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Planned Vulnerabilities? Street Flooding and Drainage Infrastructure in Colonial Dar es Salaam

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Abstract: Technology can be both a problem and a solution in connection with critical events like road flooding in cities. This article explores how roadwork undertaken during German and British colonial rule created a situation which has, ever since, made the city of Dar es Salaam in Tanganyika (now Tanzania) vulnerable to flooding. The article identifies colonial spatial planning, a globally circulating engineering culture, and an undue emphasis on anti-malarial measures as the main causes of the flood vulnerability of roads. After decades of neglect, repeatedly flooded streets made the construction of drainage infrastructure an increasingly necessary preventive solution. Only slowly did drainage become an integral feature of road design, thus decreasing the city's vulnerability to floods. Drawing on analyses of archival and documentary sources, the article contends that the making of the vulnerability and criticality of roads and drainage systems unfolded within a socio-technical context which reflects colonial structures and terrains in the Global South.

Keywords: master plans; drainage engineering; flood vulnerability; critical infrastructure; Tanzania

Introduction

In May 1960, the *Tanganyika Standard* published a picture of a car that belonged "to Dar es Salaam Municipal Council . . . truly bogged in a lake caused by heavy rainstorm" just outside the weekly paper's offices downtown.[1] Hardly two years later and a month before independence of modern Tanzania, again the *Tanganyika Standard* printed a small headline on its front page and a picture of the newly-built headquarters of the ruling Tanganyika African National Union (TANU) party flooded by storm water. Used as temporary premises of the Dar es Salaam University College, the building looked like a "new luxury lakeside hotel."[2] To indicate that flooding was not facing Dar es Salaam alone and as way of underling the call for concerted action, the *Sunday News* reported on the havoc floods had caused over a tarmacked road in the northern town of Mwanza. Floods were reported to have led to "the serious interruption of communication," hence the "the lack of news" and halting of government and business activities. The paper also hinted at the danger the airport and railway were facing from floods if the rains did not stop.[3] The paper revealed that within government circles, plans were being made to provide the airport with storm water drainage. Neither the paper editors nor the government found it necessary for unaffected roads to be outfitted with drains. The papers only implied that floods were occurring because of the ongoing heavy rain season. None suggested that the flooding was an outcome of earlier planning decisions or a lack of drainage infrastructure in the streets. Although they regarded roads as critical to "communication" in urban settings, they did not suggest that the lack of drainage was the main cause of the road system's obvious vulnerability.[4]

Although the streets discussed in the two weeklies were inhabited by Africans, their European and Asian middle- and upper-class readers were alarmed because their businesses, workplaces and vehicles were dependent upon smooth functioning of those streets. Dar es Salaam was the capital of colonial Tanzania where governors and heads of government departments lived. It was developed through master plans, first by the Germans (1891-1918) and then by the British (1919-1961). As such, the pictures and news of flooded streets were a source of inharmoniousness to the colonial officials of Dar es Salaam between 1930 and 1961. In 1936, for instance, the Director of Medical Services wrote to the Chief Secretary of Tanganyika about the sanitary conditions of Dar es Salaam, complaining that "a matter of storm water drainage gives so many unfavourable comments in the press."[5] To the senior government officials, the

[1] *Tanganyika Standard,* 12 May 1960.

[2] *Tanganyika Standard*, "Dar Building at Lakeside," 4 November 1961.

[3] *Sunday News*, "Havoc Round the Lake," 14 January 1962.

[4] The conceptual terms of criticality and vulnerability are examined in detail in Jens Ivo Engels, ed., *Key Concepts for Critical Infrastructure Research* (Wiesbaden: Springer VS, 2018).

[5] Director of Medical Services to Chief Secretary, 12 August, 1936 in Tanzania National Archives (hereafter TNA) Accession no. 61/247/1: Sanitation – Dar es Salaam.

comments were undermining the colonial modernisation crusade. The streets' vulnerability to flooding was seasonal and posed health, communication and business dangers to all inhabitants of the city. Yet, anti-flood engineering measures were developed to cover only a few areas of a planned city. This article tries to explain why that was the case.

This contribution is concerned with the introduction and development of roads and drainage infrastructure as vulnerable and critical systems in Dar es Salaam. It covers the colonial period, from roughly 1890 to 1960. It discusses how the German and British colonial regimes interpreted the perennial flooding events and how they one-sidedly assigned a certain degree of criticality to these two interconnected infrastructures in different streets of the city. The work is situated within the literature on criticality and vulnerability. Since storm water drainage was never developed along the lines of a networked infrastructure ideal throughout the colonial period, I consider the literature on splintered urbanism less relevant to my case.[6]

In the most technologically advanced nations, urban road vulnerabilities are rarely noticed due to a high level of preparedness. Those nations have embraced the fact that "vulnerability is an emergent property of systems."[7] Although recent flooding events in Germany prove that Global North countries are not immune to extreme events, perennial flooding is usually kept at bay by means of coordinated spatial planning and sensible engineering solutions. Andrew Karvonen, for instance, discusses how the United States reduced road vulnerability by planning, designing, and building drainage for storm water. Drainage infrastructure is vital to control flooding, thus making cities more liveable and sustainable.[8] Some recent studies on storm water drainage contend that before the twenty-first century, such a broader understanding seldom existed in the Global South.[9] As we will see below, cognizance of infrastructure vulnerability was ad-libbed at best and for a long time was only mentioned in reaction to sudden flooding events. Since studies on the vulnerability and criticality of infrastructures are rare in the Global South, this article—like the other contributions to this special issue—aims to open a discussion on the relevance of the critical infrastructure discourse for previously colonised areas.[10]

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[6] Cf. Stephen Graham and Simon Graham, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London and New York: Routledge, 2001); Olivier Coutard, "Placing Splintering Urbanism: Introduction," *Geoforum* 39 (2008): 1815-1820; Michelle Kooy and Karen Bakker, "Splintered Networks: The Colonial and Contemporary Waters of Jakarta," *Geoforum* 39 (2008): 1843-58.

