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Common-Pool Resource Management and Conflict Resolution: A Case Study of Two Self-Governed Irrigation Schemes in Ntcheu, Malawi

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COMMON-POOL RESOURCE MANAGEMENT AND CONFLICT RESOLUTION: A CASE STUDY OF TWO SELF-GOVERNED IRRIGATION SCHEMES IN NTCHEU, MALAWI

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Abstract

Contrary to conventional common-pool resource (CPR) theory – where it is presumed that strong central states must be the primary actors in regulating the commons – self-governed CPR theory is a method that enables the appropriators themselves to be the primary actors in designing and managing a given CPR. Irrigation systems are one on the most common examples of CPR sharing. Using Elinor Ostrom's theory on self-governed CPR management and her Eight Design Principles, I examine the mechanisms by which two neighboring small-scale irrigation schemes in rural Malawi manage and govern common-pool water resources to contrast intra-scheme functions and the presence or absence of inter-scheme conflict and collaboration. I discuss how Elinor Ostrom's design principles should be critically examined, especially in contexts where CPR arenas have limited to no coordination or oversight from external authorities. I elaborate how these schemes have a top-down governance approach, thus, local agriculture offices should organize schemes to introduce more democratic bottom-up reforms. Even in these setting where appropriators are generally homogenous, I demonstrate how appropriators from both schemes often avoid conflict and collaboration. Ultimately, this study demonstrates the coordination opportunities amongst neighboring schemes and local external authorities; specifically, in market integration, crop diversification and joint-scheme capacity building so other self-governed irrigation schemes can be more resilient to climate change, combat food insecurities and have enhanced conflict-resolution tools for self-governed water systems in rural Malawi.

Keywords: Common-pool resource (CPR), common-pool resource management (CPRM), rural Malawi, irrigation, self-governed irrigation schemes, conflict resolution, Elinor Ostrom's Eight Design Principles

Common-Pool Resource Management and Conflict Resolution: A Case Study of Two Self-Governed Irrigation Schemes in Ntcheu, Malawi

In this research I examine the nature of irrigation resource management and conflict resolution within and between neighboring small-scale irrigation schemes in rural Malawi. I explore the mechanism by which two schemes, Chauluka and Kamwaza in the Ntcheu District, manage and govern common-pool water resources to contrast intra-scheme functions and the presence or absence of inter-scheme conflict and collaboration. This research contributes to the wider understanding of the commons, presenting a case study of how small-scale common pool irrigation systems operate in a Malawian context. It contributes to the existing literature, expanding the understanding about the conditions where such governance is more likely to be adopted from a rural agricultural perspective. The broader impacts of this work include identifying how the appropriators and the governance structures may best implement common-pool resource design conditions to increase resiliency to climate change, reduce food insecurity, and adopt conflict resolution mechanisms most appropriate for rural common-pool resource arenas.

Malawi is a predominant agrarian economy and pressures from climate change, food insecurity and population growth has encouraged the Malawian government to invest in irrigation technologies (Nkhoma & Mulwafu 2004; Ferguson & Mulwafu 2007; McNulty et al. 2016). In 2000, the Malawi government rolled out its first National Irrigation Policy and Development Strategy (JICA 2022). Yet, on only four-percent of the cultivated land have farmers adopted irrigation technologies with roughly ninety percent of agricultural production is entirely reliant on rain-fed systems (Osiemo & Kalumo, 2018, p.1). In 2016, they released a National Irrigation Policy (NIP) which aims at addressing “critical issues affecting the irrigation

sector that include spatial and temporal water shortages; customary land tenure disputes; and, poor operation and maintenance of infrastructure" (NIP, 2016, p.ix).

Common-pool resources (CPRs) are commonly defined as, "finite resources that one users' extraction of that resource has an impact on another user's availability to that same source" (Ostrom, 2002, p.1317). Irrigation schemes are one of the most common examples of CPR management (CPRM). Effective implementation of self-governed irrigation systems has been proven to be a prosperous method for establishing community-based environmental management, as the methods enable the appropriators themselves to be the primary actors in designing and managing the common-pool resource (Ostrom 2002; Schlager 2004). This research draws heavily on Elinor Ostrom's (1990) Eight Design Principles, which has been widely considered the essential conditions needed for robust CPR institutions to support long-term cooperation and coordination in CPR arenas. Self-governed CPRs are described as institutions autonomous from most governmental or external authorities. This then requires actors involved to design and adapt rules that effect the sustainability, distribution, management, conflict-resolution, and obligations of that resource (Ostrom, 2002, p.1317). This concept diverges away from the previous held belief that only a strong central government have the resources and expertise to properly address the issues of natural resource degradation and CPR sharing (Schlager, 2004, p.148).

Local Setting

This research was conducted in the central-western edge of the Ntcheu district that boundaries along the Malawi/Mozambique border (*figure 1*). The study area focuses on two neighboring irrigation schemes on the eastern side of the Kirk Mountain Range of the Lower Njolomole Traditional Authority, within the Ntcheu District. The region is semi-arid and is

separated by two seasons – dry and wet. The dry season is divided by the "dry-cool" period (May to August) and the "dry-hot" period (September to October). The wet season is divided by the "wet-hot" period (November to January) and the "wet-cool" period (February to April).

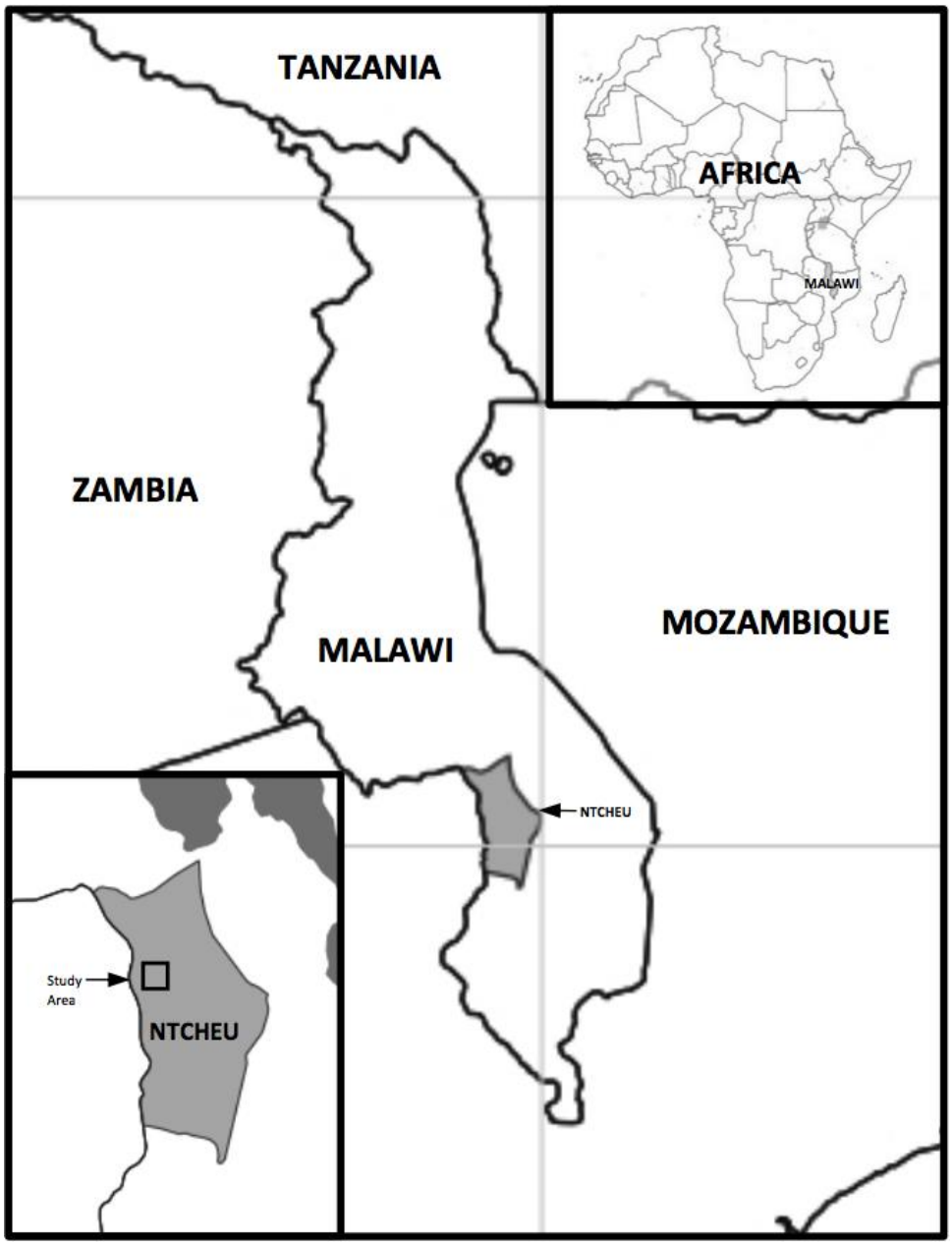

Figure 1: Map of the study area.

The study area is historically Ngoni ethnic land. People often identify as Ngoni, yet the majority of people speak the national language, Chichewa (Lanning, 2016, p.148). Composition

of ethnic groups differ, however the dominant ethnic group in the region is Chewa people practicing Christianity (Makwemba et al, 2019, p.30). The study area is reflective of the dominant matrilineal Chewa cultural identity where lineage-based landholding systems and property are tied and passed down to the women (Berg, 2014, p.62).

Expansion of agriculture, rising population pressers, tied with a large demand for firewood and charcoal has resulted in most of the natural trees being cut down (Ngwira & Watanabe, 2019, p.2). The remaining trees are mostly used for agriculture purposes – mango and acacia trees (*Msangu*). The impact of charcoal is partly associated with limited economic livelihood alternatives (Smith, 2017, p.1) and for cooking Malawi's maize-based staple food (*nshima*) – characterized as hard porridge. The absence of trees in the Kirk range has resulted in massive eroded gullies that extend to communities.

In the study area, smallholder agriculture is the main source of economic livelihood – representative of the broader Malawian and southern African regional practices (Lanning, 2016, p.159). The participants targeted from the rural communities rely on small-scale farming, mostly rain-fed agriculture practices. Some households in the valleys and hillsides along the Kirk range use gravity-fed or riverside irrigation to supplement the rainy season harvest, "either in formally organized community irrigation schemes or in private wetland fields (*dimba*) – irrigating with foot pumps or watering cans" (Lanning, 2016, p.159). Both schemes included in this research practice gravity-fed irrigation systems. Gravity-fed irrigation systems are trenched or piped canals dug from the mountains hillside to divert water from a source river into to their respective schemes (*see Appendix B, C, M & N*). From the sampled participants (*n=48*), the most common crops cultivated are beans, sweet potatoes, and maize. Surplus crops are used to be sold at local or major markets.

There are two local markets in proximity from the study, Masamba and Kandeu. There are three major markets located along the M1 highway – Mlangeni, Tsangango, and Ntcheu. The M1 shapes the western border with Mozambique. Sometimes, farmers hike 300 meters up and eight kilometers across the Kirk Range to sell at Mlangeni. Transportation to these markets would either require public transportation (in truck beds or minibus taxis) or a push bike.

Chauluka Irrigation Scheme

Chauluka irrigation scheme was established in the year 2000 and was one of various other small-scale irrigation schemes that was promoted by the Malawian Government (Mulwafu, 2015, p.13). Farmers divert water from the Mponda River to their scheme during the dry season. The scheme began with thirteen male members and has grown to 130 – 73 women, and 57 men. The total land area is 52 hectares. The scheme has a committee of ten (three women, seven men) which are responsible for enforcing rules and regulations, monitoring scheme members, and managing scheme funds. In 2006, member farmers from Kamwaza village working at Chauluka irrigation scheme were mandated to transition to their own newly-establish irrigation scheme in the hills of Kamwaza Village. This was partly a consequence of an intra-scheme member dispute that was resolved by the Njolomole Traditional Authority. The result shaped the founding of the Kamwaza irrigation scheme.

Figure 2: (East) The main irrigation canal of Chauluka Irrigation Scheme.

Kamwaza Irrigation Scheme

Kamwaza irrigation scheme was established in 2006 with thirteen members and has grown to a membership of 60 – 48 women and 12 men. Once a Kamwaza village member was able to divert water from the Mbirimbite River, CARE Malawi, a non-governmental organization, assisted Kamwaza farmers to build and design their own canal. The exact total land area of Kamwaza was not clearly provided. The scheme has a committee of ten (four women, six men) who are also responsible for enforcing rules and regulations, monitoring scheme members, and managing scheme funds.

