therefore under constant pressure. In favour of separating the two, one can argue that agriculture interferes with

the efficient functioning and the progressive image of the modern city. In favour of integration, one can argue that it is foolish to become too distanced from the multiple benefits of agriculture in an uncertain world. Studying urban development from the perspective of urban farmers has contributed to addressing knowledge inequities regarding the farmers' role as part of urbanising landscapes. Smallholder farming systems are important in providing for the city through food provisioning and offering employment opportunities. Also, the widespread farmer-initiated water reuse in irrigated agriculture eases the pressure on freshwater availability. Given that agriculture and the city are often seen as an oxymoron, agriculture as urban land use, irrigation as part of the urban water system, and food production as an urban function largely remain unaddressed in the urban planning and visioning of growing cities in Africa. This results in the marginalisation of urban dwellers who resort to agriculture for their livelihood security, including the network of informal food vendors that link producers and consumers. Understanding the reciprocal relationship in which farmers respond to urban expansion in their day-to-day practices (and vice versa how the city responds to the necessity of food supply) is essential for cities (both large-sized and medium-sized) in sub-Saharan Africa where rapid growth puts pressure on securing access to safe and sufficient food. To prevent growing cities from growing hungry, the flow of food from production to consumption can be considered a vital infrastructure of activities that is a determining factor for the sustainability and resilience of cities.

This research contributes an in-depth analysis of day-to-day practices of irrigated urban agriculture in Dar es Salaam, showing how these practices are configured and respond to the growing city. Doing this, it communicates the interdisciplinarity of studying urban land, water, and food. The research pluralises the understanding of the city and how it functions. Studying agricultural and water use practices within the city has shown how urban space is often a complex blend of formal and informal, traditional and modern, and planned and unplanned. Agriculture in the city of Dar es Salaam is conditionally condoned; showing the importance of urban ambiguity which offers the room for the interplay between top-down planning of the city with the bottom-up processes of how the city is taking shape. While this ambiguity allows for different forces of city-making, it also leaves farmers in a delicate space of existence given embedded power asymmetries. This creates *Fields of Friction*, both literally and discursively. Farmers get confronted with the loss of agricultural land or changes to the flows and qualities of their irrigation sources,

while their practices are contested given that they are deemed incompatible with dominant images around the city of what the city or what agriculture is supposed to look like. This shows a larger debate on whom the city belongs to: although urban space is actively shaped and controlled by its citizens, not everybody has an equal right to the future city. Particularly with rising urban inequalities and increased risks of climate change in growing African cities, it is important to politicise the discussion about the envisioned future city and "what the terms of African urban citizenship might be" (Pieterse et al., 2018, p. 153).

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Supplementary materials

Research story 'Fields of friction'

Ethnographic research is full of stories; it actually depends and thrives on them. Yet, the day-to-day experiences of doing research often get abstracted and objectified through the construction of theory from empirics and the silencing or distancing of the writer's voice, as discussed in Chapter 7.2. In response, I wrote a research story about irrigated urban agriculture to offer a more intimate insight into the lived experiences of being a farmer, as well as the researcher being part of this environment. Scientific storytelling is a powerful way of science communication and many universities nowadays organise storytelling workshops. When based on a careful, reflective, and systematic approach, storytelling can be a legitimate research method or product to augment our understanding (or perhaps present a 'different' understanding) of a particular phenomenon (Koch, 1998; Usher, 2005; Krauss et al., 2022). Those who tell the story should be careful, however, not to detract from the process and credibility of scientific reasoning (Dahlstrom & Schuefele, 2018; Martinez-Conde & Macknik, 2017). Telling a research story on irrigated urban agriculture is academically valuable for two reasons. First, the research story gives a primary account of empirical insights that is closer to the studied reality and keeps the researcher as part of this reality. Especially given that ethnography is characterised by the researcher sharing everyday experiences with his or her research participants to understand how life is lived, the researcher is invested in the context studied. Second, using a story can bring the research to life for its audience, as it engrosses our imagination and prompts emotion, which bolsters engagement with the topic.

The story presented below draws on material from various sources, reconstructed through a detailed timeline covering the period from March 2021 to February 2022. This timeline was developed using a combination of interviews, observations, informal conversations, visual documentation, and written research reflections. A memo on this reconstruction was written as part of the data analysis (see Chapter 1.5) and served as input for Box 1 in Chapter 4. The research story, however, offers a more intimate insight into how the researcher shares everyday life with his or her research participants, as is characteristic of ethnographic research. The story is non-fictional; only the farmers' names are fictional to protect their identities.

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Fields of friction

I heard about TAZARA-Mchicha when somebody referred to a bus stop along Nyerere Road called *mchicha*. This sparked my interest, as the bus stop is located along one of the busiest roads in the city and yet carries the name of this popular leafy vegetable. Disembarking the *daladala in* early 2021, I ended up in an area where agriculture was thriving. You could see multiple farmers cultivating, vendors arriving or departing for business activities, and a constant stream of pedestrians (including flocks of students going to and coming from school) passing through the area from one neighbourhood to another. The area, which can be considered a small valley, has a makeshift bridge in the centre, allowing people to pass through the lowest parts of the valley during floods. At particular times of the day, small queues appear on both sides of the bridge and people take turns crossing the bridge. The area – owned by railway authority TAZARA that links the seaport of Dar es Salaam with the East-African interior – has existed since the 1980s and agriculture used to extend until the main road. The total area has decreased over time because of construction, so agriculture is no longer in direct sight of the bus stop. This has resulted in the bus stop nowadays also being referred to as *karakana* ('workshop', referring to the railway workshop also located in the area) and the name *mchicha* slowly fading for daily commuters taking this route.

