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Irrigation and Equality: An integrative Gender-Analytical Approach to Water Governance with Examples from Ethiopia and Argentina

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ABSTRACT: This paper proposes the use of an integrative framework for better conceptualisation and operationalisation of research geared toward understanding irrigation systems, practices and processes, especially as relates to gender equality in water governance. More specifically, it discusses the importance of developing an integrative gender-analytical approach that enables both researchers and practitioners to analyse the complex interactions between technical and social dimensions of water governance, in order to determine how they contribute to, and thus effect, the overall success and sustainability of irrigated agriculture. Consequently, this paper provides a detailed account of the framework's key components; including how it is informed by feminist, ecological and sociological theories. There is also an account of the framework's practical application through a focus on specific outcomes in the dynamic field of water governance. To this end, the paper presents some results derived from an application of the integrative gender-analytical framework on data from a comparative study of small-scale irrigation systems in Ethiopia and Argentina. Ultimately, the goal of this paper is to promote a more nuanced and holistic approach to the study of water governance—one that takes both social and technical dimensions into similar account; particularly, if the aim is to promote broader social equality and the sustainability of irrigation systems.

KEYWORDS: Small-scale irrigation, gender-analytical framework, water governance, social relations, Ethiopia, Argentina

INTRODUCTION

Irrigation development is a critically important strategy to increase agricultural productivity, secure agricultural livelihoods, enhance food security and, overall, overcome rural poverty for a large number of smallholders in diverse parts of the world (van den Berg and Ruben, 2006; Namara et al., 2010; Gebrehiwot et al., 2015). The question of equality – regarding access to resources, participation in managerial decisions and benefit distribution – in connection with sustainability and long endurance of communal irrigation systems is an ongoing subject of study and debate (Baland and Platteau, 1999; Ostrom, 2011; Lecoutere, 2011; Senanayake et al., 2015; Oates et al., 2017). This is particularly relevant today as traditional, hierarchical, top-down water management institutions undergo transition processes towards more inclusive forms of participation (van Buuren et al., 2019). It is well documented that within small-scale irrigation systems (SSIS), women are significant users of irrigation water (Wallace and Coles, 2005; Bennett et al., 2008). And yet, globally, gender differences remain evident in participation in irrigation scheme management and representation of water users in local irrigation governance structures, where male leadership dominates (Zwarteveen et al., 2010; Yami, 2013). A multitude of issues related to gendered social relations of power converge here, including control of and access to water (and other resources), traditional roles in the division of labour, unequal education opportunities, differentiated benefit-sharing mechanisms and incentives structures, and uneven gender participation

and representation (Zwarteveen, 2008; D'Exelle et al., 2012; Agarwal, 2018). In many places, women continue to be deprived of secure tenure rights to land, while access to agricultural water rights from common water sources is usually dependent upon such land entitlements (Meinzen-Dick, 2014). This is a persistent source of gender difference and inequality that hinders poverty alleviation efforts (Agarwal and Herring, 2013; Meinzen-Dick et al., 2017).

While conducting gender assessments is now a required standard practice in most internationally funded natural resource management (NRM) and agricultural development programmes, advances in gender equality in the irrigation sector are not always commensurate with the gaps identified. This seems to be at odds with the urgency of the problem (Lefore et al., 2017; Imburgia et al., forthcoming). A thorough understanding of the dynamics of gender involvement in self-governed communal SSIS is fundamentally important to devise sound technical and policy interventions for equitable economic livelihood development and food security (Domènech, 2015; Theis et al., 2018). It is also a necessity in the analysis of complex interactions within and between the social and technical dimensions of irrigation agriculture. In the study of water governance and equity in irrigation systems, there are scholars who have robustly integrated diverse theoretical perspectives, including an analysis of power (Brisbois and de Loë, 2016) and intersectionality, as relates to water, gender and other social differences (for examples, Thompson, 2016; Harris et al., 2017). It is argued however, that these theoretical approaches are difficult to be used as operational tools (Hanson and Buechler, 2015).

On the other hand, researchers and development organisations have elaborated various operational methods to collect and analyse gender-sensitive and gender-responsive data. For example, the Irrigation Learning and Improvement Tool (GILIT) (Lefore et al., 2017) and the Gender Performance Indicator (Van Koppen, 2002), offer mechanisms for scoring gender performance in small-scale irrigation schemes and projects based on pre-established sets of premises. Further, the Women's Empowerment in Agriculture Index (WEAI) is used to measure women's empowerment in agriculture by scoring key agricultural themes, including production, productive resources, incomes, leadership and time allocation (Alkire et al., 2013). While these tools contribute useful ways to systematically collect data and structure analyses, their quantifications are insufficient to understand and characterise socio-cultural and subtle power relations, as well as underlying drivers of gender difference (Akter et al., 2017). In addition, their effective implementation can be onerous and time-consuming; especially when considering that development projects often only have very short time-frames available to conduct comprehensive gender and livelihood analyses.

From this premise, it becomes clear that there is the need for a comprehensive and theoretically robust framework that allows the capture of holistic views of the complex interactions inherent to the operation and governance of natural resources, including irrigation systems. This paper addresses this issue through the provision of an integrative conceptual framework that does not pose high operational challenges. More specifically, as a gender-analytical framework, it seeks to examine a key question: *what are the outcomes of the interactions of gender, social relations and irrigation practice within the context of collective water governance?* The range of processes that govern these interactions are relevant to provide a comprehensive and nuanced understanding of how NRM, including water management, is gendered.

