Women, wellbeing and Wildlife Management Areas in Tanzania

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Abstract:

Community-based wildlife management claims pro-poor, gender-sensitive outcomes. However, intersectional political ecology predicts adverse impacts on marginalised people. Our large-scale quantitative approach draws out common patterns and differentiated ways women are affected by Tanzania's Wildlife Management Areas (WMAs). This first large-scale, rigorous evaluation studies WMA impacts on livelihoods and wellbeing of 937 married women in 42 villages across six WMAs and matched controls in Northern and Southern Tanzania. While WMAs bring community infrastructure benefits, most women have limited political participation, and experience resource use restrictions and fear of wildlife attacks. Wealth and region are important determinants, with the poorest worst impacted.

Keywords:

Married women, Tanzania, conservation impacts, causal evaluation, wellbeing, Community-Based Wildlife Management, Bayesian Hierarchical models.

Introduction

This paper explores the ways married women in rural Tanzania have been affected by a major environmental intervention, the revision of the national Wildlife Policy introducing Wildlife Management Areas (WMAs; more recently Community Wildlife Management Areas CWMAs). Building on the history of conservation in Tanzania, we outline Community-Based Wildlife Management (CBWM), and Tanzania's WMAs, as a subset of Community-Based Natural Resource Management (CBNRM). We then review current thinking on implications of such interventions, with respect to gender and other axes of social difference. Predictions from intersectional political ecology, alongside qualitative work and a recent systematic review, challenge the pro-poor, gender-sensitive claims underpinning government policy and implementing NGOs' theories of change. Operationalising these perspectives as competing hypotheses, we describe a rigorous, mixed-methods quasi-experimental evaluation, testing their relative validity for WMA impacts on married women in rural households of different wealth in north and south Tanzania.

CBNRM, CBWM and WMAs

State and donor agencies see CBNRM as bringing win/win conservation and development, an approach embedded in the Sustainable Development Goals (e.g. UNDP 2012) and national poverty reduction strategies. Conservation NGOs receive development funds to implement CBNRM initiatives, aiming to alleviate poverty while achieving conservation goals, often through regulating and commoditising access to resources on which poor, marginalised people have hitherto depended. As a prominent CBWM donor/NGO implementing partnership states: 'The central idea of CBNRM is that when local communities have ownership of natural resources and they derive significant benefits from the use of those

resources, then those resources will be sustainably managed... This involves shifting control of natural resources from the state to the community and the development of opportunities for local residents to earn income from the resources newly under their control' (WWF-USAID 2014:2). CBNRM has become the new global conservation orthodoxy, with the rapid spread of CBWM variously attributed to its perceived success (Naidoo et al. 2011, 2016), or conversely to compliance with donor demands (Nelson et al 2007, Humphries 2012) and structural adjustment pressures (Western and Wright 2013: 354).

Tanzania has since colonial times been the focus of intensifying conservation intervention. Initial fortress conservation (Neumann 1998, Brockington 2002) was overtaken from the 1980s on by community conservation, and now by landscape-scale conservation policies promoted by conservation NGOs[1] and bilateral donors (see Bluwstein 2018 for a brief history). Currently 43% of Tanzania's land area is devoted to conservation. There are now some 22 WMAs operating, and a planned total of 38[2] are envisaged to cover a further 14-15% of Tanzania's land area, directly and indirectly affecting several million people (Bluwstein et al 2018b). Neoliberal conservation (Igoe and Brockington 2007) is promoted as a pathway to rural prosperity, despite its demonstrable elision of rural priorities in favour of wildlife (Bluwstein 2018, Garland 2008), and the numerous qualitative analyses of its problematic impacts on Tanzanian rural communities (Benjaminsen et al 2013, Sulle et al 2011, Bluwstein references), particularly women (Mariki 2016, see also Archambault 2016).

Tanzania's *Mkukuta I* poverty reduction policy paper (URT 2005) proposed developing rural livelihoods through CBNRM; *Mkukuta II* reiterated this (URT 2010: operational target 1.5.1). Natural resource use in rural Tanzania is now increasingly governed by CBNRM for forests (Persha and Meshack 2015), fisheries (Rocliffe et al. 2014) and wildlife (URT 2007, URT

2012, WWF-USAID 2014). Tanzania's 2007 Wildlife Policy stated: 'government will ensure equitable distribution of costs and benefits' (URT 2007:28)…. [and]…give wildlife economic value…to enhance village communities' development…[so] that the benefits accrued to them compensate for the opportunity cost to other forms of land use through promotion of WMAs' (URT 2007:34).

WMAs require a number of villages to come together and set aside a significant proportion of their pooled village lands for wildlife conservation. Regulations vary (http://www.twma.co.tz/about-us-cwmac.html), but commonly restrict through-passage and use, e.g. for grazing, collection of water or non-timber forest products (NTFPs), except under permit (if at all). WMAs are supposed to attract tourism entrepreneurs bidding for operating contracts. Income from such investors is paid to the state, which top-slices approximately one-third[3], returning the rest to operating AAs. AAs retain around half for administrative purposes, training and employment of village game scouts enforcing WMA regulations, and conservation initiatives[4]. Remaining funds – around one-third of original WMA earnings[3] - are divided equally between governments of participating villages (WWF-USAID 2014), for community projects (e.g. village infrastructure; educational bursaries).

However, such Natural Resource Management (NRM) decentralization programmes have generally performed poorly on social outcomes (Galvin et al 2018), often paradoxically culminating in greater state control and revenue capture (Nelson and Agrawal 2008). Hill (1996) described CBWM as a rural taxation programme, earning governments income from resources otherwise returning little directly to the state. This may be the case for Tanzania's WMAs[3,5] (Benjaminsen et al. 2013). Sustainable development rhetoric may mask effective enclosure of the commons, undermining or commoditizing local natural resources alongside

needs, practices and knowledge formerly enabling rural livelihoods (Isla 2017). Tanzanian conservation's territorialisation of space is likely exacerbating circumstances for many marginalised people (Bluwstein and Lund 2016, Bluwstein 2017; Green and Adams, 2014: Benjaminsen et al. 2013; Igoe and Croucher 2007).

Building on explicit attention to gender in a background document (URT 2003 (14): 37), the Policy asserts 'government will strive to promote gender equity in sustainable management, conservation, utilisation and development of wildlife' (URT 2007:32). The 2012 Wildlife Regulations require Authorised Associations (AAs) operating WMAs to 'Respect and implement gender mainstreaming' (URT 2012:37). Implementing NGOs[1] and supporting donors detail ways poor Tanzanian women's livelihoods, entrepreneurship and participation in governance will be enhanced (WWF-USAID 2014: 29, 41). WMA association recruitment emphasises gender equality, justice and advocacy[6]. But the pro-poor, gender-sensitive policy rhetoric takes little account of prevailing intersecting inequalities, nor their commonly perverse interactions with NRM interventions (Cornwall 2003, Kabeer 2005, 2015).