Interested to learn more about how agriculture lived as part of the city here, I reached out to the agricultural department of Temeke Municipal Council (one of Dar es Salaam's five municipalities) and the local *mtaa* (subward) leader to ask if I could be introduced to the farmers of TAZARA-Mchicha. Walking through the area with the agricultural officer soon after, she explained about the 'local scheme' and I learned to recognise the combination of different sources and water flows. Water for irrigation is taken from shallow wells and in-stream reservoirs that capture water flowing from and into the residential areas via small canals. "Working with farmers is a challenge", she explains, while also admitting that her seldom visits to the area make it difficult to tell farmers what they are supposed to do. After this first visit where I was accompanied by this government official, Pendo (with whom I spent most of my time in the area) and I started going to the area by ourselves. Although farmers did not mind taking a short break from their work for a chat, they regularly questioned why we were here, what we were doing, and what they would get in return. The presence of researchers (or strangers more generally) was not directly

appreciated. Later, I understood that water quality measurements by the Ministry of Health some years ago had contributed to a general distrust towards strangers, as the outcome of this sampling activity was the reported contamination of the irrigation water that was being used. I could imagine the farmers' suspicion towards newcomers and visited the area regularly for a walk and short talks to see if I could establish a relation of trust with the farmers in order to learn from their day-to-day practices.

Photo 1. Cultivation of the leafy vegetable mchicha on different plots in TAZARA-Mchicha (29-03-2021)

Over the course of months, we visit TAZARA-Mchicha weekly or every other week (except for a few periods where I stepped back from fieldwork to analyse my data) and slowly start to get to know farmers and their respective practices better. We usually arrive before 8 AM and first sit under a tree on a tree trunk and a car tyre. It has become our routine to first sit and observe what is happening in the area, as well as talk about social matters and our plans for the day. On a regular morning, you see farmers working on their fields, preparations that are being made for irrigation (for example positioning the petrol pump near a water source and laying the flexible pipes towards a plot in need of water), and vendors passing by with baskets full of vegetables on their heads or on the carrier of their bikes. Based on what we see, we make a plan for the morning. We, for example, pass by the plot of Juma when we see his bike parked along one of the footpaths that run between the agricultural plots. Juma spends most of his time on the farm doing different agricultural activities while waiting for customers to pass by and request to harvest some bunches of vegetables (or sometimes a full *tuta,* which is a planting bed). Occasionally, the amount of vegetables ready to harvest does not match the number of customers he gets. When this happens, he harvests this vegetable surplus and transports it by bike to the market. Water has become a limiting factor for his agricultural activity since construction took place near his plot some years ago. This cut off the canal connected to the drainage system of the nearby main road that used to supply him with water. When this happened, he dug a shallow well from which he draws water by bucket. He sometimes requests help from Baraka, a nearby farmer who is more engaged in running his irrigation business than earning from his own plot. Baraka irrigates the plots of others that don't have their own pumps. He irrigates himself and, depending on the plot size, charges between 2,000 and 3,000 TSH[25] for his service. Every morning, he arrives in the area with just a notebook to first take stock of irrigation needs. The notebook holds the order of irrigation, as well as a record of who still needs to pay. This system, referred to as *mali kauli* (*mali* refers to a commodity, *kauli* refers to a verbal agreement), enables irrigation to take place on credit so farmers can pay Baraka with their harvested produce or earnings afterwards. Once he finds farmers that require irrigation, he goes to fetch his mobile petrol pump (this prevents carrying the pump to the area on days when he has no customers) which is stored in a house in the adjacent neighbourhood. The order of his irrigation is based on the order in which he receives his requests, although he has five permanent

[25] 0.9-1.3 USD at the time of research

customers that always get priority over the others. When there is not enough water entering the area during the dry period or due to upstream blockages, the number of farmers served on a day reduces and farmers are forced to wait longer than agreed upon.

On an early morning in June 2021, an excavator arrives to the area and, after getting offloaded at the roadside, starts excavating trenches to construct a wall around the area. Although the local government office received prior notice, the news was not yet relayed to the farmers that TAZARA had come to an agreement with a large energy and transportation company wanting to construct a dry port. This came as a surprise not only to the farmers but also to the surrounding community. Soon after the start of construction, the community showed resistance by backfilling the trenches and demolishing the stacks of building blocks already delivered. Despite the trenches being backfilled out of protest, the excavator had torn a clear border along the area that marked the finality of the area. Construction came to a halt due to the protest, but farmers realised that this stop would only be temporary and the end had come for their agricultural presence in this area. They called for a meeting with all farmers to discuss their options under the tree where we would always start our fieldwork. Meetings like this are uncommon since social heterogeneity and the temporality of urban agriculture generally limit social organisation. Farmers have originally come from different regions of Tanzania, reside in different neighbourhoods, and have different levels of engagement in the area, which creates a situation where '*kila mtu ana mambo yake*' ('every person has his/her own things'). However, collective action by farmers is common to see in Dar es Salaam when access to land and water is at risk. Rather than trying to oppose this recent development, farmers realised that not much could be done. They knew about the temporary nature of the land use agreement from which they had reaped the benefits over many years. The farmers concluded during the meeting that they would request compensation for the land to be lost and prior notice of construction to be able to harvest their last crops.

Photo 2. Excavated trench that is backfilled and building blocks that are demolished out of protest against the planned development of the area (15-07-2021). Photo 3. Wall construction is underway while farmers in the background harvest their last crops (17-08-2021).

