Irrigation Governance: A Case of Equitable Irrigation Access Across Tanzania

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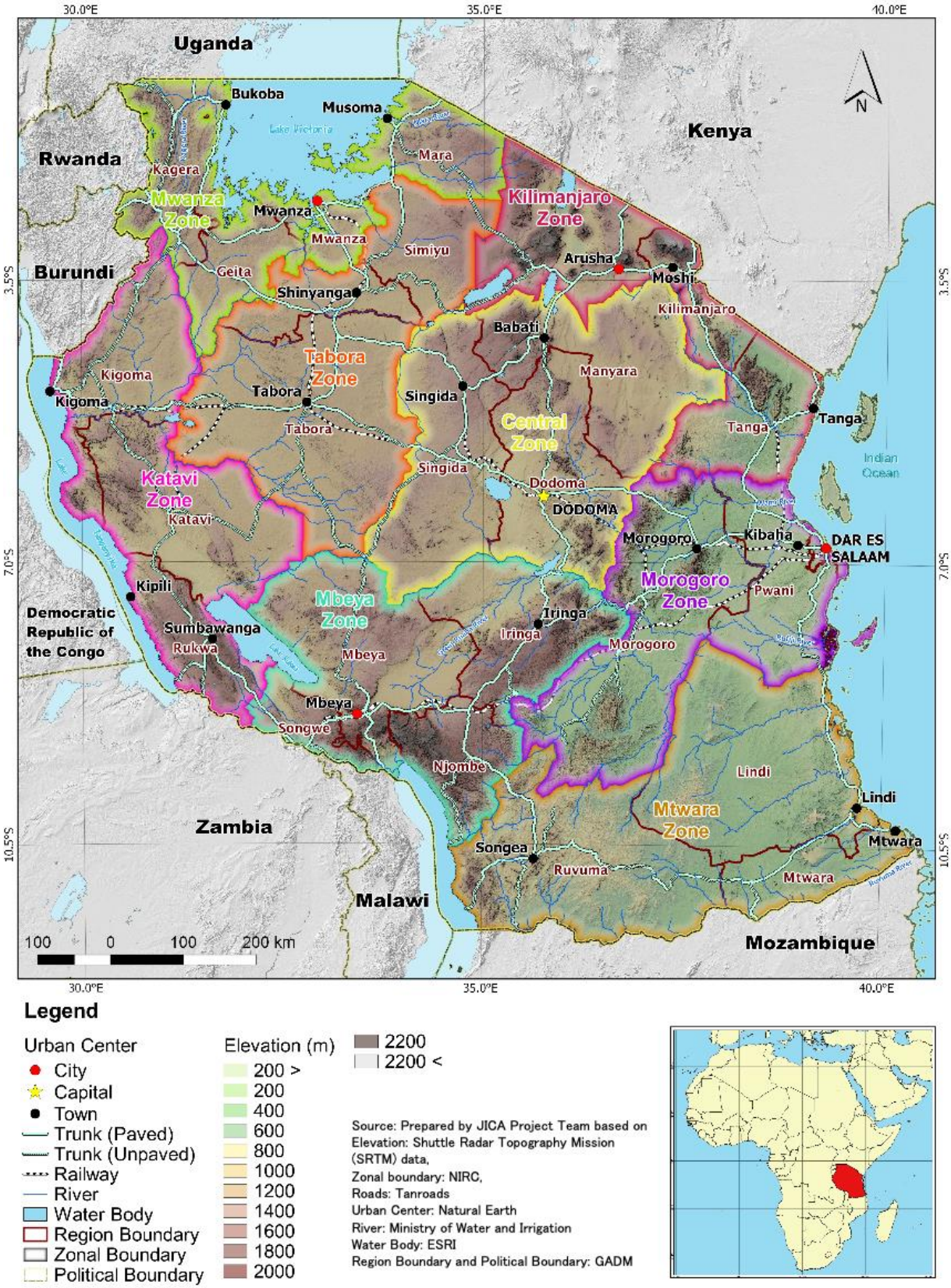
Map 1. Irrigation Zones Across Tanzania



Abstract

Irrigation is essential for agricultural crop transformation. In line with this, the African Union created the Comprehensive African Agricultural Development Programme to ambitiously ensure greater food self-sufficiency through water management or irrigation governance. Although current literature acknowledges the causal significance of governance for irrigation schemes' effectiveness, little scholarly work measures effectiveness as equitable irrigation access across East and Southern Africa. Thus, in this study, the influence of irrigation governance in determining the presence of equitable irrigation across Tanzania as a country located in East and Southern Africa is deductively investigated. Drawing from critical commons scholarship on irrigation schemes, irrigation governance modes, and institutions within irrigation governance alongside farmers' collective participation, this study focuses on irrigation scheme associations' collective participation and local state irrigation authorities' legitimisation. It's fundamentally hypothesised that irrigation governance is a determinant of equitable irrigation access through irrigation scheme associations' collective participation and local state irrigation authorities' legitimisation across Tanzania. Results from this study's deductive theory-testing process tracing reveal that though irrigation scheme associations and the National Irrigation Commission alongside the Ministry of Water and Irrigation are central within Tanzania's irrigation schemes, petition advocacy as an avenue of collective participation is absent. Therefore, future, inductive theory-building process tracing is needed to comparatively ascertain the causal mechanism underlying irrigation governance and equitable irrigation within Tanzania and beyond.

Keywords: irrigation governance, irrigation scheme associations, collective participation, state authorities' legitimisation, fair irrigation water distribution, equitable irrigation access, Tanzania

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> Freedom is not something one people can bestow on another as a gift but rather something that ought to be owned.
>
> — Francis Kwame Nkrumah, Ghanaian politician & pan-Africanist

Introduction

Irrigation is essential for agricultural crop transformation. The motive of this study stems from the African Union Comprehensive African Agricultural Development Programme's (CAADP) ambition to ensure greater food self-sufficiency in sub-Saharan Africa through irrigation governance (CAADP, 2024). Irrigation governance refers to the rules or institutions that determine the use and management of the system's resources by local users (Akuriba et al., 2020, p. 2). Irrigation schemes are systems that artificially provide a stable water supply for farmers to effectively cultivate crops for income (Higginbottom et al., 2021). Types of irrigation schemes range from sprinkler irrigation (high-pressure water through pipes), and drip irrigation (low-pressure through pipes) to furrow irrigation (water from mountain streams) and dams (large-scale water storage) (Valipour, 2014, pp. 370-373; Woodhouse et al., 2016, p. 216).

Across Tanzania (seen in *Map 1)* irrigation is highly prioritized, leading to an increase in the number of irrigation schemes by the National Irrigation Commission (Mdemu et al., 2017, p. 727). Despite this, there are accessibility problems – meaning the problem of ensuring equitable access stretches beyond technical irrigation itself. In line with this, Higginbottom et al. (2021) quantitatively identify governance effectiveness as a significant causal factor to irrigation schemes' effectiveness across sub-Saharan Africa. However, effectiveness is also measured by the land area covered as opposed to the extent to which equitable irrigation access is guaranteed to small-scale farmers. Thus, the influence of governance effectiveness on symmetrical irrigation access across farmers' proximity to upstream (head) or downstream (tail) irrigation schemes is absent (Manero et al., 2019; Ostrom & Gardner, 1993). Nevertheless, previous studies show that upstream farmers benefit from greater irrigation access than downstream farmers (Manero et al., 2019; Ostrom & Gardner, 1993).