Women and wellbeing in environment and development

Women are the main and most frequent collectors of wild products in Africa (Sunderland et al. 2014); poorer women commonly rely disproportionately on environmental resources (Angelsen et al. 2014). Past narratives of women as natural conservators, and of strong synergies between NRM interventions, women's participation, and their enhanced wellbeing (Shiva 1988) have been challenged, debated and refined (Agarwal 2001, 2009; Mwangi et al. 2011). Conceptual frameworks analysing interactions of women with environment and development, and the interplay of those frameworks with feminist political ecology, have evolved rapidly over the last decades (Cornwall 2003, Kabeer 2005, 2015; see brief

summary in Meinzen-Dick et al 2014). Key insights stress widespread, inappropriate subsuming of women's differentiated and nuanced priorities under generic 'community' goals; all-too-common slippage between 'gender' and 'women'; and the need to understand gender relations as intersecting synergistically with other axes of social difference, producing highly differentiated experiences for individual men and women. The multiple intersections of gender relations with other individual circumstances shape people's resource access and use not only through legal and social institutions, but also through internalised, unquestioned perceptions of their place in society, governing their behaviours (Kabeer 2015), and their associated patterns of production, consumption (Macgregor 2017, Nightingale 2006) and livelihoods overall (Cruz-Torres and McElwee 2017).

Policy rhetoric around WMAs, as for many other interventions, remains mired in earlier framings, conflating 'gender' with 'women' and seeing women as a homogeneous group, readily represented by any female[6]. Among other problems, this equates elite women (able to make their views heard, but unlikely to articulate the priorities of, say, poor women of marginalised ethnicity and occupation), with token appointees (often poor and marginalised women, unlikely to be heard on issues customarily perceived as within men's domain, and likely subject to harassment and pressure if they do speak up: Cornwall 2003, Kabeer 2005).

Postcolonial histories entail power relations structuring the differentiated impacts of sustainable development interventions and the inequalities these foster or mitigate (Meinzen-Dick et al 2014, Mollet 2017, Isla 2017). Conservation distributes fortune and misfortune (Brockington et al. 2009). While well-placed people may benefit, those marginalized by gender, ethnicity, political, cultural and/or economic structures are often further disadvantaged, even by interventions purporting to improve their situation (eg. formalization

of public participation: Cleaver (2000); and of land tenure: Kevane (2012), reinforcing 'power relations written on land', Peluso and Lund (2011), Rocheleau (2005)). Qualitative case studies critique social and economic effects of Tanzania's WMAs on these grounds (Sulle et al. 2011; Noe 2013, Noe and Kangalawe 2015; Bluwstein and Lund 2016; Bluwstein et al. 2016, 2018b), exploring their gendered impacts (Mariki 2016); but are countered by claims for CBWM's conservation and development successes (WWF-USAID 2014) showcasing Namibia's conservancies as model success stories (Naidoo et al. 2011, 2016).

Research question

Currently therefore, two diametrically opposed sets of expectations exist as to the impacts of Tanzania's WMAs on women. Conservation interventions' theories of change predict more secure rights; increased income through enhanced tourism or payment for ecosystem services; enhanced empowerment, decision-making and capacity-building through participation in governance and entrepreneurial opportunities (URT 2003, WWF-USAID 2014). However, political ecology and postcolonial intersectional thinking predict that WMAs may exacerbate circumstances for people marginalised by gender, poverty and other axes of social and ecological difference, as evidenced by numerous qualitative studies, and recent systematic review (Galvin et al. 2018). We operationalise and explore these competing hypotheses for women in households of different wealth and region, themselves strongly correlated with different ethnicities, occupation and levels of education.

Our evaluation here is restricted to impacts of WMAs on rural married women, with some comparative information on female heads of household (FHHs). Because the study reported here was undertaken as part of a larger household survey (see below), it offered

the opportunity to look in more detail into the experience of married women in study households (and in a further paper, to relate their experiences to those of male and female heads of household). However, this nesting within an overarching study imposed certain constraints. Ethical permissions, as well as cultural and logistical practicalities, restricted our survey to interviewing adult women (Bluwstein et al 2018a). The large scale of the overarching study, its household-based sample frame, and cultural constraints prevalent in rural North and South Tanzania respectively, meant we initially interviewed household heads, mostly men. We then sought these household heads' permission to interview senior wives. Data reported here therefore focus on married women, with only supplementary information on FHHs (see methods). Our FHH data cannot be compared directly to our data on married women, for two reasons. First, data for FHHs were collected through a different, and more detailed, survey designed for household heads, rather than the specific, shorter interview schedule designed for married women (Bluwstein et al 2018a). These surveys used different instruments and did not collect the same information. Second the 937 married women analysed here were selected using stratified random sampling, in order to provide adequate representation of key groups (e.g. wives from very poor households) across regions, WMAs and control villages. By contrast, the FHHs were few by comparison (187 women; representing around 10% of the 1924 households interviewed overall), and concentrated in two North WMAs. This small number does not allow for the type of disaggregated analysis used here for married women. The FHH data that are given here as simple descriptive statistics therefore provide only indicative results. FHH data are analysed in depth elsewhere as part of a separate study focusing on the dataset for households overall (Keane et al in press).

Places, people and patterns of resource use change through time for all sorts of reasons, making robust causal attribution of the impacts of large environmental interventions difficult and complex. Direct experiment is not possible, there are multiple dimensions and many external confounding factors, with no straightforward counterfactuals to show what would have happened in the absence of intervention (Pressey and Ferraro 2015). Nonetheless, careful research design can establish intervention-driven change and attribute causation (Jagger et al. 2010; Persha and Meshack 2015). We compare married women in WMA villages to those in statistically matched control villages, to evaluate differentiated impacts of WMA implementation for wives within male-headed households.