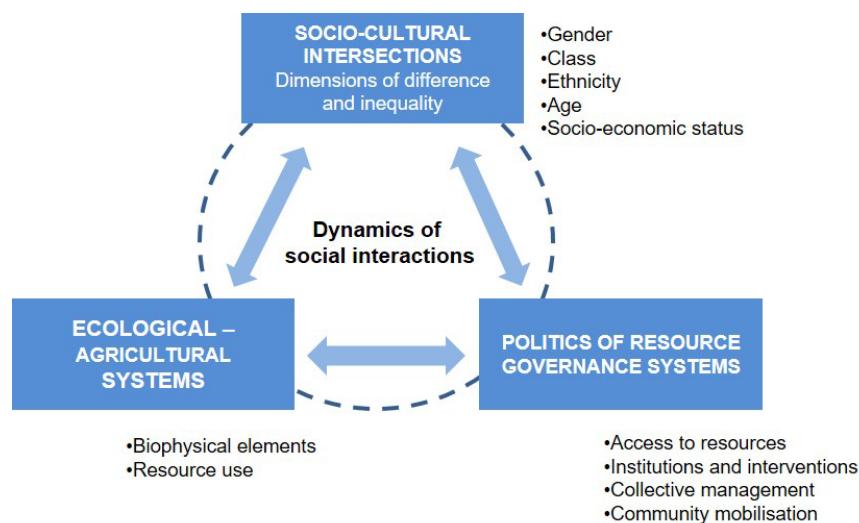
The paper therefore offers the framework to be used for the identification of key NRM and social inequality problems that are gendered. It does so by first providing a review of existing analytical approaches; thus discussing key insights from the literature in order to develop a conceptual framework that is suitable for gender analysis. The framework is then used to design and interpret a study of self-governed communal SSIS of Ethiopia and Argentina. These examples illustrate gendered differences in the access, use and participation of different groups of irrigation water users. Reflections on the application and the usefulness of the framework, as well as policy and practical implications, are also presented. The paper therefore seeks to contribute to ways in which involvement of different groups of women and men in communal small-scale irrigation can be explored.

THE INTEGRATIVE GENDER-ANALYTICAL FRAMEWORK TO WATER GOVERNANCE

The conceptual framework proposed here aims to make visible two important aspects that have received only partial attention in the literature about women, gender and irrigation: (1) the intersections between technical properties of irrigation systems and practices derived from social interactions in collective irrigation water governance; in particular, gender roles and relations, and (2) the effects of those interactions in livelihood strategies. The framework is rooted in three theoretical concepts: feminist political ecology (FPE); social-ecological systems (SES) and social relations framework. These theoretical bodies offer useful analytical elements for the construction of the conceptual framework, as outlined below.

The FPE framework is useful to show how environmental policies and practices are influenced and defined by social, economic and political balances of power (Rocheleau et al., 1996). This framework understands all social relations as determinant variables, which explain local and global ecological, economic and development processes. It also assumes the existence of social differences and inequalities, in particular those related to gender (Rocheleau et al., 1996). Scholarship on FPE has been expanding at various levels as a need to theoretically contribute to current critical development and environmental matters (Harris, 2015).¹ Applied to an irrigation system collectively managed by different users, an expanded FPE is conceptualised here as an interconnected arrangement of socio-cultural intersections, ecological-agricultural systems and governance arrangements. Figure 1 below shows selected elements of the expanded FPE, which have been utilised for the development of the gender-analytical framework as shown later as Figure 3.

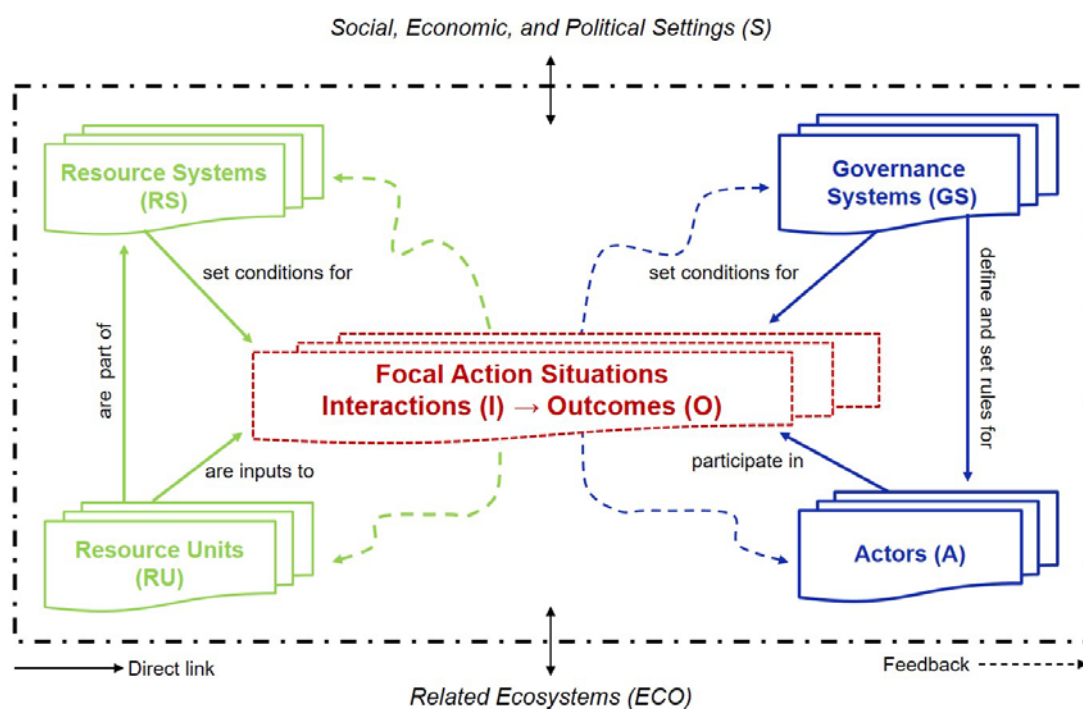
Figure 1. An extended feminist political ecology (FPE) conceptual approach, adapted by the author based on conceptual expansions of the FPE (Buechler and Hanson, 2015; Harris, 2015).