Construction restarted close to a month after the protest. I am meeting two female farmers (one of whom is called Fatuma) who are harvesting cassava leaves (*mnavu*) for the last time. While talking with them about what is happening, I am standing on top of uprooted cassava plants bulldozered by a large Caterpillar that needed to cross the women's fields to start levelling the area just adjacent to their fields. I feel heavy-hearted while talking to these women who voice their desperation and ask for our help. For the past weeks, I have been contemplating about my position in all this: Is this the moment that I stand up and resist the social injustice I feel is taking place here? Or should the researcher try to be of minimal disturbance to the context they are engaging in? I must admit, I have also felt excitement about this development project taking place in one of my study areas since the exact dynamic that I was researching was now happening right in front of me. Yet, I simultaneously felt ashamed about this, as I could be part of this story as an outsider who is not experiencing the impact of this loss of livelihood. Pendo and I visited the local *mtaa* leader when the construction project was halted, asking if farmers could undertake anything in such a situation. He responded to us with realism: farmers knew about the temporality of this land, and the stakes here are much higher than we can all imagine. He clarifies this by saying: "It is not easy to stop a person with money if you don't have anything in your pocket." The interests of high-value development outweigh the agricultural function the area had over the past decades.

Over the last months, I gained access to the area, got to know the people, and better understand their day-to-day practices. From the moment the area was 'signed off' to a new owner, the accessibility also changed for me. I would get approached by the building supervisors who questioned my presence, forbade me from taking pictures, and insisted on the permission I needed to acquire first in order to return. This posed me with an ethical dilemma concerning the continuation of my research activities. I did not have formal consent from the new owner to enter the area, although farmers still allowed me to move around and talk with them about what was happening. This created an ambiguous situation concerning access and consent where I ultimately decided to rely on the consent of farmers to stay present in the area and continue capturing the (or my) story of TAZARA-Mchicha. I started taking more photographs (something I never really liked) to capture the progressing frontier of construction that was eating all agricultural land from one side to the other (the construction started in the southern part of the valley and slowly moved towards the northern side). Although the area continued to be used for agriculture or to

cross by pedestrians from one side to the other, access also started to become physically challenging. “It becomes more difficult to enter the area now; we have to jump on and off a half-finished wall. The place where we normally enter is already closed by a wall. It makes me realise that this might be one of the last moments I can enter” (research diary 17 August 2021).

Photo 4. Agricultural plots are left fallow after the last harvest, while in the background a bulldozer is levelling the agricultural fields for construction (23-11-2021).

Photo 5. Containers arriving from or heading to the seaport (23-11-2021).

"Do you notice any differences?" Pendo and I are back again under the tree to observe what has changed since our previous visit. Construction has slowly progressed over the past months, and part of the agricultural area already has rows of sea containers stacked on top of each other. Most farmers received a financial compensation, although many did not feel taken seriously by the small amount they received. The farmers were given a deadline to leave, but a number of them decided to continue until the very end while other plots turned fallow as farmers already left. The liveliness of the area disappeared and only a few farmers still prepare their soils, while the bulldozers do the rest. "Yes, I see a difference! The tree near the plot of *mzee*[26] Swai has been cut down!" Indeed, one of the few large trees in the area got cut down since our last visit. In this way, we observe how the area is slowly transforming and losing the function of providing food and incomes as part of the informal (food) economy. At the end of November, all farmers have moved out and the bulldozers have taken over. Some weeks later, the walls that surround the area are finished and close off the area.

I still get dropped at the *mchicha* bus stop a couple of times in early 2022 to take a walk around the area. The dry port is fully operational and there is no any sign of the agricultural history of the place that farmers, vendors, and consumers have used for a long time. As I don't meet the farmers in their 'office' anymore (several farmers referred to their field as their office), Pendo and I conduct two rounds of telephone calls in November and February. Juma secured a plot in a peri-urban ward called Chanika. Baraka initially planned to move to Mkuranga (a rural district adjacent to Dar es Salaam) but ultimately managed to secure two smaller plots within the city (one public space, one private plot near somebody's house). Fatuma, one of the female farmers, indicated that she could not find a new plot nearby to continue her work. She wished to have received more compensation in order to use this as starting capital for a business. This selection of stories shows how everybody is going their way to find new opportunities in the city, whether this is in or outside agriculture. When visiting TAZARA-Mchicha now, one might think that urban agriculture is slowly disappearing from the urban landscape of Dar es Salaam. Talking to those who lost their agricultural land before reveals that the practice migrates through the city in search of land and water for agricultural production.

[26] Title of respect given to an older person.

Policy brief 'Irrigated agriculture in Dar es Salaam'

There is a known gap between the production of research evidence and its use by policymakers, as well as the communication to general audiences (Gluckman, 2016; Martinez-Conde & Macknik, 2017). Several science communication strategies exist to promote the use of research, as the format in which content is communicated is believed to be just as important as the content when supporting evidence-informed policy decisions (Arnautu & Dagenais, 2021). One such strategy is the policy brief, defined as "a short document that uses graphics and text to summarise the key elements of one or multiple research studies and provides a succinct explanation of a policy issue or problem, along with options and specific recommendations for addressing that issue or problem" (Arnautu & Dagenais, 2021, p. 2). As mentioned earlier in this dissertation, decision-making is a complex process that cannot be reduced to scientific input only but requires commitment, participation, political will, and the balancing of adjacent interests. Nevertheless, I do believe that researchers share the responsibility of addressing barriers to evidence-informed policy.

The following policy briefs (in both English and Swahili) were therefore written in 2022 to summarise research findings in an accessible format, aimed at facilitating policy discussions and enhancing research results' uptake. These documents have been shared and discussed with the different local authorities in Dar es Salaam, as well as distributed to a broader audience to foster a dialogue on irrigated urban agriculture beyond the case studied. As such, these policy briefs are considered a complementary and inseparable part of the scientific treatment presented in this dissertation.

