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Knowledge, Attitude and Practice in Water Resources Management among Smallholder Irrigators in the Tsavo Sub-Catchment, Kenya

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Abstract: The rising demand for food production in a changing climate impacts water resources negatively in semi-arid agro-ecosystems. In the Tsavo sub-catchment of Kenya, this is compounded by a surging population and expansion of cropping as a land use; leading to increased abstraction of surface water resources and deterioration of related ecosystem services. The impact of increased abstraction is more profound during water stress seasons when stream-flow levels are low. While water policies have incorporated a requirement for environmental flows, unregulated abstractions persist suggesting an inherent challenge. Drawing on a sample of 279 households, we analysed farmers' engagement in water resources management and explored how this can inform water resource planning. Seasonal water scarcity and user conflicts were the major challenges experienced by the farmers. Ordinal and logistic regression models show that knowledge, attitude and practices were culture-dependent being impacted by educational attainment, level of income, access to extension and membership to local networks. Attitude and practice were further influenced by land tenure and farm distance to water sources. Since knowledge of water management issues informed attitudes and practices, improved awareness and targeted extension support are necessary in the development and implementation of policy decisions on water resources management.

Keywords: water resources management; smallholder irrigation; abstraction; ecosystems; Tsavo sub-catchment

1. Introduction

The rising food demand amid changing climate impacts water resources negatively [1,2]. An outcome is scarcity with escalation of conflicts and severe crop losses as consequences [3,4]. This situation portends dire consequences for food security, and for sustainable water withdrawals. For Sub-Saharan Africa where the number of people living in extreme poverty has been growing [5] and about one-quarter of the population is undernourished [6], water scarcity presents a serious challenge to sustainable development. Although, the Sub-Saharan region lags in water resource development for sustainable agriculture [7,8], agricultural policies give high priority to irrigation as a potential engine for socio-economic development [9,10]. This has led to expansion of acreage under irrigation, and extended the benefits of food security and poverty reduction. Despite positive outcomes, irrigation expansion has brought up new challenges in water resource governance [7,11,12] and impacted riparian ecosystems negatively [13,14].

Managing water-related challenges to food production and ecosystems calls for novel approaches to water governance that promote stakeholder engagement and support innovative solutions to water allocation challenges [15,16]. While some innovative solutions are focused on developing more water through centralised infrastructure, such as dams, others call for consideration of decentralised on-farm technologies and practices that safeguard ecosystems [7]. There is however, a concurrence that water management approaches must strike a balance between economy and ecosystems [3,17]. Water management interventions are thus perceived as delicate balancing act with many trade-offs, particularly in water stressed river basins where trade-offs are associated with high opportunity costs [8]. While less water for food may condemn many people to hunger, less water for the environment will undermine ecosystems [8,18,19]. However, with increased knowledge of water management, water stressed environments have higher prospects for sustainable agriculture [20]. Water-efficient technologies if integrated with appropriate agronomic practices have the potential to improve food productivity while safeguarding ecosystems [20,21].

Water management approaches that focus on decentralised technologies, such as on-farm surface water storage, can improve food production without allocation of additional water from the ecosystems [21,22]. As a result, decentralised water management technologies have received renewed attention in many countries that have acknowledged their contribution in sustainable agriculture [22–24]. Moreover, agriculture is now considered both as an integrated system and as an agro-ecosystem, providing services and interacting with other ecosystems [7]. Transitioning to sustainable agricultural water management requires broad understanding and support for changes in water policies [25,26]. However, the process towards understanding and accepting new policies is multi-layered, integrating knowledge and awareness of water issues, attitude, and sustainable practices [26]. Many river basin management approaches engage water users not only to promote understanding of water sector reforms, but as means of building support for policies and sustainable practices [25,27]. Developed countries have made considerable progress in these efforts [28,29] which are driven by the need to incorporate local perspectives and values in water governance. However, in many developing countries, citizen participation in water resources management is taking root [27,30–32].