Materials and methods

Study area and people

This study built on researchers' long experience of field work in North and South Tanzania, (collectively totalling over 5 decades' engagement on a range of livelihoods and land use issues), and on preliminary field visits interviewing key informants (village and district government, traditional leaders, women friends) and focus groups prior to project start. We selected 3 WMAs in each of northern and southern Tanzania (henceforth North, including Enduimet, Burunge and Makame WMAs; South: Mbarang'andu, Tunduru and Liwale WMAs; and each site's matched control villages: Fig 1; for detail on these WMAs, see Table 1; WWF-USAID 2014; https://www.ucl.ac.uk/pima/resources.htm and Bluwstein et al. 2018a). The six study WMAs represented one-third of the 18 WMAs implemented in Tanzania at the time. Selection criteria included: date of establishment (choosing older WMAs, in which changes were more likely); availability of pre-existing data (aerial wildlife counts; pre-WMA socio-economic data); habitat type (Table 1). In the semi-arid savannas of

the North, most rural livelihoods are agro-pastoral, and community-based conservation can tap into the booming conservation-based tourism industry. In the more remote sub-humid miombo woodlands of the South, rural livelihoods are mostly crop-based and tourism is limited to trophy hunting[7], offering few opportunities for local communities (World Bank 2015).

[Figure 1]

[Table 1]

To create the initial sample frame for the overarching study surveying impacts of WMAs on rural households (Bluwstein et al 2018a), focus groups in each of the study villages collected (*inter alia*) village-specific, participatory wealth ranking data for 13,578 households, representing all registered households established by 2007 across the 42 WMA and matched non-WMA study villages (Bluwstein et al 2018a). From this sample frame a stratified random sample of 1,924 household heads were selected (Bluwstein et al 2018a), of which 187 were female. Alongside the 1924 survey interviews with heads of household, 937 married women (whose husbands were willing for them to do this, who had been married in 2007, were able to recall their situation at that time clearly, and willing to explain how things had changed for them by the time of the 2014-5 survey), completed detailed interviews (both on contemporary conditions, and on recall of a 2007 baseline, the period when the first-gazetted WMAs began to become operational). Village meetings using short written reports and infographics in Swahili and Maa gathered feedback on preliminary findings. Follow-up interviews and focus groups (with men, women and youth separately) yielded further qualitative information.

This means specific opportunities and constraints for our analysis. The data on married women allow rigorous quantitative analysis following the logic of a before-after control-impact (BACI), difference-in-difference evaluation of potential effects of WMA presence, which we disaggregate by region and wealth (cf Pereznieto and Taylor 2014). However, we have no data on women under the age of 18 in 2014-5, nor any women who were not married by 2007, restricting the age categories addressed by this study. Also, the 187 FHHs were geographically clustered in the North, constituting too small and too spatially-biased a sample to support comparable analysis, though we draw on their data for comparative purposes.

Women's ethnicity, occupation, age, wealth, and education:

Women in North villages are predominantly Maa-speaking Arusha and Maasai (62% non-WMA, 69% WMA respondents) and primarily agropastoralist (78% non-WMA; 81% WMA). Their day-to-day lives are well described elsewhere (Mariki 2016; Homewood et al 2009), centred on managing household chores (collecting firewood and water; preparing food; child care; milking livestock; house construction; farming) but diversifying and generating income through milk and crop sales, petty vending and waged labour on- and off-farm (Wangui 2008).

Yao, Ngindo and Ndendeuli jointly made up 93% of non-WMA and 95% WMA South respondents. As well as being housewives managing domestic chores and child care, South women were mostly farmers (88% non-WMA; 90% WMA). Tsetse and other disease vectors limit ruminant livestock in the South, but fishponds and poultry are relatively common, as is beekeeping in this miombo landscape.

Over 80% all wives interviewed were 20-49yrs; none were <20yrs in 2014; only 3% were >59yrs. Age distributions were closely similar for non-WMA and WMA samples, and for North and South (Bluwstein et al 2018a).

Across all 937 married women, 1.3% had 8+yrs education. Over half of all North wives had no education and only around one-third had 7yrs primary education. By contrast >60% South wives had 7yrs primary education, and only one-fifth no schooling. Despite these large differences *between* North and South, WMA and non-WMA wives' education was closely similar *within* each of North and South regions.

Original wealth rankings returned four categories (very poor, poor, normal[i], and rich) but to simplify analysis, we use two pooled categories (very poor/poor, and normal/rich).

Our analyses are disaggregated by wealth, North/South location, presence/absence of WMA, and date (2007/2014). This paper seeks to pinpoint the effect of WMAs in differing regional contexts. While we aim to give a representative overview of the scale and relative importance of different dimensions of impacts for women in different circumstances, for our overall analysis of WMA impacts, education and ethnicity effects are captured in our 'region' indicator. Given their balanced distribution across the sample, age, education and ethnicity –

[i] The term 'normal' here emerged during the focus group discussions as a common parlance shorthand indicating women and households considered to be neither particularly poor nor rich. There is no connotation that other categories (very poor/poor/rich) are in any sense abnormal. More households fell into the 'poor' or 'very poor' categories in most study sites, making alternative terms like 'average' or 'medium income' problematic. While we acknowledge the risk of the term 'normal' reinforcing perceptions instead of questioning them, ultimately we have chosen to retain it for consistency in terminology with other publications on this dataset, and with the publicly available dataset itself.

while significant axes of social difference - do not substantially affect our primary WMA/non-WMA comparison.

Documenting change through time

Baseline data collected prior to conservation interventions are rarely available, constraining counterfactual-based assessment of conservation policies' effects on local livelihoods. White (2009) advocates recall data to overcome this problem, cautioning against the biases involved (see also Jagger et al. 2010). Biases were minimised by (a) building on Krishna (2005)'s 'ladder of progress' to understand households' pathways through locally-specified wealth ranks; (b) using recall of circumstances in 2007 (prior to implementation of the relevant WMAs) pinpointed by description of a prominent event as baseline to facilitate recollection. North respondents were asked to recall the 2007 eruption of Ol Doinyo Lengai volcano (sacred to Maasai). In the South, where this was less salient, married women were asked to think back to President Kikwete's 2005 election, and then work forward through local and personal marker events up to 2007. Focusing on important and easily quantifiable household assets further reduced potential recall bias. The overarching survey was further validated by reference to a subsample for which pre-WMA inception data were available as well as 2014 survey and 2007 recall (Keane et al in press). The dataset has been deposited at http://reshare.ukdataservice.ac.uk/852960/.

Key indicators:

Education, income-generating activities, and political participation are key dimensions of women's empowerment, though they require nuanced understanding (Kabeer 2005). Multi-dimensional wellbeing also encompasses further dimensions, especially security

(Gough and MacGregor 2007; Woodhouse et al, 2015). Beyond women's sociodemographic characteristics, and direct questions to WMA wives about WMA costs and benefits, and levels of political participation, the main data collection focused on married women's self-reported perceptions of changes in their access to a range of resources, with 20 questions capturing responses relevant to three domains (five questions on access to natural resources, 11 on changes in income-generating activities, and four relevant to safety and food security).