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Martinez-Conde, S., & Macknik, S. L. (2017). Finding the plot in science storytelling in hopes of enhancing science communication. *Proceedings of the National Academy of Sciences, 114*(31), 8127–8129. https://doi.org/10.1073/pnas.1711790114

Arnautu, D., & Dagenais, C. (2021). Use and effectiveness of policy briefs as a knowledge transfer tool: A scoping review. *Humanities and Social Sciences Communications*, *8*(1), 211. https://doi.org/10.1057/s41599-021-00885-9

Irrigated agriculture in Dar es Salaam

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The rapid growth of African cities puts pressure on land and water, which are essential for urban farmers. Research across the continent indicates that urban citizens continue to turn to farming for their livelihood security. The question is how agriculture persists despite these increasing pressures and how to secure its benefits of local employment, fresh food provision and putting value to vacant urban land. This information sheet summarises findings of recent research conducted in Dar es Salaam, Tanzania.

For whom?

The research was conducted to provide insights for municipal officials (from different departments) and other public and private organisations that work on the planning and regulation of urban areas. The information is also valuable for those specifically focusing on urban agriculture or urban food networks. What has been found in Dar es Salaam can also be helpful for other African cities in similar situations.

Research approach

Dar es Salaam is one of the fastest growing cities in Africa. This research studied how irrigated agriculture is affected by this rapid urban growth. Farmers and other participants were interviewed and observed at six agricultural locations within Dar es Salaam between May 2021 and February 2022. The locations represent open space cultivation in river valleys, low-lying areas, and developing urban areas.

Characteristics of irrigated urban agriculture

- **Farmers in Dar es Salaam use vacant land for temporary cultivation, providing food, employment, and more benefits to urban society.**
- In Dar es Salaam, irrigated agriculture is common in the open spaces. Farmers grow leafy vegetables (especially Amaranth) commercially in flood-prone or to-be-developed areas. By making use of this temporarily unused space, they not only produce food and generate income but also keep these urban areas clean and safe.
- Most farmers are first-generation migrants from other regions of Tanzania. They turn to farming after working in other jobs for an average period of six years. They decide to start farming to generate more income and find more stable employment than in their previous jobs.
- Men have a stronger hold over these open spaces; they are more often first-time users and have access to larger plots. Women often visit agricultural areas for years as a vegetable or food vendor before they get the chance to farm.
- Farmers sell most of their vegetables to street vendors and business(wo)men that, in turn, sell it to different areas of the city. These farmed areas, even though small, are profitable as the crops grow quickly and the demand for fresh vegetables is high.
- Water for irrigation comes from rain, groundwater, piped water, and wastewater. Farmers can use piped water directly, or benefit from water leakages in the distribution network. Wastewater can come from domestic or industrial sources (or a mixture) and be completely untreated, or partially or fully treated.

Farmers do not rely on one type of water flow only; water flows mix before it reaches them or farmers rely on different irrigation sources from different supplies.

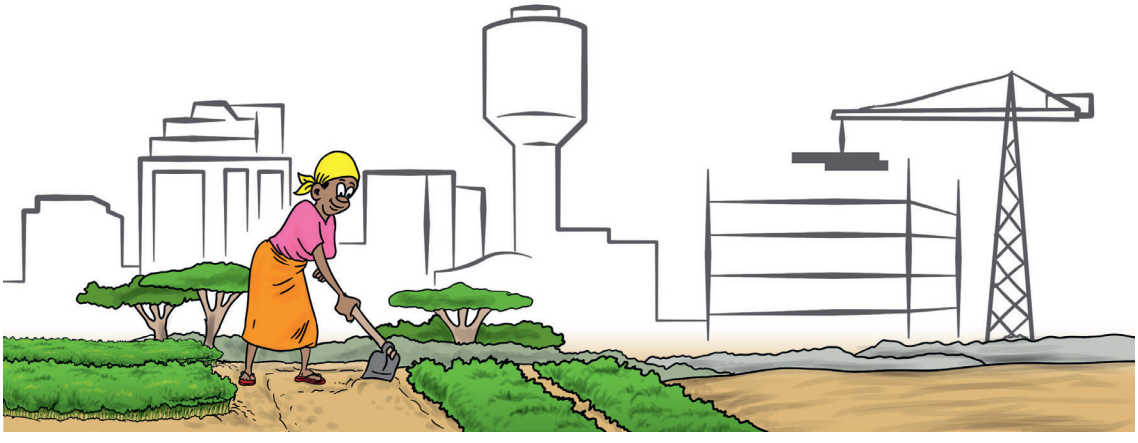
- The main sources of irrigation water in Dar es Salaam are rivers, canals, shallow wells and water taps. Farmers use (petrol) pumps, buckets, and watering cans. Pump irrigation is mostly done by men, although women also own pumps but commonly don't irrigate themselves. Urban farmers have to be flexible to switch between these different sources to continue cultivation in the dry season.

Response to urbanisation

- **By being mobile and flexible, urban farmers can continue to farm and keep their relevance in the city. If they lose their land, farmers search for new locations to restart farming and flexibly respond to any changes in their access to water.**
- In rapidly expanding cities like Dar es Salaam, the areas that can be used for agriculture are shrinking. So, farmers have to continually search for new farming locations. They keep on farming but are gradually being forced to move to marginalised areas or the city's periphery.
- Urban cultivation of leafy vegetables on small plots remains attractive as a business opportunity. Urban farmers provide a supply of fresh vegetables almost directly to the consumer. Other fruits and vegetables are largely imported from outside the city to meet the urban food demand.
- The city's growth also affects the availability of water for irrigation. In the rainy season, increased water runoff causes longer periods of flooded agricultural land. In the dry season, farmers benefit from more reliable water flows from new residential areas as more people reside, use, and dispose water. At the same time, water access can be cut off at any moment due to urban development.
- Increasing amounts of wastewater reduce the quality of water used for irrigation. Farmers are aware of these changes but don't experience problems in cultivation. Since the use of these water flows for irrigation is formally not allowed and previous publicity around water pollution has damaged the public image of urban farmers, farmers try to be of limited disturbance and do not raise their concerns about upstream water pollution.