Furthermore, Akuriba et al. (2020) and Bazin et al. (2017), qualitatively outline the significance of irrigation governance from the West Africa sub-region including Ghana, Burkina Faso, Mali, and Senegal. Both authors predominately measure the performance of irrigation schemes based on

economic returns or farmers' income levels but not equitable irrigation access as a main outcome. This study, therefore, aims to understand the influence of irrigation governance on equitable irrigation access in Tanzania, a country located in East and Southern Africa. Thus, this study's research question is *How does irrigation governance influence equitable irrigation access in Tanzania?*

To get to the answer, the single case study design is used to select Tanzania as a case and a variety of textual documents are examined using deductive theory-testing process tracing. Theory-testing process tracing is used to confirm or disconfirm confidence in the validity of this study's hypothesised causal mechanism that irrigation governance through irrigation scheme associations' collective participation and state authorities' legitimization leads to equitable irrigation access across Tanzania.

This study begins with a theoretical framework that uncovers relevant insights used to deduce a conceptual framework with a hypothesised causal mechanism. From there, the methodology and research design utilized to deductively test the influence of irrigation governance on equitable irrigation access and operationalise this study's hypothesised causal mechanism will be outlined. Subsequently, results from the empirical investigation of the hypothesised causal mechanism are systematically showcased and analyzed to confirm or disconfirm confidence in the validity of the influence of irrigation governance on equitable irrigation access across Tanzania. Whether confidence in the validity of the influence of irrigation governance is confirmed or disconfirmed provides implications and improvements for future research.

Theoretical Framework

Prior to formulating the hypothesised causal mechanism, existing theories regarding irrigation schemes, irrigation governance and collective participation for equitable irrigation access are critically discussed to guide the research of this study.

Irrigation Schemes as a Common Pool Resource

As a common pool resource, irrigation schemes such as the Usangu Basin (southwest Tanzania) institute spatial hierarchies, whereby farmers physically closer to schemes (upstream headenders) possess better and easier access to irrigation water resources than physically distant farmers

(downstream tailenders) (Machibya & Mdemu, 2005, p. 341; Mirhanoğlu, Loopmans & Özerol, 2021, p. 185; Ostrom & Gardner, 1993, p. 93). According to Elinor Ostrom & Roy Gardner (1993, p. 96) within large centrally built irrigation schemes, upstream farmers selfishly and rationally ignore the irrigation scarcity and limited irrigation access they generate for downstream farmers in the scheme. If upstream farmers attain most of the irrigation water resources, downstream farmers with insufficient irrigation access are less inclined to collectively contribute to the maintenance of the irrigation system (ibid). Effectively creating a provision problem in the irrigation scheme whereby the maintenance of an irrigation scheme is ineffective (p. 97). Moreover, an appropriation problem may develop whereby the allocation of water to crop production may be uneven (ibid). This occurs as downstream farmers' insufficient irrigation access may lead to irrigation water resources being distributed outside crop production but to farmers' other immediate needs (ibid).

Relatedly, irrigation schemes' non-excludability exacerbates inequitable irrigation access. The costs associated with designing and enforcing irrigation rights as rules or institutions limit collective action or participation to ensure equitable irrigation access (p. 93). Without adequate institutions, a coordination failure occurs, and inequitable irrigation provision remains pervasive. Thus, downstream farmers as rational selfish users are unlikely to solely contribute to maintenance if they bear the associated costs while non-contributing upstream farmers only benefit from maintenance without bearing any costs (ibid). Additionally, the amount of benefits irrigation upstream farmers can gain is unavailable to downstream farmers (p. 94). Therefore, upstream farmers' private gains outbalance downstream farmers' share of the resource leading to the "tragedy of the commons" whereby irrigation water is overused by upstream farmers at the expense of equitably benefiting downstream farmers (ibid).

However, as Anastasia Quintana & Lisa Campbell (2019, p. 1118) emphasise, a rational focus on irrigation schemes as a common pool resource merely outlines the effective use and collective management without paying attention to addressing structural access inequalities within irrigation schemes. To address these asymmetries, there is a need to acknowledge the political authority and ownership dynamics within irrigation governance (Akuriba et al., 2020, p. 2; Ribot & Peluso, 2009, p. 153).

Irrigation Governance

Irrigation governance comes in various modes. According to Charles Abernethy (2010, p. 39), irrigation schemes can be either authoritarian (state governance) or participatory (self-governance). On the one hand, state governance as in Gezira, Sudan (East Africa) is "top-down" whereby state authority determines the rules that govern irrigation access to users (p. 34). On the other hand, self-governance as in Chhattis Mauja, Nepal is "bottom-up" whereby local farmers as the authority actively resist state intrusion in their decision-making processes (p. 34). Abernethy's typology echoes Quentin Grafton's (2000, pp. 506 –507) modes of community-rights-based governance and state-rights-based governance. On the one hand state rights-based governance includes state ownership whereby states exercise direct authority over schemes to overcome coordination failures (p. 507). On the other hand, within community rights-based governance user communities' own irrigation schemes systems whilst utilising informal social norms and reciprocity for mutual benefits or reciprocity (p. 506). Despite the usefulness of these modes to reveal political ownership and authority structures within irrigation schemes, they have been empirically investigated outside sub-Saharan Africa with case studies in Nepal, New Zealand, India and Turkey.

Institutions within Irrigation Governance

Accommodatingly, adequate institutions are just as crucial to enable equitable irrigation access. Drawing from a study on the Nshara Furrow's (northeast Tanzania) indigenous irrigation governance, Mary Gillingham (1999, pp. 420 - 421) emphasises that informal institutions better highlight the real-life instruments used by farmers as users of irrigation schemes compared to top-down formal institutions. To be more explicit, Ben Cousins (1997, p. 61) differentiates that formal institutions are supported by the law whereas informal institutions are upheld by reciprocity or relations of power and authority.

Relatedly, despite the usefulness of structural-functionalist theory that highlights irrigation schemes' formal elements including maintenance, allocation of water and conflict management, the design of these elements often ignores the interests of farmers as irrigation users and omits informal institutions (Gillingham, 1999, p. 421). As similarly argued by Bazin et al. (2017), farmers' diverse irrigation requirements may not be sufficiently met by standardised formal institutions (Sikor & Lund, 2009, p. 5). Thus, drawing from institutional economics, informal institutions including modifications to formal institutions and social sanctioning norms enable

farmers as irrigation users to evade formal institutions (Gillingham, 1999, p. 421). In other words, while formal institutions intend to outline what ought to ideally occur, informal institutions reveal what occurs on the ground (ibid). Hence, to ensure equitable irrigation access, which is insufficiently provided by formal institutions, informal institutions enable farmers to re-negotiate their formal irrigation rights that better suit their heterogeneous interests (ibid).