We took resources to include natural resources (assets: land, livestock; common pool resources: water, fuel, construction materials); and social resources (health and education infrastructure, political representation, security, autonomy). We conceptualised access as taking into account complex overlapping, nested rights of access, control, stewardship and use within and across households, focusing on the exercise of independent choice and access, rather than formal ownership *per se* (Kabeer 2005, Goldman et al 2016; Pereznieto and Taylor 2014).We recorded married women's self-reported changing ability to access farmland, irrespective of intra-household land ownership, and to *independently* decide whether they themselves or their dependents could consume or sell produce. With livestock produce, we asked about changes in women's ability to *independently* consume or sell produce from livestock associated with the homestead, irrespective of the animals' potentially multi-layered ownership. Access to water, fuel, construction materials and NTFPs was explored in terms of self-reported changing ability to go into locations where these were available.

Analysis

Here we present a summary of the statistical analyses used to obtain our results, but full technical details are provided in the Supplementary Material. We present three types of results in the text: (1) simple overall percentages of women's responses concerning participation in the WMA, and their perceptions of the top 5 costs and benefits of WMA membership (2) summaries of women's perceptions of changes in access to natural resources, income-generating activities, and security adjusted for differences between the wealth-stratified sample and the overall study population, and (3) estimates of WMA effects on access, income and security. The latter two sets of results are derived from a series of Bayesian hierarchical models (BHM) which predicted each of the relevant outcomes based on variables representing the household's wealth category, region of origin in Tanzania, presence or absence of a WMA, distance to nearest road, nearest town, nearest wildlife corridor; perpendicular distance to edge of nearest national park/game reserve; population density, and proportion of village land covered by forest, as well as accounting for the clustering of responses within households, villages and matched pairs of WMA and non-WMA villages. For (2) we used a procedure called poststratification to adjust our results to reflect the study population. For (3) we use the difference-in-differences of married women's perceived changes through time to disentangle the effects of WMA presence from other potential confounding factors for women of different wealth and in different regions, a best-practice quasi-experimental approach to evaluating impacts of interventions (Pereznieto and Taylor 2014).

Results

Key findings on WMA effects are summarised in Table 2, which also indicates the specific analysis upon which each is based; and the Supplementary Information (SI) figure displaying specific statistical outputs underlying each statement.

[Table 2]

However, these findings on the impacts of WMAs on married women's participation, access to/use of resources, income generation and dimensions of security are not experienced by women as isolated WMA effects, but rather as embedded within other dimensions of change through time. Also, the evidence about certain WMA-related effects is mixed, and open to interpretation. For example, asked directly about WMA effects, women report several benefits operating at community rather than household level. But triangulating these reported perceptions against responses to other questions not phrased directly in terms of WMA effects suggest some were strategic answers on sensitive topics. For example, while women reported employment opportunities created by WMAs as a benefit, data on women's own paid employment, and on their remittances, do not support this (Table 2).

Before focusing on individual WMA effects, we therefore present our findings on wider change through time in broader context, looking at survey-wide, village-level and individual patterns of changing participation, costs and benefits, access to resources, income-generating activities, and dimensions of security, relating perceived changes to women's wealth and region. We then return to conclude with causally-attributed WMA effects.

Participation

Within our sample, most WMA wives knew about the WMA, and some two-thirds knew the land areas set aside (Fig 2). Around half knew their village representatives who liaise with the AA. Over half North but only ~10% South wives felt informed as to conservation

initiatives carried out by the WMA. Few wives (13% South; 21% North) felt informed as to the use by village government of revenues coming from the WMA: rather, most declined to answer this question. (Fig 2).

By comparison, FHHs were better informed than wives about the WMA, its local representatives, its conservation initiatives and the village's use of any revenue share (though consistently less well-informed than their male counterparts), and better able than wives to state their views publicly.

Most WMA wives said they were in favour of their village's current WMA membership, though only half (North) or fewer (South) had agreed to their village joining the WMA at inception. Fewer than half those who knew their village AA representatives felt able to influence them: most declined to answer this question (Fig 2). By comparison, most FHHs who knew their representatives felt able to influence them (91% Burunge; 63% Enduimet). With a couple of prominent exceptions, and despite nearly half receiving support from absent household members[8], these rural FHHs were poor, (See table S4 for detail). However, given relative freedom from male authority, and their empowering, albeit limited[8] access to land (Goldman et al 2016, Grabe 2015), FHHs' greater knowledge and lesser reticence compared to wives is not surprising.

While most wives, FHHs and indeed male household heads expressed themselves in favour of participation in WMAs, even in conflict hotspots such as Burunge WMA (cf. Bluwstein et al. 2016), these stated opinions need triangulation. People are skilled in dealing with politicised issues over WMAs (Wright 2017). Questions perceived as particularly sensitive may elicit strategic answers, or be avoided altogether (Browne-Nunez and Jonker 2008).

Wives' reticence over village use of revenue, and over their personal ability to influence AA representatives, suggests that many felt constrained in responding on these particular issues; and forthright opinions over WMA presence may not be expressed to outsiders (Fig 2).

Participation in governance is a complex process with potentially double-edged outcomes for marginalised people, and by no means a straightforward route to empowerment (Cleaver 2000), particularly given the realities of 'participation' (Cornwall 2003). Among North WMAs' predominantly Maasai population, women are customarily seen as juridical minors, with neither property nor a public voice, despite grassroots NGOs supporting women's education, empowerment and trade (Goldman and Little 2015, Smith 2015). Domestic violence remains common; many see wife-beating as legitimate, and wives cannot easily assert a voice in public affairs (Goldman and Little 2015). South wives, with their considerably greater levels of educational achievement, might be expected to have stronger political participation. However, even higher proportions of South women declined to answer as to their influence over village representatives (Fig 2). Many South women's public voices are perhaps constrained by the intersection of Islamicisation with greater poverty levels (World Bank 2015) in these customarily matrilineal, matrilocal Yao and neighbour communities. Poverty makes for lack of voice and choice, and increases likelihood of domestic violence (Kabeer 2015). However, all women confirmed their ability and that of their dependents to participate fully in social ceremonies (religious festivals, customary ceremonies, weddings, funerals), with no regional, wealth or WMA effect.

Perceived costs and benefits

Asked directly about WMA effects, WMA wives overwhelmingly reported costs and benefits as accruing to the whole household, rarely to themselves as individuals alone. The three main benefits WMA wives perceived their household derived from the WMA were infrastructure, schools, and employment (Fig 3). Though schools were a widely perceived benefit, and 71% North and 86% South women within our sample had school age children between 2007 and 2014, overall just 4% North and 3% South had received WMA sponsorship for any of these children, with scholarships clustered in Enduimet (~25%) and Mbarang'andu (~25%) and to a lesser extent Tunduru (~12%) but virtually none elsewhere.