[7] Wiebe Bijker, Anique Hommels, and Jessica Mesman, "Studying Vulnerability in Technological Cultures," in *Vulnerability in Technological Cultures*, ed. Anique Hommels, Jessica Mesman, and Wiebe E. Bijker, 1-26 (Cambridge, MA & London: The MIT Press, 2014), 6.

[8] Andrew Karvonen, *Politics of Urban Runoff: Nature, Technology and Sustainable City* (Cambridge, MA & London: The MIT Press, 2011).

[9] Brian Reed, "Storm-Water Management in Low-income Countries," *Municipal Engineer* 166, no. 2 (2013): 111-20.

[10] Cf. The introduction to this thematic dossier by Mikael Hård and the paper by Emanuel Lukio Mchome.

Roads, whether in rural or urban areas, have historically and globally been built for the purpose of enabling the mobility of goods, services and people. Roads have become solutions to transport problems by answering human needs.[11] Drainage intersects with roads insofar as poor drainage can obstruct mobility, cause inconvenience, and damage roads, but its importance is also manifest in the role it plays in saving larger areas from floods and the population from disease.[12] The vulnerability of roads becomes notable when events such as flooding and crossroad building projects make passage impossible. As Eifert, Knauf and Thiessen illustrate, roads qualify to be treated as a vulnerable infrastructure because it is a materiality which is prone to the risk of being flooded and damaged in certain historic moments.[13] Additionally, road vulnerabilities are an indication of the criticality of drainage infrastructure. Drainage criticality is therefore relational to roads vulnerability, an important dimension in critical infrastructure research, as highlighted by Lukitsch, Müller and Stahlhut.[14] Drainage channels and pipes lead water to inland, river, lake or sea recipients, thus reducing road damage as well as the possible interruption of communication and transport. In this article, focus is on urban roads that define street social interactions and mobility. They are lifelines and arteries of urban life. In precolonial Dar es Salaam, such forms of road criticality did not exist, since the area was not urbanised and had no wheel technologies. As such, when streets were introduced in the colonial era, they represented a new "technological culture." Borrowing from Wiebe Bijker, Anique Hommels and Jessica Mesman, a "technological culture" refers to the embeddedness of materiality in social systems and how they go hand-in-hand with experiences and values.[15] This article demonstrates that the criticality and vulnerability of road and drainage designs were the outcome of a "technological culture" which did not take seriously flooding events occurring on a perennial basis.

Both in colonial settings and in the imperial metropolis, engineers did not begin to consider urban drainage until the late nineteenth century. Only after municipal governance had become formalized and professionalized did the topic receive larger attention.[16] As the papers quoted in the opening of this article reveal, this neglect was also obvious in colonial urban Tanzania, where roads were built without surface drainage structures. Illustrating how various planning

[11] On human needs, see Eric Katz, "The Big Lie" cited in Steven Vogel, *Thinking Like a Mall: Environmental Philosophy After the End of Nature* (Cambridge, MA & London: The MIT Press, 2015), 103-5.

[12] For the functions of drainage, see David Butler and John W. Davies, *Urban Drainage* (London: Son Press, 2004).

[13] Stephanie Eifert, Alice Knauf, and Nadja Thiessen, "Vulnerability," in *Key Concepts for Critical Infrastructure Research*, ed. Jens Ivo Engels, 21-29 (Wiesbaden: Springer VS, 2018).

[14] Kristof Lukitsch, Marcel Müller, and Chris Stahlhut, "Criticality," in *Key Concepts for Critical Infrastructure Research*, ed. Jens Ivo Engels, 11-20 (Wiesbaden: Springer VS, 2018).

[15] Bijker, Hommels, and Mesman, "Studying Vulnerability in Technological Cultures," 5.

[16] See in Karvonen, *Politics of Urban Runoff*.

schemes ignored drainage as a critical infrastructure in the streets of Dar es Salaam, the next section will address the question why colonial regimes were able to withstand seven decades of serious flood events and obvious road vulnerabilities.

Spatial planning: precedence of flooding vulnerabilities

Historians and social scholars of technology rarely investigate the relations between spatial planning and the making of vulnerabilities that intersect two or more technical infrastructures. In this section, I use planned streets and drainage to underscore the importance of considering such socio-technical connections. The first important aspect has to do with the plans. Dar es Salaam assumed city status in August 1891 when the Germans decided to make it the capital of German East Africa. On arrival in Dar es Salaam, the Germans drafted their first master plan which defined land use and the spatial arrangement of the city. The master plan was a spatial modernisation tool that transformed the area from a mere fishing and farming village into a dominant administrative, economic, and transportation centre in the territory.[17] A place where the governor and the key colonial department heads resided and worked, the town acquired a European appearance. In order to underscore the civilizational features of the colonial project in Africa, the Germans deemed it necessary to build large technical systems such as roads, sewerage and water pipes, electricity lines, as well as modern public buildings and residential housing units. How could a governor justify colonialism if he left the area unmodernised? Within a decade, the Germans turned Dar es Salaam into the most modern and multicultural location in the territory, replacing the old town of Bagamoyo. Pleased with their transformation work, they called it "Little Potsdam," and diverted all trade routes to the city in 1894.[18]

The German plan of Dar es Salaam organised space according to two criteria: function and building type. According to William Dawson, function and building types had become established spatial planning criteria in Germany in the second half of the nineteenth century.[19] Towns and cities that were not using these planning tools were labelled conservative and backward. Most modern towns in Germany, thus, adopted the "zone system" which categorised "separate districts to which different building regulations apply."[20] The plans divided towns into residential, industrial, commercial, and administrative areas. Echoing the words of a Tanzanian