Figure 3: (East) The main canal of Kamwaza Irrigation Scheme.

This research specifically examines the mechanisms by which these two schemes manage and govern common-pool water resources to contrast intra-scheme functions and the presence or absence of inter-scheme conflict or collaboration. This contributes to the limited understanding of how CPR irrigation institutions are governed from a rural Malawian context. This work offers CPR users, local resource partners and policy-makers alike, a more complete understanding about the conditions where such governance is more likely to be adopted and what is needed to have more robust, sustainable systems.

Literature Review

In this review I draw on direct literature by Elinor Ostrom (1990, 2002) and others (Gordon 1954; Olson 1965; Hardin 1968; Schlager 2004) on developing CPR theory. It is organized into the following sections: the evolution of CPR theory; CPR irrigation management in practice; gender, agriculture and climate change; followed by conflict and natural resource governance. This review portrays why self-governing CPR systems exist and what institutions are necessary in settings where resource management is mostly autonomous from external authorities.

In conventional theory, it is presumed that external authorities need to be the primary actors in establishing rules on appropriators for best CPR practices. Ostrom (2002) states:

> In such systems, it is assumed that the resource generates a highly predictable, finite supply of one type of resource unit (one species, for example) in each relevant time period. Appropriators are assumed to be homogeneous in terms of their assets, skills, discount rates, and cultural views. They are also assumed to be short-term, profit-maximizing actors who possess complete information. In this theory, anyone can enter the resource and appropriate resource units. Appropriators gain property rights only to what they harvest, which they then sell in an open competitive market. The open access condition is a given. The appropriators make no effort to change it. Appropriators act independently and do not communicate or coordinate their activities in any way (p.1318).

This differs to the self-governed CPR model, where the appropriators themselves design and adapt design principles to manage and use such resource (Ostrom, 2002, p.1324). Ostrom (2002) explains:

> A self-governed common-pool resource is one where actors, who are major appropriators of the resource, are involved over time in making and adapting rules within collective-choice arenas regarding the inclusion or exclusion of participants, appropriation strategies, obligations of participants, monitoring and sanctioning, and conflict resolution (p.1317).

In order to understand how CPRs are organized and governed, Ostrom's book, *Governing the Commons* (1990), explains some basic definitions to distinguish, specifically resource system and resource units, and their dependence of one another. Resource systems refer to the "stock variables that are capable, under favorable conditions, of producing maximum quantity of flow variable without harming the stock or the resource system itself" (p.30). Examples include irrigation canals, lakes, fisheries, and forests. Resource units are what the individuals or appropriators use from the resource system (p.30). Examples include acre feet or cubic meters of water withdrawn from an irrigation canal or tons of fish harvested from the ocean. The term "appropriator" is defined as those who withdraw resource units. Ostrom (1990) explains that it is essential to distinguish between these two concepts as its relationship defines if appropriators are behaving in a manner that is sustainable. As long as the average rate of withdrawal from appropriators does not exceed the average rate of replenishment, a shared resource can be sustained (p.30).

The Evolution of Common-Pool Resource Management: Conventional Theory (1950's-1970's)

Literature began to emerge in the 1950's on how environmental mismanagement was impacting the commons. H. Scott Gordon's book, *The Economic Theory of Common-Property Resource: The Fisheries* (1954), published a theory on individual rationality of the commons. Gordon (1954) considers how the "open access nature of fisheries ultimately leads to the depletion of fisheries, as fisherman do not attend to the costs that they impose on other fisheries" (p.125). The over-exploitative nature of the appropriators are considered inherently self-interested, profit-maximizing actors, that could drive fishery commons to become biologically and economically unviable (Gordon, 1954, p.124). He was one of the first to consider that unregulated exploitation of the commons by private parties was not sustainable and sustainable methods could only be performed by commons that were either owned by the government or private property owners, where users where subject to "unified directing power" (Gordon, 1954, p.135). This is considered a catalyst to the acknowledgement of "the tragedy model of the commons" scenarios.

Around the same time Gordon's work was being published, game theory was emerging into academic discussions, which at its core states that the "game pits individual rationality against collective rationality as each of the participants chooses his or her actions independently of one another" (Schlager, 2004, p.147). Similar to Gordon, game theory suggests that the behavior of human beings is driven by perceived costs and benefits – in the game of global natural resource management, "the stakes are sustainable natural resource use and the playing field is our planet" (Dodds, 2005, p.1). It was argued that there always will be users that behave selfishly or cheat in the commons, and as the resource becomes more scarce, the benefits to

cheating become more rational (Dodds, 2005, p.1). This then traps rational decision-making of the commons in this self-interested, overexploited nature.

Through this, theories of collective action started to emerge, prominently Mansur Olson's, *Theory of Collective Action* (1965). Olsen was trying to explore conditions where cooperation was more likely to occur, yet his conclusions partly reiterated previous models, stating, "unless the number of individuals are quite small, or unless there is coercion or some other special device to make individuals act on common interest, rational, self-interested individuals will not act to achieve their common or group interest" (Olsen, 1965, p.2). These terms of group size and heterogeneity in managing CPRs have also been addressed as challenges in governing or managing CPRs, particularly in larger nested enterprise systems.

The existing theories surrounding rational decision-making of CPRs led to Garrett Hardin's influential thesis of the, *Tragedy of the Commons* (1968). Hardin (1968) argued that "overpopulation will stress ecosystems beyond their limits and cause a resource catastrophe" (p.2). Like academics before him, Hardin assumes that individuals are inherently self-interested and the commons well-being will be neglected and ultimately depleted in the pursuit of appropriators personal gain. In his thesis, he states, "No technical solution can rescue us from the misery of overpopulation. Freedom to bread will bring ruin to all" (Hardin, 1968, p.7). Hardin's thesis was so influential to academia and policy-makers alike, that it immersed itself into decision-making processes and developmental organizations. It generated a hegemonic ideology that only strong central states had the expertise and the resources to address the problems of natural resource degradation **(**Schlager, 2004, p.148). In the context of the developing world, many CPRs that were once managed at the community level, were becoming nationalized (Schlager, 2004, p.148). These external institutions drafted broad brush stroke rules surrounding

CPRM and failed to consider the local complexities and the value of community-based resource management.

Reconsidering the "Tragedy Models" Scenario (1980's-Present)

Starting in the 1980's, there was increasing dissatisfaction towards this approach, and policy-makers and scholars alike started to question the hegemonic models of conventional CPRM (Schlager, 2004, p.149). Equally, there were evolving academic examples in which local communities were designing, developing, and shaping context-specific institutions that challenged the tragedy scenario. Scholars began to consider that communities and shared resource arenas were not always fixed in these tragedy of the commons scenarios.

In 1990, Elinor Ostrom's, *Governing of the Commons*, was published, where it provided examples and conditions needed for groups to support long-term cooperation and coordination of CPRM. Here, she suggests an alternative approach to CPRM – a system of institutions which are organized and governed by the resource appropriators themselves. Her major question was, "how a group of principals who are in an interdependent situation can organize and govern themselves to obtain continuing joint benefits when all face temptation to free-ride, shirk, or otherwise act opportunistically" (Ostrom, 1990, p.29). In order for self-governed institutions to exist, Ostrom (1990) drafted Eight Design Principles or conditions to measure the effectiveness and sustainability of these self-governing CPR systems. The greater presence and institutionalization of these design principles would suggest a greater chance of a sustained CPRM system. *Figure 3* is a direct excerpt from Ostrom's design principles (Ostrom, 1990, p.90).

Principle 1: Clearly Defined Boundaries – Individuals or households with rights to withdraw resource units from the common-pool resource and the boundaries of the common-pool resource itself are clearly defined.

Principle 2: Proportional Equivalence Between Benefits and Costs – The distribution of benefits from appropriation roles is roughly proportionate to the costs imposed by provision rules. Appropriation roles restricting time, place, technology, and/or quantity of resource units are related to local conditions.
Principle 3: Collective-Choice Arrangement – Most individuals affected by operational rules can participate in modifying operational rules.
Principle 4: Monitoring – Monitors, who actively audit CPR conditions and appropriate behavior, are accountable to the appropriators and the appropriators behavior.
Principle 5: Graduated Sanctions – Appropriators who violate operational rules are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other appropriators, from officials accountable to these appropriators, or from both.
Principle 6: Conflict Resolution Mechanisms – Appropriators and their officials have rapid access to low-cost, local arenas to resolve conflict among appropriators or between appropriators and officials.
Principle 7: Minimal Recognition of Rights – The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.
Principle 8: Nested Enterprises (Coordination in Governance Across Scales) – Appropriation, provision, monitoring, enforcement, conflict resolution and governance activities are organized in multiple layers of nested enterprises.

Figure 3: Adopted from Ostrom, Elinor. (1990) *Governing the Commons: The Evolution of Institutions for Collective Action*.

Self-Governed Common-Pool Resource Irrigation Management; in Practice

Three case studies are presented below, linking Elinor Ostrom's (1990) Eight Design Principles to CPRM of irrigation schemes. They illuminate the strengths and challenged facing self-governed irrigation management.

First, Sarker & Itoh (2001) explain how Japan has long practiced and established robust CPR irrigation institutions. Unlike other Asian countries, the responsibility of irrigation management has historically belonged to the water users, even in large-scale systems (Sarker & Itoh, 2001, p.90). The government has entrusted the maintenance, operation, monitoring, and institutional design-making to the water users themselves, by establishing land improvement

districts (LID) – a “corporate, decentralized and financially autonomous association of those farmers who self-govern and self-manage the agricultural water systems in a specific area” (Sarker & Itoh, 2001, p.91). This then has created this non-coercive, yet supportive relationship with the external authority (government) which has significantly shaped strong endogenous self-governed institutions arrangements. LIDs elect farmers to be representatives of certain water systems that has many major functions, including: applying for or promoting a land improvement projects; collecting money from water users to repay both the irrigation project costs and maintenance and operation costs; and are the legal corporate bodies that conduct cost-sharing negotiations between the government and the irrigation water users (Sarker & Itoh, 2001, p.92). The government does not get involved with institutions, but do provide funds in irrigation and drainage projects (Sarker & Itoh, 2001, p.95). For the case of Japan, this endogenous, self-governed institutions have proved to be far more effective than exogenous imposed institutions (Sarker & Itoh, 2001, p.97).

Next, Oates et al. (2020) conducted research with two self-governed smallholder farmer irrigation schemes – under 200 ha – in Tigray, Ethiopia. The research was to understand how state interventions influence self-governed irrigation institutions and their ability to manage schemes (Oates et al., 2020, p.7). These questions are argued to be critical in understanding future development projects of smallholder irrigation development in Africa (Oates et al., 2020, p.1). The research conducted semi-structured and focus group discussions with irrigation users of two irrigation sites: a modern site (small-scale schemes with fixed or improved water control or diversion structures managed by water users) and a traditional irrigation site (small-scale schemes with impermanent structures made with local materials and managed by customary community institutions) (Oates et al, 2020, p.4). Results demonstrated that despite the reality that

external interventions do often provide key modern infrastructure, they are weak at tailoring to diverse local contexts, and may fail to build on the existing local institutions, and improperly addressing the constraints farmers face (Oates et al., 2020, p.7). The authors argue that state irrigation-led interventions have large challenges and that tailoring CPR institutions to local contexts and farmers' perspectives are key in shaping lasting smallholder irrigation systems.

Finally, in Malawi, irrigation management transfers (IMTs) have been on the rise to meet high population density, and food insecurities (Nkhoma & Mulwafu 2004; Ferguson & Mulwafu 2007; McNulty et al. 2016). IMTs are the "handover of control and ownership of an irrigation system from a public sector entity to a private sector organization" (cited from Garces-Restrepo et al., 2007 in McNulty et al., 2016, p. 32). Nkhoma & Mulwafu (2004) studied the rehabilitation and handover of two irrigation schemes in Southern Malawi. The study found that the success of these programs heavily rely on government efforts to resolve challenges in the early stage (Nkhoma & Mulwafu, 2004, p.7). These include, lack of government financing, withdrawal of technical assistance and conflicting perceptions of ownership that generate intra-scheme conflict (p.7). Wiyo & Mkandawire (2018) measured the assumption if poor rural farmers could effectively govern water user association with proper training. The study found that despite the water user association providing improved efficiency and governance standard to irrigation schemes, they lacked technical capacity to manage on their own (Wiyo & Mkandawire, 2018, p.1). Although there are signs of optimism. McNulty et al (2016) studied the willingness of 300 smallholder farming households to invest in capital and unpaid labor towards constructing, maintaining and managing a hypothetical small-scale irrigation scheme in their villages in Dedza, Malawi (McNulty, 2016, p21). There were three objectives (McNulty et al. 2016, p.16-17): first, to manage natural resources and enforce resource use rules; second, increase

democratization and empower people; and third, to alleviate the financial strain of the national government. The results concluded that, yes, farmers were "indeed willing to invest unpaid labor, instead of or in addition to capital" (McNulty et al. 2016, p.31), suggesting important findings for future targeting and implementation of potential small-scale irrigation programs in Malawi.