[Figure 3]

The three main perceived costs of WMAs were fear of livestock predation, fear of wildlife, and loss of access to firewood[9] (followed by loss of farmland and grazing) (Fig 4)

[Figure 4]

Access to resources

Assets

All South and 94% North wives within our sample were members of households having a farmed field (Swahili: *shamba*) or home garden (*bustani*) at some time between 2007 and 2014-15. Around one-third North and two-fifths South wives had access to cultivated *shamba* products which they could independently consume or sell. Fewer had access to home garden produce (14 % South; 17% North). In 2014, most wives (around 94% North, but only 62% South) could independently access household animal products (milk, meat, eggs, fish etc.) for their own and their dependents' consumption or sale.

Natural resources

Overall, access to four categories of natural resources – land for settlement, land for cultivation, water and construction materials - was viewed as worsening by a clear majority of all wives (Table S1).

There are clear site-specific patterns in changing access to natural resources, with strong positive correlations between village-level access to land for cultivation and for settlement, and between access to water and to construction materials (Fig S1; as well as a weaker correlation between access to firewood, and access to land for settlement and cultivation). For example, particular concerns about declining access to water and construction materials were expressed by most women in Burunge's WMA and matched non-WMA villages. Women are affected by site-specific natural resources endowments and by the constraints on natural resource access in a physically and administratively fragmented and zoned landscape, irrespective of marital status, wealth, region, or WMA membership, but women in different circumstances experience (and respond) differently to scarcity.

However, village-level patterns were not strongly linked to WMA membership, and evidence of WMA impact on individual wives' access to land, firewood, building materials or water is mixed (Fig S2). Modelling individual-level data to disaggregate effects shows weak evidence for North WMAs reducing Very poor/Poor wives' access to farmland, but shows South WMAs conversely facilitating this for Normal/Rich wives (Table 2, Fig S2). Overall, uptake of farming is increasing in the North (McCabe et al 2010) but tight enforcement of WMA zoning there likely hindered access to farmland by Very poor/Poor North wives lacking financial and social resources. By contrast, enforcement of South WMA boundaries was relatively low at the time of our survey, with many South rural people not yet aware of

the full effects to come (Noe and Kangalawe 2015, Bluwstein and Lund 2016). South Normal/Rich wives with the means to invest in opening new farms may have done so despite WMAs' notional implementation.

More generally, land-related conflicts in Tanzania are increasing, while inequalities around and barriers to women's access to land persist (Dancer 2015). Current policies exacerbate this (Benjaminsen and Bryceson 2012). In Tanzania some 43% land is set aside for conservation; WMAs impose further restrictions (Kangalawe and Noe 2012, Bluwstein and Lund 2016, Bluwstein et al. 2018b). Green grabbing has arguably been exaggerated to date (Locher and Sulle 2014) but is accelerating. Ongoing government demarcation is set to alienate huge areas (e.g. SAGCOT 2012). Multiple, mutually reinforcing land alienations and reconfigurations by conservation, agribusiness and mining converge to constitute a scramble for land (Bluwstein et al. 2018b), displacing and dispossessing marginalised rural people, particularly poor women of marginalised ethnicities with little or no education (Berhman et al 2012; Wegerif et al., 2013). However, better-placed people may benefit. For example, those with the resources to do so may pre-emptively clear new farms in areas designated for future set-aside, as a profitable move in terms of both immediate returns and also potential eventual compensation.

There is a statistically strong if small positive WMA effect on access to construction materials for North women of all wealth groups. Timber quality and species requirements often make construction materials more difficult to find than firewood: but here firewood showed weak evidence for a negative WMA effect for access by North Normal/Rich WMA wives. Women were forbidden to enter Kilimanjaro Forest reserve with anything other than rope for binding fallen deadwood[10]. With increasingly severe, violent (sometimes lethal)

conservation enforcement, poor men and women spent longer and took greater risks gathering firewood for sale, and prices rose accordingly (Mariki 2016), affecting Normal/Rich wives' budgets. However, while women in WMA villages reported access to firewood as a major cost, across all women interviewed, a majority reported no change (Tables 1, S3). There was no WMA effect on access to natural resources for South Poor/Very poor wives, again likely due to low enforcement at the time.

Despite village-level correlations between declining access to land and to water (Fig S1), and over half wives reporting worsening water access (Table S1) there is only weak evidence of WMA impact (especially for South wives: Fig S2), though uranium mining now risks poisoning the Mbarang'andu WMA drainage basin (Noe 2013).

Income-generating activities

In 2014, around one-quarter North and one-third South wives sold livestock produce, and around one-quarter overall earned income from *kibarua* (casual unskilled labour). The next most common source of income was from remittances (around one-fifth of wives). Few wives (~5% overall) engaged in sales of crops, cooked foods or petty vending. Paid work, sales of water, NTFPs, crafts and receipt of external aid were even less frequent (Table S2).

There are clear individual-level correlations between the types of income-generating activities pursued (Fig S3), which fall into recognisable multistranded bundles taken up by women in different circumstances. There are positive correlations between natural-resources-based income-generating activities (sales of NTFPs/crafts and water sales; water sales/ *kibarua*). Weaker correlations emerge between *kibarua* and sale of NTFPs (also petty

vending/selling cooked food; sales of food or crafts/receipt of aid). *Kibarua*, and to a lesser degree NTFP and water sales, correlate inversely with formal paid work (vanishingly rare: found only among 0.2% of the richest women overall). Wealth was a major determinant, with engagement in *kibarua*, and in selling livestock produce, respectively strongly associated with poverty and wealth (see below).

Married women's income-generating activities have changed through time, with patterns differing by WMA/non-WMA, region and wealth group (Fig S5). In the North there has been a general pattern of increased activity through time across a broad range of income sources, suggesting generalised diversification with no clear examples of a decrease. Patterns of change were more varied in the South. We focus here on the effect of WMA membership on the most common income sources (Fig S6): *kibarua*, livestock and crop sales, remittances and aid. Petty vending was the fourth most common income-generating activity amongst very poor women, but even there was only reported by 4% (see SI).