[17] John Iliffe, "The Age of Improvement and Differentiation, 1907-45," in *A History of Tanzania*, ed. Isaria N. Kimambo and Arnold Temu, 123-60 (Nairobi: EAPH, 1969), 143.
[18] John Iliffe, *A Modern History of Tanganyika* (Cambridge: Cambridge University Press, 1979), 128.
[19] William Harbutt Dawson, *Municipal Life and Government in Germany* (London: Longmans, Green and Co., 1914), 142-4.
[20] Ibid., 143.

urban planning scholar, Lussuga Kironde, it is obvious that the plans of colonial Dar es Salaam were "western" in origin.[21]

In Dar es Salaam, the Germans circulated the contemporary urban land-use practices from their mother country. They introduced a residential, a commercial and a government zone. As three different ethnic groups – which in colonial records are referred to as "races" (Europeans, Asians and Africans) – inhabited the area, and since the "races" had significant income differences, it is not surprising that the Germans decided to classify the zones according to building material types.[22] To ensure that the zones were differentiated clearly by the building materials, the Germans enacted the 1891 *Building Ordinance* which laid out the building codes (*Bauordnung*).[23] Whereas government and European buildings were to be built with stones and roofed using iron corrugated sheets or tiles, Asian and African buildings were allowed to use mud and wattle poles for the walls, and grass or coconut-leaf thatched roofs. All buildings were supposed to be built along the newly carved out streets and use rectangular designs. However, if an African or an Asian had the financial power to buy stones and modern building materials, they were allowed to build stone houses in the "European zone" as well. Some Asians, especially a few rich merchants, managed to build stone houses which raised the eyebrows of certain Germans.[24] This special treatment of Dar es Salaam by the Germans was unique, as it was not practiced in other German colonial cities in modern day Togo, Cameroon or Namibia. In those colonies, the Germans had a planning philosophy that was similar to the French and the British, as their colonial town plans used ethnicity as a factor in separating spaces. That is, planning was used as a tool for racial segregation.[25] One possible reason for Dar es Salaam's uniqueness is that the majority of its African residents were not natives of the city. Some of them had come from abroad and others from upcountry to work for the Germans as domestic servants, in labour gangs, as soldiers or policemen.[26] The second reason is that the Africans of Dar es Salaam had not resisted colonial penetration enough to create a security threat to the Germans, a threat that was strongly felt in Douala, Lome and Windhoek.

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[21] Joseph M. Lussuga Kironde, "The Evolution of the Land Use Structure of Dar es Salaam, 1890-1990" (PhD thesis, University of Nairobi, 1995), 11-12.

[22] Bundesarchivs, Berlin Lichterfeld, R1001/309: Reichskolonialamt.

[23] James R. Brennan and Andrew Burton, "The Emerging Metropolis: A History of Dar es Salaam, circa 1862-2000," in *Dar es Salaam: Histories from an Emerging African Metropolis*, ed. James R. Brennan, Andrew Burton, and Yusuf Lawi, 13-75, (Dar es Salaam: Mkuki na Nyota, 2007), 24.

[24] Brennan and Burton, "The Emerging Metropolis," 26.

[25] For French and British colonial spatial planning in Africa, see Ambe J. Njoh, "Colonial Philosophies, Urban Space, and Racial Segregation in British and French Colonial Africa," *Journal of Black Studies* 38, no. 4 (2008): 579-99.

[26] Frank Edward, "Circulation and Appropriation of Urban Technologies: Traffic and Drainage Infrastructures in Dar es Salaam, 1913-1999" (PhD Diss., Darmstadt University of Technology, *forthcoming*).

Before 1913, infrastructure provision in Dar es Salaam was coordinated and supervised by the *Bezirksamtmann*, the district commissioner, who worked with the *kommunaler Bezirksrat*, a communal district council. The situation changed in early 1914, when the Germans established the municipal administration of Dar es Salaam through the 1910 *Municipal Ordinance* whose application had been delayed for three years.[27] As the First World War was looming, the municipal administration was short-lived.

Rodemann and Kironde contend that the money for infrastructure building and maintenance was disbursed by the government in Germany, with some of it coming from local taxes, municipal businesses, subsidies from the treasury, and land rent collected in German East Africa.[28] Considered critical for urban life, roads were provided in all areas according to the 1891 master plan. During the German colonial period, most of the city roads were unpaved. The roads were built by German engineers, who probably introduced German road engineering culture.[29] By engineering culture, I refer to specific traditions and practices in the way technical artefacts are designed and made.[30] Some streets were outfitted with surface drainage, especially those along the seafront. A good example of such streets was the Kaiser Strasse which drained storm water to the sea.[31] However, by 1914, the commercial streets of Unter den Akazien, Kaiser Strasse, Arab Strasse and Stuhlmannstrasse had both surface and underground pipe drainage, a sign of change in the drainage design from single to dual drainage systems.[32]

Until the formal end of German rule in Dar es Salaam in 1918, roads were important for bicycles, rickshaws, pedestrians and army parades. There were no automobile vehicles, neither in the city nor elsewhere in the territory. The urban spatial design had a grid shape, and roads intersected at roughly 90°. The archival records reveal that some roads were particularly vulnerable to flooding. When considering drainage solutions for the flooded roads of the city like those adjacent to the Chafukoga area, the Germans were prompted not by damage to the roads from floods but by the danger of water-borne diseases, especially malaria.[33] Since large amounts of water in the urban area created ideal mosquito breeding grounds, the drainage

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[27] Hans William Rodemann, "Tanganyika, 1890-1914: Selected Aspects of German Administration" (PhD diss., University of Chicago, 1961), 84.

[28] Rodemann, "Tanganyika," 85; Kironde, "Land Use Structure," 29.

[29] Frank M. Chiteji, *The Development and Socio-Economic Impact of Transportation in Tanzania, 1884-Present* (Washington, D.C.: University Press of America, 1980), 25.