¹ Thematic expansions useful for the current study include: the dimensions of difference that intersect gender with other social characteristics such as ethnicity, race, poverty, and 'coloniality' (Harris, 2015: xx); the legal frameworks for property rights (Vaz-Jones, 2018); the increasingly complex environmental contexts of degradation, depletion of natural resources, and climate change (Harris, 2015); and the global socio-economic contexts such as massive migration movements (Momsen, 2017). There have also been thematic expansions that include multiple scales of analysis (Nightingale, 2015), issues of resource governance (Adams, Juran and Ajibade, 2018), and production systems based on the management of natural resources and agricultural systems (for example, Buechler, 2015).

To introduce robustness to the 'ecology' dimension of the FPE framework, both conceptually (Najjar, 2015) and methodologically (Hanson and Buechler, 2015), the expanded FPE perspective is combined with the conceptualisation of a communal irrigation system as a social-ecological system (SES).² Useful here is the definition of SES by Anderies et al. (2004: 6) as "the subset of social systems in which some of the interdependent relationships among humans are mediated through interacting biophysical and non-human biological units", resulting in complex systems of multiple subsystems and larger systems. Building upon this reasoning, Ostrom (2007) proposes a "diagnostic method" that reflects complexity by organising variables into tiers at different levels, which can be further unpacked into multiple conceptual tiers (McGinnis and Ostrom, 2014) as shown in Figure 2 below. Not all variables in a sub-system are relevant in analysing a given SES, and they function as "partially decomposable systems" (McGinnis and Ostrom, 2014); this feature is particularly useful for the proposed gender-analytical framework as it allows sufficient flexibility to analyse particular aspects of any natural resource system.

Figure 2. Revised SES framework with multiple first-tier components (McGinnis and Ostrom (2014), permission granted by the first author).



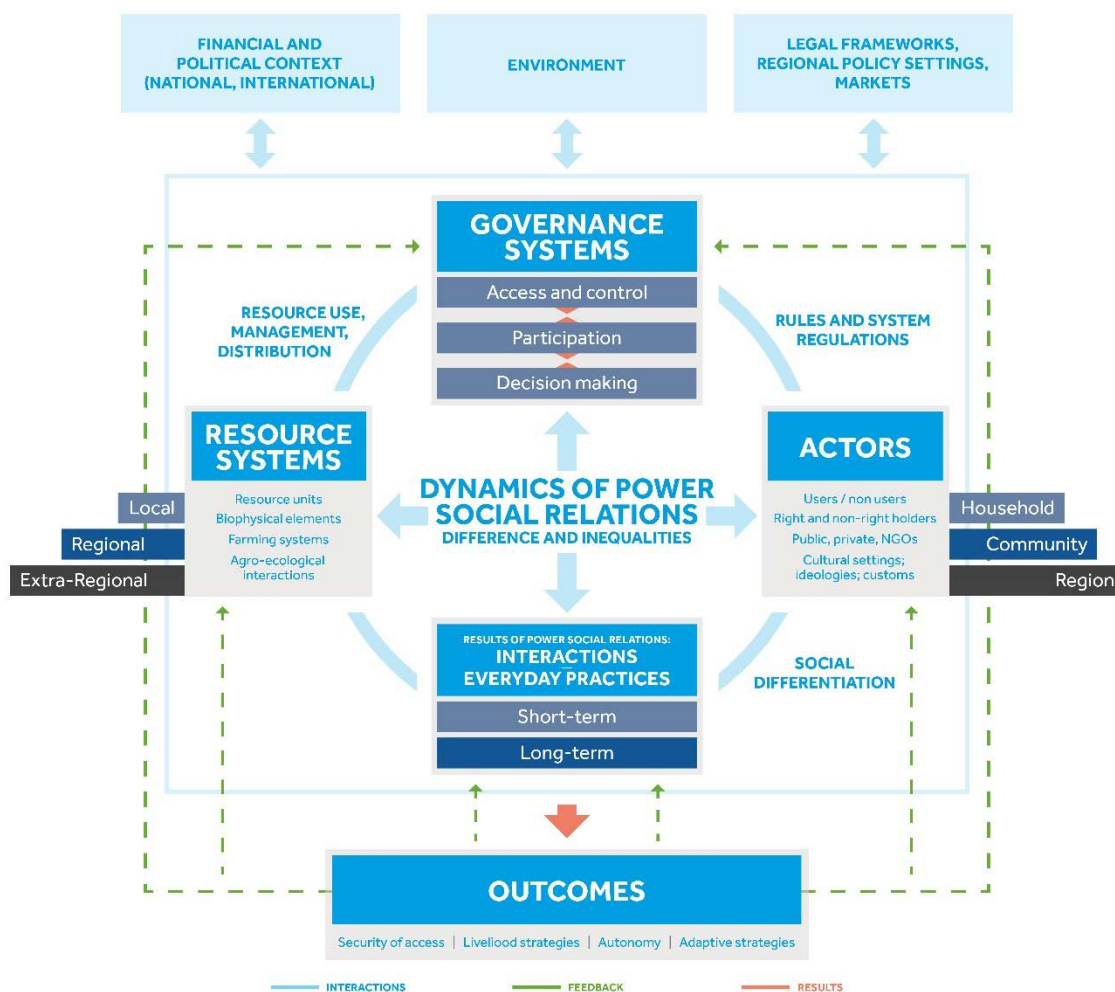
It is acknowledged that a comprehensive analysis of social relations of power appears to be missing within the Ostrom SES approach (Fabinyi et al., 2014); in particular, considerations of gender differences in the use and management of resource systems (Łapniewska, 2016). In order to address this limitation, three useful elements of the social relations framework (Kabeer, 1994; Kabeer and Subrahmanian, 1996) are drawn upon and connected to the combined expanded FPE and SES frameworks: (1) social relations between people, (2) relationships of people to resources and activities, and (3) configurations of those relationships and institutions. Thus social identities, roles, responsibilities, rights and control over one's self and others are understood as originating from social relations (March et al., 1999).

² The linkage between FPE and SES frameworks is described as useful, by Buechler (2015), for examining interactions between activities performed by gender and ecological systems.