Kibarua:

Overall, 45% Very poor wives earn income from *kibarua*, compared to <0.1% of Rich wives. North WMAs effectively increase the engagement of Very poor/poor North WMA wives in *kibarua* through time (Figs S5, S6), with women increasingly weeding and harvesting on local and neighbouring commercial farms[10]. *Kibarua* is a crucial indicator of poverty across multiple Tanzanian site-specific concepts of wealth (Brockington et al 2018), but can also be an investment strategy. For example, Rukwa oxen owners' *kibarua* allowed them to employ labour in turn (Östberg et al. 2018). Mueller (2011) argued that most Tanzanian households, while self-identifying as farmers, engage in *kibarua*, accounting for ~10% household income in the top quintile in his northern Tanzania study area, and >60% in the poorest. The strong

significant correlation between poverty and women's *kibarua* in this study suggests it is primarily 'distress sale of labour' (Kabeer 2005).

There is also weak evidence that North WMAs are associated with an increased number of income-generating activities by Very Poor/Poor wives (Table 2; Fig S7). Where individuals take on an ever-wider range of unskilled low-paid activities, diversification is likely driven by need, rather than investment opportunity (where individuals will specialise, while the household portfolio overall diversifies: Ellis 2000). We therefore interpret the increase in women's *kibarua* and range of income-generating activities as driven by increasing need.

Livestock and crops:

Only 9% of very poor women sold livestock products, compared to 57% of rich wives, for whom this likely represents active choice not driven by necessity. These patterns are further shaped by region (Fig S4). For example, in the North, livestock products were sold by 50% of Enduimet WMA and matched non-WMA households, but by <2% of Liwale and Tunduru households in the South. There is weak evidence for a decline in sales of livestock produce through time among all South Very poor/Poor wives (Fig S5) but no WMA effect (Fig S6). Crop sales appear to have increased or remained stable through time for all groups (Fig S5), with weak evidence for a positive WMA effect on crop sales by South Very Poor/Poor wives (Fig S6).

Remittances and aid:

Receipt of remittances increased or remained stable through time for most groups, with strong evidence for increases among Very poor/Poor North WMA and South non-WMA wives (Fig S5), but no WMA effect (Fig S6). Interestingly, twice as many FHHs received

remittances as compared to married women overall in 2014 (41% vs 21%: see SI). By contrast with remittances, receipt of aid decreased through time overall in the South, but increased through time in the North (Fig S5), reflecting increasing NGO activity[3,12] (Goldman and Little 2015) and, for some, government intervention following the 2009 drought[11]. Despite a clear decline in aid overall across the South (Fig S5) there is weak evidence that South WMAs had some protective effect on very poor/poor wives' receipt of external aid (Fig S6). This likely flows from ephemeral philanthropic initiatives in South WMAs (WWF-USAID 2014). In Mbarang'andu WMA, uranium mining triggered cancellation of tourism contracts. Local people nominally own the WMA, but lack either wildlife or mineral rights, and received neither compensation nor concession fees, unlike tour operators and state departments (Noe 2013, Noe and Kangalawe 2015). As a token gesture, wildlife NGOs, tour operators and mining contractors established a small community fund. Our survey picked up this effect, though the fund's operation appears erratic and ultimately unsustainable (Noe 2013), borne out by our strong evidence of significant decline through time (Fig S5). Elsewhere, donors and conservation NGOs establish philanthropic initiatives fostering local support for South WMAs unable to earn income for themselves. These include numerous capacity-building initiatives, Danish Hunters' Association donations supporting Wami-Mbiki WMA up till 2010, and USAID cash-for-work programmes in Idodi-Pawaga (WWF-USAID 2014).

Dimensions of security

Most women saw little or no change in freedom of movement. Other outcomes are much more mixed, with similar proportions experiencing improvements as perceive deterioration (Table S3). But this overall picture masks pronounced geographical and wealth-related differences. Perceptions of changing severity of crop damage, food security, ease of

movement, and physical security are all positively correlated at the village-level (Fig S9). Higher levels of crop damage are strongly associated with increased site-specific problems of food security, ease of movement and physical safety. Ease of movement and physical security are similarly closely associated, though less closely linked to food security. Very poor wives are more likely to say that ability to provide food is getting worse than are married women in rich households.

Crop damage, food security and ease of movement showed no WMA effect (Fig S8), though qualitative data and parallel surveys stress a WMA effect on crop losses[12], and South WMA villages had significantly higher crop damage than did matched controls (Zafra-Calvo et al, 2018). The discrepancy may stem from the placement of non-WMA villages which, even after matching, lay further from other large protected areas (e.g. Selous Game Reserve) than did WMA villages. We attempted to control for these residual differences through model-based regression adjustment, reducing the risk of bias[14]. There is a clear WMA effect on physical safety concerns in the North, with North WMA wives worrying more about wildlife hazard, at a significant cost to their wellbeing (strong evidence for Normal/rich wives; weaker for Very poor/poor: Fig S8). During qualitative work in North WMAs[10], men, women and youth focus groups recounted recent deaths and losses due to wildlife attacks. As in Namibia's conservancies, WMA women experience fear, sleeplessness and exhaustion due to active deterrence of night-marauding wildlife, and distress over perennial hazards to people and livestock (Mariki 2016, Khumalo and Jung 2015).

Discussion

Beyond their overarching aims of conservation, sustainable development, and poverty reduction, state policies and implementing partners claim WMAs will promote women's income-generation, participation in governance, employment and enterprise skills (WWF-USAID 2014:41). Galvin et al's (2018) systematic review challenges this, as do intersectional political ecology analyses of such policies (Cornwall 2003, Kabeer 2005), predicting adverse impacts on those marginalised by intersections of gender, poverty, region, and other axes of social difference, encompassing many rural women. We have summarised and put in context WMA effects on married women's participation in governance, access to and use of resources, and on their food and physical security, differentiating effects by region and wealth.

We now critically assess the methodologies of this and other large-scale studies evaluating CBNRM impacts. We conclude by returning to summarise and evaluate the extent to which our findings are consistent with either competing hypothesis.

Critical evaluation of methods:

Previous studies have variously credited WMAs with enhancing (Pailler et al 2015) or decreasing food security (Salerno et al 2016). Despite poverty- and site-related effects, we found no WMA effect on food security (Fig S8). Different studies' apparent contradictions could stem from contrasting methodologies. The Salerno study took place during the 2009 drought, particularly severe in Longido District hosting their major study WMAs. It compares results from villages inside and outside WMAs, but without controlling for sociodemographic, biophysical, infrastructural and other differences between WMA and non-WMA study villages, and so may not be comparing like with like. Their single-round study

had no prior baseline data exploring change through time. By contrast, Pailler et al. (2015) use national Demographic and Health Survey health-related data, where successive samples are different. Enumerators' knowledge (or lack) of local language may also be a factor, where local populations have limited familiarity with the national language Swahili.