[30] Wolfgang König, "Design and Engineering," in *The Oxford Handbook of Business History*, ed. Geoffrey Jones and Jonathan Zeitlin, 374-95 (Oxford: Oxford University Press, 2008).

[31] Rodemann, "Tanganyika," 4.

[32] Cf. Uebersichtskarte von der Stadt Dar-es-Salam 1892/93, E11:25 – Dar es Salaam, Weston Bodleian Collection, University of Oxford Library (hereafter cited as Weston Bodleian MSS); Director of Medical Services to Chief Secretary, 12 August 1936, TNA, Accession no. 61/247/1; Dar es Salaam: Plan Showing Existing German Drains, BNA Reference no. CO 1054.

[33] Report by Dr. Orenstein on Dar es Salaam, TNA Accession no. 450/29/10.

infrastructure became critical for reasons of health rather than for intra-urban mobility. The criticality of road drainage to urban well-being continued to gain substantial importance in the British colonial era. The notion that proper drainage was critical to health persisted through the interwar period, as most of the drainage works were anti-malarial. In fact, the best concrete-lined open drains were not built along roads, but in the Gerezani and Msimbazi creeks as well as at the golf course to ensure effective runoff of storm water.[34] The creeks drainage works sought to control malarial mosquitoes whereas the golf course works were designed to serve class interests.

By the time they were introduced in Dar es Salaam, the concrete-lined surface drains had already disappeared in Britain. Such drains were common in Britain's macadamised roads in the nineteenth century,[35] but were soon replaced by Joseph W. Bazalgette's combined and piped drains which, according to historian of technology Hans Buiter's European perspective, "became an international standard."[36] The anti-malarial concrete-lined drain system which was built by the British in the 1930s borrowed from a road drainage practice that was no longer in use at home or in other Global North nations. In other words, the British applied outdated road engineering solutions in the colonies. Despite using a cheap and sub-standard drainage designs, colonial reports on Dar es Salaam reveal a significant number of complaints over the lack of funds for better road drainage provision from the 1920s to the early 1940s. What they could do at best was the repair and maintenance of the open dirt drains along the existing roads on a seasonal basis.[37] Put pithily, the criticality of drainage in the German era was primarily defined in medical terms, whereas in the British era it was rooted in the mitigation of both medical and road transport vulnerabilities.

The streets planned by the Germans and the British are situated in the low-lying plain level. However, the fact that these plain areas are surrounded by gently rising parts explains why these streets have continued to experience flooding ever since the German period. Whenever rain falls, the runoff from those gently raised areas flow to the lower areas, which in the 1892/93 and 1949 master plans were defined as the residential and commercial parts of town.[38] In particular, the western boundary of the city, which during the British era were either left as a

[34] Second (Final) Report of the Malaria Unit, Dar es Salaam, for the period from November 1934 to December 1936, British Library W 103 (hereafter BL).

[35] Robert J. Forbes, "Roads to c. 1900," in *A History of Technology: The Industrial Revolution c. 1750 to c. 1850,* Volume 4, ed. Charles Singer et al., 520-47 (Oxford: Oxford University Press, 1958), 536.

[36] Hans Buiter, "Constructing Dutch Streets: A Melting Pot of European Technologies," in *Urban Machinery: Inside Modern European Cities*, ed. Mikael Hård and Thomas J. Misa, 141-62 (Cambridge, Ma & London: The MIT Press, 2008), 150.

[37] Frank Edward and Mikael Hård, "Maintaining the Local Empire: The Public Works Department in Dar es Salaam, 1920-60," *The Journal of Transport History* 41, no. 1 (2020): 27-46, on 38-9.

[38] Tanganyika, *A Plan for Dar es Salaam*: *Report* (London, Nairobi & Dar es Salaam: Sir Alexander Gibb & Partners, 1949).

cordon sanitaire or as an area for Africans, was higher than the inner and central parts of the city. In the rainy season, water ran down to the golf course and to the Chafukoga area where Africans and Asians lived. "Just about a mile away, along the sea-front, in the vicinity of the General Post Office," the *Tanganyika Standard* of 24 March 1930 reported, "and in what is regarded as the commercial area, the waters lay dark and deep. Pedestrians had to paddle through mud to reach the heart of commercial activity." This flood indicated how vulnerable the streets were even in the best planned area.

Inappropriate engineering solutions were not the only problem for flood-prone areas. Spatial planning decisions had a fair share too. Planners of the city overlooked the land elevation, and they did not seem to have taken into serious consideration the fact that the native Zaramo had never built their huts in the water pathways. The Zaramo called the area *Chafukoga* to imply a place where people "take baths in muddy waters." The Germans were concerned with ensuring that all urban inhabitants lived in planned areas, but they did not understand the natural properties of the area. The Germans, most probably, mistook the sparsely populated areas—by then largely coconut-tree farmland—less prone to floods. When plots were surveyed, the Africans who were allocated plots were largely non-natives to the area, which means they also lacked knowledge about local conditions. The tendency of ignoring local spatial knowledge did not end in the German colonial period. It persisted throughout the British era and in post-colonial times as well, thus making many more planned streets vulnerable to perennial flooding.[39] Thus, when the *Tanganyika Standard* and the *Sunday News* talked about floods creating lakes in streets—as shown in the opening paragraph—they were not exaggerating. Flooding clearly illustrates the pitfalls of spatial planning since the 1890s and the persistent neglect of drainage infrastructure especially during the British colonial era.

In addition, knowledge of local meteorological and geographical factors was also ill appreciated by the colonial spatial planners. Geomorphological studies reveal that Dar es Salaam is largely a sandy area.[40] As colonial officials noted, the sandy soil "contains enough clay to prevent ready percolation."[41] The presence of clay in sand soils impacted the rate of storm water percolation. It is no wonder that Dar es Salaam has historically been prone to floods even when light rains fall for short periods. Silt and sand also pose a big problem to drainage, especially during tropical, torrential rains. Such rains might lead to the erosion of sand in one area and its deposition in other areas. British colonial records show that torrential rains in the city did not only erode roads and drains but also filled the drains with sand and silt. On November 1927,

[39] Allen Armstrong, "Colonial and Neo-colonial Urban Planning: Three Generations of Master Plans for Dar es Salaam, Tanzania," *Utafiti* 8, no. 1 (1986): 43-66.