The notion that gender identities, roles and relations comprise what is known as 'socially constructed' and therefore not immutable has been widely adopted within gender and development scholarship. It is also a core concept of the gender-analytical framework proposed in this paper. Dynamics of gender relations are shaped, even modified by different factors including: access and control of resources and bargaining power (Agarwal, 1994, 1997); constraints imposed by family relationships, commonly expressed as patriarchal models (Kabeer, 2011); balance of power and 'ability to exercise choice', i.e., agency (Kabeer, 1999); gender awareness (Kabeer and Subrahmanian, 1996); and development policies and their influence in modifying the balance of power between women and men (Momsen, 2010).

In many agricultural contexts today, common gender roles are changing and, in some places, quickly. The drivers of change are complex and context-specific. For example, in some places a 'feminisation' of agricultural activities is evident (Radel et al., 2012; Pattnaik et al., 2018) while in others, this process is less clear (Palacios-Lopez et al., 2015). Therefore, the development of an integrative gender analysis of NRM requires elements that broaden understandings of *who* accesses and uses the resources and *how*. This is done here by examining configurations of social relations of power as a core element of the conceptual framework filtering and/or catalysing the SES processes. By combining the above discussed elements of the expanded FPE, SES and social relations approaches, the gender-analytical framework for examining the dynamics of social relations driving the processes and outcomes of NRM governance is established and illustrated in Figure 3.

Figure 3. An integrative gender-analytical framework to natural resource governance.



In the application of the above conceptual framework, three key variables of resource governance are emphasised: access and control through property rights; participation in institutions of collective resource use, i.e., water users' associations (WUA), and decision-making regarding management practices. The resource systems (e.g. communal SSIS) are self-governed by diverse types of actors that include female and male farmers, who hold diverse land tenure rights. Other relevant actors are water- and agriculture-sector officials, and the private sector. These actors interrelate, producing certain dynamic social relations of power. In so doing, a number of overarching interactions emerge such as resource use, management and distribution; rules and system regulation; and social differentiation. These interactions materialise in everyday activities (Kabeer, 1994) related to the irrigation practice. In combination these elements produce governance outcomes that synthesise the core elements of the functioning of the irrigation governance system.

The remainder of this paper is a discussion on the application of the integrated gender-analytical framework to examine gendered outcomes of collective governance within small-scale irrigated agriculture in Ethiopia and Argentina. Focusing specifically on these outcomes (see the bottom of Figure 3) will help describe the most critical factors and mechanisms of women's and men's involvement in resource management. In order to contextualise the gendered governance outcomes, the next section will briefly describe resource systems, actors and governance systems.

METHODOLOGICAL APPROACH

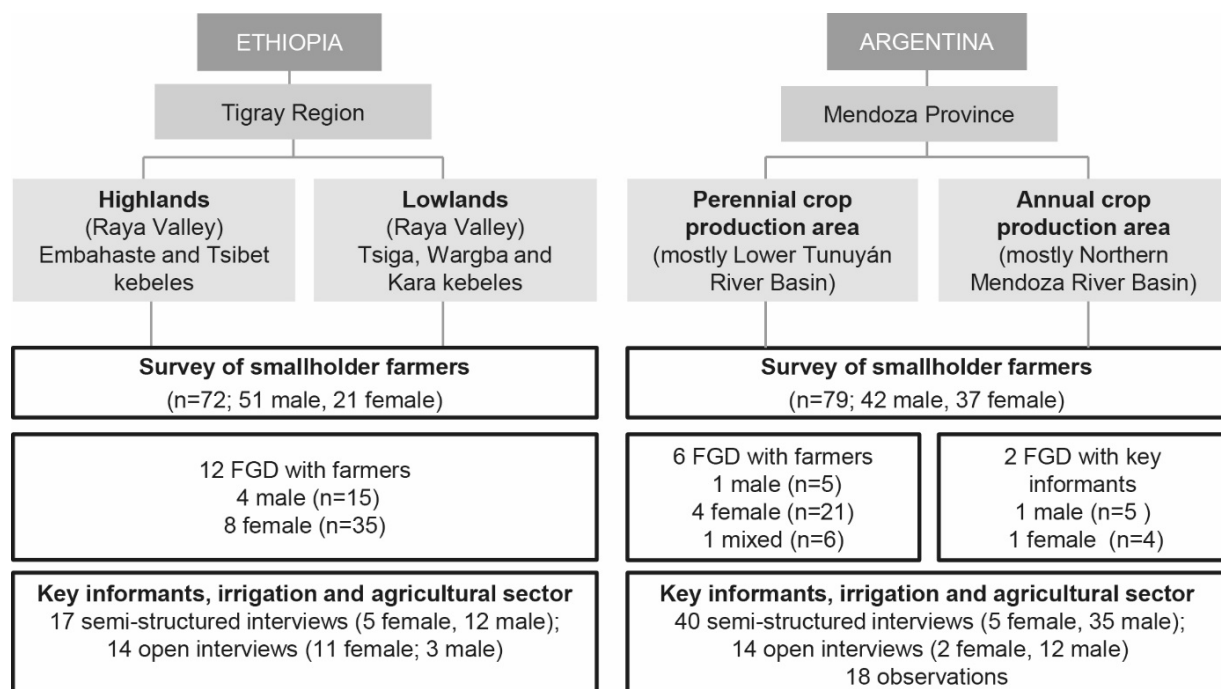
A high diversity of data was required to test this integrative gender-analytical framework. This diversity was pursued through two main approaches: first, designing a multicase study in two countries, and second, by using a mixed-method research approach. This research strategy proved useful in capturing a broad variety of aspects from two contrasting countries. It allowed for the systematic collection and analysis of both qualitative and quantitative data.

The data for the multicase study was collected from southern Tigray (northern Ethiopia) and northern Mendoza (centre-west Argentina), during 2016-2018. The selected study sites offer a representation of diverse irrigation and cropping systems, as well as socio-cultural backgrounds. Data collection was undertaken in both locations using a mixed-method approach, which included a survey, in-depth interviews, focus group discussions (FGDs), and direct observations as shown in Figure 4.