More generally, large-scale quantitative surveys on social impacts of Tanzania WMAs (Pailler et al. 2015; Salerno et al. 2016), joint forest management (JFM: Persha and Meshack 2015) and community-based forest management (CBFM: Gross-Camp 2017) reveal few significant changes associated with these interventions. There are several possible interpretations for this. We illustrate them by considering limitations of the present study, though it has yielded clearer and more robust evidence for WMA effects than have previous large-scale studies. One possible explanation is that conceptual and methodological issues limit the ability of even best-practice evaluations to define and isolate WMA effects from confounding processes. CBNRM interventions operate in complex contexts. Crosscutting effects can swamp intervention outcomes, obscuring impact evaluation, despite statistical matching processes controlling for confounding factors. Non-WMA villages may be subject to comparable restrictions on customary lands; or located close to protected areas or wildlife corridors with levels of human-wildlife conflict comparable to WMA villages[13],[14]. WMA restrictions may not always be strictly enforced (Bluwstein et al. 2018b). Matching is imperfect, and despite our correction for residual WMA/non-WMA differences (Bluwstein et al. 2018a), WMA and non-WMA samples may have differed in other ways which we were not able to observe, a limitation of all matching methods (Stuart 2010).

Another possibility is that, despite all the investment that goes into them, WMAs, JFM (Persha and Meshack 2015) and CBFM (Gross-Camp 2017) interventions alike have

relatively limited impact on the ground. Conservation and development outcomes may be less transformative than hoped, where governance structures are weak (e.g. lack of enforcement of South WMA boundaries: Bluwstein and Lund 2016), elite capture common in CBWM (Dressler et al 2010; Bluwstein 2017), and people may use 'weapons of the weak' (Scott 1985) to manage restrictions (by sabotage, passive resistance, or circumventing restrictions, as evidenced in Enduimet and Lake Natron WMAs: Wright 2017, Mariki 2016).

Conclusion: WMA effects on rural married women

Several of our key findings (Table 2) are consistent with intersectional political ecology predictions of generally adverse WMA effects for the marginalised. Most married women display limited political participation, and though FHHs display better knowledge and greater readiness to articulate their opinions of WMA governance, they remain less informed than male counterparts. Most married women, but especially the poorest, experience WMA-related problems of resource access (eg. scarcity of land, increased risks and effort in gathering firewood). WMA wives, especially in the North, experience heightened concerns for people's and livestock's physical security.

The evidence for increasing uptake of *kibarua* in general is strong in the North (Fig. S5), and linked to poverty, indicating this is 'distress sale of labour' more than an active response to opportunity. There is some evidence of North WMAs increasing poverty-related uptake of *kibarua* (Fig. S6). Other WMA effects appear clearly wealth-related. WMA gazettement means worsening access to farmland for North very poor/poor WMA wives (not in a position to mobilise social or financial resources to secure access); but, with low enforcement, increased access for South normal/rich WMA wives. Where better-off women may exploit a lack of enforcement to access land and invest in farms, they may also feel the restrictions

impacting poor people's natural resources-based livelihoods through the rising prices they pay for NTFPs like firewood.

North/South differences are consistent with their different regional ecologies, economies and cultures. In the North, conservation restrictions apply more widely and are more harshly enforced through violence and economic sanctions[10] (Mariki 2016). At the same time the expanding economy and infrastructure (transport: roads, trailbikes; communications: mobile phones) alongside tourism, trade and proliferating NGO activity, all generate economic possibilities. From being customarily pastoralist producers, women here are increasingly diversifying across a wide range of income-generating activities, though levels of engagement in most of these remain relatively low. The two high-uptake exceptions are *kibarua* (driven by necessity) and livestock produce sales (associated with wealth). By contrast in the more remote, poorer South, there are fewer opportunities. Despite women's generally higher levels of education, diversification remains low-level and patchy.

There are fewer positive WMA effects supporting conservation theories of change. Though women listed infrastructure, education and employment as positive outcomes of WMAs, as predicted by conservation theories of change, detailed survey findings challenge these suggested benefits. In an overall picture of declining receipt of aid by South wives through time (Fig S5), philanthropic aid associated with WMA presence may have had a small protective effect on South Very poor/Poor women's (nonetheless declining) receipt of aid (Fig S6), though this was neither from WMA revenues, nor self-sustaining.

Though mixed, nuanced and complex, WMA effects to date are on balance more broadly consistent with the negative predictions of intersectional political ecology than the positive

CBWM theories of change. Tanzanian WMAs, and perhaps other CBWM initiatives, need to reconsider their approach and evolve more effective ways to improve outcomes for marginalised folk including poor rural women across Tanzania and beyond.

Most WMAs already established are not financially viable without donor assistance[3], even without attempting to compensate the opportunity costs WMAs impose on rural livelihoods and especially on women. Recent evaluations see such economically non-viable WMAs as unsustainable[3], and recommend their de-gazettement. Village governments should at the very least have the right to withdraw from WMAs that do not work to their benefit (Kicheleri et al 2019). For those which are economically viable, we advocate giving village residents access to key natural resources within WMAs for domestic use, and meaningful participation in their management[15]. Both empirical observation (Benjaminsen et al 2013, Mariki 2016, Bluwstein 2018) and theoretical analysis (Cornwall 2003; Kabeer 2005) suggest reality does not live up to the rhetoric of participation and devolution (Kicheleri et al 2018). To deliver positive outcomes, WMAs will need to establish case-specific, culturally appropriate ways of hearing the voices of local women and men of different ethnicities, ages, classes, and education in any given site, as well as clear pathways for adapting WMA resource management in response to changing needs. Despite the pitfalls, there are signs of this happening, building on customary decision-making institutions (Goldman and Milliary 2014, Goldman and Little 2015) alongside growing political engagement and skill in navigating the drivers of interventions (Wright 2017), citizen organisations[16], and gender-sensitive initiatives for local rules around land rights (Richard et al 2019), crucial to gender-equitable empowerment (Kabeer 2005, Grabe 2015).

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Declaration of interest

The authors declare no conflicts of interest

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Table 1 Study WMAs and respondent samples

Ecosystem type	WMA	Tourism potential and type*	Rural livelihoods	Region	No. villages in WMA	Registered	WMA wives**	Non-WMA wives**
Savanna	Enduimet	High (GV+H)	Agro-pastoral	Arusha (North)	9	2007	77	79
	Makame	Low (GV+H)	Agro-pastoral	Manyara (North)	4	2009	74	77
	Burunge	High (GV+H)	Agro-pastoral	Manyara (North)	10	2006	75	79
Miombo	Tunduru Nalika	Low (H)	Farm-based	Ruvuma (South)	9	2003	79	79
	Mbarang'andu	Low (H)	Farm-based	Ruvuma (South)	7	2006	79	80
	Liwale	Low (H)	Farm-Based	Lindi (South)	9	2003	79	80

* GV=game viewing; H=Hunting.