Collective Participation for Equitable Irrigation Access

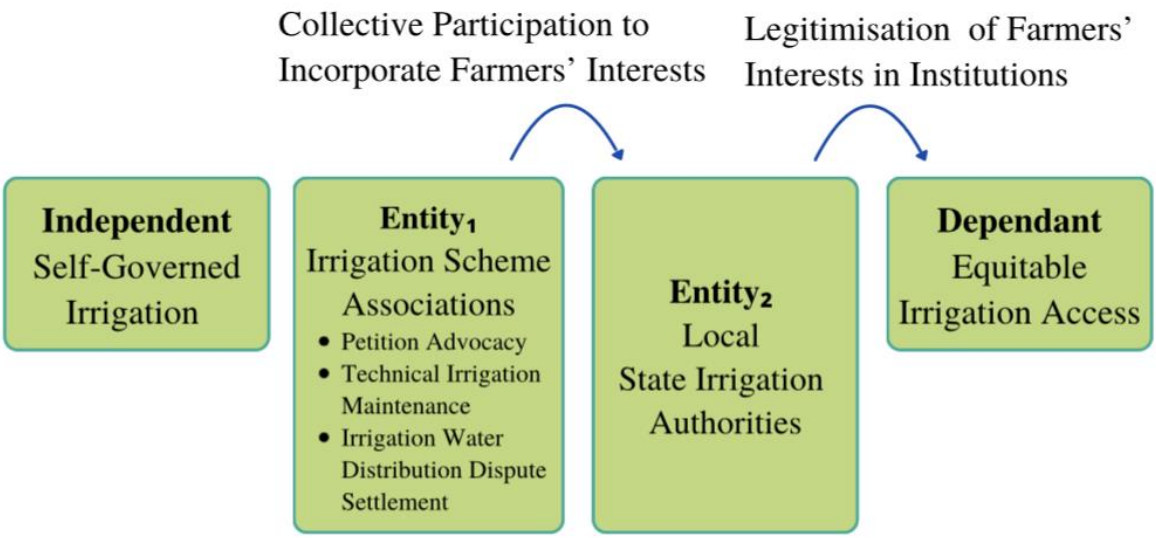
Given this study's emphasis on equitable access, participation as a dimension of participatory irrigation governance is chosen as scarce literature links collective participation with equitable access across Tanzania. In line with this, Joseph Kangile and Zena Mpenda (2019, p. 2122) outline that collective participation is critical to ensure equitable provision of irrigation through collaboration with more than two farmers. Moreover, drawing from Claudia Pahl-Wostl (2015, p. 235), this study focuses on farmers' collective participation within irrigation governance to enable the integration of farmers' beneficial formal and informal institutions. Farmers' engagement in decision-making and management as irrigation users enables them to influence their access to irrigation facilities more directly (Akuriba et al., 2020, pp. 4-6).

Across Tanzania, farmers self-govern irrigation schemes with collective participation through either irrigation associations or cooperatives (Kangile & Mpenda, 2019, p. 2122). On the one hand irrigation scheme associations are a group of farmers as irrigation users with direct leadership to enforce informal and formal institutions. They primarily address irrigation water distribution, operations, and maintenance (ibid). On the other hand, cooperatives are representative farmers that supply irrigation and govern irrigation schemes on behalf of their farmer members (ibid). They are mainly concerned with marketing activities in addition to the maintenance and operation of irrigation schemes (ibid). Considering this, the study's interest in equitable irrigation access from irrigation water distribution means the collective participation of irrigation scheme associations will be assessed.

Conceptually, collective participation is understood as actions taken by farmers as members of irrigation scheme associations to ensure equitable access (Rajan, 2014; van Zomeren, Leach & Spears, p. 181, 2012). Linked to this, equitable irrigation access is defined as the delivery of a fair share of irrigation water based on crop water requirements (Makaka, 2020, p. 32; National Irrigation Commission, 2013, pp. 7-8).

Conceptual Framework

Now that relevant existing theories have been discussed, a hypothesised causal mechanism is deductively established. Thus, this study predicts that *"Self-governed irrigation with irrigation associations' participation and local authorities' legitimisation ensures equitable irrigation access"*. There is high prior confidence in the expected causal mechanism due to extensive theoretical backing from existing theories (Beach & Pederson, 2019, p. 98)



Note. Adapted from Akuriba et al. (2020), Bazin et al. (2017), Beach & Pederson (2019), Kangile & Mpenda (2019), Gillingham (1999), Grafton (2000), Ostrom & Gardner (1993), Ribot & Peluso (2009), Sikor & Lund (2009)

Figure 2. Hypothesised Causal Mechanism

As illustrated above, self-governed irrigation schemes as the independent or explanatory variable are expected to causally ensure equitable irrigation access as the dependent or outcome variable. In other words, the presence of self-governed irrigation schemes determines the presence of equitable irrigation access across Tanzania.

For this to occur farmers' collective participation through irrigation scheme associations as an entity is necessary to incorporate farmers' heterogeneous interests for fair distribution of irrigation

water. In response, local state irrigation authorities as the second entity are expected to legitimise or reflect these interests within formal institutions to ensure equitable irrigation access (Sikor & Lund, 2009, p. 8). It is essential to note, as Grafton (2000) outlines, that self-governed irrigation does not annihilate the role of the state in shaping formal institutions for irrigation scheme associations. Hence, the state's role in shaping associations' actions is theoretically expected. This effectively eliminates prospects of reverse causality whereby the local state authority causally precedes irrigation scheme associations to ensure self-governed irrigation determines the occurrence of equitable irrigation access in Tanzania (George & Bennet, 2005).

Furthermore, as Alexander George and Andrew Bennett (2005, p. 11) emphasize, alternative explanations are important to prevent confirmation bias. Therefore, the influence of self-governed irrigation is theoretically expected to lead to equitable irrigation access through irrigation associations' incorporation of farmers' interests through different collective participation avenues. These are notably petition advocacy, technical irrigation maintenance and irrigation water distribution dispute settlement (Akuriba et al., 2020; Higginbottom et al., 2021). Irrigation water distribution dispute settlements are a response to externally or internally induced critical junctures including climate change within self-governed irrigation schemes. As outlined by the National Irrigation Commission (2018) external climate-induced water shortages or excess, and internal population growth may lead to irrigation water distribution disputes in need of resolutions or settlements. Within this context, irrigation water distribution dispute settlement is collective because disputes are resolved by irrigation scheme associations as opposed to external single arbitrators.

Additionally, this study's null hypothesis predicts that *"Self-governed irrigation with irrigation associations' participation and local authorities' legitimisation does not ensure equitable irrigation access"*. This occurs if any of the activities or entities within the hypothesised causal mechanism are absent.

Research Design and Methodology

Methodology and Justification

Theory-testing Process Tracing

To investigate whether irrigation governance is a determinant of equitable irrigation access, theory-testing process tracing is chosen as a suitable research method (Beach & Pedersen, 2019). Effectively enabling the presence and functioning of the expected causal mechanism between self-governed irrigation governance and equitable irrigation access to be deductively assessed. Specifically, this theory-centric research method will construct causal inferences by confirming or disconfirming confidence in the validity of the hypothesised causal mechanism (pp. 11, 14). Confirming or disconfirming depends on whether irrigation associations' collective participation alongside local state authorities' legitimization as the expected underlying causal mechanism between irrigation governance and equitable irrigation access are present accompanied by whether the mechanism functions as expected (p. 14). The measurement and observation parameters for collective participation and legitimization are explained later in the Data Analysis and Operationalisation section. Importantly, rather than tracing a series of events or narratives, this study aims to fundamentally trace the theorised causal mechanism between irrigation governance and equitable irrigation access (Beach & Pearson, 2019, p. 15). To do so effectively, relevant in-depth sources will be assessed to adjudicate whether the causal mechanism aligns more with collective participation in the form of petition advocacy, technical irrigation maintenance, and irrigation water distribution dispute settlement.