Implications for decision makers

- Urban agriculture as described above is expected to persist as a temporal activity where open spaces are available. Above all, strengthening the farmers' position requires normalising that this practice is (and remains) an important part of the city.
- Using land and water for crop production is not simply a 'passing phase' of the growing city. A multi-disciplinary process of urban planning that includes farmers as active participants is recommended to encourage food production and secure farmers' employment and income. However, care should be taken to reduce health risks.
- Farmers use a mix of different types of urban water for irrigation. Wastewater is the term commonly used to describe this irrigation source, however it simplifies the actual combination of water types. Differentiating between urban water flows in research and governance is important to target the water sources that are harmful to food safety while maintaining access to water for irrigation.



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Kilimo cha umwagiliaji jijini Dar es Salaam

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Weledi na Ustawi

Ukuaji wa kasi wa miji ya Afrika umeweka shinikizo kubwa katika ardhi na maji, vitu ambavyo ni muhimu kwa wakulima wa mjini. Utafiti barani Afrika unaonyesha kwamba wananchi wa mijini wanaendelea kugeukia kilimo ili kujihakikishia usalama wa kipato chao. Swali ni kwamba, ni jinsi gani kilimo kinaweza kuendelea licha ya ongezeko la mashinikizo haya na inawezekanaje kupata manufaa ya kilimo kama ya ajira, chakula, na kuweka thamani katika ardhi za wazi za mjini. Nakala hii ya taarifa inatoa muhtasari wa matokeo ya utafiti wa hivi karibuni uliofanyika Dar es Salaam, Tanzania.

Kwa nani?

Utafiti ulifanyika ili kutoa ufahamu kwa maafisa wa manispaa (katika vitengo mbalimbali) na mashirika mengine ya umma na ya binafsi yanayofanya kazi ya kupanga na kusimamia maeneo ya mijini. Taarifa hii pia ni muhimu kwa watu waliojikita katika kilimo cha mijini au wanaohusika katika mifumo ya chakula mijini. Kilichogundulika mjini Dar es Salaam kinaweza kuwa na msaada katika miji mingine ya Afrika pia iliyo na hali sawa.

Mbinu ya utafiti

Dar es Salaam ni moja ya miji inayokua kwa kasi Afrika. Utafiti huu ulichunguza namna kilimo cha umwagiliaji kinavyoathiriwa na ukuaji wa kasi wa mji. Wakulima pamoja na washiriki wengine walihojiwa na kutazamwa katika maeneo sita ya kilimo mjini Dar es Salaam kati ya Mei 2021 na Februari 2022. Maeneo hayo yanawakilisha maeneo ya wazi ya kilimo katika mabonde ya mito, maeneo ya chini, na maeneo yanayoendelea mjini.

Sifa za kilimo cha umwagiliaji mjini

- **Wakulima mjini Dar es Salaam wanatumia ardhi ya wazi kwa kilimo cha muda mfupi kupata chakula, ajira, na faida zingine katika jamii ya mjini.**
- Mjini Dar es Salaam, kilimo cha umwagiliaji kinapatikana sana katika maeneo ya wazi. Wakulima wanalima mboga za majani (haswa mchicha) kibiashara katika maeneo yanayokumbwa na mafuriko au yanayotarajia kuendelea. Kwa kutumia maeneo haya ambayo hayatumiki kwa muda, wanaweza kuzalisha chakula, kupata kipato, na pia wanafanya maeneo haya ya mji kuwa safi na salama.
- Wakulima wengi ni kizazi cha kwanza cha wahamiaji kutoka katika mikoa mingine ya Tanzania. Wanageukia kilimo baada ya kufanya kazi zingine za mjini kwa wastani wa muda wa miaka sita. Wanaamua kuanza kulima ili kuzalisha kipato zaidi na kupata ajira imara zaidi kuliko kazi zao za awali.
- Mara nyingi wanaume wanakuwa watumiaji wa mwanzo na wanapata ardhi kubwa zaidi. Wanawake mara nyingi wanatembelea maeneo ya kilimo kwa miaka mingi kama wauzaji wa mboga au chakula kabla ya kupata fursa ya kulima.
- Wakulima huuza mboga zao za majani nyingi kwa wauzaji na wafanyabiashara wa mtaani, wanaoziuza katika maeneo tofauti ya mji. Maeneo haya yanayolimwa, japokuwa ni madogo, yana faida kwani mazao yanakua kwa haraka na uhitaji wa mboga za majani safi ni mkubwa.
- Maji ya kumwagilia yanatokana na mvua, maji ya ardhini, maji ya bombani, na maji taka. Wakulima

wanaweza kutumia maji ya bombani moja kwa moja, au kutumia maji yanayovuja katika mifumo ya usambazaji. Maji taka yanayotumika yanatoka katika vyanzo vya majumbani au viwandani (au mchanganyiko) na yanaweza kuwa hayajatibiwa kabisa, yametibiwa kidogo au yametibiwa kikamilifu. Wakulima hawategemei aina moja tu ya chanzo cha maji; vyanzo vya maji vinachanganywa kabla ya kuwafikia au wakulima wanategemea vyanzo tofauti vya umwagiliaji kutoka kwa wasambazaji tofauti.