A cross-sectional³ stratified survey was used to obtain quantitative characterisations of the local resource systems, with a focus on the agricultural livelihoods of the SSIS studied. Participants of the survey were smallholder female and male farmers who used irrigation and were members of WUAs. In each country, the survey questions related to gender roles and distribution of labour in productive and domestic work, household livelihood structure, irrigation water access and management, and participation in WUAs – including their influence on gender equality.

In-depth interviews were conducted with a purposeful sample of female and male informants, including farmers, leaders of WUAs, central water agency officials, and irrigation and agricultural experts at district and local levels. The questionnaires focused on understanding the agricultural production and the irrigation governance systems of each research location. Questions regarding the differentiated roles of different groups of women and men in the irrigation sector were also included in all interviews. Additionally, semi-structured FGDs with purposively selected female and male farmers were used to obtain views, experiences and ideas regarding everyday interactions and practices of actors in the selected SSIS. A background depicting age, marital status and socio-culture was pursued.

³ Data was collected in one point in time.

Figure 4. Study locations in Tigray and Mendoza including sample size (Imburgia et al., forthcoming).⁴

Data analysis was done through the coding and thematic analysis of qualitative data, and the utilisation of descriptive statistics. Thematic interconnections between qualitative and quantitative data were explored and synthesised into an analytical scheme. The resulting categories were related to the themes defined in the conceptual framework. The results informed all adjustments made to the framework.

CONTEXTUAL CHARACTERISATION OF THE STUDY LOCATIONS

In Tigray, the study was conducted in the Raya Valley, a semiarid area with an agriculture-dependent economy. In this region, 86.4% of households practise farming, and the large majority of these households are smallholders (WWDSE&CECE, 2014). Rains follow a bi-modal pattern, and are usually scarce and erratic. The government is supporting the expansion of irrigated agriculture to improve food security (Gebrehiwot et al., 2015).⁵ All respondents from the survey obtained income from irrigated crop sales. Livestock was also an important additional income source for people (as indicated by 83% of respondents in the highlands and 56% in the lowlands). Surveyed women and men were found to be growing similar crops, mostly cereals for household use with some surplus for the market in rain-fed plots, plus vegetables, cereals, pulses and fruits, mostly for the market in irrigated plots. All farmers interviewed utilised traditional low input agricultural practices to cultivate the farm plots.

In the highlands of Tigray, all irrigation is done with surface water distributed through communal earthen and lined channels, and furrow irrigation systems. In the lowlands, smallholders used groundwater lifted by electric pumps and distributed by furrows and pressurised irrigation systems (drip

⁴ *Kebele* is the Amharic word for sub-district.

⁵ By 2017, the total irrigated area of Tigray was 50,083 ha (based on data from the Tigray Regional Water Bureau) (Tewolde, 2019). In the lowlands of Raya Valley, a regional governmental programme of irrigation modernisation has drilled deep wells and installed pressurised irrigation systems for smallholders. The programme includes the creation of WUAs, and management and cost transfer to farmers (source: In-depth interviews to officials of the Regional Water Bureau, Mekele, February, 2016).

and sprinklers). All rights and responsibilities of access and use of irrigation water are by law, inherent to land rights and, thus, become operational by participation in a WUA.⁶ In the highlands, the formation of WUAs to collectively manage surface water is voluntary. Once an organisation is established, however, anybody who has land (that they wish to irrigate) in the WUA service area must become a member. The collective management of groundwater in the lowlands is performed by WUAs that have been established by the Water Office and participation is mandatory. Although in interviews with the regional Water Bureau it was mentioned that WUAs have a quota of women participating in water committees, this was not verified on the ground. In most WUAs interviewed (except one in the highlands) interviewees denied having to fulfil a gender quota for women.⁷

In Mendoza, the agriculture sector relies exclusively on irrigation due to the prevalent arid conditions. Data for this study were collected in irrigated farming areas of the Mendoza and Lower Tunuyán River Basins, where SSIS are important: an average of 62% of the farm land is occupied by family farms of up to 10 ha and an average of 48.3% of farms have less than 4 ha; farm sizes considered as medium and small scale, respectively, in the local context (Imburgia, 2017). In the perennial horticulture areas, plots are commonly dominated by one crop (mostly wine grapes) and stone fruits. In the annual horticultural areas, farmers rotate several vegetables per season. Recurrent economic and political crises in Argentina, with high inflation rates, huge cost increases and currency devaluation, undermine the profitability of the agriculture sector (Imburgia et al., forthcoming).

Surface water and groundwater are both used for irrigation in the study localities of Mendoza. Most SSIS surveyed use furrow and flood irrigation. Interviews with key informants revealed that a large part of the existing irrigation schemes require modernisation of hydraulic structures and implementation of water conservation measures (e.g., water-saving irrigation practices, water reservoirs, and crop demand-led water distribution) in order to adapt to the severe and persistent drought of the last decade and to meet the growing demand of competing (urban, rural and industrial) water uses. The central water administration of Mendoza does not have a gender equality framework in place.⁸

OUTCOMES OF SMALL-SCALE IRRIGATION SYSTEMS VIEWED THROUGH AN INTEGRATIVE GENDER PERSPECTIVE

In applying the proposed gender-analytical framework on communal SSIS in Ethiopia and Argentina, four key interrelated governance outcomes (shown in Figure 3) were identified: the functioning of the SSIS provided variable degrees of (1) security of access to water, which in turn conditioned (2) security of livelihood strategies and (3) the autonomy of individuals and communities to make informed decisions, lead resource management and solve collective-action problems. In addition, certain (4) adaptive strategies were used by farmers to protect their well-being or at the very least, their survival, especially from the variability and unpredictability of climatic patterns. For the purposes of this paper, this section presents the empirical evidence organised according to an analysis of those outcomes under a gender perspective, at both the household and local levels.⁹

⁶ Different types of WUAs were found in Tigray; i.e., formal irrigation WUAs registered in the Water Office, irrigation cooperatives registered in the Agricultural Office, and informal non-registered WUAs. A recent governmental Proclamation (nº 841/2014) provides detailed stipulations for the establishment of irrigation WUAs within the context of decentralisation and transfer of irrigation and drainage services to users (MWIE, 2014). The policy intends to amend the observed problematic governance of irrigation schemes due to the lack of differentiated roles of agricultural cooperatives and WUAs. Those problems were also reported by Yami (2013).