Case Selection: Typical Single Case

Empirically investigating the influence of irrigation governance requires a case study. In this study, Tanzania is chosen as a typical single case study to empirically test whether irrigation governance influences equitable irrigation access through the presence of associations' collective participation and irrigation authorities' legitimisation (Gerring, 2008, p. 647). As a typical case, it is suitable for theory-testing and highly representative of developmental states across sub-Saharan Africa (Gerring, 2008, p. 647; Halperin & Heath, 2020; Routley, 2014). Specifically, due to the economy's reliance on farmers' agricultural crop production, Tanzania encompasses numerous self-governed irrigation schemes with state efforts to enhance collective participation and local state authorities' engagement for greater irrigation effectiveness (Magoum, 2022; Namulondo, 2020). Additionally,

a developmental state provides a context whereby the hypothesised causal mechanism between irrigation governance and equitable irrigation access can function as predicted (Beach & Pederson, 2019, p. 11; Routley, 2014, p. 164). This is particularly due to the presence of capable political leadership in Tanzania committed to the construction and implementation of transformative formal institutions by a professional bureaucracy (Kayizzi-Mugerawa & Lufumpa, 2021, p. 6).

Data Collection: Purposive Sampling

To investigate the relation between irrigation governance and equitable irrigation access data collection from relevant sources is necessary. In this study, purposive sampling is employed for data collection whereby source selection depends on the types of evidence suitable to engage in this study's theory tests (Beach & Pederson, 2019, p. 132). Effectively, enabling the research question of how irrigation governance influences equitable irrigation access in Tanzania to be answered.

More precisely, sources were selected based on the presence of self-governed irrigation schemes in the form of "small-scale irrigation schemes". Furthermore, to ensure relevance to irrigation scheme associations' participation and local state irrigation authorities' legitimisation, sources were predominately chosen from Tanzania's National Irrigation Commission alongside the Ministry of Water and Irrigation. This guarantees the collection of relevant data because the National Irrigation Commission facilitates the formation of irrigation scheme associations and monitors their performance (National Irrigation Commission, 2015, pp. 9-10). Relatedly, their irrigation-related reports, acts, regulations and policies illustrate whether such documentation was driven by irrigation scheme associations and whether adjusted formal institutions within them are legitimised by local irrigation authorities (National Irrigation Commission, 2019). Additionally, the time frame for sources is 2013 and beyond, to capture modern trends within Tanzania's irrigation schemes after the ratification of the 2010 National Irrigation Policy which could not be publicly accessed online. All of this aligns with Beach and Pederson's criteria of reports and archival material as adequate sources to conduct theory-testing process tracing (pp. 134 – 143). Lastly, as an English speaker only English language documents are used compared to, for instance, similar official sources in Swahili.

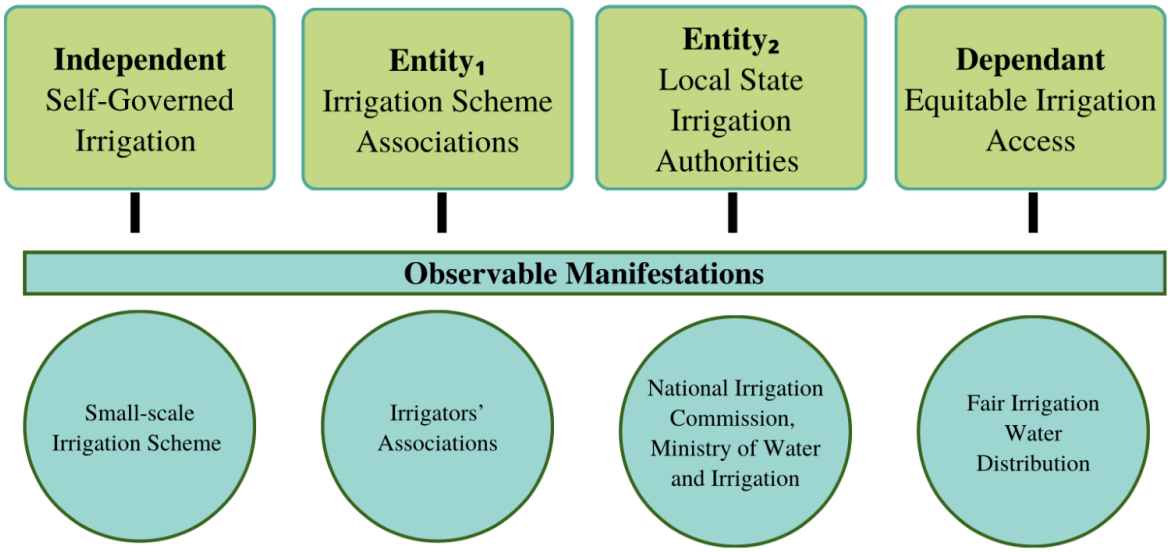
Data Analysis and Operationalisation

As mentioned beforehand, utilising theory-testing process tracing to analyse data from sources requires the operationalisation of conceptual elements within the hypothesised causal mechanism. These will enable the systematic assessment of whether the independent variable, causal mechanism and outcome variable manifest across Tanzania (Beach & Pederson, 2019, p. 34).

The operationalisation of all the conceptual elements from the expected causal mechanism are illustrated in *Figure 3* and *Table 1*. Drawing from Akuriba et al. (2020, pp. 4 –6) and Hassan Kiseto (2014, p. 11) collective participation is indicated by the presence of irrigators' associations, irrigators' associations' collaboration with local state irrigation authorities, irrigators' associations petitions, farmers' irrigation water fees and farmers' membership fees, and repair of irrigation facilities. Unlike water users' associations outlined in the 2009 Water Resources Management Act, irrigators' associations specifically focus on inequality within irrigation schemes (United Republic of Tanzania, 2009). Moreover, because irrigated land ownership is a prerequisite for farmers' membership to irrigators' associations, land inequality isn't investigated in this study (National Irrigation Commission, 2013). Rather, equitable irrigation access is indicated by adequate irrigation water distribution compared to the number of farmers as irrigation users (Akuriba et al., 2020).

Within publicly available sources identifying irrigation scheme associations and local state irrigation authorities requires flexibility. On the one hand, for irrigators' associations, scarce explicit centring on irrigators' associations means evidence relevant to all-encompassing irrigators' organisations is utilised as a proxy to draw observational implications. On the other hand, local state irrigation authorities are indicated by the presence of the National Irrigation Commission (NIRC) and the Ministry of Water and Irrigation (MoWI). These are supported by relevant local subnational authorities including Zonal Irrigation Officers, District Officers and River Basin Authorities. Finally, due to this study's inclination towards understanding self-governed irrigation schemes with irrigation scheme associations' collective participation, operation & maintenance reports alongside the irrigation facilities repair manual were chosen over, for instance, implementation reports and irrigation facilities rehabilitation manual (National Irrigation Commission, 2013).

Importantly, the deductive tests utilised assess the presence or absence of the causal mechanism's conceptual elements alongside its functioning. Effectively enabling the theoretical certainty of this study's hypothesised causal mechanism to be evaluated. A greater variety of tracing evidence (mere mention) for the variables and sequencing evidence (sequential occurrence) for the causal mechanism within data sources enhances the theoretical certainty of this study's expected causal mechanism (Beach & Pederson, 2019). Therefore, data within sources that fulfil the qualifying conditions with either trace or sequence evidence enables confidence in the validity of the hypothesised causal mechanism to be confirmed (Beach & Pederson, 2019, p. 105). Conversely, data that fails to fulfil the qualifying conditions disconfirms confidence in the validity of the hypothesised causal mechanism.