Gender, Agriculture, and Climate Change

It is necessary to incorporate a gender analysis when researching the nature of resource sharing and conflict resolution of self-governed irrigation schemes in rural Malawi. Gender mainstreaming is an approach to policy-making and project design that takes into account both women's and men's interests and concerns (UN Women, 2014, p.1). As women and men have different needs, conditions and circumstances, gender mainstreaming in agriculture recognizes that gender impacts resource accessibility, decision-making power, and participation (Chanza, 2023). Moreover, a gender analysis is crucial to designing effective planning and implementation of development projects, polices and research design (Chanza, 2023). In Malawi, the confluence of climate change and a failure to include a gender in research presents a major challenge to recognizing how women smallholder farmers have systematic inequities in agricultural production, rural livelihoods, access to climate-smart agriculture training, access to information, and decision-making power (Murray et al, 2016; Asfaw & Maggio 2018; Mudege et al. 2018). Gender mainstreaming activities aim to improve adaptive capacity and mitigation practices to climate change in both men and women rural smallholder farmers (Chanza, 2023).

From a statistical perspective, women smallholder farmers in Malawi earn 71% less than male counterparts, have, on average, fewer years of formal education, own less acreage compared to male counterparts, and in turn, produce less food than their male counterparts

(Buehren et al, 2015, p.2). In 2015, a joint-development agency study led by UN Women measured the gender-gap costs in agriculture productivity in Malawi, Tanzania, and Uganda. Costs to agriculture productivity is measured by "the value of agriculture produce per unit of cultivated land" (Buehren et al, 2015, p.1). In Malawi, it is estimated that the gender gap costs Malawi $100 million/per year in agriculture production loss; this is related to women having unequal access to land, knowledge, key agriculture inputs, or improved seeds than to their male counterparts (Buehren et al, 2015, p.1). Similarly, even when women have access to basic irrigation technologies, Murray et al. (2016) argued that women are less likely to adopt further climate smart technologies than males, as they have limited access to basic agriculture tools, transportation, or rural energy (p.131).

Gender experts recommend that in order for women smallholder farmers to become more resilient, a few actions are required. First, a gender mainstreaming approach is needed to address the constraints that women face in community-based natural resource management (Murray et al. 2016, p1). Additionally, development agencies, governments, and non-governmental organizations (NGOs) have to be integrating a gender analysis into agricultural development programs and advocate for more accessible gender-equitable CSA information and technology (Chanza 2023). If project outcomes do not change life-outcomes in women, project outcomes must shift. And lastly, incorporating gender mainstreaming into development projects or research design not only recognizes the hidden gender disparities, but also views how men's and women's differing roles, responsibilities and resource accessibility impact a successful project implementation (Mabundza et al. 2014, p.2).

Conflict and Natural Resource Governance

A section of this research asks if the two irrigation schemes – who have independent CPR systems – have designed a proper self-governed CPR system where neighboring schemes could benefit from knowledge sharing or skills and manage potential inter-scheme disputes. Therefore, a brief understanding of community-based conflict management will be discussed.

Conflicts are inevitable is all aspects of society – yet the term often carries a negative connotation with violence (Warner, 2000, p.9) Natural resource conflicts are defined when two or more parties have disagreements or disputes over access to, control and use of, natural resources which when unaddressed can lead to violence, environmental degradation, disrupt livelihoods or disrupt projects (Matiru & Castro, 2022, p.4). Rather than claiming that conflicts must be avoided at all cost, CPR conflict resolution experts (Van Laerhoven & Andersson 2006; Ostrom 1990; Thomas & Kilmann 2008) argue that "conflict may be necessary for the eventual emergence of a more stable set of institutions that are capable of managing conflicts and differences in opinion in a way that are non-destructive for CPR use" (Van Laerhoven & Andersson, 2013, p.1). In this context, not only is conflict an inherent component of CPRM, but is necessary to prevent over-exploitation of a given CPR. This is then vital to consider, as the ability of decentralized self-governed CPR institutions to manage inevitable conflicts may determine the likelihood of success of such systems (Van Laerhoven & Andersson, 2013, p.1). Furthermore, this supports Ostrom's (1990) notion that "getting the institutions right is a difficult, time-consuming and conflict-invoking process" (p.14).

In the 1970s, Kenneth W. Thomas & Ralph H. Kilmann designed an instrument that assesses an individual's behavior in conflict situation, called the Thomas-Kilmann Conflict Mode Instrument (Kenneth & Kilmann, 2008, p.2). This model has been used successfully for

over 40 years to help individuals in a variety of settings to understand how differing conflict styles affect group dynamics (Schaubhut, 2007, p.1). As conflicts are inevitable and can be positive within CPRM, it can offer users a rational choice in approaching natural resource governance. This instrument can be described along two basic dimensions on the graph: assertiveness (y-axis) and cooperativeness (x-axis) (Kenneth & Kilmann, 2008, p.2). Assertiveness is "the extent to which the individual attempts to satisfy his or her own concerns" and cooperativeness is "the extent to which the individual attempts to satisfy the other people's concerns" (Kenneth & Kilmann, 2008, p.2). From this, there are five methods of individual or group methods in dealing with conflict: competing, collaborating, avoiding, or accommodating (Kenneth & Kilmann, 2008, p.2). *See figure 4* below. This study will use this model to determine the inter-scheme relations with key informants (committee members) from Chauluka and Kamwaza irrigation scheme.

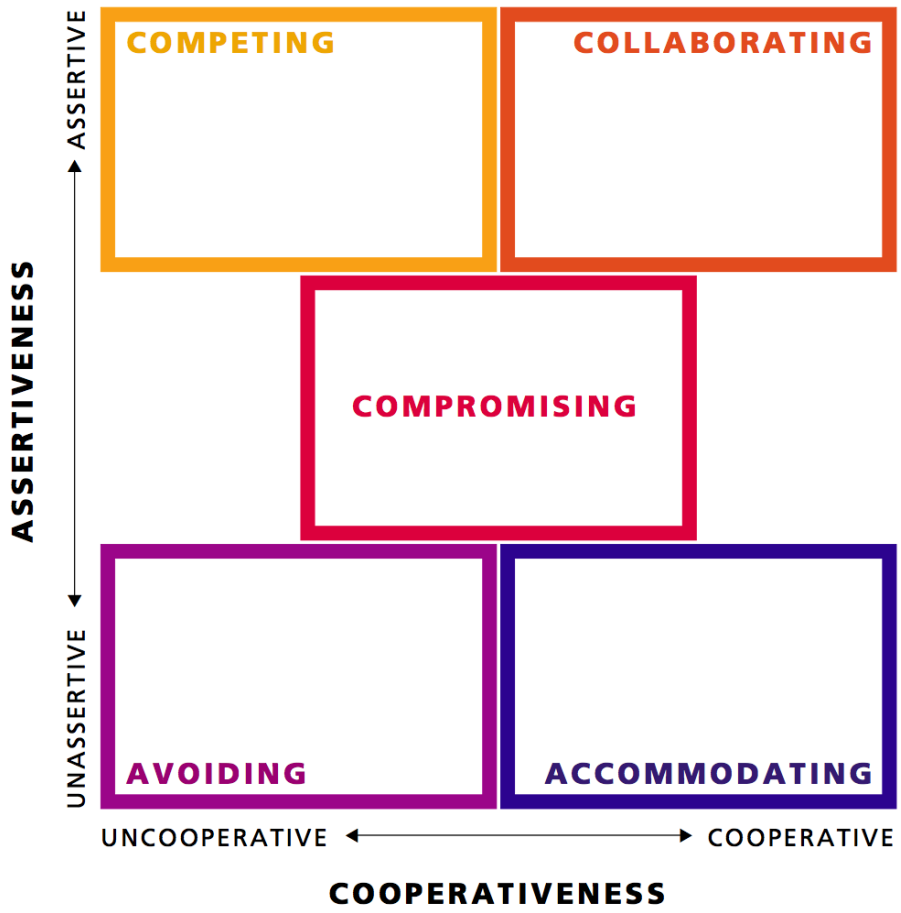

Figure 4: A two-dimensional model of conflict-handling behavior adopted from Kenneth & Kilmann (2008), "Thomas-Kilmann Conflict Mode Instrument".

Researcher's Positionality

Malawi is not my birthplace and I do not formally speak the regional language Chichewa. I am a white male that was raised from a middle-class family in a heavily-dominated white, Christian culture in the United States. Though I have limited scope of the lived experiences of the research participants, I purposely partook in academic immersion over six weeks, participant observation over two months, and extended daily cycling activities in Ntcheu District and the surrounding districts among the Kirk Range to intimately observe the culture and practice the language. I understand that cycling is an act of leisure is a form of privilege in this context, yet this effort allowed me to connect my research and the theoretical framework from my

experiences by bike as I built rapport with local residents both within the irrigation schemes under study and the wider community.

Methodology

A qualitative/quantitative analysis was performed to examine which conditions were present or absent for effective common-pool resource sharing and conflict resolution between the neighboring self-governed irrigation schemes in rural Malawi. The methodology is organized to incorporate and align with Elinor Ostrom's (1990) Eight Design Principles. The research was conducted with two small-scale irrigation schemes – Chauluka and Kamwaza – located in Ntcheu, Malawi. Data was collected through field observations, focus group discussions and questionnaire surveys with scheme members and key informants from each scheme. Questionnaire surveys were performed with key informants and scheme members from each group to measure intra-scheme CPR design principles using the five-point Likert-Scale and draws off the questionnaire items adopted in Burbach et al. (2022) (*figure 5*). Ostrom's (1990) Eight Design Principles were measured with participant's responses ranging from "1" (strongly disagree) to "5" (strongly agree). A "3" would suggest that the respondent neither disagrees or agrees.

In addition to the individual questionnaires, focus group discussions were organized to examine how responses to Ostrom's (1990) design principles may differ in group settings. Five total focus groups were conducted – two with scheme members from each group (all stratified by gender) to measure intra-scheme management; and one joint-scheme focus group discussion with key informants from both schemes to measure the presence or absence of joint-scheme conflict or collaboration. Field observations of both irrigation schemes provided supplementary context to the focus groups and questionnaire surveys. Data from focus groups was thematically coded

and analyzed to identify patterns with the questionnaire surveys in alignment with Ostrom's (1990) eight design principles. Data from the questionnaire surveys was organized by a mean, median, and range score.

Principle or Criteria	Questionnaire Item(s)
1. *Clearly Defined Boundaries*	Irrigation boundaries and rights to water use is clearly defined.
2. *Benefits and Costs*	The benefits of using water resources outweigh the costs of developing, managing, and using the irrigation scheme.
3. *Collective-Choice Arrangements*	Members are able to influence regulations put in place to manage irrigation scheme.
4. *Monitoring*	Overall, there are effective methods in place to monitor people's use of water.
5. *Graduated Sanctions*	Sufficient penalties are enforced for failing to abide by water use regulations.
6. *Conflict-Resolution Mechanisms*	Adequate regulations are in place to resolve local and neighboring water conflicts.
7. *Minimal Recognition of Rights to Organize*	The rights of the scheme to design their own rules are not challenged by governmental authorities or non-governmental organizations.
8. *Nested Enterprises (Coordination in Governance Across Scales)*	National government and local water management activities are well integrated.