** Nº wives interviewed within villages in study WMAs and their matched, non-WMA villages.

Table 2: Summary of WMA impacts:

	WMA effect	Variable	Region	Wealth	Analysis	Evidence
1	+ve	Infrastructure[⊗]	All	All	% responses	Fig 3
2	+ve	Schools[⊗]	All	All	% responses	Fig 3
3	+ve	Employment[⊗]	All	All	% responses	Fig 3
4	+ve	Land for cultivation	South	N/R	BHM	Fig S2
5	+ve	Construction materials	North	All	BHM	Fig S2
6	+ve	Aid (relative, within overall decline)	South	Vp/P	BHM	Fig S6
7	+ve	Income from crop sales	South	Vp/P	BHM	Fig S6
8	0	Sales of livestock produce	All	All	BHM	Fig S6
9	0	Sales of craft	All	All	BHM	Fig S6
10	0	Remittances	All	All	BHM	Fig S6
11	0	Paid work	All	All	BHM	Fig S6
12	0	NTFPs	All	All	BHM	Fig S6
13	0	Crop damage	all	All	BHM	Fig S8
14	0	Food security	All	All	BHM	Fig S8
15	0	Ease of movement	All	All	BHM	Fig S8
16	-ve	Participation	All	All	% responses	Fig 2
17	-ve	Livestock predation[∅]	All	All	% responses	Fig 4
18	-ve	Worry over wildlife hazard[∅]	All	All	% responses	Fig 4
19	-ve	Access to firewood, farmland, pasture[∅]	All	All	% responses	Fig 4

20	-ve	School bursaries, children of only 3-4% women	All	elite capture	Survey data	Bluwstein et al 2018a
21	-ve	Decreasing access to land for cultivation	North	Vp/P	BHM	Fig S2
22	-ve	Decreasing access to firewood	North	N/R	BHM	Fig S2
23	-ve	Decreasing water sales*	All	All	BHM	Fig S6
24	-ve	Decreasing sales cooked foods	South	Vp/P	BHM	Fig S6
25	-ve	Decreasing petty vending	South	N/R	BHM	Fig S6
26	-ve	Increased kibarua**	North	Vp/P	BHM	Fig S6
28	-ve	Increased N^{o} income- earning activities**	North	Vp/P	BHM	Fig S7
29	-ve	Increasing worry of wildlife hazard	North	All	BHM	Fig S8

⊗ top 5 perceived benefit

∅ top 5 perceived cost

* effect driven by single control village: see Supplementary Materials. The apparent WMA effect decreasing income from water is strongly linked to changes in one control village, which showed a surge in proportions earning income from water sales 2007-14. Across the entire study area <1% of households earn income from water sales: the statistical salience of this effect is misleading, and it is not dealt with further.

** 'positive' increase in activity equates to 'distress sale of labour' (Kabeer 2005) entailing negative wellbeing impacts.

Vp/P = very poor/poor

N/R = normal/rich

BHM Bayesian hierarchical models

% responses; simple unweighted percentages on raw data from all women's responses

Footnotes

[1] Section 77 in the 2002 and 2005 WMA Regulations authorised NGOs, in collaboration with government agencies, to facilitate WMA initiation, planning, establishment, rulemaking, enforcement. Section 28(1) in the 2012 WMA Regulations maintains similar wording. New subsection 28(2) specifies written approval from the Minister before establishing/ implementing WMAs. Implementing NGOs have included World Wide Fund for Nature (WWF); African Wildlife Foundation (AWF), Conservation International (CI) among others

[2] CWMA consortium website: www.twma.co.tz

[3] USAID_PROTECT 2016 Promoting Tanzania's Environment, Conservation And Tourism (PROTECT) Activity. Analysis Of WMA Financial Viability And Options Study. Acacia natural resources consultants for USAID-PROTECT. Contract No. Aid-621-To-15-00004

[4] Additional funding comes to the WMA administration through NGOs in cash and in kind (Village Game Scout (VGS) equipment, their salaries, crop protection patrols, VGS training, predator-proof bomas, workshops, seminars, boundary demarcations and surveys, land use planning, etc).

[5] Homewood, K., et al 2015 The economic and social viability of Tanzanian Wildlife Management Areas. http://curis.ku.dk/ws/files/145970574/Homewood_et_al_2015_PIMA_Policy_Brief_No_04_2015.pdf

[6] see current CWMA vacancy (Capacity Building and Advocacy officer)

http://www.twma.co.tz/news.html viewed 20/08/2019

[7] for which entrepreneurs' licenses and revenues are managed by the central state, with WMAs minimally involved

[8] Our (small, geographically restricted) subset of female-headed households (n=187) were on average smaller in terms of membership than male-headed households (n= 1737), and markedly less well off in terms of land owned and cultivated per adult equivalent (Table S4). Intersections of gender, poverty, culture and education predict that rural female-headed households are likely to be among the poorest, with the most limited opportunities. However, out of 187 female-headed households, 41% received remittances (compared to 21% all

wives) and two showed up as outliers, owning and cultivating an order of magnitude more land than the mean for women heads of household: one of these was a retired police officer, whose salary and subsequent pension had enabled her to buy land.

[9] Omitting 'other costs' which ranked third but which comprise a miscellany

[10] Kitendeni women's, men's and youth FGs, Enduimet WMA, 2017

[11] *Laigwenan* interview, Sinonik, 2012

[12] NTRI 2016. Making wildlife management areas deliver for conservation and communities. http://www.ujamaa-crt.org/uploads/1/2/5/7/12575135/ntri_brief_final.pdf. Northern Tanzania Rangelands Initiative, implementing USAID-funded project 'Endangered Ecosystems of Northern Tanzania'.

[13] Ngabobo focus group, 2017

[14] By design, our control villages are likely affected by other conservation restrictions (e.g. they should be similarly close to other protected areas). This begs a bigger conceptual question about what the appropriate counterfactual for a WMA effect should be? This study took as controls other villages that could plausibly have become WMAs according to their observed characteristics: this contributes to WMA effects being relatively small. But there could be an argument for a hypothetical "village that isn't affected by conservation at all" being the counterfactual that some will have in mind

[15] Homewood K., et al (2017) Realising the Potential of Tanzania's Community Wildlife Management Areas. ESPA Policy and Practice Briefing. http://www.espa.ac.uk/results/policy-practice-briefs/realising-promise-tanzanias-wildlife-management-areas

[16] Pastoral Women's Council: https://www.youtube.com/watch?v=nD-RNhMHrDo&feature=youtu.be