[40] Paul H. Temple, "Aspects of the Morphology of the Dar es Salaam Area," *Tanzania Notes and Records* 71 (1970): 21-53.

[41] Dar-es-Salaam Stormwater Drainage, 17 August 1932, BNA Reference no. CO 691/125/11.

a report on the floods in the Twiga, Mkunguni, Narung'ombe, Sikukuu, Livingstone, Swahili, Sukuma and Mafia Streets in the African area of Kariakoo by the Health Officer observed:

> Permanent and semi-permanent drains are required in those places enumerated [above]: efforts have been made by the Health Office to dispose of the water by the use of earth drains, but the sandy nature of soils defeated them. The fall in places is very small, and the amount of water entering from the sides large, the drains fill up with sand which the speed of flow cannot remove. The drains choke and become useless. The properly lined drains are essential, and sand traps or weirs for trapping and easy removal of sand, are equally necessary.[42]

As shown above, the colonial officials understood that Dar es Salaam was a sandy area, yet they had planned for further settlements and built earth drains even after the Second World War. Although they knew that the planned streets were experiencing floods on a yearly basis, they saw "no possibility of providing alternative sites, and it would appear to be incumbent upon the Government to make these places habitable."[43] In 1937, the annual report from the Medical and Sanitary Services Department noted that "storm-water drainage in certain parts of Dar es Salaam is very unsatisfactory and increasing erosion in the native areas calls for provision of new drains as soon as possible."[44] Despite the fact that they acknowledged the criticality of efficient drainage infrastructure, the British did not propose to relocate the inhabitants of the most affected areas. In planning for these areas, both the Germans and British turned a blind eye, because of ethnic naivety and racism respectively, which was reinforced by their inability and unwillingness to examine the nature of the area before allocating plots for housing. As such, drainage technologies that are critical for street flood control were nipped in the bud by the practices of colonial spatial planning. The sandy nature of roads also affected roads leading outward from the city. In January 1938, for instance, one resident wrote a letter to *Kwetu*, an African fortnightly Swahili paper, complaining of the sandy roads which made vehicles and bicycles unable to ride through the African streets in Ilala area, west of the Dar es Salaam township. In particular, the resident mentioned one house that burned to ashes because the fire engine could not pass through the sandy roads, fearing to get stuck.[45]

If drains and roads were tools of empire, they were poorly built in the colonial cities, particularly in the African areas.[46] Unlike streets in the Asian and European areas, those built in the African parts of town were not consolidated with new soil, gravel or bitumen. In the African areas, road building did not amount to much more than excavating a plain surface to make a level

[42] Health Officer to Provincial Commissioner, 1 November 1927, TNA Accession no. 61/247/1.
[43] Ibid.
[44] Tanganyika, *Annual Report of the Medical and Sanitary Services Department for 1936* (Dar es Salaam: The Government Printer, 1937), 40.
[45] *Kwetu*, "Mji wa Ilala, Dar es Salaam," 14 January 1938.
[46] Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York & Oxford: Oxford University Press, 1981).

path. Apart from considering the Africans as transient inhabitants of the town, the British perceived them as a redundant population because they did "not contribute significantly to the economy of the town."[47] Why would, so the argument went, the British provide Africans with the same kind of roads and drains as the Asians, who were sustaining the commercial sector, or the Europeans, who administered the territory and managed export-import trade? By refusing to build infrastructures in line with the established and conventional standards which had circulated from the Global North, and which were already in use in Dar es Salaam's Asian and European streets, the British accepted a high degree of vulnerability in African areas.[48] This policy contrasts sharply with the relatively high degree of preparedness against flooding prescribed by European standards, guidelines which aim at preventing the built infrastructures from being affected by users or hazards regardless of where they are applied.[49]

Planning for drainage without building: plans and rules

In interwar Dar es Salaam, a large part of infrastructure planning measures in the downtown areas was directed towards improving anti-malarial drainage. Unfortunately, most of the plans were never materialised. As Edward and Hård have shown, the Public Works Department, which was responsible for planning, building, maintenance and repair of infrastructures in Tanganyika, was more concerned with repair and maintenance of German technological vestiges because the funds required for new constructions were lacking.[50] Having changed the status of Dar es Salaam from a city to a township, the British expanded the city boundary twice in the interwar period, and once in the post-war period. The extended boundary was meant to survey and plan new areas for provision of residential plots for Africans, Asians and Europeans. The boundary extension did not go hand-in-hand with infrastructure provision. As will be shown below, the newly incorporated African areas had little or no infrastructure works, even if the actual paper plans had established the provision of roads and drainage.

The first boundary extension was laid out in the *Land Ordinance* of 1923, which put all lands in Tanganyika under the jurisdiction of the Governor.[51] It also introduced *Township Rules* which

[47] Tanganyika, *Annual Report of the Eastern Province for 1957* by G. N. Clark (Dar es Salaam: The Government Printer, 1958), 19.

[48] The use of soil stabilisation and bitumen in road building was tested for the first time by road engineers in Tanganyika in 1945 as shown in Tanganyika, *Annual Report of the Public Works Department for 1945* (Dar es Salaam: The Government Printer, 1947), 6.

[49] For a broader discussion on the concept of preparedness, see Arturo Crespo, Marcus Dombois, and Jan Henning, "Preparedness & Prevention," in *Key Concepts for Critical Infrastructure Research*, ed. Jens Ivo Engels, 39-44 (Wiesbaden: Springer VS, 2018).