Figure 5: Questionnaire items drawn off and adopted from Burbach, et al. 2022

Sampling

A total of 48 combined members from both schemes participated in the study – 27 from Chauluka and 21 from Kamwaza. The researcher along with a local interpreter worked with the scheme committees to organize the questionnaire interviews, focus group discussions, and observation visits. Interviews were in Chichewa and translated to English. The interview questions were back translated prior to research to test language differentiations. The researcher and the local interpreter coordinated with the scheme committees for organizing participant sampling. All direct participant sampling was performed by scheme committees, yet we asked the committees to target a diverse sample of members that ranged in age, land use, opinions and

tenure on scheme. We had one interview location in each village where participants were informed to approach us at a given date and time. From the 27 members interviewed from Chauluka, 17 members were interviewed for the questionnaire surveys. Another ten were interviewed in focus group discussions, stratified by gender – five people in two separate groups. In Chauluka village, the interview setting was located in a large open community space under a bulky tree. In Kamwaza village, the interview location was in a private, empty fire-brick home. From the 21 members interviewed from Kamwaza, 10 members were interviewed for questionnaire surveys. Another 10 were interviewed in focus group discussions, stratified by gender – five people in two separate groups. The final participant from Kamwaza was from in the joint-scheme focus group discussion. Every participant in the joint-scheme focus group from both schemes was an overlap interviewee except for the one male key

Questionnaire Surveys							
Chauluka Irrigation Scheme				*Kamwaza Irrigation Scheme*			
	Male	*Female*	*Sample Size*		*Male*	*Female*	*Sample Size*
Key Informants	4	3	7	Key Informants	2	3	5
Scheme members	6	4	10	Scheme Members	3	2	5
			17 total				*10 total*
Scheme-Member Focus Group Discussions							
Chauluka Irrigation Scheme				*Kamwaza Irrigation Scheme*			
Male Focus Group	5		5	Male Focus Group	5		5
Female Focus Group		5	5	Female Focus Group		5	5
			10 total				*10 total*
Joint-Scheme Focus Group Discussion							
Chauluka Irrigation Scheme (Key Informants)	2**	1*	3				
Kamwaza Irrigation Scheme (Key Informants)	2*	1*	3				
			6 total				
Total Participants							

Chauluka Irrigation Scheme	13	14	27 total
Kamwaza Irrigation Scheme	11	10	21 total
			48 Total Participants

**Overlap interviewees*

informant from Kamwaza. A total participant tally is outlined in *figure 6*.

Figure 6: Participant sampling of Chauluka and Kamwaza Irrigation Schemes.

Findings

Chauluka Irrigation Scheme

Principle 1: Clearly Defined Boundaries

A majority of the surveyed scheme members *(n=14 of 17)* in the questionnaire survey "agreed" or "strongly agreed" that the scheme boundaries and the rights to water use were clearly defined. However, much of this was in accordance to individual boundaries and the rules following the water block distribution system was not clear. The scheme is separated into three separate blocks – A, B, and C. One respondent reported that members know the boundaries of the irrigation canal based off of their allocated time and date to use the water. Some of the scheme members were unsure of the exact size of the scheme. However, as many of the scheme members were farming inherited intergenerational land, this likely strengthened their confidence of individual and member scheme boundaries (this would exclude scheme renters). Respondents reported many activities for defining their individual boundaries, such as; planting cassava (*see Appendix L*), building large ridges, planting trees (*see Appendix G & H*) and farming style. Observations noted large shrubs planted on the south side of the scheme to avoid cattle and goats from entering the scheme, along with vetiver grass growing on the edges of walking paths. The

west boundary enters into the Kirk Range, the north boundary is defined by the Mponda river, while the east boundary ends near a wetland.

Figure 6: A concreted block distribution box in the lower section of the scheme. Block A faces right (east) and Black B faces left (west).

Principle 2: Proportional Equivalence Between Benefits and Costs

A majority of the surveyed scheme members *(n=13 of 17)* "agreed" or "strongly agreed" that the benefits outweighed the costs of developing, managing and using the irrigation scheme. Of the members that "disagreed" or "strongly disagreed", two were in response to their scheme location and the upstream users impacts on their water use. Another referred to unfair water distribution and another referred to improper water capture technology which effects water quantity late in the dry season months (August-November). Stated benefits included: a second change to harvest, income for children attending school, medication, transportation, and food for

family. Additionally, it was universally stated that access to benefits were not equal and depended on land size, crop diversification, work ethic, access to inputs (fertilizer, manure or herbicides), water distribution, inherited versus rented land, access to superior seeds, and reported individual behavior related to excess drinking of alcohol.

Principle 3: Collective-Choice Arrangements

Most collective decision making is done by a top-down approach. In brief, the committee has ten elected members as outlined: Chairperson, Vice-Chairperson, Secretary, Vice Secretary, Treasury, Water Use Manager, Discipline Manager, Canal Manager, Crop Manager, and Market Manager (*committee member structure is outlined in Appendix A*). First, the ten committee members have "closed-door" discussions to reach a majority consensus on ideas/conflicts/plans for the scheme Once they have reached a consensus, their decision is transcribed to the members through mandatory scheme meetings. At the end of each meeting, the committee leaves time for members to comment. Despite all surveyed questionnaire participants responding "agree" or "strongly agree" *(n=17)*, there was two members that mentioned scheme members influence in decision making matter was limited. One stated that it was up to the members to bring up concerns to committee and another was fear of the committee. Interviewee #4 stated, "Sometimes, it is very difficult for scheme members to influence decisions because we have people in power saying: 'we started this scheme' or 'we are the ones who took water from the mountains'. We feel like we cannot say anything to them [the committee]". Findings suggest that most decision making is done by elected committee members in "closed-door" discussions and scheme members do not have legitimate power to challenge irrigation scheme regulations.

Principle 4: Monitoring

The responsibility of monitoring the 130 members of the scheme is almost exclusively held by the chairperson. There are three block monitors (A, B, C) who are responsible for managing water distribution in the respective block, but the chairperson is formally responsible for monitoring water distribution and addressing illegal water use for all its members. Block monitors are not committee members, yet are responsible for making sure every member is following the distribution rules and reports to the committee of potential rule-breaking activities. In terms of monitoring committee members, there is no independent body or official rules that keeps the committee members in check. Much of the monitoring of the scheme is dependent on scheme member oversight and trust, particularly for committee members.

Figure 7: A female scheme member from Chauluka irrigates her bean crops.

Principle 5: Graduated Sanctions

Of the seventeen members, three "strongly disagreed" that sufficient penalties were enforced for failing to abide by water use regulations, ranking "graduated sanctions" the second to lowest score of the eight principles. Two of the three respondents who "strongly disagreed" stated that many members were family or relatives to committee members, making it much more difficult to enforce penalties. The Chairperson and the committee designed the penalties and determine severity. Some of the penalties have a three-strike offence system, both financial and non-financial (verbal warnings). A third offence results in the expulsion of the scheme following the next irrigation season. Stated penalties include, missing mandatory work-day, failing to pay membership fee, illegal water use, and a non-member working for a scheme member. More detailed examples are provided in *Appendix A.*

Principle 6: Conflict-Resolution Mechanisms

There was wide agreement across all surveyed scheme members that there were adequate regulations in place to resolve local and neighboring water conflicts. Comments of intra-scheme disputes was almost absent. In terms of inter-scheme neighboring conflicts, there has been some previous disputes with Kamwaza Irrigation Scheme, but such was resolved years ago. Nothing has been reported as of recently. There are no regulations that guide the event of neighboring water conflicts. Chauluka is a member of Lower Njolomole Irrigation Committee (*figure 8)*, but this committee is now not active due to financial and transportation constraints for committee meetings. The hierarchy of conflict resolution is displayed below (*figure 9*).

Lower Njolomole Irrigation Committee

A committee of seven local small-scale irrigation schemes in the lower Njolomole traditional authority. The primary responsibility is to act as a mediator for inter/intra-scheme conflict resolution. Three representatives from each scheme would be elected. The schemes represented include:

1. Chauluka Irrigation Scheme
2. Kamwaza Irrigation Scheme
3. Dowdy Irrigation Scheme
4. Namang'ung'u Irrigation Scheme
5. Khomba Irrigation Scheme
6. Kaziputa Irrigation Scheme
7. Mitchi Irrigation Scheme

Figure (8): Responsibilities and irrigation representatives of the Lower Njolomole Irrigation Committee

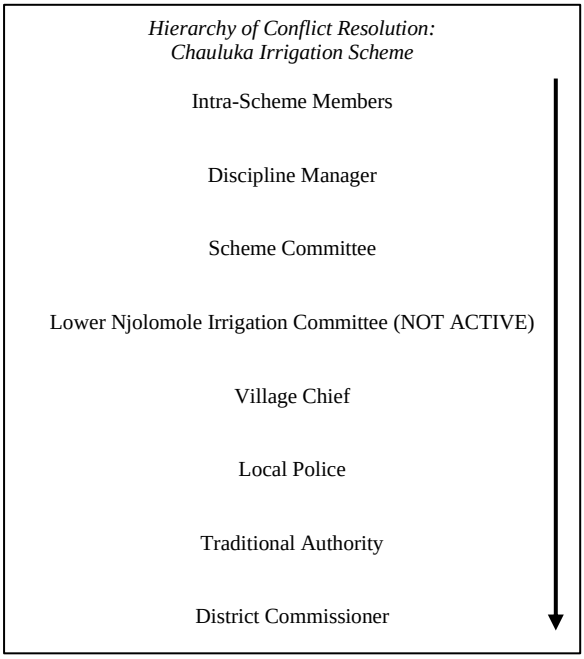

Figure (9): Hierarchy of Conflict Resolution in Chauluka Irrigation Scheme

Principle 7: Minimal Recognition of Rights

The right of Chauluka irrigation scheme to design their own rules are not challenged by governmental or non-governmental organizations. Surveyed members have stated that they take pride in the rules that they have designed, but also acknowledge they cannot do everything they would like to do completely autonomous from external authorities. Member #9 stated, "We feel it is our right to make our own rules that work best for us. We are more beneficial with the rules we have". Another member (#19) stated, "It is not right. It is difficult to manage everything on our own". The one exception is that a representative from the Ntcheu District Agriculture Office (NDAO) – the local agriculture government institution – must be present to monitor elections. Simply, the major factor for why the rules are not challenged is because external authorities are absent in scheme coordination. There was a wide assumption that scheme members desired increased government or NGO involvement, but mostly in reference to infrastructural investment (canal eminence, pipes, solar pump, dam), not scheme rule design.

Principle 8: Nested Enterprises (Coordination in Governance Across Scales)

Chauluka irrigation scheme does not coordinate adequately with governance institutions across all scales – with the NDAO, national government, NGOs or neighboring scheme committees. However, coordination in governance across all scales was interpreted in two separate ways. The eight members who chose to answer "strongly agree" typically tied that to previous NGO and government involvement into the construction of the concreted scheme canal. The five members who chose "strongly disagree" associated their response with little to no involvement or visitations of local agriculture officers, agriculture extension workers, or NGOs in the previous years. Principle eight was the lowest ranked of the eight criteria measured in Chauluka. The questionnaire results from Chauluka is outlined in *figure 14.a* (below).

Chauluka Irrigation Scheme

Principle	*Mean*	*Median*	*Range*
Clearly Defined Boundaries	4.5	5	1 to 5
Benefits and Costs	4.2	5	1 to 5
Collective-Choice Arrangements	4.7	5	4 to 5
Monitoring	4.5	5	1 to 5
Graduated Sanctions	3.9	5	1 to 5
Conflict-Resolution Mechanisms	4.9	5	3 to 5
Minimal recognition of rights to organize	4.6	5	1 to 5
Nested Enterprises	3.6	4.5	1 to 5

*Sample Size: 17 research participants

Figure 14.a: Chauluka Irrigation Scheme questionnaire results in accordance to Ostrom's (1990) Eight Design Principles.

Kamwaza Irrigation Scheme

Principle 1: Clearly Defined Boundaries

Irrigation boundaries and rights to water use was inadequately defined. Kamwaza is separated into four separate blocks – A, B, C, and D. One member was unsure which block they farmed in. Despite the majority of surveyed participants selecting "agree" or "strongly agree",

not one participant could provide an answer for the total land mass (hectares) of the scheme. However, individual boundaries were, in general, well defined. As the majority of the questionnaire participants interviewed (*n= 7 of 10*) were property owners and farming on intergenerational land, this likely strengthened their confidence of individual and member scheme boundaries (this would exclude scheme renters). Unlike Chauluka, Kamwaza's irrigation shape is more irregular and swerves by following scheme member's property and the Mbirimbite River. Respondents reported many activities for defining their own irrigation boundaries including: planting trees (*see Appendix O*), planting cassava, and building large ridges. The scheme plants vetiver grass on the concreted and piped canal edges to reduce soil erosion on the steep banks (*see Appendix R*) and has fire-bricks around the scheme to avoid wild bush fires. Field observation noted sisal and pigeon-pea shrubs being a common individual boundary marker. Also, an estimated 55 to 65 percent of the main scheme has no concrete and is defined by hand-dug canals (*see Appendix T & U*). Consequently, the bottom half of the canal is often times visually eroded and challenging to define. The irrigation boundaries to the south and west is defined by the Mbirimbite river, the north is partially defined by the irrigation canal and irrigation property, and east by more irrigation property.