Note. Adapted from Kangile & Mpenda (2019), Beach & Pederson (2019)

Figure 3. Operationalisation of Hypothesised Causal Mechanism Variables and Entities

Table 1. *Operationalisation of Causal Mechanism Activities*

Causal Mechanism Activities	Tests	Qualifying Conditions
Irrigation Scheme Associations' Collective Participation to Incorporate Farmers' Interests	**Petition Advocacy** Did irrigation scheme associations jointly	• Evidence of petitions by irrigators' associations towards the National Irrigation Commission

	engage with local state irrigation scheme authorities through petitions? **Technical Irrigation Maintenance** Were there requirements for farmers within irrigation scheme associations to pay irrigation service fees, water fees, and maintenance costs? Did farmers sufficiently obtain irrigated water user permits? Did irrigation scheme associations engage in the repair of facilities inhibiting equitable irrigation access? **Irrigation Water Distribution Dispute Settlement** Were there apparatuses for irrigation water disputes arising from water shortage to be resolved by irrigation scheme associations?	alongside the Ministry of Water and Irrigation • Evidence of irrigation service feed, water fees and maintenance costs • Evidence of irrigators' associations' water distribution plan, crop calendars, water schedules etc. • Evidence of participatory efforts by irrigators' associations to repair damaged irrigation facilities inhibiting equitable irrigation access • Evidence of apparatuses for irrigation water distribution disputes by irrigators' associations and local subnational irrigation authorities amongst crop farmers, livestock farmers, out-growers etc.

Local State Irrigation Authorities' Legitimisation of Farmers' Interests within Institutions	Did regulations, policies, manuals, and acts decisions involve the facilitation of irrigation associations' decision-making? Were regulations, policies, manuals and act decisions on irrigation access made to ensure equitable irrigation access? Did regulations, policies, manuals and acts consider farmers' heterogeneous needs?	• Evidence of Integrated Water Resource Management which holistically engaged with all irrigation users in irrigation governance • Evidence of the National Irrigation Commission alongside the Ministry of Water and Irrigation objectives centered on equitable or fair irrigation access • Evidence of local subnational irrigation authorities in irrigation water distribution dispute settlement

Note. Adapted from Beach & Pederson (2019), Kangile & Mpenda (2019), National Irrigation Commission (2015), Ulriksen & Dadalauri (2016)

Quality Assurance: Sources, Measures of Fit, Generalisability

Quality within this study is assured in various ways. Firstly, the utilisation of eight in-depth sources ensures the reliability of the research due to the assessment of various irrigation regulations, policies, manuals, reports and acts (Halperin & Heath, 2020). These were filtered from an initial sample of twenty-six sources through the identification of key terms including "small-scale irrigation", "irrigators' association/organisation, "equity/fair/equitable/smooth/even", "participation", "water distribution", "operation & maintenance/repair", "water dispute/conflict". As elaborated by Frank Schimmelfenning (2014, p. 102), large amounts of data are necessary to dictate whether a causal mechanism exists within a case and if it functions as predicted. Therefore, lengthily immersion into sources is necessary to identify alternative explanations, pinpoint biases and gather diverse evidence (p. 102). Moreover, the availability of sources with explicit data related to the causal mechanism including the manual on Irrigation Water Distribution and Farmers' Participatory Irrigation Repair, ensures internal validity (Halperin & Heath, 2020).

However, due to the time constraints of this study, other publicly available sources including newspaper articles could not be analysed.

Secondly, Relatedly, the question of whether enough evidence is gathered to either confirm or disconfirm a hypothesis can be ambiguous (Schimmelfenning, 2015, p. 103). Dissimilar to statistical analysis or qualitative content analysis, process tracing does not employ independent units of analyses and a firmly defined number of observations (ibid). In line with this, the conceptual entities and activities within the hypothesised causal mechanism aren't comparable. Furthermore, the number of entities and activities included within a hypothesised causal mechanism can be understood to be arbitrary. Despite this, a wide array of sources has been selected for this study and the number of entities and activities included within this study's expected causal mechanism strictly adheres to Beach and Pederson's (2019, p. 15) illustration of theory-testing process tracing.

Lastly, given the operationalisation of the causal mechanism in Tanzania as a single case, Bennett and Checkel (2015, p. 13) outline that, generalisability can be problematic. The causal inferences that may be deductively drawn from the deductive testing ensure internal validity, however, external validity may be weak as inferences may not apply to a broader range of diverse cases outside East and Southern Africa (Schimmelfenning, 2015, p. 102). Simultaneously, it can be argued that the presence of the hypothesised causal mechanism across developmental states in sub-Saharan Africa can create complementarity whereby process tracing analyses can apply to congruent cases (Schimmelfenning, 2015, p. 104).

Research Results and Analysis

With the conceptual framework and research methodology in mind, theory-testing process tracing is conducted. Results from the methodology reveal how irrigation governance influences equitable irrigation access across Tanzania. Unlike theoretically hypothesised, irrigation governance fails to influence equitable irrigation access across Tanzania through irrigation scheme associations' collective participation and local state irrigation authorities' legitimisation. As showcased in *Table 2*, self-governed irrigation as this study's independent variable and equitable irrigation access as the outcome variable are empirically present across Tanzania. However, though technical irrigation maintenance and irrigation water distribution dispute settlement are present as avenues

of irrigation scheme associations' collective participation alongside the needed local state irrigation authorities' legitimisation are present across the country, petition advocacy is absent.

Table 2. *Summary of Results for Causal Mechanism Variables and Activities*

Causal Mechanism Variables		**Results**
Self-Governed Irrigation		Present
Equitable Irrigation Access		Present
Causal Mechanism Entities and Activities		**Results**
Irrigation Scheme Associations' Collective Participation to Incorporate Farmers' Interests	**Petition Advocacy**	Absent
	Technical Irrigation Maintenance	Present
	Irrigation Water Distribution Dispute Settlement	Present
Local State Irrigation Authorities' Legitimisation of Farmers' Interests within Institutions		Present

Self-Governed Irrigation and Equitable Irrigation Access

To begin, self-governed irrigation and equitable irrigation access are present across Tanzania. On the one hand, self-governed irrigation as this study's independent variable is present across the East and Southern African countries. In 2013, the National Irrigation Commission of Tanzania enacted the National Irrigation Act which outlines small-scale irrigation as one of the fundamental forms of irrigation schemes across the country alongside large-scale and medium-scale irrigation schemes (National Irrigation Commission, 2013, p. 27). Within small-scale irrigation schemes, the Act bestows responsibility for the technical maintenance of irrigation schemes onto the farmers as members of irrigation scheme associations (National Irrigation Commission, 2013, pp. 34-35). More recently in 2019, the National Irrigation Commission as a state irrigation authority committed the Comprehensive Guidelines for Irrigation Scheme Development to strengthening

small-scall irrigation schemes (National Irrigation Commission, 2019, p. 11). Similarly, Tanzania's Ministry of Water and Irrigation (MoWI) alongside the National Irrigation Commission outline irrigation water distribution planning and operation within the Water Distribution Manual exclusively for small-scale irrigation schemes (National Irrigation Commission & Ministry of Water and Irrigation, 2017). Lastly, in 2018 the MoWI and National Irrigation Commission revised previous versions of national irrigation strategies and established a renewed national irrigation master plan emphasising efforts to promote small-scale irrigation schemes to support local subnational irrigation authorities including Zonal Irrigation Officers (National Irrigation Commission et al., 2018, pp. 367, 385).

On the other hand, equitable irrigation access as this study's outcome variable is present across Tanzania. In 2017, the National Irrigation Commission released the Water Distribution Manual which underlines the importance of equitable irrigation access (National Irrigation Commission & Ministry of Water and Irrigation, 2017, p. 1).