⁷ The governmental Proclamation on irrigation WUAs (nº 841/2014) does not mention a female quota for WUAs (MWIE, 2014).

⁸ The central water agency of Mendoza does not request conducting gender analyses for any of their management activities, except for the implementation of projects of modernisation or expansion of the irrigation infrastructure funded by international credit institutions.

⁹ Complementary fieldwork results and findings are presented in Imburgia et al. (forthcoming).

Security of access

Data analysis of the two case studies indicates that the degree of security of access to irrigation water is conditioned by the legal framework in place, which impacts reliability and affordability of the resource. However, the capacity of farmers to actually use the irrigation water provided depends on factors that transcend the legal framework, the amount of water available, access to land and their gendered characteristics. A critically important factor is, for example, the physical ability of farmers to perform routine tasks of irrigation agriculture. As will be discussed below, technical properties of irrigation systems determine to a very large extent the corresponding physical work demand. Obviously, there are important gender differences in the ability to cope. Likewise, domestic workload, a well-recognised gender factor (Centrone et al., 2017) constrains the ability of female farmers to perform the work necessary to actually benefit from the availability of irrigation water.

In both countries, legal access to irrigation water is conditioned by access to land. All users with irrigated land rights are entitled to water rights from the corresponding communal irrigation schemes. This basic entitlement extends to the charter of WUAs with their rights and obligations. In Tigray and Mendoza, women in the survey had less independent land titles than men as was also found in farmer registries provided by WUAs.¹⁰ In Tigray, of all interviewed farmers holding land certificates (n=62)¹¹, 22.6% were women as sole landowners, 59.7% were men as sole landowners and 12.9% were joint registrations, while rest at 4.8% did not know. Since the recent implementation of a land policy change in Ethiopia¹², more women are entitled to register land certificates in their own names (Holden and Tilahun, 2017). During data collection in 2016, these policy revisions had not been fully instituted in all of Tigray; however, by the 2018 data collection period there was substantial progress as an increased number of single and married women described having land certificates in their name. In Mendoza, of the surveyed farmers owning land (n=69), 21.7% were women as sole landowners, 8.7% had jointly registered titles with their husbands and 69.6% were men as sole landowners. In Tigray, all of the women surveyed (except one), who had their own land entitlements, were also heads of households (93%). In Mendoza, this was not the case – since only 20% of the interviewed women owning land belonged to female-headed households; whereas, 40% belonged to male-headed households and 40% to dual-headed households (wife and husband present).¹³

The prevailing gender difference in land tenure in Ethiopia and Argentina may be explained by both countries having land policies that enable women to independently acquire land; however, women are still constrained in exercising those rights due to prevalent structural inequalities such as lack of own capital, their lower societal status, and other socio-cultural restrictions (Imburgia et al., forthcoming). Similar findings were noted in previous studies in Ethiopia (Berhane and Miruts, 2015; Dokken, 2015). In Mendoza, where the private property inheritance regime is egalitarian for both women and men, it was found that not all the women in the survey owning land were making decisions on the agricultural use of their farms. In many cases, they did not even control the profits from their farming activity. Of the female respondents holding independent land titles in Mendoza, only 11% made farming decisions on their own.

¹⁰ For detailed analysis of official registries, see Imburgia et al. (forthcoming).

¹¹ The rest of farmers surveyed in Tigray leased land (2 farmers) and used a communal irrigated land, which use was granted by the *kebele* office.

¹² Traditionally in Ethiopia, land right certificates were commonly issued in the name of the head of the household, who tended to be male. In contrast, due to the Second Stage of Land Registration and Certification (SSLR) law, started in 2014, land acquired jointly by spouses can be registered jointly. At the same time, the law enables the addition of wives' names on older land certificates. In addition, young single women can register farming plots in their own names. This is land that they have inherited from their parents or else have received through government land distribution.

¹³ In rural Mendoza, the female/male-headship classification does not always match how families consider their intra-household roles. Whereas these categories are observed in elderly households and those of Bolivian origins, among younger families, a higher awareness of gender equality matters in terms of income generation and decision making. This renders this classification less useful.

Of the remainder of the cases, 36% made decisions jointly with their husbands, and in 53% of the cases only husbands or male relatives were the decision-makers.

Less access to land rights not only implies less independent water rights for women but also less independent membership in WUAs as stipulated by the legal frameworks of Tigray and Mendoza. This implies that those women not being independent members in WUAs do not attend managerial meetings; their water needs are probably mediated by their husbands or male neighbours; they are not called for trainings and do not have the opportunity to become members of managerial water committees.

Holding legal water rights and being members of WUAs, however, may not necessarily guarantee sufficient water at the time people need it; water access for smallholders was found to be strongly linked to the condition of the hydraulic equipment and infrastructure. This technical dimension of irrigation agriculture clearly influences the ability of women and men to reliably and affordably access water. Most of the irrigation infrastructure found in the study areas of Tigray and Mendoza consists of earthen channels, which require significant physical effort for routine cleaning for water distribution. Furthermore, in both study locations, most farmers irrigating with surface water were using irrigation systems that require opening and closing furrows with a hoe. This causes disproportionate difficulties for women to practise irrigation because of the physical demand. Therefore, women need the assistance of family members or hired labour to practise irrigation. In the lowlands of Tigray, where most of the new irrigation systems established by governmental programmes are pressurised, women find it easier to irrigate – as there is no need to construct furrows with oxen or to distribute water manually.