Figure (10): A photograph of the non-concreted portion in the lower half of Kamwaza irrigation scheme.

Principle 2: Proportional Equivalence Between Benefits and Costs

The equivalence between benefits and costs had mixed results. Participants ranged from ranking the principle from “strongly disagree” to “strongly agree”. Stated benefits of the scheme included: providing food for the family, income from crop surplus, money to improve on household construction and money to purchase household items. Universally *(n=10),* surveyed members agreed that benefits were not equal and depends on work ethic, land size, access to inputs, location on scheme, separate responsibilities off scheme (i.e. parenting or jobs), type of seed, and reported individual behavior related to excess drinking of alcohol. Member #1 explains, “We work very hard and know so many inputs have gone in, but have never harvested

enough crops that would outweigh how much energy has gone into the scheme". Two members stated that the benefits are greater to those on the committee, specifically the amount of water used and the time allocated for irrigation purposes. Committee negligence was also reported and was tied to unequal benefits to non-committee members. Member #16 explained, "some committee members water their fields three-times per week while other only water once per week. This complies over time, creating less benefits". It was also mentioned that members who have access to the concreted canal have better access to water quantity and less soil erosion on their surrounding land. This was confirmed in the focus groups discussions. Due to the absence of a concreted canal, spillovers occur, meaning that water may escape the main canal, causing further erosion in member's fields (*see figure 11 below*). The unfinished canal was one of the most common concerns when speaking to participants. Principle Two was the second lowest ranked criteria.

Figure 11: Deep soil-erosion occurring in the un-concreated lower section of the main canal at Kamwaza Irrigation Scheme.

Principle 3: Collective-Choice Arrangements

Collective-choice arrangements are preformed similarly to Chauluka. In brief, the committee has ten elected members as outlined: Chairperson, Vice-Chairperson, Secretary, Vice-Secretary, Treasury, Vice-Treasury, Community Advisor, Visitor Coordinator, and two more elected members in supportive roles (*see Appendix A for committee member structure*). First, the ten committee members first gather to discuss about future ideas or plans for the upcoming season. Once they reach a majority consensus, the then inform the members what they have decided. They too leave time for members to comment and ideas to be considered by the committee. From a gendered perspective, women represent four of the ten committee members, but make up for 48 of the 60 total scheme members. When asked if women have equal decision

making power, one member indicated gender bias stating “the strength of what women say is less than men. If woman say’s something, it may not be considered as wise as men”. Therefore, women may not be accurately represented in the scheme. Also, multiple members stated that they were afraid to speak up or bring up their concerns to the committee. This was related to the committee members outstaying their seat duration and fear of elderly committee members. One member stated, “We feel that things in the scheme don’t go well because we don’t tell the committee members their concerns”. This was supported by interviewees #21 and #16. One committee member stated, “If someone feels like they don’t agree with a rule, it would be better for that someone to leave the scheme”. Lastly, the scheme has not had an election since 2018 and is two years overdue. Their rules state the committee members have three-year terms, but no term limits. The fact that there has not been an election in five years may be effecting the collective-choice decision-making arena. In general, Likert-Score responses did not reflect member responses.

Principle 4: Monitoring

The responsibility of monitoring the 60 scheme members is also almost exclusively performed by the chairperson, but is supported by the block monitors. Block monitors are not a part of the committee and are responsible for block water distribution and reporting illegal water use. There was reported negligence to monitoring directed at the committee chairperson and block monitors. There are no formal monitoring rules keeping the committee members from breaking rules. There was also concerns of selective monitoring from the block chairpersons. One member states, “there are no rules, anyone can use the water the way they want to. People are overusing water for personal use.” Despite the majority of surveyed members *(n=8 of 10)* responding “agree” or “strongly agree” that they are effective methods in place to monitor

peoples' use of water, many participant responses challenge the questionnaire results. This may be in part to do with the fact that members are nervous to give accurate responses due to fear of the committee and chairperson negligence.

Figure 12: A male scheme Kamwaza member irrigates his sweet potato crops in the evening light.

Principle 5: Graduated Sanctions

Graduated sanctions was ranked one of the highest scored principles. However, the questionnaire results were at times not correlated to member responses. Stated concerns of selective penalties were brought up, specifically to the committee members. Multiple members *(n=3 of 10)* stated concerns that committee members are more likely to break the rules. One

member stated, “most of the time those who break the rules are the committee members, the chairperson for example. He is also a member of the Chauluka Irrigation Scheme, so I think that the less present he is here, he is more likely to break the rules.” Stated penalties include illegal water use, missing mandatory work days, and intimidation. All of the penalties stated were financial penalties. The committee designed the penalties and determines severity. More detailed examples are provided in *Appendix A.*

Principle 6: Conflict-Resolution Mechanisms

Conflict-resolutions are almost identical to Chauluka irrigation scheme, except Kamwaza does not has an intra-scheme discipline manager. There was wide agreement across all scheme members that there were adequate regulations in place to resolve local and neighboring water conflicts. Intra-scheme concerns were reported, but most members seem to avoid conflict. As noted before, there was some reported inter-scheme neighboring conflicts with Chauluka years ago, but nothing has occurred recently. There are no regulations that guide neighboring water conflicts. Kamwaza is also a member of the non-active Lower Njolomole Irrigation Committee. The hierarchy of conflict resolution is displayed below (*figure 13).*

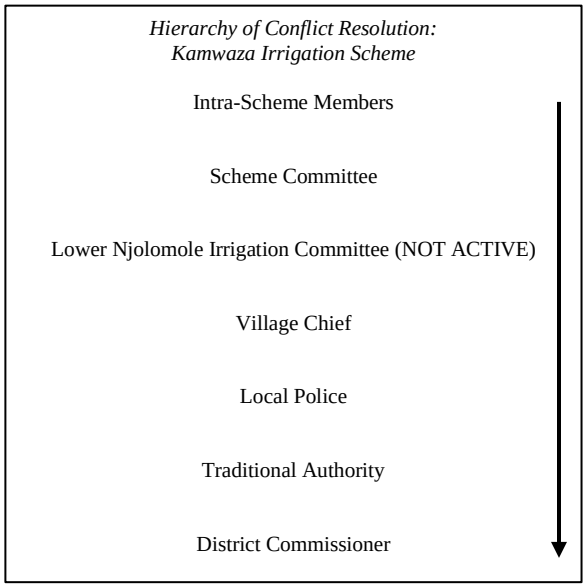

Figure 13: Conflict Resolution Hierarchy at Kamwaza Irrigation Scheme

Principle 7: Minimal Recognition of Rights

The right of Kamwaza irrigation scheme to design their own rules are not challenged by governmental or non-governmental organizations. Members have taken pride in the rules they have designed. However, one member stated that every single rule was adopted by the NDAO. This has not been confirmed. Also, a representative from the NDAO must be present to monitor an election. This tied into another common scheme member concern, being that the scheme has not had an election since 2018. It is up to committee members to organize a re-election process with the NDAO. It is possible that this government rule is interfering with scheme autonomy and its ability to manage and govern themselves properly, particularly when committee member negligence is present. Lack of government or NGO involvement is a major factor when considering why the rules of the scheme is not challenged. There was also strong agreement that government or NGO intervention was wanted, but this too was mainly tied to infrastructural investment (to concrete the entire canal, dam, pipes), not scheme rule design.

Principle 8: Nested Enterprises (Coordination in Governance Across Scales)

Similar to Chauluka irrigation scheme, Kamwaza irrigation scheme does not coordinate adequately with governance institutions across all scales – with the NDAO, national government, NGOs or neighboring scheme committees. Similarly, members either chose "strongly disagree" to "strongly disagree" in coordination in governance across all scales. Of the four members who chose "disagree" or "strongly disagree", this was mostly tied to lack of local government involvement and lack of physical presence on scheme. Of the six members who selected "agree" or "strongly agree", this was typically tied to the response of previous NGO involvement in the construction of the scheme canal and piping (*see Appendix O & S*). Therefore, it is more related

to NGO coordination, rather than direct government coordination. Coordination with government extension workers was very limited as they rarely have visited in the past several years. The questionnaire results of Kamwaza, including a comparative figure of the questionnaire scheme results with Chauluka is outlined in *figure 14.b* (below).

Kamwaza Irrigation Scheme				**Chauluka Irrigation Scheme**			
Principle	*Mean*	*Median*	*Range*	*Principle*	*Mean*	*Median*	*Range*
Clearly Defined Boundaries	4.5	5	2 to 5	*Clearly Defined Boundaries*	4.5	5	1 to 5
Benefits and Costs	3.5	4	1 to 5	*Benefits and Costs*	4.2	5	1 to 5
Collective-Choice Arrangements	4.4	5	1 to 5	*Collective-Choice Arrangements*	4.7	5	4 to 5
Monitoring	4.3	5	1 to 5	*Monitoring*	4.5	5	1 to 5
Graduated Sanctions	4.9	5	4 to 5	*Graduated Sanctions*	3.9	5	1 to 5
Conflict-Resolution Mechanisms	4.3	5	1 to 5	*Conflict-Resolution Mechanisms*	4.9	5	3 to 5
Minimal recognition of rights to organize	4.3	5	1 to 5	*Minimal recognition of rights to organize*	4.6	5	1 to 5
Nested Enterprises	3.4	4.5	1 to 5	*Nested Enterprises*	3.6	4.5	1 to 5
*Sample Size: 10 Research Participants				*Sample Size: 17 research participants			

Figure 14.b: Comparative Questionnaire scheme results in accordance to Elinor Ostrom's (1990) Eight Design Principles

The Presence or Absence of Conflict and Collaboration Within and Between Schemes

Participants were asked questions in conflict resolution within the scheme and if they could foresee benefits from sharing information, knowledge, or skills with their neighboring scheme. This was asked in the form of questionnaires and focus group discussions. As conflicts or disputes are inevitable and can be positive within CPRM, this section measured rational individual decision-making in approaching natural resource disputes. To measure a presence or absence of joint-scheme conflict or collaboration, this study uses the Thomas-Kilmann Conflict Mode Instrument (TKI) Model to identify individuals conflict-handling behavior.

Scheme member questionnaire responses from both schemes were mixed for potential joint-scheme collaboration. Members responses to those who disapproved joint-scheme collaboration were partially related to an avoidance/lack of dialogue or "resentment of the other".

One member from Chauluka states, “If we were to work together, many conflicts would come up. I feel Kamwaza people see themselves wiser than us.” This same idea was confirmed with a Kamwaza member. One member stated, “We do not feel like there will be any benefits. They [Chauluka] are too proud with their big scheme. We decided to stay away from them”.

Gender stratified focus group responses were more positive from both schemes. Members from Chauluka responded, “That would be great because what we know and what they know could be different.” This was reciprocated in Kamwaza, as one member states, “There is a really good opportunity to work together because we can visit Chauluka to see what they are doing to improve our scheme and yields. It will help us be a better scheme.” Responses and observation in the gender stratified focus group settings exhibited that there was the lack of an emergence of constructive debate or deliberation between members in the collaborative focus group settings. Responses to each focus group question was either a universal “agree” or “disagree”. This demonstrates the discrepancy of questionnaire and focus group responses when in a confidential, individual settings versus a group setting where other members are present.

The final focus group was the joint-scheme focus group discussion with three committee members from both schemes. The chairperson, vice-chairperson, and treasury represented Chauluka. The secretary, treasury, and vice-chairperson represented Kamwaza. The Kamwaza chairperson was invited, but did not attend. Overall, the discussion was overwhelmingly positive. Both schemes shared similar challenges (i.e. pest and disease management) and visions for their schemes including transitioning the scheme into a legitimate business and wanting the community to be reliable and inspire others to be food secure. Responses from all members displayed traces of interdependency in manners they may not have recognized, including election monitoring, previous inter-scheme conflict resolution and the non-active Lower Njolomole

Irrigation Committee. When asked if failing to meet more frequently or restarting the Lower Njolomole Irrigation Committee could have an impact on the future prosperity of the scheme, all participants agreed. One respondent from Chauluka stated, “this has been a surprise to us having this meeting, but moving forward with this idea is something that we would like to do more of”. This was reciprocated with Kamwaza, with one respondent stating, “Issues can be overcome if we work together as committees. If we as a committee collectively come up with solutions, we can better provide for our members. The idea of this is collective farming, not individual farming”. When asked what would be needed to shape this scenario, respondents agreed that the chairs from both schemes must meet to come to a joint-consensus and goals of discussion. Then they can rely the vision to the scheme members through a mandatory meeting.