- Vyanzo vikuu cha maji ya umwagiliaji mjini Dar es Salaam ni mito, mifereji, visima vifupi na maji ya bomba. Wakulima wanatumia pampu (za petroli), ndoo, na madumu maalumu ya kumwagilia. Umwagiliaji kwa kutumia pampu mara nyingi unatumiwa na wanaume, japokuwa wanawake pia wanamiliki pampu lakini mara nyingi hawazitumii kumwagilia. Wakulima wa mjini wanalazimika kuwa wepesi katika kubadilisha vyanzo hivi tofauti ili kuendelea kulima katika majira ya kiangazi.

Mwitikio wa ukuaji wa mji

- **Kwa kuwa wepesi kuhama na kubadilika, wakulima wa mjini wanaweza kuendelea kulima na kuweka umuhimu wao mjini. Kama wakipoteza ardhi yao, wakulima hutafuta maeneo mengine na kuanza upya kulima na pia huwa wanaweza kubadilika kunapotokea mabadiliko yoyote katika upatikanaji wa maji.**
- Katika miji inayotanuka kwa kasi kama vile Dar es Salaam, maeneo yanayoweza kutumika kwa ajili ya kilimo yanapungua. Hivyo, wakulima wanaendelea kutafuta maeneo mapya ya kilimo. Wanaendelea kulima lakini taratibu wanazidi kusukumwa katika maeneo ya nje ya mji.

- Kilimo cha mjini cha mboga za majani katika maeneo madogo-madogo bado ni fursa ya biashara ya kuvutia. Wakulima wa mjini wanahusika kwenye usambazaji wa moja kwa moja wa mboga za majani kwa mtumiaji. Matunda na mboga za majani zingine kwa wingi zinaingizwa kutoka nje ya mji ili kukidhi mahitaji ya chakula cha mjini.
- Ukuaji wa mji unaathiri pia upatikanaji wa maji ya umwagiliaji. Katika kipindi cha mvua, ongezeko la mtiririko wa maji husababisha mafuriko ya muda mrefu katika ardhi ya kilimo. Katika kipindi cha kiangazi, wakulima wananufaika na upatikanaji wa maji wa kuaminika kutoka katika maeneo ya makazi mapya kwa sababu watu wengi zaidi wanakaa, wanatumia, na kumwaga maji. Wakati huohuo, maji yanaweza kukatwa wakati wowote kutokana na ujenzi wa mji.
- Ongezeko la maji taka hupunguza ubora wa maji yanayotumika katika umwagiliaji. Wakulima wanafahamu mabadiliko haya lakini hawakumbwi na matatizo katika kilimo. Kwa sababu matumizi ya vyanzo hivi vya maji kwa umwagiliaji hayaruhusiwi na taarifa kwa umma za awali zinazohusu uchafuzi wa maji zimeharibu taswira ya wakulima wa mjini, wakulima wanajaribu kutokuwa vikwanzo na hawatoi wasiwasi wao kuhusu uchafuzi wa maji unaotokana maeneo ya juu ya vyanzo.

Athari kwa watoa maamuzi

- Kilimo cha mjini kama ilivyofafanuliwa hapo juu kinatarajiwa kuendelea kuwepo kama shughuli ya muda mfupi katika maeneo ya wazi yanayopatikana. Zaidi ya yote, kuipa nguvu nafasi ya wakulima kunahitaji kutambua suala hili ni (na litaendelea kuwa) sehemu muhimu ya mji.
- Kutumia ardhi na maji kwa ajili ya uzalishaji wa mazao sio tu 'hatua ya kupita' ya mji unaokua. Inapendekezwa kuwa na mchakato unaohusisha fani mbalimbali katika upangaji wa mji unaokuwa na wakulima kama washiriki hai ndani yake ili kuchochea uzalishaji wa chakula na kulinda ajira na kipato cha wakulima. Hata hivyo, tahadhari zichukuliwe ili kupunguza hatari za kiafya.
- Wakulima wanatumia mchanganyiko wa aina tofauti ya maji ya mjini kwa umwagiliaji. Maji taka ni neno linalotumika sana katika utafiti kuelezea chanzo hiki cha maji ya umwagiliaji, lakini linarahisisha tu mchanganyiko halisi wa aina mbalimbali za maji. Kutofautisha vyanzo vya maji yanayotiririka katika mji ndani ya utafiti ni muhimu ili kulenga vyanzo vya maji ambavyo vina madhara katika usalama wa vyakula na kuendeleza upatikanaji wa maji kwa ajili ya umwagiliaji.

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Summary

Irrigated urban agriculture is a day-to-day reality in many cities across sub-Saharan Africa despite not receiving popular attention. This dissertation engages with the question of how the practices and politics of irrigated urban agriculture configure urban space in the growing city of Dar es Salaam, Tanzania. The research simultaneously exemplifies the larger trend of urban growth across sub-Saharan Africa and its impact on the agricultural land and water that is feeding it. Irrigated urban agriculture is defined as the irrigated production of food crops on land located within cities or as part of urbanising landscapes, interacting both quantitatively and qualitatively with other urban water usage, surrounded by policies and other institutions, while serving multiple functions. The dissertation describes the *Fields of Friction* between irrigated agriculture and the city. These fields represent more than just the spaces for growing food; they are spaces where issues of access, equity, and sustainability are contested.