In all study locations, maintenance of irrigation infrastructure was deficient (e.g. broken canals and water gates, infilled reservoirs). As a result, water is often not properly distributed to all farms. This requires negotiations with neighbours and WUA leaders to re-arrange water turns. Men usually have more mobility and social connections with WUA leaders and are less socially constrained to make successful agreements. In Mendoza and the lowlands of Tigray, water turns are usually supplied at night due to the warm weather conditions. This was found to be a critical constraint for women in irrigation practice. Women could not irrigate at night alone due to security risks (robberies and sexual harassment) in both Tigray and Mendoza. Additionally, cultural norms restrict independent mobility of women in Tigray.

Study results found that security of water access is also influenced by the time constraints because of the demands on farmers' time placed by communal WUA activities. In Tigray, traditional gender roles and division of labour were found to be strong, with men mostly in charge of farming tasks, but women nevertheless performing a large share of farming activities (Imburgia et al., forthcoming). In addition, women are responsible for most of the domestic tasks, which in rural areas of Ethiopia are very time-consuming. For example, all interviewed farmers needed to fetch drinking water from a communal water source located outside their compounds. They also had to collect firewood for cooking and heating. Women and girls were responsible for the largest part of both activities. Likewise, a lack of affordable and reliable energy sources and technology rules out the use of time- and labour-saving implements for cooking (e.g. manual mill for grains; improved cooking stoves).

As a result, women have much less available time to participate in all activities related to irrigation management. These activities include participation in regular (usually weekly) WUA meetings, where irrigation schedules are discussed, and monthly meetings where other agricultural issues are discussed (e.g. pest management programmes and market updates). Female landowners, mostly heads of households, are allowed to be absent from the weekly meetings. This implies that they have no saying in setting water delivery schedules.

In the case of Mendoza, a higher proportion of men than women were found performing irrigation tasks; however, women's involvement in agricultural activities appeared to be related to whether belonging or not to a family with strong farming traditions (Imburgia et al., forthcoming). In Mendoza, workloads related to domestic tasks are less time-consuming and demand less physical effort for women

and men than in Tigray. For example, rural households do not need to fetch water or firewood as they have their own supply. While rural women in Mendoza held a more prominent domestic role than men, husbands and sons were found sharing some domestic responsibilities. Therefore, the workloads of farmers are less of a constraint to fulfil WUAs' responsibilities. Nonetheless, participation of farmers in WUAs' activities was found to be low for all members, and minimal for women. Results from FGDs revealed that impoverished rural families may decide that women stay at home and do the household work, including taking care of children and elders, while men work on the farm (except in those cases where men have off-farm jobs and therefore, women are more involved in farming).

Gender differences in workload (and therefore in participation) of the different social groups are not static, even within the same research region. Socio-cultural factors shape these differences. For example, while women in the highlands of Tigray help in soil preparation and cleaning field channels, social norms do not allow those tasks for women in the lowlands. In Mendoza, groups of women with a strong farming tradition (including those migrants from the north of the country and from Bolivia) were generally very busy with numerous farming tasks and most of the domestic work. Instead, *Criollas* (women born in Mendoza and being of European descent), were found generally less involved in farming tasks but assisting in farm administration tasks. It is also important to note that gender roles might be changing rather quickly, in particular in peri-urban areas where accessing off-farm jobs is easier.

Security of livelihood strategies

The gendered analysis of this outcome is vital as access to irrigation is a key factor to make farming a viable livelihood strategy to cope with poverty and food insecurity in Ethiopia (Haile and Kasa, 2015). For example, findings from a parallel study in Tigray found that smallholders cultivating irrigated land were better able to secure subsistence than those having only rain-fed land (Imburgia et al., forthcoming). That empirical study also shows that irrigation supports the subsistence farming efforts of independent women, as well as vulnerable farmers, for example, elders, youth with no other income options, and women and men returnees from migration.

In Mendoza, almost half of the irrigated land is dedicated to small-scale farming (Imburgia, 2017); however, profitability of SSIS is seriously at risk due to persistent national financial crises that make it very difficult to invest in improved practices and more efficient irrigation systems. Interviews with leaders of WUAs revealed a large number of farms with almost no maintenance, or even abandoned farming plots, because farmers cannot afford to maintain their lands. FGD findings also revealed that it is considerably more difficult for many women farming on their own to stay in the activity not only because of constraints related to the physical and managerial aspects of irrigation, but also because women farming on their own have higher costs, cultivate less land, and earn less income from farming; therefore, they may have less financial capacity to invest in modernisation of irrigation systems. This in turn, has a negative effect on productivity of female-operated farms and even on their ability to stay in the activity (Nation, 2010). This partly explains a decrease in female participation in the small-scale agriculture sector in Mendoza, as indicated by the survey and results of FGDs. Some rural women state they did much more in farming in the past, when there was less of a need to earn off-farm income.

Autonomy

This outcome relates to the ability to independently access and control resources (Agarwal, 1997) and the 'ability to exercise choice' (Kabeer, 1999) once irrigation water and agricultural livelihood are secured. This study shows that farming as a livelihood alternative provides the main independent source of employment for many women and men with limited opportunities to access off-farm jobs. For example, a female farmer growing vegetables in Mendoza explained: "I'd like to be doing something else, like working in a shop in town or having my own business. But I didn't study. The only thing I have is this

land".¹⁴ On the other hand, farming is a livelihood strategy of choice for women who have their own land and prefer an independent source of income. In FGDs in the lowlands of Tigray, female farmers reported that since several of them had divorced their husbands in order to get out of conflictive marriages, they had also received half of their land as a result. For this reason, they felt 'at peace', in addition to the fact that they had started to progress economically. These examples particularly show that irrigated agriculture – as an independent livelihood strategy – has an empowering potential, provided women have their own land and access to water.¹⁵

Adaptive strategies

Lastly, this outcome relates to the adaptive strategies that farmers use to manage the increasing incidence of water shortages and unpredictable environmental changes. Empirical findings showed that a typical strategy used by both female and male farmers interviewed in both countries was to resort to informal agreements to maintain sufficient access to irrigation water. Interviewed farmers mentioned that WUAs would try to schedule water distribution according to crop demand and swap or split water turns among neighbours. Yet, FGDs with water officials indicated that while in some cases these informal arrangements were a useful fix to the system, in other cases those informal rules allowed for abuses of power that may include favouring friends and relatives. Women and men not well-connected to WUA leaders were unlikely to benefit from those informal agreements. In both countries, a small number of smallholders were able to dig their own wells (i.e., shallow wells in the highlands of Tigray and deep wells in Mendoza) to mitigate water shortages. However, this option was only affordable for well-to-do farmers, irrespective of gender.