Despite the overwhelming support for further joint-scheme collaboration, some concerns exist. Firstly, the reliability of respondents in a group setting may have been limited. There was no constructive debate or concerns brought up in all five focus group discussions. Additionally, securing an overdue election in Kamwaza needs to be addressed before coordination between schemes can fully be put into practice. Committee negligence and fear of the committee may limit both schemes full commitment, but more Kamwaza based off of member responses. And lastly, further attention should be considered to what the regulatory structures would look like for this inter-scheme committee. What would this look like, how would Ostrom’s (1990) design principles contribute in this setting and how would local agriculture and government institutions be involved?

From the available responses, I would grade the conflict-handling behavior according to the TKI model in the avoidance category, as assertiveness within and between schemes is generally absent and cooperation between schemes is very low. I argue that the confidentiality of

questionnaire responses enabled participants to behave more truthfully and when put in a focus group setting, none of those concerns where addressed. The absence of debate among members in all of the focus group discussions – both gender stratified and joint-scheme focus groups – also indicates a presence of unassertiveness and avoidance within and between schemes. Additionally, the historical lack of formal dialogue and collaboration with the schemes, except for when government officials arrive, has indicated that there has been limited political will to collaborate. Assertiveness in this context is nearly absent. Also, government visits are not a constructive setting to share knowledge, skills, or information. When the government or NGOs arrive, both schemes may be trying to distinguish themselves from the other to be offered assistance. As one Kamwaza member states, "The baby who cries the most, is the one who gets her mother's milk".

Discussion

Chauluka and Kamwaza irrigation schemes are two separate systems, but their members both share histories, families, culture and experience. The two villages are neighbors and there is no border or break that separates the communities. From an outside perspective, one may likely perceive the two villages as one. They are, by many characteristics, "one people". The majority of these scheme members are homogenous appropriators in language, interests, skills and culture. However, when observing these two villages from the lens of CPR management, these characteristics become more complex. The following will include a critique on Elinor Ostrom's (1990) Eight Design Principles in the context of rural Ntcheu, Malawi, the interdependence and independence of the corresponding schemes, and opportunities for coordination self-governed small-scale irrigation schemes and local government in rural Malawi.

Interdependence versus Independency of the Neighboring Schemes under the CPR Umbrella

Ostrom (1990) questioned how a "group of principals who are in an interdependent situation can organize and govern themselves to obtain continuing joint benefits when all face temptation to free-ride, shirk, or otherwise act opportunistically" (p.29). This addresses how the design principles influence appropriator and collective behavior. Additionally, I argue that it considers how neighboring CPR users interact, share knowledge, skills, or information and coordinate with local or national resource institutions. In the context of rural Malawi, I asked how the two neighboring schemes interact in sharing knowledge, skills, information or trainings. The two schemes may be different by name, but share challenges in terms of resource allocation, market access and governing limitations.

The two schemes are interdependent with each other in several ways, most significantly is coordinating with the local and national water/agriculture institutions. The local water and agriculture institution is the NDAO. They are the local office that sends out agriculture extension officers for trainings and site visits. The office is also a central point for seed and input distribution. In the scenario where the NDAO has visited, both schemes meet together for a presentation. A Chauluka committee member was explaining how both schemes meet in Chauluka when NDAO arrives, stating, "We are two different schemes, with two different rivers. However, we are considered as one, as we are the same descendants from the same village." The NDAO is located in Ntcheu, approximately 15 kilometers away, mostly on rural dirt roads. As most would have to rely off public transportation to attend this office, it is financially challenging for scheme members to travel. There was also events of the Ministry of Agriculture

visiting back in 2020, were both schemes gathered together. Schemes organized the event together and then represented their groups and shared ideas.

Crop diversification and local market prices are also interrelated. According to the sample size, both schemes are planting similar crops and sell at identical locations. Crop prices are likely to be impacted if both schemes are farming similar crops. Access to markets are also interdependent, particularly Masamba and Kandeu. Schemes do not share what crops their members are planting, but do individually have a scheme member archive.

Elections are both independent and interdependent on one another. As elections are governed and managed autonomously from neighboring schemes, representatives from nearby schemes are invited to monitor the elections. Though schemes have the right to design their own election by-laws (term limits, election cycles), they do include some commitment from neighboring schemes to keep their governing standards accountable.

Members on both sides were explaining similar issues of pest and disease management, and are planting very similar crop types according to the sample size. Beans, sweet potatoes, and maize were the most common crops planted and both are experiencing issues of pest and disease management, particularly with maize. Two respondents from Chauluka experienced disease or pest issues, along with one confirmed member from Kamwaza. Field observation also noted maize disease issues. Currently, there is little coordination on crop diversification or pest/disease management. If both schemes are planting identical crops, the demand will reduce, dropping local product value. There is enormous potential for this crop planting coordination. One Kamwaza stated, “It would be nice to meet and talk about what crops we are all planting. If we are both planting these varieties, then we should share what pests and diseases we are facing in both schemes”.

The schemes are independent of each other in many aspects as well. Both are free to draw individual and scheme boundaries, along with choosing how many appropriators they can handle. They also choose when appropriators have access to water along with the quantity of weekly water use. Both rely on two separate rivers in the Kirk range and are experiencing different impacts on upstream users. In Chauluka, there are experiences much more upstream water use impact, these are mostly private riverside (*dimba*) irrigation sites. Schemes are also free to design their own rules, graduated sanctions, and intra-scheme conflict resolution measures. This includes the penalty severity as well. Both schemes have very similar graduated sanction and conflict-resolution measures. This may be because the majority of the founders of Kamwaza was previously members of Chauluka irrigation scheme and may have adapted similar rule-making structures.

The importance to distinguish the interdependency and independency is significant, as these two schemes do have two separate source rivers, but are interconnected intimately and have opportunities to improve, adapt and monitor their CPR management structures through increased coordination and dialogue.

A Critique of Ostrom's Design Principles in the Context of Self-Governed Irrigation Schemes in Rural Ntcheu, Malawi

Ostrom's (1990) design principles are intended to be tailored in a developing world context, however, all CPR arenas are different and are dependent on many various factors including culture, gendered division of labor, access to markets and interactions/coordination with local or national resource institutions. For this example, it was noticed that some of questionnaire items were not clearly understood and did not intimately relate to this rural Malawian context. Specifically, Principle Seven and Principle Eight.

Principle Seven and Eight are interrelated to autonomy. Ostrom (2002) explains, "when the rights of a group to devise their own institutions are recognized by national, regional, and local governments, the legitimacy of the rules crafted by appropriators will be less frequently challenged in courts, administrative and legislative settings" (p.1332). The criteria of Principle Seven states, "the rights of the scheme to design their own rules are not challenged by governmental and non-governmental authorities" (non-governmental authorities were intentionally added due to the historical involvement of NGOs in both schemes). Government authorities in this context would come in the form of agriculture extension workers or the NDAO. It was noted that government and NGO authorities have had little involvement in the scheme for many years and there is a consensus that more governmental involvement would be welcomed. Aside from elections and occasional visits, these self-governed and managed systems are physically and technologically isolated from all government authorities. Thus, it is not surprising to discover that their rules are not challenged. These agriculture extension worker's role is to accelerate broad-based sustainable agriculture methods to farmers in Malawi, along with offering improved technologies and institutional capacity building for irrigation schemes. Yet in Malawi, there is a major agriculture extension worker shortage. As of 2021, close to 1,700 extension workers are responsible for nearly four million farmers; that is equivalent to 2,500 to 3,000 farmers for one extension worker (Chavula, 2020). The criteria of this principle is crucial for effective CRPM, especially the governmental authorities' role is assisting these schemes in design effective rules, yet in this context, their rights to design their own rules are rarely challenged because there are incredibly isolated from governmental and NGO authorities.

Principle Eight plays off of the concerns with Principle Seven. Principle Eight is more applicable to CPRM that are in larger systems. The criteria of Principle Eight states, "National

government and local water management activities are well-integrated". These nested enterprises range in size from small to large and enable participants to "solve complex problems involving different scale economies in coordination with their government partnerships" (Ostrom, 2002, p.1332). In this research context, market and governing opportunities are limited in terms of local, regional and national scale, and the farmers are poorly connected to the existing, more competitive major markets (Mlangeni, Tsangango, and Ntcheu). Transportation to more local government offices or more competitive markets costs about MWK (Malawian Kwacha) 5,000-6,000 round trip. In this context, these Malawian farmers depend on subsistence production systems, mainly maize, beans, and potatoes and sell surplus produce in local, nearby markets. And finally, coordination of local and national water management activities is essentially non-existent from the context of these schemes. This questionnaires criterion was likely difficult to comprehend because there is limited capacity to coordinate or communicate with local and national water management institutions. Furthermore, alternative criteria's in this case should be considered. Principle Eight should be reduced in scope. For example, "regional government offices, extension workers and local resource sharing activities are well integrated".

Opportunities for coordination for self-governed small-scale irrigation schemes and local government in rural Malawi

The Ntcheu and Dedza districts of central Malawi are fortunate to have steep mountains that collect rain water and descend into the rift valley. Consequently, there is enormous potential for gravity fed small-scale irrigation capacity. However, there needs to be a concentrated focus on human and technical capacity building of these schemes in coordination with local water/agriculture institutions. The central aim should be to further expose what water resource governing and managing conditions exist in rural irrigation schemes to increase communities'

resilience to climate change, reduced food insecurity and enhanced conflict resolution tools for self-governed water systems in rural Malawi. A heavy reliance on government or non-governmental rehabilitation or financial capital from donor communities, NGOs or governments is not a sustainable approach for small-scale irrigation schemes in rural Malawi. Therefore, there needs to be participatory capacity building exercises with local agriculture district offices, NGOs and neighboring schemes. As there is a deficiency of available agriculture extension workers, I consider that local agriculture district offices should coordinate further integration and dialogue through existing inter-scheme district committees. In the context of Ntcheu, the NDAO should consider to recover the Lower Njolomole Irrigation Committee, not just for conflict resolution, but to establish a setting where schemes can represent their achievements, challenges, and visions. Its goal should be to establish a non-coercive, yet supportive relationship with the external authorities and irrigation committees, which can significantly shape strong endogenous self-governed institutions arrangements among the water users themselves. It can be a setting where schemes can empower each other, engage with agriculture extension workers, in an environment where most small-scale irrigation schemes are mostly isolated from government involvement.

In this case, I argue that the government should provide advice on more democratic scheme rule design which would require some necessary recommendations on scheme rules. The purpose would be to give more power to scheme members in decision making processes and monitoring activities. Other than that, their main duty should be to assist in funding towards irrigation related projects and agriculture extension related activities – such as pest and disease management or scheme infrastructure. Having collaborative, multi-scheme meetings with

government offices lowers the work burden on agriculture extension workers and empowers the irrigation users to share information a democratic manner.

Separately, as irrigation management transfers (IMTs) have been on the rise to meet high population density and food insecurities in Malawi, this strategy should be closely observed. As IMTs are consistent with global trends where once centralized natural resource sectors are then handed over to the users themselves, this should not evolve to be an excuse for the public sector to ignore self-governed irrigation schemes. There must to be a continued and positive relationship with local agriculture institutions that help facilitate the technical and managerial capacity of these schemes. This study exposed examples of what government or managerial structures exist in a rural irrigation schemes in a Malawian context. This demonstrates what works well and what does not, so further small-scale irrigation schemes in coordination with government officials can be better equipped to be more resilient to climate change, have enhanced food securities, and enhanced conflict-resolution tools for self-governed irrigation system in rural Malawi.

Limitations of Study and Directions for Future Research.

One factor that determines a sustainable impact of self-governed, farmer-managed irrigation systems are the initial or future investments in physical infrastructure or technical capacity from external funding's (NGOs, philanthropic donors, or governments). As the challenges of the dependency on external funding's of small-scale irrigation schemes was addressed, it is outside of the project scope. Additionally, the role that NGOs play in funding or managing CPR physical capital towards these rural self-governed irrigation systems should be a topic for future research, but it beyond the scope of this paper. While this research does incorporate gender into the conceptual framework of the study – and stratifying gender in

scheme member focus group discussions – a full gender analysis was not performed and was beyond the scope of the study. As the majority of scheme members were women and that the intergenerational land tenure is tied to women in this matrilineal and matrilocal cultural context, it is critical that further research asks what governing/managing mechanisms can be introduced to improve the adaptive capacity of women rural smallholder farmers in small-scale self-governed irrigation schemes. Further questionnaire surveys with all scheme members and committee members should be performed to depict a more accurate, confidential responses from individual members.