Studies show various conditions that influence knowledge, attitude and practices in relation to water management. These conditions include geographical experiences, such as information on climatic conditions and changing river regimes; farm characteristics, such as farm location relative to a water source; and social experiences, such as membership to a social network [25,26,33]. Other predictors of knowledge, attitude and practices include residency status [32] and psychological factors, such as, environmental identity and values [25,26]. Studies show that while some water users acknowledge the challenges of water resources management, their grasp of integrated water resources management (IWRM) principles is sparse [33]. The Global Water Partnership defines IWRM as: '... a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems' [34] (p. 22). In this articulation, IWRM seeks to establish a path for sustainable development and management of water and related resources, while improving the livelihoods of people and maintaining the integrity of natural systems [34]. IWRM places emphasis on coordinated development of land and water resources, surface and groundwater resources, and upstream and downstream interests.

Although a swell of literature has focused on illuminating the relationship between knowledge and support for water reforms and sustainable practices, little is known about how knowledge of water resources management among irrigators affects their attitude and practices, and how policies can address existing gaps in knowledge and practice. Previous studies show the relationship between farmers' attitude and practice in soil and water conservation [35,36]. However, there is scant evidence how farmers' knowledge of water issues, land tenure arrangements and farm characteristics affect attitude and practice in water resources management. In Kenya, water policies have incorporated a requirement for environment flows to sustain riverine ecology. However, in the Tsavo sub-catchment, water resources are under intense pressure to supply irrigation needs. Unregulated spread of smallholder irrigation systems in region has led to increased abstraction of surface water resources and deterioration of related ecosystems [37–39]. This paper therefore analyses how irrigators in the sub-catchment are engaged in water management, specifically what they know and value, and their practices; and explores how this can inform water resource planning. Our analysis identifies existing gaps in knowledge and interventions necessary to improve support for water policies and sustainable practices. We also identify conditions that may enhance irrigators and policy-makers interactions in the development of sustainable water resource governance.

2. Materials and Methods

2.1. Study Area

This study was carried out in March 2018 in the Tsavo sub-catchment of southern Kenya (Figure 1). The sub-catchment is part of the Athi River basin and lies at the foot slopes of Mt. Kilimanjaro to its northern plains with elevations ranging from 411 to 2198 m above the sea level [40]. The climate of the sub-catchment varies from semi-arid to sub-humid, with average annual rainfall of 1200 mm on Kilimanjaro slopes, and 400 mm in the vast semi-arid lowland areas. The elevation and orientation of major topographical features, sway rainfall distribution over the basin [41]. Tsavo sub-catchment has a population of 178,314 [42] with a density of 28 people per square m. However, population distribution is uneven and largely determined by ecological potential, water availability and infrastructure. Thus, human settlements are concentrated around riparian areas, urban and local trading centres, and on the upper catchments. While large areas of the sub-catchment are taken by group ranches and conservancies, pastoralism remains the dominant land use in semi-arid lowlands. However, riparian areas in the lowlands support a thriving horticulture [37].