Here, trace evidence for self-governed irrigation and equitable irrigation access is sufficient to ascertain the presence of the independent and outcome variables. This is due to the variety of sources mentioning either small-scale irrigation schemes or fair irrigation water distribution as the respective variables' observable manifestations. Moreover, these observable manifestations are within official documentation sources which reflects the existence of self-governed irrigation and equitable irrigation access nationally across Tanzania.

Despite this, the presence of both self-governed irrigation and equitable irrigation access alone does not enable the confirmation or disconfirmation of the hypothesised causal mechanism linking both variables. Hence, to assess confidence in the validity of this study's expected causal mechanism, the presence and function of irrigation scheme associations and local state irrigation authorities alongside their activities are deductively investigated.

Local State Irrigation Authorities' Legitimisation

Within Tanzania's self-governed irrigation schemes, as theoretically hypothesised, local state irrigation authorities, play a mutually constitutive role in ensuring equitable irrigation access (Grafton, 2000). While local state irrigation authorities' policies, manuals acts and guidelines actively legitimise and shape irrigation scheme associations' collective participation, revisions and

drafts reveal the National Irrigation Commission and MoWI legitimising farmer's heterogeneous interests. For instance, in the 2013 National Irrigation Act, the National Irrigation Commission mandates the responsibility of ensuring equitable irrigation access to irrigation scheme associations (National Irrigation Commission, 2013, pp. 40-41). Simultaneously, the MoWI's updating of the 2002 National Water Policy through the 2023 Draft National Water Policy recognises the strength of collective participation due to irrigation scheme associations' governance that ensures equitable irrigation access (Ministry of Water, 2023, p. 23). Therefore, not only is local state authorities' legitimisation present within irrigation schemes, but it also plays a mutually constitutive role by shaping and being shaped by irrigation scheme associations' activities.

Considering this, the empirical presence of local state irrigation authorities' legitimisation is ascertained by the sequence of evidence obtained from the 2013 National Irrigation Act and the 2023 Draft National Water Policy. Here, the background for local state irrigation authorities' publishing of these official documentation sources reflects the authorities' efforts to causally ensure equitable irrigation access. Moreover, the expected functioning of state irrigation authorities' legitimisation within the hypothesised causal mechanism is present due to the entity's bidirectional interaction with irrigation scheme associations. Thus, confirming confidence in the validity of local state irrigation authorities as an entity within this study's hypothesised causal mechanism. This will be further explored throughout the assessment of irrigation scheme associations' collective participation to incorporate farmers' interests within institutions.

Irrigation Scheme Associations' Collective Participation

Now that the causal validity of state irrigation authorities' legitimisation is clear, an assessment of irrigation scheme associations' collective participation is carried out.

Indeed, the National Irrigation Commission outlined in 2013 that irrigation scheme associations are mandated to prepare irrigation water schedules, collect irrigation service fees and resolve irrigation water distribution disputes experienced by irrigation scheme associations' members (National Irrigation Commission, 2013, pp. 53-54). This is effectively demonstrated by the MoWI and National Irrigation Commission in the Kilimanjaro Irrigation Zone (northeast Tanzania), whereby increased presence of irrigators' associations by "enhancing farmers' sense of ownership" through collective participatory irrigation (Mbowe & National Irrigation Commission, 2016, p.

31). Here, trace evidence for the presence of irrigation scheme associations is indicated by irrigators' associations within the 2013 National Irrigation Act as a nationally applicable formal institutional framework. Furthermore, sequence evidence of irrigation scheme associations' empirical contribution to equitable irrigation access in Kilimanjaro. Put together, both of this evidence confirm confidence in the validity of irrigation scheme associations as an entity within the hypothesised causal mechanism.

Nevertheless, whether all the collective participation avenues through which irrigation scheme associations ensure equitable irrigation access are present remains ambiguous. Hence, it is crucial to test whether petition advocacy, technical irrigation maintenance and irrigation water distribution dispute settlement as collective participation avenues vary in their empirical manifestations.

Irrigation Scheme Associations' Petition Advocacy

Firstly, petition advocacy as an avenue of collective participation by irrigation scheme associations is absent across Tanzania. Despite the participation of local community representatives including farmers on irrigation land for "stakeholder consultations" as Integrated Water Resource Management by local authorities for the 2018 National Irrigation Master Plan, trace evidence from sources observationally implies the absence of petition advocacy (Ministry of Water, 2023; National Irrigation Commission, 2018, p. 364). This is because sources lack trace evidence of irrigators' associations petitioning the National Irrigation Commission and MoWI to incorporate farmers' heterogeneous needs that secure equitable irrigation access. Thus, confidence in the validity of petition advocacy as an avenue of irrigation scheme associations' collective participation within this study's hypothesised causal mechanism is disconfirmed.

Irrigation Scheme Associations' Technical Irrigation Maintenance

Secondly, technical irrigation maintenance as an avenue of collective participation by irrigation scheme associations is present and causally functions as hypothesised. The 2023 drafting of Tanzania's National Water Policy underlines the essential role of irrigation scheme associations to amplify farmers' "awareness of water fees" and maintenance costs (Ministry of Water, 2023, pp. 23-24). Insufficient payment of water fees and maintenance costs makes it difficult for irrigators' associations to be self-reliant and fulfil their mandated responsibility of securing equitable distribution of irrigation water among its users as outlined in the National Irrigation Act (National Irrigation Commission, 2013, pp. 30-31). In line with this, as outlined the 2017 National Water

Distribution Manual specifically outlines that payment of water fees by farmers as members of irrigators' associations is crucial (National Irrigation Commission & Ministry of Water and Irrigation, 2017, p. 5). If these fees aren't paid, the irrigators' association is unable to consistently pay the irrigation water use permit fee to the River Basin Authority which ensures that irrigators' association remains registered (ibid). Relatedly, Tanzania's 2017 Water Distribution Manual emphasises the "rational" centrality of technical irrigation maintenance in ensuring equitable irrigation access by the irrigators' associations' water master, management sub-committee and water sub-committee (National Irrigation Commission & Ministry of Water and Irrigation, 2017, p. 1).

To be particular, the 2015 National Irrigation Act Regulations that accompany the 2013 National Irrigation Act, advance the preparation of an irrigation water distribution plan by irrigators' associations before the "commencement of a cropping season" (National Irrigation Commission, 2015, pp. 38-39). Here, irrigators' associations' management sub-committees or working groups employ water masters or gatekeepers, prepare "a water requirement budget", crop calendars, equitable irrigation water distribution based on farmers' heterogonous needs determined by irrigation land size area, and block system of irrigation water distribution (ibid). Complementarily, Tanzania's irrigators' associations receive further guidance from the National Irrigation Commission's 2019 Comprehensive Guideline for Irrigation Scheme Development: Operation and Maintenance. This lays out the necessity of cropping calendars alongside schedules of irrigation water distribution as critical to technically ensuring equitable irrigation access (National Irrigation Commission, 2019, pp. 77-78). For these to be beneficial, farmers as members of irrigators' associations ought to use irrigation water user permits that equip them to collectively ensure equitable irrigated water as demarcated by individual irrigators' associations' water distribution plans (National Irrigation Commission & Ministry of Water and Irrigation, 2017, p. 1). As an on-ground example, within the Kilimanjaro Irrigation Zone, farmers' enhanced sense of ownership as members of irrigators' associations led to greater collective willingness to contribute to the operation and maintenance fees required to ensure irrigators' associations' adherence to plans, calendars and schedules (Mbowe & National Irrigation Commission, 2016, p. 31). Clearly, diverse sources demonstrate the presence of technical irrigation maintenance by adequate reference to irrigation scheme associations' fees, and maintenance costs alongside the existence of water distribution plans and cropping calendars.