Language and cultural barriers were also present, which may have impacted what I heard, saw and interpreted. Language barriers may have impacted the accuracy of participant responses, specifically concerning the Five-Point Likert-Scale questionnaire.

In total, we interviewed 21 percent of scheme members from Chauluka *(n=27 of 130)* and 35 percent of scheme members from Kamwaza *(n=21 of 60).* Hereby, the accuracy of the participant responses also may be limited to the sample size and that research participants were chosen by the committee. We asked for a diverse sample size, but there was little oversight.

Further future research should replicate the use of Ostrom's (1990) Eight Design Principles in the context of self-governed, small-scale irrigation systems in rural central Malawi to verify and challenge results. Also, decentralization and democratization of self-governed irrigation schemes in rural Malawi should be a considered research topic. As the Malawian National Government both recognizes the need to expand irrigation technologies, further studies should measure the sustainability of IMTs, how democratic scheme rule designs are, and how integrated national and local water institutions are in these contexts. And finally, another topic of research should inspect the localized interactions and impacts of irrigation schemes on local

markets in the dry season. As smallholder agriculture is the main source of economic livelihood in the region, further work should examine what the impact of these schemes is on households that do not have access to irrigation systems.

Conclusion

This research contributes to a wider understanding of the commons as it provides a case study of how small-scale common pool irrigation systems are governed from a rural Malawian context. This study demonstrates the complexity of CPR water management, even in settings where CPR arenas seem to be homogenous in terms of culture, language, skills and interests. Elinor Ostrom's (1990) Eight Design Principles for self-governed CPR systems is a practical and useful tool to measure the institutional design structures of self-governed small-scale irrigation schemes in rural Ntcheu, Malawi. Analyzing Ostrom's (1990) design principles helped expose the strengths and weaknesses of these CPR arenas and revealed opportunities for improved institutional capacity building within and outside of these schemes. In addition, using the Kenneth and Kilmann (2008) conflict-handling model, this study was able to demonstrate that these neighboring irrigation schemes are often avoiding perspective schemes and has demonstrated limited political will to collaborate. Nevertheless, this may be due to the unproductive settings were such collaboration could occur.

This research presented several key findings. First is on the topic of irrigation scheme autonomy. Self-governed CPRM structures are observed to be mainly autonomous arenas where the appropriators themselves design and adapt design principles to manage and use a context specific resource. However, in this context, the autonomy of these schemes was met with almost no local or national government integration. Autonomous CPR systems does not mean that external authorities should be absent from these rural irrigation systems. In this setting, both

schemes require further technical and financial assistance and have been reliant on NGO support for the infrastructural designs of their scheme. Such a dependency and lack of institutional capacity has contributed to this dependency on aid organizations. It is then recommended that an alternative criterion for Principle 7 and 8 should be considered as scheme autonomy and coordination with governmental or non-governmental organizations are almost absent. Local and national governments should coordinate and invest in small-scale irrigation scheme infrastructural projects, so self-governed schemes can focus on designing democratic CPR institutions and less on improving infrastructural capacity. In addition, as schemes do have the autonomy to design their own rules, local governments and irrigation experts should propose schemes more democratic bottom-up forms of scheme governance rules so committee negligence or top-down forms of governance are less likely to occur. And lastly, further coordination should be facilitated through local agriculture district offices to improve coordination and cooperation between neighboring schemes for potential knowledge, skill, and relationship building. This can also be an opportunity for local agriculture officers to lower their work burden as Malawi has a dramatic shortage of agriculture extension workers to farmers (1:3,000).

Next, completing a comparative study of two neighboring schemes demonstrated the complexity and differences of CPRM in places that are homogenous and small in size. Even in these settings, challenges of unclear boundaries, top-down governance, fear of leaders, and mentions of gender bias were present. When considering applying these design principles to larger enterprises which may be heterogeneous, larger in size, more complex power dynamics, advanced irrigation infrastructure and varying interests, these design principles should be challenged in such arenas. No CPR arena is the same, but can these design principles be intercultural valid?

And finally, the study suggests opportunities for coordination and participatory engagement amongst neighboring schemes and external authorities. Firstly, these local irrigation schemes are interdependent on each other in several ways, including: local market crop prices, government coordination and scheme-elections. Both schemes plant similar crops and with further information sharing of what types of crops are being planted, they can positively influence local market supplies and demand. As access to major markets are limited, a focus on the impacts of local markets should be considered. This can be performed by sharing crop types in prospective schemes, along with increasing crop diversification. This is also related to joint-scheme pest and disease management activities, as both schemes are experiencing similar challenges. Lastly, further coordination and knowledge sharing of not just Chauluka and Kamwaza should be implemented, but of the entire representatives of the Lower Njolomole Irrigation Committee. This can be a setting which should be mediated by local agriculture offices and can accelerate rural Malawian irrigation schemes to envision an environment where schemes are more resilient to climate change, have improved food security and enhanced conflict-resolution tools for self-governed water systems in rural Malawi.

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Appendix

Appendix A – Comparative analysis of the governing structures of Chauluka and Kamwaza Irrigation Schemes.

Chauluka Irrigation Scheme

Total Membership: 130
- Men – 57
- Women – 73

Year Established: 2000

Irrigation Size: 52 hectares
- Three distribution blocks (A, B, C)

Irrigation Source: Mponda River

Average Individual Land Size from Sample Size: 0.82 acres
***Medium land size: 0.5 acres*
***Range of land size: 0.25-2 acres*

Committee: 7 men, 3 women
1. Chairperson
2. Vice-Chairperson
3. Secretary
4. Vice-Secretary
5. Treasury
6. Water Use Manager
7. Discipline Manager
8. Canal Manager
9. Crop Manager
10. Market Manager

Election Cycle: Three-year terms, no term limits

Membership Fee: MWK 2000
- New membership fee: MWK 10,000 + MWK 2,000 annual membership fee

Breakdown of annual fee
- MWK 1,000 water levy fee
- MWK 1000 membership fee
- Location of home village does not affect membership fee amount

How compensation is handled between renters and property owners:
- Construct ridges following irrigation harvest
- Money (amount negotiated with property owner); prices varied from:
  - MWK 2,000 per row
  - 0.5 acres: MWK 20,000 – 30,000

Most common crops planted (according to sample size):
1. Beans: 25
2. Sweet Potatoes: 22
3. Maize: 12
4. Tomatoes: 6
5. Irish Potatoes: 4
6. Peas: 2
7. Groundnuts: 1
8. Mustard Seeds: 1
9. Lettuce: 1

Members Access to Irrigation Scheme:

Kamwaza Irrigation Scheme

Total Membership: 60
- Men – 12
- Women – 48

Year Established: 2006

Irrigation Size: Did not get an exact answer, smaller than Chauluka
- Four distribution blocks (A, B, C, D)

Irrigation Source: Mbirimbite River

Average Individual Land Size from Sample Size: 0.65 acres
***Medium land size: 0.5 acres*
***Range of land size: 0.25-1.5 acres*

Committee: 7 men, 3 women
1. Chairperson
2. Vice-Chairperson
3. Secretary
4. Vice-Secretary
5. Treasury
6. Vice Treasury
7. Community Advisor
8. Visitor Coordinator
9. *Committee Member
10. *Committee Member

**These are elected members that are in supportive roles of the committee, especially in conflict-resolution measures.*

Election Cycle: Three-year terms, no term limits
- Has not had an election since 2018. Committee members two-years over term limit.

Membership Fee: MWK 2000
- New membership fee: MWK 10,000 + MWK 2,000 annual membership fee

Breakdown of annual fee
- MWK 1,000 water levy fee
- MWK 1000 membership fee
- Location of home village does not affect membership fee amount

How compensation is handled between renters and property owners:
- Construct ridges following irrigation harvest
- Money (amount negotiated with property owner); prices varied from:
  - 0.5 acres: MWK 6,000 – 20,000
  - 0.25 acres: MWK 24,000 and a small share of harvest to owner
  - 0.5-acre renter in dry season: MWK 4,000 vs MWK 20,000 in irrigation season

Most common crops planted (according to sample size):
1. Maize: 19
2. Sweet Potatoes: 19
3. Beans: 17
4. Tomatoes: 3
5. Peas: 2
6. Mustard Greens: 2

• Until all members are finished harvesting from the rain-fed season and have planted their seeds, the block distribution rule is not in effect. Until then, members must ask permission to water from the chairperson. There a date and time will be provided to that member. • Block Distribution Rule - One block waters at a time. Members in the next block is not allowed to water until all the members in that block is entirely finished. They have a max of four days to finish *(should verify this).* - Members must visually confirm this before using water. - Block water distribution managers for each block are responsible for responsible water use. - **Exception:** In the scenario that a member is in dire need for water, then the member must first ask the chairperson so the committee can organize and plan a date and time to use. • Some members have to water once a week, others have to water twice a week. This is dependent on your crop type.	**Members Access to Irrigation Scheme:** • Until all members are finished harvesting from the rain-fed season and have planted their seeds, the block distribution rule is not in effect. Until then, members must ask permission to water from the chairperson. There a date and time will be provided to that member. • Block Distribution Rule - One block waters at a time. Members in the next block is not allowed to water until all the members in that block is entirely finished. They have a max of four days to finish *(should verify this).* - Members must visually confirm this before using water. - Block water distribution managers for each block are responsible for responsible water use. • Some members have to water once a week, others have to water twice a week. This is dependent on your crop type.

Appendix B – Chauluka Irrigation Scheme Chairperson, Davis Chambo (right), stands next to the intake of the Mponda River of the Chauluka Irrigation Scheme.

Appendix C – Davis Chambo (grey shirt) and Geoffrey Mlongoti (red shirt) climbing to the Chauluka Irrigation Scheme intake. Water from the canal rushes down on the left side.

Appendix D – A photograph of the concreted canal of Chauluka Irrigation Scheme in May of 2023.

Appendix E – An example of how dirt and rocks are used to block water allocation at Chauluka Irrigation Scheme. Members are responsible opening and closing canals on their given water allocation intervals.

Appendix F – Vetiver grass planted along a walking trail at Chauluka Irrigation Scheme. Used to identify individual boundaries scheme boundaries.

Appendix G – A mature banana trees planted in Davis Chambo's property (Chauluka Chairperson) to identify his individual scheme boundaries.

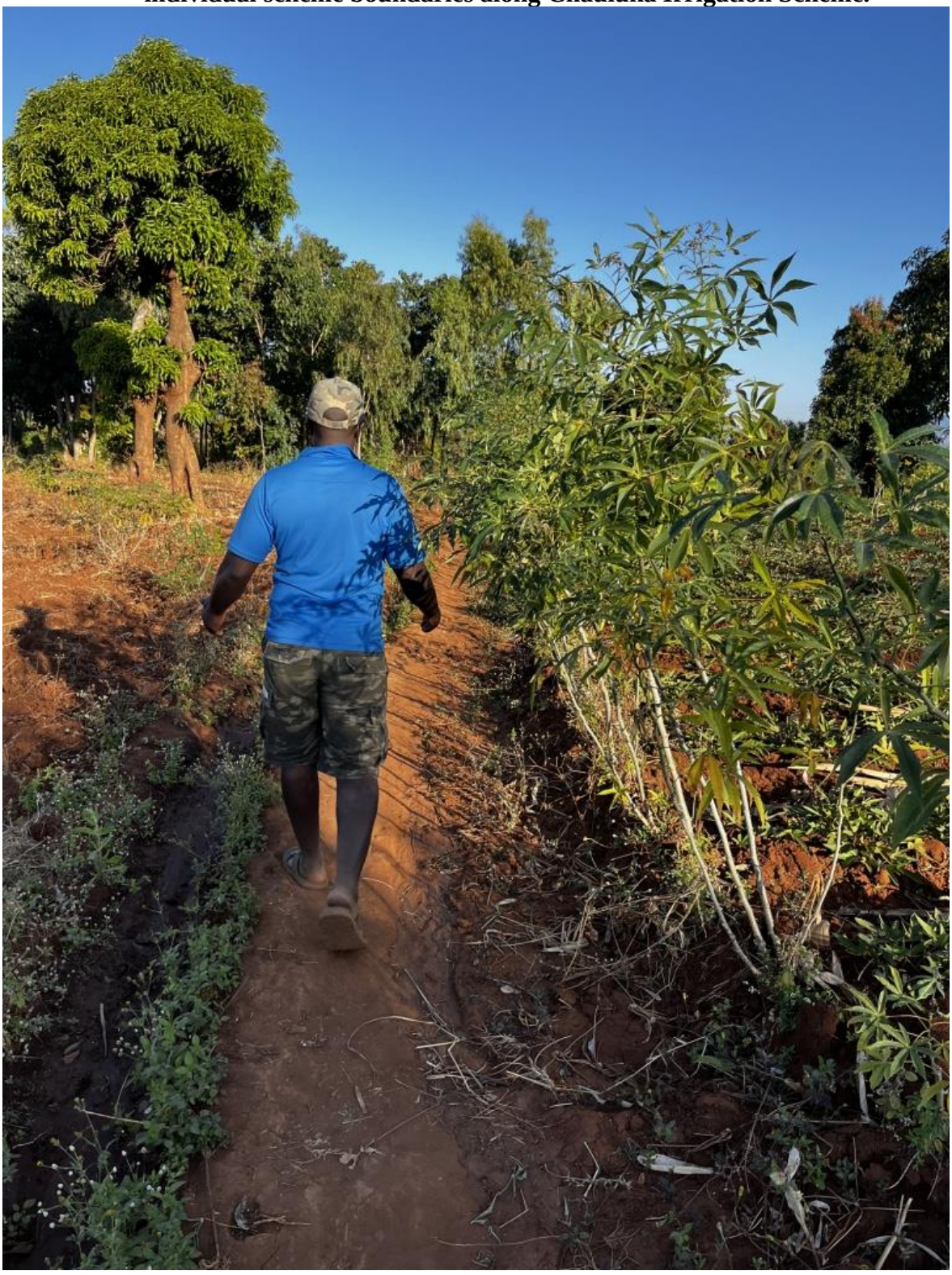
Appendix H – Two more banana trees planted on Davis Chambo's property (highlighted in yellow) to indicate personal scheme boundaries.