This dissertation consists of seven chapters, with **Chapters 1 and 2** introducing the research context and approach. Ethnographic research in six agricultural areas within the city of Dar es Salaam forms the core of this research and is supplemented by stakeholder interviews, literature reviews, and vendor and consumer surveys. The research is positioned at the intersections of water, food, and the city. To understand the interplay between everyday practices and the structuring socio-material environment within which people interact and society takes shape, the second chapter alternates between two conceptual lenses (Social Practice Theory and Urban Political Ecology) when studying urban water in East Africa. This conceptualisation of social practices as part of politically-constituted spaces is related to the case of irrigated urban agriculture throughout this work. Studying practices and politics in this way helps to focus on *how* interaction and change take place through practices while raising questions about *why* social interaction and social change are structured in particular ways.

Chapters 3 to 5 present a detailed analysis of these everyday practices while showing how they are part of a politically-constituted space and how they contribute to food systems. The flow of food from producer to consumer is studied in Chapter 3 to understand the functioning and resilience of cities' food systems. A foodshed analysis quantifies and maps the food flow of the leafy vegetable amaranth in Dar es Salaam. A

total of 70 per cent of all amaranth consumed in Dar es Salaam was found to be produced by farmers within the same urban locale. Two-thirds of all amaranth purchases occur via informal vendors operating in residential neighbourhoods through which food supply reaches the eater's doorstep. The findings show that there is an important role for urban areas in providing for their own food demands, which shows the need for urban authorities to actively envision (and strategise) the position of agriculture in the city, also considering those producers and vendors that informally shape the city and its foodshed.

This embeddedness of agriculture in the city raises questions about farmers' right to existence, as urban planning and governance largely ignore agriculture as urban land use, irrigation as part of the urban water system, and local production for urban food security. As a result, the dynamic relations between urban and peri-urban farmers and their changing environment are little known. To address this gap, irrigated urban agriculture is studied in **Chapter 4** as an exponent of everyday urbanism in which the city is made to work through the everyday practices of ordinary people. It shows how farmers claim their (informal) right to the city and are persistently part of the city's appearance and how it functions. By constructing (and reconstructing) networks of provision, urban farmers offer food, employment, and more for the improvement of their lives and the wider citizenry. These networks function independently from systems of the state and are responsive to changes that occur (e.g. upstream water pollution or forced relocation). Nevertheless, farmers find themselves in a delicate space of existence, facing pressure from powerful ideas about what fits the modern city.

As the city of Dar es Salaam grows, both the physical and political pressure on irrigated agriculture increases. Studying the policies and politics of irrigated urban agriculture, **Chapter 5** shows that a standing discourse emphasising agricultural and economic productivity is increasingly challenged by emerging discourses foregrounding health and modernity. Health issues related to urban water are increasingly presented as a reason to enforce strict rules of use or to remove agriculture altogether. Two distinct types of 'urban agriculture' are recognised by policy actors in Dar es Salaam, referred to as 'apartment agriculture' and 'city agriculture' (in Swahili expressions) that respectively align with modern planning ideals and the embodied reality of agriculture. While authorities aim for modern technologies that legitimise the presence of agriculture in the city, the majority of urban farmers rely on self-organised types of agriculture built on informal agreements

over access to land and water. The introduction and support of new farming models – such as hydroponics and vertical farming – represent the materialisation of urban ideals and seek to integrate modern elements into existing agricultural practices. In this way, existing ideas around agricultural realities are reconfigured to fit modern narratives of 'being urban'. This exposes farmers to urban land grabs and water pollution and implicitly positions most of the current agricultural practices 'outside' of the city's future.

Having studied the practices and politics of irrigated urban agriculture in Dar es Salaam, **Chapter 6** moves beyond this specific case by zooming out and exploring academic literature and the day-to-day governance of wastewater reuse in agriculture and what it is made to represent. There is a growing attention for wastewater as a 'new' resource to respond to the increasing pressure on water supplies. The academic attention for wastewater reuse shows a prevalent managerial focus on water quality and quantity, which makes the control of water appear as solvable through technical know-how, rational water use, and good governance; rendering the role of power and politics invisible. Wastewater reuse is, however, inherently political, as people seek to take control over water through the manipulation of physical flows and qualities. Studying the socio-political processes that configure water reuse in Dar es Salaam highlights the different water knowledges, values, and interests surrounding water flows and qualities. Water quality can be instrumental in studying inequalities in the urban waterscape and a pluralised understanding of wastewater reuse allows to learn from the knowledges and interventions that farmers have devised.

The last chapter, **Chapter 7,** synthesises the research and sheds light on the (contested) appropriation of urban space. Building on empirical and conceptual lessons and reflecting on methodology and positionality, three ways are explored that are believed to be meaningful for the engagement with water and food in the city. First, despite not fitting the strictly defined ideas around the condition of the city, the continued presence and contribution of irrigated urban agriculture makes that it could be regarded as a form of 'urbanness'. More so, with newly emerging questions around urban liveability and sustainability, agriculture could contribute to developing a more robust, equitable city. Second, given the mutual and interactive appropriation of space through both top-down and bottom-up forces of city-building, co-creation is suggested as a way to restructure the power relations that underlie the production of the city and shift control towards the

everyday city-makers that (through formal, informal, or hybrid networks) govern the city. Third, rethinking water reuse from an end-user perspective can enhance the understanding of the diverse flows and qualities found in water reuse. This creates room for a more active engagement with the socio-political dynamics surrounding water reuse.

To conclude, this research offers an in-depth understanding of the day-to-day practices of irrigated urban agriculture in Dar es Salaam, showing how these practices are configured by and respond to the growing city. Studying urban space from the perspective of farmers pluralises the understanding of cities and contributes to addressing knowledge inequities. The relationship between agriculture and the city creates *Fields of Friction* that encapsulate both physical and discursive tensions. Farmers get confronted with the loss of land, with changes to the quantity and quality of their irrigation water, and with dominant views that portray their practices as incompatible with the modern city. This research exemplifies that urban farmers, in practice, actively shape and control urban space, yet do not hold an equal right to the future city.