Moreover, repair of damaged irrigation facilities as integral to the technical maintenance of irrigation schemes is present across Tanzania. The existence of the 2013 Manual for Farmers' Participatory Work sufficiently fulfils the qualifying criteria of evidence required to ascertain the presence of the repair of damaged irrigation facilities inhibiting equitable irrigation access (Ministry of Water and Irrigation, 2013, pp. 3-4) technical maintenance of irrigation schemes. It is crucial to note, however, that the repair of irrigation schemes alone isn't committed and is rarely linked to ensuring equitable irrigation access. Rather, the repair of irrigation facilities despite its participatory nature primarily ensures the effectiveness of irrigation schemes rather than equity concerns within effectiveness.

Valuably, technical maintenance of irrigation as an alternative avenue of collective participation upholds irrigation scheme associations' autonomy as they actively shape plans, calendars and schedules legitimised by relevant local state irrigation authorities to ensure equitable irrigation access. For instance, the National Irrigation Commission and MoWI legitimise farmers' heterogeneous needs by the main objective of the 2017 Water Distribution Manual. The Manual's objective is not only to resolve instances of inequitable irrigation access but also to acknowledge that irrigation water can be "unfairly" distributed due to inadequate technical maintenance (National Irrigation Commission & Ministry of Water and Irrigation, 2017, p. 1). Therefore, from the perspective of these local state irrigation authorities, a "rationally prepared water distribution plan and proper maintenance" are essential (ibid). Within it, equitable utilization of limited irrigation water is non-negotiable, as deviating from established plans leads to inequitable irrigation access and "disputes amongst irrigation water users" (p. 5). To be optimal, farmers' collectivity within irrigation scheme associations is necessary (ibid.). Evidently, across Tanzania, the local state irrigation authorities bidirectionally legitimise irrigation scheme associations' technical maintenance as a form of collective participation.

Relatedly, local subnational District Officers and Zonal Irrigation Officers work with the MoWI and the National Irrigation Commission to review, irrigation scheme associations' assurance of fairness in irrigation water distribution for equitable irrigation access (National Irrigation Commission, 2015). This is outlined in the 2013 National Irrigation Act, 2015 National Irrigation Act Regulations, 2017 Water Distribution Manual alongside the 2019 Comprehensive Guidelines for Irrigation Scheme Development: Operation and Maintenance. According to these sources, local subnational District Officers and Zonal Irrigation Officers regularly review the supply and use of

irrigation water to ensure adherence to fair irrigation water distribution for equitable irrigation access (Ministry of Water, 2017; National Irrigation Commission, 2015; National Irrigation Commission, 2019).

By analysing all the mentioned relevant sources, confidence in the validity of technical irrigation maintenance as irrigation scheme associations' avenue for collective participation within this study's hypothesised causal mechanism is confirmed. Due to the high prior confidence in the hypothesised causal mechanism, the depth of trace and sequence evidence from sources fulfils the qualifying conditions for causality (Beach & Pederson, 2019). Not only is technical irrigation maintenance present across Tanzania, but it also functions as theoretically expected. Irrigation scheme associations' technical maintenance of irrigation schemes through repair, fees, plans, schedules, and calendars is accompanied by local state irrigation authorities' legitimisation.

Irrigation Scheme Associations' Irrigation Water Distribution Dispute Settlement

Finally, similar to technical irrigation maintenance, irrigation water distribution dispute settlement is present, and causally functions as hypothesised. Fundamentally it's important to note that irrigation schemes as constructions that artificially contour natural water resources create socio-economic competition among irrigation users (National Irrigation Commission, 2018 et al., pp. 373-374). Furthermore, notwithstanding the significant inequitable irrigation access between upstream and downstream farmers, it is paramount to acknowledge disputes between other irrigation users. This goes beyond Ostrom and Garnder's (1993) narrow illustration of equity contestation between only upstream and downstream farmers. As observed from this study's sources, upstream irrigated land areas may be owned by multiple farmers with varying access to irrigation access (National Irrigation Commission, 2018 et al., pp. 373-374). Additionally, Moreover, upstream and downstream out-growers, cultivating crops outside irrigation schemes from the schemes' natural water resource could disrupt fair irrigation water distribution for farmers within irrigation schemes leading to inequitable irrigation access (National Irrigation Commission & Ministry of Water and Irrigation, 2017, pp. 1-2). Lastly, disputes could occur due to the unfair sharing of irrigation water by livestock farmers and crop cultivation farmers (National Irrigation Commission et al., 2018, p. 25).

Considering this, although farmers as members of irrigation scheme associations may rationally adhere to technical irrigation maintenance, inequitable irrigation arising from natural water resource shortages is addressed by irrigation scheme associations' irrigation water dispute settlement. Despite downstream and upstream farmers' ownership of irrigation water use permits, climate-induced droughts may lead to downstream farmers ending up with a decreased amount of available irrigation water leading to social conflicts in the form of inequitable irrigation access. In anticipation of this irrigators' associations centrally facilitate dialogue between upstream and downstream farmers, arrange communication with water masters, and adopt water-efficient cropping patterns (National Irrigation Commission et al., 2018). As recognised in the 2017 Water Distribution Manual, irrigators' associations are in the right position to do so due to their ability to ensure unity among farmers (National Irrigation Commission & Ministry of Water and Irrigation, p. 2). This is convincingly evident within the Minepa irrigation scheme in the Morogoro Irrigation Zone (eastern Tanzania) whereby irrigators' associations a participatory water distribution manual to address water shortages from dry crop seasons (National Irrigation Commission et al., 2018, pp. 325-326). In correspondence to this, in the 2019 Comprehensive Guidelines for Irrigation Scheme Development: Operation & Maintenance, irrigation scheme associations are suitable to handle irrigation water distributional disputes (National Irrigation Commission, 2019, pp. 22 - 23).

To be specific, irrigation scheme associations settle irrigation water disputes through irrigators' associations water masters and irrigation block leaders. Water masters ensure fair irrigation water distribution in collaboration with irrigation block leaders as outlined in Tanzania's Water Distribution Manual (National Irrigation Commission & Ministry of Water and Irrigation, 2017, p. 40). According to the Manual, water masters operate as gatekeepers along a main irrigation canal – in the case of irrigation water shortage or excess in an irrigation land area, the water master adjusts the distributed amount of irrigation water across different irrigation land areas (ibid). Thus, water masters close the "gap between rational calculated equitable water requirements and the on-the-ground requirement" influenced by climate shifts and increasing population growth (ibid). The adjustment of distributed irrigation water enables irrigators' associations to incorporate farmers' heterogeneous needs even as they vary due to water shortages (ibid). Supplementarily, irrigation scheme block leaders resolve equity issues among farmers' irrigation blocks by facilitating discussions amongst the irrigators' associations' water sub-committees and water master (pp. 42 – 43). Clearly, the presence of irrigation water dispute settlement is present due to the existence of nationally applicable institutional apparatuses designed to resolve irrigation water disputes.