[50] Edward and Hård, "Maintaining the Local Empire," 35.

[51] United Kingdom, *Report on Tanganyika Territory to the League of Nations for the Year 1927* (London: His Majesty's Stationary Office, 1928), 69.

would guide urban governance and spatial management.[52] In Dar es Salaam, the *Ordinance* did not just lead to widening the boundary. It was instrumentalised to introduce spatial segregation along racial lines by removing the Africans from the old part of town, separating them from the Asians and Europeans. It became a blueprint of the British zonal system. Unlike the German zonal system, which was based on function and building codes, the British zonal system was an extension of colonial spatial racism and class culture from other British colonies and from Britain itself.[53] Kariakoo was the first area to be planned, and it was allocated to the Africans after they had been evicted from the commercial area.[54] The commercial area was left to the Asians. The government area and former European residential areas were left exclusively for Europeans. The three areas were labelled: Zone I for Europeans, Zone II for Asians and Zone III for Africans.[55] Later colonial boundary extensions were additions to areas in the three zones. For instance, between 1927 and 1931, two areas were added: Ilala to Zone III and Oyster Bay to Zone I.[56]

After the change of status from a township to a municipality in 1949, Zones II and III were expanded even further.[57] The Legislative Council of Tanganyika (LEGICO) passed ordinances formalising the planning of Upanga (Zone II), Magomeni, Kinondoni, and Temeke (Zone III).[58] Primarily, the expansion of the town boundary in the post-war era was meant to solve the housing crisis, because, especially, the African and Asian populations were rising fast. As the town expanded, the infrastructure was also extended to the newer areas, although in three different qualities depending on ethnicity and zone. The expansion of the road network increased the drainage problem because the new roads were built to the same discriminatory standards of ethnicity and zone.

Contrary to most European cities of the early twentieth century, drainage engineering in Dar es Salaam was primarily guided by concerns of a sanitary nature. The plans and rules for drainage provision in colonial Dar es Salaam were to a large extent influenced by the need to prevent the spread of water-borne diseases. The biggest threats were posed by cholera and malaria. Although flood control was only of marginal importance, the drainage discussion within government circles tended to arise only during flooding events. To put it succinctly, drainage for malarial

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[52] Tanganyika, *Annual Report of the Medical and Sanitary Services Department for 1923* (London: The Crown Agents for Colonies, 1924), 47.

[53] See Njoh, "Colonial Philosophies"; Philip D. Curtin, "Medical Knowledge and Urban Planning in Tropical Africa," *The American Historical Review* 90, no. 3 (1985): 594-613; Selina Todd, *The People: The Rise and Fall of the Working Class* (London: John Murray, 2015).

[54] Tanganyika, *Medical and Sanitary Services Department for 1923*, 61.

[55] Iliffe, "The Age of Improvement," 144.

[56] Executive Officer to Chief Secretary, 17 April 1931, TNA Accession no. 61/403/Vol. I.

[57] *Tanganyika Standard,* 15 January 1949: "Planning Scheme for Upanga Area."

[58] TNA Accession no. 61/4/15; Secretary of State for Colonies to Governor of Tanganyika, 31 December 1951, BNA Reference no. CO822/592.

control was *proactive*, whereas drainage for flood mitigation was *reactive*. Meant to increase the society's resilience toward disease, proactive drainage included measures to drain off waters that could offer potential breeding grounds for mosquitoes. Such drainage systems were built along roads, highlighting how flood vulnerabilities coincided with health vulnerabilities.

Politically, sanitary engineering measures carried more weight than flood control. Rules were enforced by the township authorities through building and sanitary inspectors. The building inspectors approved building plans of individual and public housing units, paying particular attention to the existence of drains in the designated plots. In their turn, the sanitary inspectors conducted regular visitations to people's homes to ensure that matters of sanitary importance, including drainage, were maintained by occupants. The first comprehensive plan to provide the city with fitting drainage was drafted in 1932 by the consulting engineering company Messrs. Howard Humphreys.[59] Humphreys had a good standing at the Colonial Office in London and was entrusted with the planning, design and construction of anti-malarial and storm water drainage in the British colonies, for example, in British Guiana, Uganda and Kenya.[60] The fact that the same engineers worked on drainage solutions throughout the empire explains the similarities of drainage infrastructure in the former British colonies. Whereas the drainage designs in Britain itself had, since the mid-nineteenth century, been piped drains buried underground, the drainage in the colonial territories were characteristically simple, concrete-lined open-surface drains. The piped drains were also known as combined drainage because they collected sewage and storm water. Surface drains collected storm water only. The British built different drains in the colonies to those back home, probably because combined drainage systems were costlier and required a higher level of expertise.

The 1932 plan was "examined with a view to deciding which zones should receive first attention, and the suggestion had been made the zones most urgently requiring attention were those in the bazaar area and, after these, certain portions of the European residential area." The explicit justification for starting with these areas was their high population density, their low altitude and the fact that sewage tended to soak there.[61] In the African areas, only a small part of Gerezani received runoff drainage but no sewage drainage. As such, the 1932 drainage scheme established a double standard in that it provided a combined drainage system in the European and Asian streets, while a few African streets were provided with surface drainage

[59] The Crown Agents to the Under Secretary of State for Colonies, 13 June 1930, BNA Reference no. CO 691/107/9.

[60] The Crown Agents to the Under Secretary of State for Colonies, 21 March, 1923, BNA Reference no. CO 111/650/34; Howard Humphreys & Sons to the Chief Secretary of Uganda Protectorate, 22 September 1930, BNA Reference no. CO 536/182/18; N. Cooper, Report on "Municipal Works in Nairobi" (London: ICE, 1960).