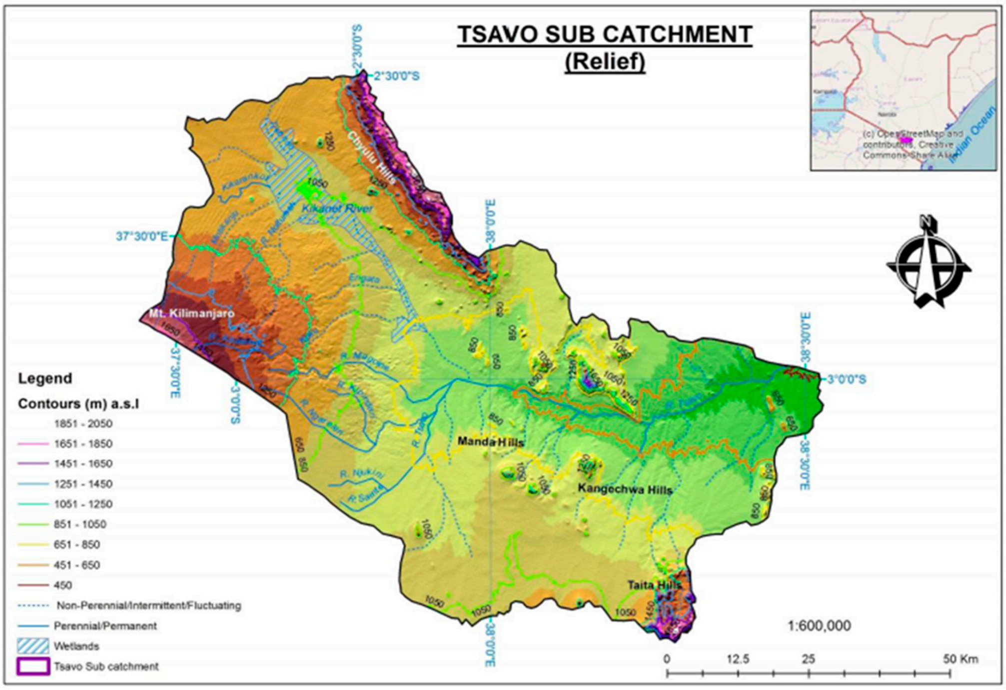

Figure 1. Topographical variation in the Tsavo sub-catchment, Kenya (Source: Ali et al., 2014 [37]).

The sub-catchment has several irrigation schemes supplied by natural springs and streams. Over the past decades, the region has experienced rapid population growth and intensification of agriculture leading to over-extraction of surface water resources [37,38]. The construction of irrigation canals and high demand for horticultural produce by local and export markets has enabled the expansion of irrigation schemes. In most schemes, a significant proportion of farmers rent agricultural land under tenure rights that permit cultivation for a specified period. However, the farm rental agreements, including their impacts on farm efficiency and sustainability remain obscure.

Water resource managers in the Tsavo sub-catchment have issued several policy decisions to safeguard environmental flows and related ecosystem services. Some of these decisions impose the construction of on-farm surface water reservoirs as a prerequisite for water allocation permit [39]. In addition to these decisions, grassroot governance institutions such as water resource users' associations (WRUAs) have supported sustainable initiatives geared towards ensuring equitable water resource allocation. Despite these efforts, illegal water abstraction persists suggesting a deep-rooted problem.

2.2. Data Collection

Data collection was undertaken in the Tsavo sub-catchment. We used a combination of multi-stage sampling and simple random sampling to select irrigation schemes and households where a questionnaire survey was carried out. Three irrigation schemes in the Tsavo sub-catchment were purposely selected in consideration of the land tenure and their spatial locations to incorporate diverse groups. In each scheme, rural population of households, based on National Population and Housing Census results [42], were used to randomly select 279 households. The survey was conducted through face-to-face interviews of irrigation farmers using semi-structured questionnaires.

Water resource management challenges are partly attributed to inadequate knowledge and information on water issues and addressing these problems requires better understanding of what is known, believed and done relative to water management. Knowledge, Attitude and Practice (KAP) survey is useful for evaluating knowledge, attitude and practice of people regarding key issues [43,44]; and identifying the most effective ways of disseminating knowledge and information from scientific research and policies [45]. A KAP survey is a representative study of a population that collects information on what is known, believed and done in relation to a particular issue [45]. KAP studies are also useful in establishing baseline indicators that can be applied to assess intervention impacts, hence, a key element of planning and evaluation research.

In our study, 'Knowledge of water issues' refers to farmers' understanding of IWRM principles. The respondents were required to demonstrate an understanding of IWRM principles. Their responses were assessed based on an elaboration by the Global Water Partnership [34] (p. 22): The responses were rated on a likert scale of 1 to 4 where 1 was 'Good', 2 was 'Average', 3 was 'Poor', and 4 was 'No Understanding'. 'Attitude' towards water resources management was elaborated as inclination to undertake specific sustainable water resources management practices, such as soil conservation, pollution reduction and on-farm surface water storage. The respondents were provided with options and asked to provide a Yes/No answer. The 'Practice', on the other hand, was categorised into two: water resource management measures (i.e., collaborative water management, on-farm surface water storage and compliance to water permit), and responses to water scarcity during low stream-flows (i.e., use of boreholes for supplemental irrigation, reduction of farm size under irrigation and suspension of farm activities). The knowledge, attitude and practice variables were adapted from established literature [26,43,46–48]