Concerning local state authorities' legitimisation, the National Irrigation Commission and MoWI actively institutionally acknowledge the pre-eminent role of irrigation scheme associations within irrigation water dispute settlement whilst emphasising the imminent eruption of distributional disputes due to climate change as a critical juncture. In the 2018 National Irrigation Master Plan, the National Irrigation Commission and MoWI predict drier conditions leading to heightened water shortages. Despite these, irrigation scheme association's collective participation is positioned as an adequate remedy for equitable irrigation access (National Irrigation Commission et al., 2018, p. 384). Relatedly, subnational irrigation authorities, notably District Officers step in to support state irrigation authorities' legitimization. As laid out in the 2019 Comprehensive Guidelines for Irrigation Scheme Development: Operation and Maintenance, water shortage in more than one irrigation scheme across the same river requires the Officers' engagement with the water master (National Irrigation Commission, 2019, pp. 4-7). Similarly, the River Basin Authority engages with the irrigators' association's water master to settle irrigation water disputes between upstream and downstream irrigation users if upstream intake is permanently worse than downstream intake (p. 3). Evidently, local state irrigation authorities' legitimisation of irrigation scheme associations' collective participation through distribution dispute settlement is mutually bidirectional across Tanzania.

By analysing all the mentioned relevant sources, confidence in the validity of irrigation water distribution dispute settlement as irrigation scheme associations' avenue for collective participation within this study's hypothesised causal mechanism is confirmed. Due to the high prior confidence in the hypothesised causal mechanism, the depth of trace and sequence evidence from sources fulfils the qualifying conditions for causality (Beach & Pederson, 2019). Not only is irrigation water distribution dispute settlement present across Tanzania, but it also functions as theoretically expected. Irrigation scheme associations' irrigation water distribution dispute settlement through apparatuses including the water masters and irrigation block leaders is accompanied by local state irrigation authorities' legitmisation.

Conclusion and Reflection

Overall, though self-governed irrigation schemes and equitable irrigation access are present across Tanzania this study fails to confirm that it is because of the presence and functioning of irrigation scheme associations' collective participation and local state irrigation authorities' legitimisation.

The absence of petition advocacy fundamentally disconfirms confidence in the validity of this study's hypothesised causal mechanism. Specifically, irrigation scheme associations' collective participation through technical irrigation maintenance and irrigation water distribution dispute settlements are unlikely to ensure equitable irrigation access without irrigation scheme associations' petition advocacy. Thus, in line with this study's null hypothesis self-governed irrigation with irrigation scheme associations' participation and local state authorities' legitimisation does not ensure equitable irrigation access across Tanzania.

Breaking it down, technical irrigation maintenance is empirically implied by farmers' mandated fees and costs to ensure the effective functioning of irrigation scheme associations comply with their institutional mandate to ensure equitable irrigation access. Interrelatedly, irrigation water distribution dispute settlement is empirically implied by the role of irrigation scheme associations' water masters and block irrigation leaders. Both avenues are followed by Tanzania's National Irrigation Commission alongside the Ministry of Water and Irrigation as local state irrigation authorities, mutually legitimising farmers' interests within formal institutions. Despite this, the occurrence of stakeholder consultations does not equate to petitions required to verify the presence of petition advocacy across Tanzania. Hence, the absence of petition advocacy as an avenue of irrigation scheme associations' collective participation disconfirms confidence in the validity of this study's hypothesised causal mechanism.

Reflecting upon this, the availability of relevant data within high-level documentation sources guaranteed a thorough testing of an underlying causal mechanism between irrigation governance and equitable irrigation access. However, the use of irrigators' organisations as a proxy for irrigators' associations undermines the internal validity within this study as an explicit empirical focus on irrigation scheme associations is omitted. Alternatively, Moreover, analysis of a strategic social and environmental assessment of an irrigation scheme specifically governed by irrigation scheme associations would have enhanced greater internal validity. Similarly, considering this study's confirmation of its null hypothesis, theory-building process tracing with comparative cases (Botswana, Zambia) would enable an inductive investigation to accurately ascertain the causal mechanism underpinning irrigation governance and equitable irrigation access across East and Southern Africa (Beach & Pederson, 2019).

Looking into the future, in-depth case studies on Tanzania's irrigation zones could demonstrate whether equitable irrigation access is homogenous across the East and Southern country with an

explicit emphasis on informal institutions (Gillingham, 1999). Moreover, the other factors including Tanzania's socialist political ideology and the moral economy could be assesed as linking determinants of equitable irrigation access (ElDidi & Corbera, 2017). Last but not least, given this study's contemporary time frame, a historical analysis of the emergence of irrigation governance within Tanzania and beyond could draw light on whether equitable irrigation access organically originated from farming citizens' interests or is a product of demands from international financial irrigation development donors.

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Appendix A – List of Empirical Sources

	Link	Source (Year)	Author (s)	Pages	Summary
1	https://www.nirc.go.tz/uploads/publications/en1566219752-VOLUME%203%20FINAL%20CGL%202019%20May.pdf	Comprehensive Guidelines for Irrigation Scheme Development: Operation and Maintenance (2019)	NIRC & JICA	104	Guide for irrigation scheme associations on preparing and monitoring ' irrigation water distribution
2	https://www.maji.go.tz/uploads/files/DRAFT%20NATIONAL%20WATER%20POLICY%202023%20.pdf	Draft National Water Policy (2023)	MoW	57	Emphasises good governance for equitable irrigation water distribution
3	https://www.nirc.go.tz/uploads/publications/en1528450695-National%20Irrigation%20Regulations%202015.pdf	National Irrigation Commission Act 2013, Irrigation Regulations (2015)	NIRC & Parliament of the United Republic of Tanzania	96	Outlines the role of irrigation scheme associations in the governance of irrigation schemes
4	https://www.nirc.go.tz/uploads/publications/sw1566294701-Water%20distribution%20manual%20V1-converted.pdf	Manual for Water Distribution in Irrigation Schemes (2017)	NIRC & MoWI	83	Handbook aiming to secure fair irrigation water distribution through the engagement of irrigation scheme associations' execution of a rational irrigation water distribution plan

5	https://www.nirc.go.tz/uploads/publications/en1542515670-National%20Irrigation%20Master%20Plan%202018%20Volume%20I%20Main%20Report.pdf	Revision of National Irrigation Master Plan Main Report (2018)	NIRC, MoWI & JICA	479	Investigates climate change concerns in irrigation water distributional disputes whilst proposing mitigation measures for irrigation scheme associations
6	https://www.nirc.go.tz/uploads/publications/en1585297337-ActNo-4-2013-Irrigation%20Act%20Tanzania.pdf	The National Irrigation Act 2013 (2013)	NIRC & Parliament of the United Republic of Tanzania	57	Conceptualisations of the roles and responsibilities of irrigation scheme association's local state irrigation authorities, and local subnational irrigation authorities
7	https://floodbased.org/wp-content/uploads/2021/05/An-overview-of-irrigation-development-in-Kilimanjaro-zone.pdf	Overview of Irrigation Development in Kilimanjaro Zone (2016)	MoWI & NIRC	48	Highlights the examples of participatory irrigation development, the willingness of farmers to engage in communal works, and farmers' contribution to irrigation schemes' operation and maintenance fees

8	https://www.nirc.go.tz/uploads/publications/en1566213371-Manual%20for%20Farmers%E2%80%99Participatory%20Repair%20Work.pdf	Manual for Farmers' Participatory Repair Work of Irrigation Facilities (2013)	MoWI & JICA	73	Handbook with repair know-how for irrigation scheme associations to enhance operation and maintenance by self-reliant repair works of damaged irrigation facilities

Note. National Irrigation Commission (NIRC), Japanese International Cooperation Agency (JICA), Ministry of Water (MoW), Ministry of Water and Irrigation (MoWI)