[61] Tanganyika*, Report of the Central Development Committee* (Dar es Salaam: The Government Printer, 1940), 158.

only. The project, like many British colonial infrastructure projects of the day, was to be funded on a loan from the Colonial Development Fund (C.D.F.). The plan was to expend around £200,000 for building the combined drainage and about £70,000 for repairing the existing drainage system. However, because of the ongoing impacts of the Great Depression, funds were not forthcoming for the execution of the plan. Writing on the matter to the Secretary of State for the Colonies in London, the Deputy Governor of Tanganyika said that "in the present financial circumstances the expenditure involved in carrying out the full scheme proposed by the Consulting Engineers cannot, of course, be contemplated."[62] Consequently, the plan was shelved for two decades until 1952 when it was revised and implemented. One of the reasons for its revision was "to conform to changes in the municipal boundaries and to town planning schemes made in the knowledge of that main drainage."[63] Covering the newly added area of Upanga for Asians, the plan still left out the African streets.

Another plan for drainage and roads which was only partly implemented was the master plan of 1949.[64] Being the first British comprehensive plan of Dar es Salaam, it sought to cater for infrastructure services to all zones. The plan established new streets for the Asians and Africans. While Asians were assigned the Upanga area, Magomeni, Temeke, Kinondoni and Magogoni were defined as the new African areas of the municipality. The Asian streets were to be supplied with the combined drainage system together with paved (macadamised) or tarmacked roads.[65] In the latter roads, erosion was meant to be prevented or minimised. In the African areas, roads were planned to be packed earth or paved. Drainage was to be open and concrete-surfaced drains. However, during the plan implementation between 1950 and 1961, the African areas were provided only with dirt-roads without drainage. Technically, even if the dirt-roads were supplied with concrete-lined drains, soil erosion in the road surfaces could not have been obviated, unless they were consolidated with gravel, concrete or tarmac.

The provision of resilient infrastructures for the African part of the population was not the main interest of the British. Rather, their main concern was to reduce the housing crisis by ensuring that Africans were allotted surveyed plots where they were supposed to build houses under self-help schemes in such a way that the authorities would be able "to control the architectural effect and street perspective as a whole."[66] Criticising the tendency of not

[62] Deputy Governor to Secretary of State for the Colonies, 17 August 1932, BNA Reference no. CO 691/125/11.

[63] Hugh Hume Dixon, "The Main Drainage of Dar es Salaam, Tanganyika Territory," *Conference Proceeding Papers: Conference on Civil Engineering Problems in the Colonies*, ICE, 95-109 (London: ICE, 1954), 98.

[64] Tanganyika, *A Plan for Dar es Salaam.*

[65] In 1947, funds were set aside from the plans to provide for macadamised and tarmac roads in European areas. See Tanganyika, *Annual Report of the Public Works Department for 1947* (Dar es Salaam: The Government Printer, 1949), 5.

[66] Director of Town Planning to Commissioner of Development and Housing, 3 February 1954, TNA

providing infrastructure facilities in the African zones, the senior government officials in 1952 noted that there were "appalling conditions in Kinondoni where plots had been allocated to the Africans before any provision had been made for roads, surface drainage or water supplies."[67] As a result of this neglect, African streets were much more seriously affected by floods than the European and Asian streets, because planning in those areas was only meant to solve the housing problem. Tragically, the postcolonial government did not break with this colonial form of spatial planning, thus rendering roads and streets vulnerable to floods. Such a structurally inherited unpreparedness explains the continuing vulnerability to floods, a situation that hardly improved in the five decades after independence.

The 1932 drainage scheme and the 1949 master plan were backed by legislation and rules to ensure the planning goals were achieved and sustained. In 1950, the British colonial government enacted the *Public Health (Sewerage and Drainage) Ordinance*.[68] The *Ordinance* created room for the provision of funds for building and maintaining the drainage system in Dar es Salaam and other towns in Tanganyika. It also laid out *Building Rules*, to which every individual or organisation had to conform when undertaking construction in urban areas. In particular, the *Building Rules* aimed at "dealing with insufficient or defective sanitary accommodation and drainage systems" in the streets.[69] The *Ordinance* helped maintain the grid pattern of streets and the building of toilets in African areas while ignoring the building and maintenance of drains in practice. Although the rules were meant to control diseases related to sanitation and maintain spatial order, they failed to oversee the development of flood control drainage. Drainage development was perceived to be an exclusively government responsibility as it required huge funds even when the colonial actors inspected the planned areas and housing units.

Racial factor: intentionality in flood control neglect

Ethnicity influenced infrastructure provision in colonial Dar es Salaam, especially during British rule. The British upheld an explicit racial policy and backed it by segregationist legislation and practice. In water supply, for instance, one medical department report stated that "a piped supply of good water is provided for each house in the [European] residential area, to a considerable number in the [Asian] commercial zone, and to a few stand-pipes in

Accession no. 32575/2.

[67] Minutes of the Director of Medical Services Department meeting with Provincial Commissioner, 17 January 1952, TNA Accession no. 41949.

[68] United Kingdom, *Report on Tanganyika Territory to the United Nations for 1950* (London: Her Majesty's Stationary Office, 1951), 139.

[69] Public Health Ordinance, TNA Accession no. 450/518/4.

the [African] native town."[70] The British had read the German reports on flood-prone streets, including a report by the American sanitary engineer who had been hired by the Germans to study the drainage problem in Dar es Salaam.[71] They were also able to observe the situation themselves from the 1920s: "in parts of the Native Town, it was seen that water stood for longer periods owing to complete lack of any drain at all. Those natives who are unfortunate enough to possess plots in these positions are faced with ponds extending through their houses each time rain falls."[72] In spite of their better understanding of the area than their predecessors, the British chose either to turn a blind eye toward drainage issues or to deny the provision of drainage in African zones downright. In 1929, the Health Office for the township remarked on its inability to condemn buildings that had been built in flooded streets "as unfit for human occupation."[73] But when it came to addressing the drainage problems for the European zones as in the case of the golf course, the British wielded their power to ensure that drainage building or maintenance and repair were accomplished, even by using prison inmates as the labour force.[74]