The need to rely on those types of adaptive strategies indicates the urgency to expand water-saving irrigation systems at the farm level. In the lowlands of Tigray, the pressurised irrigation systems implemented through government subsidies (although with deficiencies in operation and management), showed positive outcomes for farmers, particularly for women, for whom the irrigation practice became easier. In Mendoza with currently low profit margins, basically only larger commercial farms can afford such system upgrades. Nevertheless, promotion of new irrigation technologies requires cautious evaluation of the gendered outcomes to ensure equitable use, control and benefit share between men and women (Oates et al., 2017; Theis et al., 2018). Fieldwork showed that male and female smallholders, already constrained in secure water access, agricultural livelihood strategies and autonomy, were clearly less able to adapt their production to increasingly unpredictable rainfall and low profitability of small-scale agriculture. Many women in this study appear disproportionately disadvantaged in their adaptive capacity, with constraints including a lack of access to capital, information, knowledge, and time. This adds to previous evidence (Parker et al., 2016) and must be considered in future support and development programmes because farmers forced out of the sector lose a critical livelihood option.

CONCLUSIONS

A novel integrative gender-analytical framework was applied to research NRM governance in two case studies of self-governed communal small-scale irrigation systems, from widely differing cultural and economic settings. Results support the notion that the management of a scarce natural resource for agricultural production must respond to very complex interaction networks of factors that determine outcomes at multiple scales. In order to better understand how these outcomes are gendered, an analysis model was conceived that joins and extends three theoretical concepts (FPE, SES, and social relations framework). By explicit consideration of gender-specific technical constraints to full participation in irrigation practice and governance (above and beyond those commonly recognised as consequences of

¹⁴ Married, female farmer, Mendoza River basin (In-depth interview, September 2016).

¹⁵ For a detailed analysis, see Imburgia et al. (forthcoming).

gender and power relations), it opens a practical perspective on policies and interventions in the development of SSIS that effectively and comprehensively address gender issues. For example, technical design of irrigation systems, extension programmes for the improvement of irrigation governance, and training programmes for female irrigation farmers, would all benefit from a gender analysis based on this integrative framework. A joint view of socio-economic and technical issues seems to be required.

The application of the gender-analytical framework reveals how policy interventions are able to foster important changes in rather short periods of time. In Ethiopia, the reduction of gender inequalities by policy (e.g., on land tenure) allows women to secure irrigation water, food production and a decent income source. Finding showed an increased number of young, single and married women holding land certificates in their names as a consequence of the new land registration and certification policy. In less than four years since policy implementation, these women have improved their independent participation in farming, in WUA meetings, and they spoke of better confidence in their capacity to earn income. In Argentina, through joining participatory activities in the course of the study, women could access more information regarding the functioning of the WUAs and the irrigation sector. As a result, many of them indicated a growing interest in attending WUA's meetings and seemed more assertive about voicing their claims and issues with water.

On the other hand, the framework makes transparent a technical dimension of irrigation agriculture directly impinging upon gender inequality. Examples are presented of how specific technical properties of irrigation systems negatively affect women in a disproportionate way. In other words, identifying gender differences and inequalities in conventional gender analysis is necessary but not sufficient. Rather, the integration of technical properties of irrigation systems within gender analysis leads to comprehensive and effective policy and interventions when evaluated in the technical context of farming practice. For example, investment in irrigation infrastructure that reduces the physical workload in the practice of irrigation agriculture, would particularly help women farming on their own.

Furthermore, recent socio-economic processes in small-scale irrigation agriculture exacerbate gender disparities to the detriment of women. The increasingly low profitability of small-scale agriculture (typical for the subsistence type of agriculture in Tigray, and a rapidly threatening issue in Mendoza) puts at risk the viability of livelihood strategies of small and increasingly impoverished farmers, notably elderly and female farmers with caring responsibilities. In Tigray, these serious problems could be addressed by extension work providing knowledge in improved farming practices, access to market and the cost-effective use of irrigation water for high-value crops and crop diversification. In Mendoza, support is needed in the development of communal water-saving irrigation systems and infrastructure (e.g., water reservoirs, pressurised irrigation systems), plus support in accessing suitable financial instruments. The explicit consideration of specific financial, knowledge and capacity development needs of different groups of women is vital.

Interestingly, despite very significant cultural and socio-economic differences between study locations, the framework allowed to identify patterns common to both places, understand the effects of the interacting processes on governance outcomes and livelihood strategies, and highlight opportunities for sector policy and donor-funded interventions that are conducive to overcome gender and other social inequality constraints. Policy recommendations arising from these findings focus on the need for (1) explicit analysis of gender-specific effects of technical properties of irrigation development, (2) special attention paid on the design of tailored extension programmes for female and male farmers, and (3) support to overcome gendered cultural limitations to participation in the management and governance of irrigation systems. It seems advisable that researchers, project planners and implementers extend the 'usual' audience of their gender analyses to technical experts in irrigated agriculture, as they are typically not engaged in gender analysis of programmes. Consequently, the proposed framework provides a suitable platform for such integrative gender analysis, as it is also feasible to link the proposed framework

with quantitative tools, used to collect and analyse gender-related data (e.g. WEAI), as well as with participatory research approaches.¹⁶

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¹⁶ For examples, see Kumar (2002) and Cornwall (2011).

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