List of PhD related publications

Veldwisch, G. J., Amerasinghe, P., Letema, S., & Wessels, M. T. (2024). The practices and politics of irrigated urban agriculture. *Water International*, *49*(2), 129–143. https://doi.org/10.1080/02508060.2024.2325800

van Vliet, B. J. M., Haldar, K., Wessels, M. T., Kujawa-Roeleveld, K., & Veldwisch, G. J. (2024). A tale of service regimes in irrigated urban agriculture: Evidence from two cities in the Global South. *Water International*, *49*(2), 238–254. https://doi.org/10.1080/02508060.2024.2323874

Wessels, M. T. (2023). What's in a name? Politicising wastewater reuse in irrigated agriculture. *Water Alternatives*, *16*(2), 563–580.

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Acknowledgements

Proverbs play an important role in African society as transmitters of wisdom about life, relationships, and societal norms. Looking back at the past years, I remember a proverb I received (written on a postcard) from close friends in Tanzania. The Swahili proverb says "*Hata mbuyu ulianza kama mchicha*" and translates into English as "Even the baobab tree was once an amaranth". This image of something big – the baobab tree is a proud icon in the African physical and cultural landscape – which also started small and vulnerable has resonated with me over the past years. Realising that every part of this research started as (just) a first idea, conversation, or scribble has helped me to focus on the tiny, actionable steps rather than being overwhelmed by the complex task of doing a PhD. I have learnt that everything big and complex starts small, and slow motion is better than no motion. Now that my doctoral journey is finished, I owe a number of people a great debt of gratitude for their support and encouragement. My first and foremost gratitude goes to the farmers of Dar es Salaam. I have been granted access to collect stories about agriculture in the city. Your hospitality has opened up spaces that were foreign to me. What you have shown me and the stories that you shared contribute to a larger story about agriculture and the city, although I realise that this does not directly respond to the day-to-day uncertainties of being a farmer in the city. I hope that your stories – although based on my understanding and not carrying yours but my name – contribute to a larger debate on who is granted right to the city.

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About the author

Matthijs Wessels was born in the countryside of the Twente region in the Netherlands. The family's farm where he grew up has played an important role in his upbringing, and water and agriculture have fascinated him for as long as he can remember. He pursued a Bachelor's in International Land and Water Management at Wageningen University, for which he spent time in Malawi. He then continued with a master programme in the same field, but focusing on water quality by means of a specialisation in Irrigation and Water Management and an individual minor in Water Quality Management. For his thesis, he worked at the Cape Peninsula University of Technology (South Africa) on the impact of urban water pollution on commercial irrigated agriculture. There, he realised that water quality issues are often closely related to aspects of power.

Upon graduation, Matthijs left Wageningen to work as an advisor and project manager on different water-related projects at the Dutch consultancy firm Arcadis. During the same period, he worked as part of the Stockholm International Water Institute to organise the 2017 World Water Week themed *Water and waste: Reduce and reuse.* At the end of 2018, Matthijs joined the Water Resources Management group as a lecturer to further work on the topic of water (re)use in urbanising landscapes. He has taught and supervised many students on topics around water quality, water reuse, and urban-agricultural water use interactions. When he was awarded a research scholarship, Matthijs maintained a part-time position as a lecturer at the chair group but shifted most of his focus to researching irrigated urban agriculture in Dar es Salaam, Tanzania. He and his wife Joëlle moved to Tanzania to become more familiar with the daily dynamics of one of the largest cities in Africa.

When not thinking about water, Matthijs explores the wondrous world of coffee (which is essentially also mostly water) as a coffee roaster. Matthijs nowadays works on water and climate for the international relief and recovery organisation ZOA.

WASS training certificate

Matthias Teunis Wessels

Wageningen School of Social Sciences (WASS)

Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
A1 Managing a research project			
WASS introduction course	WASS	2019	1
Scientific writing	Wageningen in'to Languages	2019	1.8
Efficient writing strategies	Wageningen in'to Languages	2020	1.3
'Going with the food flow: Consumer foodsheds in rapidly growing East African cities'	Global Food Security Conference, Leuven	2024	1
Research visit to Leuven (Belgium) and Nairobi (Kenya)	WASS junior grant	2023	5
A2 Integrating research in the corresponding discipline			
Water governance	International WaTERS	2019	1
Summer school *"Land governance for development"*	The Netherlands Land Academy (LANDac)	2023	3
Institutions and societal transformation	WASS	2023	2
Advanced qualitative research design and data collection	GEO56806	2020	6

Food and nutrition security in urbanising landscapes	WageningenX	2023	0.5
B) General research related competences			
B1 Placing research in a broader scientific context			
African philosophy	CPT 39806	2022	6
Sociology and political science of environmental transformations	WASS/SENSE	2020	1.5
B2 Placing research in a societal context			
Making impact: Increasing the relevance of research through science-society interaction	WGS	2023	1
Organisation of international workshop *'Practices, policies and politics of urban irrigation in Africa and Asia'*	UrbIA, Wageningen	2019	3
C) Career related competences/personal development			
C1 Employing transferable skills in different domains/careers			
Supervising BSc & MSc thesis students	ESC	2020	0.64
PhD workshop carousel	WGS	2019	0.3
Student supervision	WUR	2022-2023	1.8
Writing grant proposals	Wageningen in'to Languages	2020	2
Language course Swahili	Kiswahili na Utamaduni	2019; 2021	3
Guest editor of the Special Issue *'Irrigation in urban catchments: Politics, practices and technologies'*	Water International	2022-2024	3
Total			44.8

*One credit according to ECTS is on average equivalent to 28 hours of study load

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