When the British planned a comprehensive drainage system for Dar es Salaam in 1930-1932, the zones which they had in mind were those of the Europeans and Asians. The reports of the Medical Department from 1929 reveal that the targeted areas were the commercial bazaar because the plots were small, houses were packed and there was difficulty in finding spots for cesspits. The goal was to improve drainage of both sewage and storm water. The other area was the newly built area of Sea View. The two areas were part of Zones I and II, respectively. When the consulting engineers were commissioned to prepare the designs in 1931, they did not even care to survey the African areas. During the final building of the drainage system in 1952-1954, the African areas were still missing in the comprehensive drainage network, despite the fact that it had been revised to include newer areas and building costs had risen to almost £230,000.[75] In the provision of housing for the Africans in newer areas, the colonial officials maintained their double standard in infrastructure services. In a 1952 letter, to the Member for Development Works, concerning basic infrastructure building in the surveyed area of Magomeni, W. L. Rolleston, Commissioner for Development, stated that:

> Development should proceed in the logical order of underground services (water and sewerage), roads and buildings. No building should exist before services are instable. Although we can justly be criticized for allowing development in many

[70] Tanganyika, *Annual Report of the Medical and Sanitary Services Department for 1929* (Dar es Salaam: The Government Printer, 1930).
[71] Report by Dr. Orenstein on Dar es Salaam in TNA Accession no. 450/39/10.
[72] Health Officer to Provincial Commissioner, 1 November 1927, TNA Accession no. 61/247/1.
[73] Tanganyika, *Medical and Sanitary Services for 1929*, 49.
[74] Tanganyika, *Annual Report for the Medical and Sanitary Services Department for 1931* (Dar es Salaam: The Government Printer, 1933), 23.
[75] Dixon, "The Main Drainage of Dar es Salaam," 98.

> areas before adequate services are supplied, the Municipal proposals in this case are so Utopian as to make one inclined to withdraw the Government effort to African housing in Dar es Salaam and apply it elsewhere in the territory.[76]

The position of Rolleston not only contradicted that of the Municipal Council but also the architect of the Magomeni Housing Plan, who considered drainage infrastructure extremely important to make the place habitable, as well as to protect the roads from storm-water erosion and to control mosquitoes.[77] Thus, if one reads the official colonial correspondence only and ignores the annual reports from the critical colonial department, one is likely to get the false impression that the British were highly concerned with African interests and problems. The truth on the ground was quite the opposite; and the colonial records uncover contradictions among the colonial actors. Their concern for African infrastructure remained lip service at best.

Conclusion

Dar es Salaam is not the only city in the colonial world in which "spatial divisions and urban constructions helped to concretize the distinctions between colonial subjects." Dakar in Senegal is another instance.[78] However, the fact that Africans were unrepresented in the municipal governance and administration in Dar es Salaam meant that their voices were unheard by the key colonial actors. It is surprising that even *Kwetu*—an African-owned paper—did not raise the issue of flooding in African streets. As a result, colonial officials were able to continue ignoring the problem of flooding, because there were no registered and concrete protests from the people who were affected most.

This article has shown how urban roads and drainage infrastructure were largely inter-dependent technical systems in colonial Dar es Salaam. Roads were critical as a technology for modern mobility, especially motorised mobility. Their criticality was manifested when they were affected by floods, bringing transport services to a halt or when roads' cross-sections were damaged by water erosion. With the introduction of drainage systems, road vulnerabilities during flooding events were reduced or averted. The article has, however, not only shown how the vulnerability of roads and drainage are connected. It has also illustrated how mobility and health issues were connected. Perhaps unexpectedly to many readers, I have shown how drainage measures were, in the first instance, meant to control malaria and other diseases, rather than to improve mobility and traffic.

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[76] W. L. Rolleston to Member for Development Works, TNA Accession no. 32575/2.

[77] *Tanganyika Standard*, 20 June 1953.

[78] Caroline Melly, *Bottleneck: Moving, Building & Belonging in an African City* (Chicago and London: The University of Chicago Press, 2017), 30.

After decades of poor engineering practices, Tanzanian technical actors have learnt their lesson. In the twenty-first century, every newly paved road in Dar es Salaam is built with drainage structures. In many parts of the city today, the roads are tarmacked and have open surface, V-shaped drains. Some drains are up to five feet wide and four feet deep, close to the measurements suggested by the architect of the earliest open surface drains, the nineteenth-century British road engineer, Thomas Hughes.[79] Finally, then, modern infrastructure planning, especially road building, has begun to take the historic vulnerabilities of roads and criticalities of drainage infrastructure regarding flooding into account. The vulnerability and criticality of infrastructure in the Global South are not matters of planning alone, but also of the policies and practices of road engineering. Roads and drainage have become critical to each other, a system-based criticality,[80] which was intentionally underestimated a century ago in colonial cities like Dar es Salaam.

Although the past and present designs of urban road networks and drainage infrastructure in Dar es Salaam have uncovered colonial and postcolonial continuities in technology, this study has drawn some documentary evidence which reveals that there was also continuity in the flooding problem in the streets. Flooding continuity builds on the fact that the twenty-first century road engineers no longer build roads without drains. A century of flooding has provided them with a critical lesson that their roadworks are susceptible to flooding, erosion and silting if drains are not built concomitantly with roads. Drainage is now making roads more resilient to flooding, as well as to wear and tear. Researchers might want to investigate further how external events influenced postcolonial governments and engineers to develop a *proactive* road drainage policy, thus replacing the colonial *reactive* policies which were still employed during the first three decades of independence. These avenues of research will prove helpful in offering insights into drainage and road engineering intersections in the postcolonial Global South.

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The author has declared that no competing interests exist.

[79] Forbes, "Roads," 536.
[80] Lukitsch, Müller and Stahlhut, "Criticality," 17.

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