Appendix I – Overflowing water spillage from excess-watering in Chauluka Irrigation Scheme.

Appendix J – A male scheme member irrigating his crops in the evening light.

Appendix K – A maintained water distribution pipe located on the southern border of Chauluka Irrigation Scheme. Plastic wrap and local timber support the bridged pipe.

Appendix L – Geoffrey Mlongoti walks next to planted cassava (right) to indicate border of individual scheme boundaries along Chauluka Irrigation Scheme.



Appendix M – Kamwaza Irrigation Scheme's intake pool of the Mbirimbite River.

Appendix N – Kamwaza's Chairperson gazes east down the valley while standing at the intake of the Mbirimbite. Pipe runs north to divert water towards main canal.

Appendix O – Jameson Viah (Secretary) displays concrete slabs securing pipes transferring water across a sloped valley in the upper section of the Kamwaza Irrigation Scheme. Built in 2014 with NGO, CARE Malawi. Banana trees border a small river crossing.

Appendix P – A section of broken pipe resulting in water loss at Kamwaza Irrigation Scheme.

Appendix Q – A member illegally creates an opening in the main canal to their plot. An example of illegal water use at Kamwaza irrigation scheme.

Appendix R – An example of how dirt and rocks are used to block water allocation at Kamwaza Irrigation Scheme. Members have also planted vetiver surrounding main canal to secure the pipes.

Appendix S – The final concreted distribution box in the middle section of the Kamwaza Irrigation Scheme. This area marks the last of the concreted section of the scheme.

Appendix T – A section of the non-concreted main canal at Kamwaza Irrigation Scheme. Members try to lay down plastic sheeting to reduce water loss and soil erosion.

Appendix U – A distribution intersection held together by rocks and soil of the non-concreted section of the main canal at Kamwaza Irrigation Scheme. Tall, dry maize stocks surround the canal.

Appendix V – Water flowing downstream (east) to a scheme members plot at Kamwaza Irrigation Scheme.

Appendix W –Participant Informed Oral Consent Form

Hello, my name is George Kasch, and I am a student with the School for International Training Graduate Institute in Vermont, USA. In this research, I will be examining how the Chauluka and Kamwaza irrigation schemes, in the Ntcheu District, manage and govern their irrigation systems to compare how the two schemes are similar or different and also the presence or absence of joint-scheme conflict and collaboration. The objective of this research is to better understand how shared water resources are governed and managed from a rural Malawian context. This aims to explain what water resource governing and managing conditions exist to increase communities' resilience to climate change, reduced food insecurity and enhanced conflict resolution tools for self-governed water systems in rural Malawi. There are no obvious risks associated with the research, but if you are tired or do not want to answer, you have a right to not answer at any point. I would like to ask you some questions about your experiences and roles in the irrigation scheme, along with how the scheme is managed and how it is governed, to describe a clear picture of how this scheme operates. You must be 18 years of age or older to participate. The interview will not take up more than one hour of your time. You do not have to answer any questions if you do not wish to answer. You may stop the interview at any time without penalty or loss to benefits. Your comments will be confidential. You have a right to not participate in the study at any time. We will use this information for research and publication. If you have any questions or concerns, you can call me at: 0988062298 or Geoffrey at: 0995243199. Do you have any questions? Do I have your permission to proceed? Is it OK if I take written notes of our conversation?

Appendix X – Interview Guide: Focus Group Discussions

Gender Stratified Focus Group Discussions

Date and Time of Discussion: _____

Name of Scheme (Circle One): Chauluka; Kamwaza; Joint Scheme Discussion

Focus Group Type: Male Members; Female Members; Joint Scheme Discussion

Members Interviewed:

Names	Age	Gender: Male or Female	Irrigation Scheme: Chauluka or Kamwaza	Land Appropriated (hectares)	Crops Grown on Irrigation Property
1.					
2.					
3.					
4.					
5.					

(These focus group questions draws off of the instruments from the Muñoz et al. (2021) study)

1. Hello everyone, to start, can everyone please describe your relationship the irrigation scheme?

Member 1:

Member 2:

Member 3:

Member 4:

Member 5:

   a. How long has everyone been a scheme member?

Member 1:

Member 2:

Member 3:

Member 4:

Member 5:

b. Is everyone involved individually or as part of a family unit?

Member 1:

Member 2:

Member 3:

Member 4:

Member 5:

2. ***Principle 1: Clearly Defined Boundaries***
    a. How are the scheme boundaries drawn out and who participated in that process?
        i. Follow-up: Are the irrigation boundaries clearly defined?
    b. Who was involved in designing the irrigation boundaries?
3. ***Principle 2: Benefits/Costs***
    a. Are there benefits of being a member of this scheme?
        i. Follow-up: Are there disadvantages of being a member of this scheme?
        ii. Follow-up: How is the membership fee determined?
        iii. Follow-up: What is the cost for non-customary land users for using the scheme?
    b. Does everyone think that all members have equal access to those benefits (time, skills, irrigation technologies)?
4. ***Principle 3: Collective-Choice Arrangements***
    a. Can everyone describe how members are involved in modifying the current rules if such rules are inaccurately meeting your needs?
        i. Follow-up: Do you all feel comfortable bringing up your concerns or ideas to the committee?

b. What is the process for electing a committee chairman and committee members?

5. ***Principle 4: Monitoring***
    a. Who is responsible for monitoring the scheme (farmers/community/member households/executive committee)?

        i. Follow-up: How does everyone feel the obedience of the rules are going?

        ii. Follow-up: Does everyone feel the scheme is sustainable?

6. ***Principle 5: Graduated Sanctions***
    a. In the event that farmers violate or break the established rules, how does the scheme determine how severe the punishment will be?

    b. Do the members, traditional leaders, or both determine the severity?

7. ***Principle 6: Conflict-Resolution Mechanisms***
    a. In the event where violations occur (i.e. water is not distributed to them on their given day), where do members file their complaints?

        i. Follow-up: Based on the severity of the offence, what are the consequences?

    b. (*This next question is related to handling disputes with neighboring irrigation schemes*) Can anyone describe any previous conflicts with your neighboring scheme? If yes, how were they resolved?

8. ***Principle 7: Minimal Recognition of Rights to Organize***
    a. Is the government or non-governmental organizations involved in how you manage or govern your irrigation scheme?

        i. Follow-up: Does anyone feel like the scheme is too isolated from government or non-governmental authorities?

    b. Follow-up to Principle 8: Nested Enterprises
        i. Is the scheme coordinating with any governmental or non-governmental agricultural extension workers?

9. This will be my last question. For the purpose of this exercise, pretend that I am the scheme chairperson. What is one thing you would like to change regarding how the scheme is governed or managed?

Names	Age	Gender: Male or Female	Irrigation Scheme: Chauluka or Kamwaza	Position on Scheme

Joint-Scheme Focus Group Discussion (Kamwaza and Chauluka Irrigation Schemes)

1. Hello everyone. I would like to begin by asking how each scheme member to describe their goals and vision of their respective scheme?

Chauluka Irrigation Scheme

Kamwaza Irrigation Scheme

2. Have the schemes ever shared any information, knowledge or experiences with each other? (*If no, why not?)
    a. Do you see any benefits of sharing information, knowledge, or labor with each other?
3. Is there any cooperation with other neighboring schemes in the district?
    a. **If no**, is it because you find it difficult to make concessions with the neighboring scheme?
        i. Follow-up: Do you feel like failing to meet more frequently with each other or other schemes has an impact on the future prosperity of your irrigation schemes?

b. **If yes**, what are some benefits you consider from cooperating (future problem solving, resource sharing, joint gain)?

4. Can you describe any past conflicts the two schemes have had, if any?

    a. ***If 2006 scheme dispute is acknowledged, ask***: Do you feel like the scheme dispute that occurred in 2006 has an impact your cooperation and relations?

5. This will be my last question. What would be needed to shape a scenario for further joint-scheme collaboration?

Appendix Y – Interview Guide – Questionnaire Surveys

Scheme Members Questionnaire Survey

Date and Time of Discussion: _____

Name of Scheme (Circle One): Chauluka or Kamwaza

Name of Member Interviewed: _____

Age: _____

Gender (Check One): Male ____ Female ____

Land Appropriated (Hectares): _____

Are you renting the scheme plot? Yes _____ No _____

- If yes, how payment or compensation is handled:

  _____

- Home Village:

  _____

Crops Grown on Irrigation Property: _____

Approximate date/time you have access to irrigation scheme:

_____

Key Informant (Committee Member) Questionnaire Survey

Date and Time of Discussion: _____

Name of Scheme (Circle One): Chauluka or Kamwaza

Name of Member Interviewed: _____

Age: _____

Gender (Check One): Male ____ Female ____

Position on Committee:

_____

Duties: _____

Land Appropriated (Hectares): _____

Crops Grown on Irrigation Property: _____

Approximate date/time you have access to irrigation scheme:

_____

Principle or Criteria	**Results**
Clearly Defined Boundaries	
Benefits and Costs	
Collective-Choice Arrangements	
Monitoring	
Graduated Sanctions	
Conflict-Resolution Mechanisms	
Minimal Recognition of Rights to Organize	
Nested Enterprises (Coordination in Governance Across Scales)	

(*The following draws off the questionnaire items adopted in Burbach, et al. 2022*)

Principle or Criteria	Survey Item
Clearly Defined Boundaries	Irrigation boundaries and rights to water use is clearly defined. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *How are your irrigation boundaries defined?*
Benefits and Costs	The benefits of using water resources outweigh the costs of developing, managing, and using the irrigation scheme. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *Do you think the benefits of this scheme are equally available to all members?*
Collective-Choice Arrangements	Members are able to influence regulations put in place to manage irrigation scheme. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *Do you feel that the committee adequately includes members into their decision-making process?*
Monitoring	Overall, there are effective methods in place to monitor people's use of water. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *How do the scheme rules determine that both scheme and committee members are adhering to the rules?*

Graduated Sanctions	Sufficient penalties are enforced for failing to abide by water use regulations. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *Can you provide examples of severity for rule breaking?*
Conflict-Resolution Mechanisms	Adequate regulations are in place to resolve local and neighboring water conflicts. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *(This question is related to neighboring scheme management) Do you have a desire to cooperate or work with your neighboring scheme (Chauluka or Kamwaza), in terms of sharing knowledge, skills, or information?*
Minimal Recognition of Rights to Organize	The rights of the scheme to design their own rules are not challenged by governmental authorities or non-governmental organizations. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *Does the government have any power in how you all govern or manage your scheme?*
Nested Enterprises (Coordination in Governance Across Scales)	National Government and local water management activities are well integrated. 1: "Strongly Disagree" 2: "Disagree" 3: "Neither agree or disagree" 4: "Agree" 5: "Strongly Agree" *Question:* *Do you feel the local agriculture office is well integrated into the management of this scheme?*