2.3. Data Analysis

Data was analysed using Stata 11 statistical software (IBM SPSS software, Portsmouth, UK) and the analysis entailed descriptive statistics for the socio-economic characteristics of the respondents. Chi-square ($\chi2$) test was used to inspect for relationships between knowledge and practices regarding water management issues and socio-economic characteristics. Also analysed were the determinants of farmers' knowledge, attitude, and practice relative to water resource management. Several models were evaluated for their suitability in predicting the determinants and two models were specifically selected to aide in the task and they are discussed below.

2.3.1. Ordered Logistic Regression

The knowledge component of the KAP study was assessed by asking the respondents to rate their understanding of the IWRM principles on a likert scale of 1 to 4 where 1 was 'Good', 2 was 'Average', 3 was 'Poor', and 4 was 'No Understanding'. This type of variable is considered an ordinal variable and the kind of regression model that is typically used in analysing it is the ordered logistic regression. If an ordinal response let's say Y with a c levels, then $(1, \ldots, c)$, and let $X = (x_1, x_2, \ldots, x_p)'$ be a vector of p explanatory variables (i.e., the factors that influence the respondents understanding of IWRM). Then an ordered logistic regression model will describe the relationship between Y and X via $c-1$ logit equations:

$$g_1(X),\ g_2(X),\ \ldots,\ g_{c-1}(X)$$

The logits relate a set of intercepts $(\propto s)$ and regression coefficients (βs) to the probability of the response categories.

2.3.2. Binary Logistic Regression

The attitude and practice components of the KAP study always have binary outcome variables coded as either a '1' for a yes or '0' for a no response; therefore, binary logistic regression was employed to help identity factors that influence these components of the KAP study, and the directions they take. Binary logistic regression is a statistics technique for the case of dependent variables of two outcomes. It expresses the probability of the occurrence of a dependent variable as a function of the independent variables. Mathematically, logistic regression takes an equation of the form:

$$logit(p) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots + b_kX_k$$

where p is the probability of presence of the characteristic of interest.

This study considered one ordinal variable (knowledge of IWRM), four binary response variables (attitude, measures taken to manage water resources, farmers' educational workshops and response to water scarcity) and eight categorical variables for regression analysis (Table 1).

Table 1. Variables used for regression analysis.

Variable	Type	Questions
Knowledge	Ordinal	Rating the understanding of IWRM concept on a four-point likert scale of good, average, poor and no understanding
Attitude	Binary	Does the respondent like to perform the following activities; soil management, pollution control, on-farm surface water storage (1: Yes, 0: No)
Practices a. Measures taken to manage water resources	Binary	Does the respondent currently participate in the following activities: collaborative governance, on-farm surface water storage and abstracting within permitted levels (1: Yes, 0: No)
b. Response to water scarcity	Binary	How do respondents respond to water scarcity: use boreholes, reduce size of land under irrigation or suspend irrigation? (1: Yes, 0: No)
Occupation	Categorical	What is the respondent' principal economic activity? Crop farming, labelled 1; Business, labelled 2; pastoralism, labelled 3; formal employment, labelled 4; or casual employment, labelled 5
Income	Categorical	What is the average monthly income (US$)? 100, labelled 1; 101–300, labelled 2; 300–500, labelled 3 or over 500, labelled 4
Membership to network	Categorical	Does the respondent belong to a network? Environment, labelled 1; social, labelled 2; or economic, labelled 4
Access to credit Farmer workshops Access to extension	Categorical Binary Categorical	Does the respondent have access to credit? (1: Yes, 0: No) Has the respondent attended farmers' education workshop? (1: Yes, 0: No) Does the respondent have access to extension services? Government, labelled 1; private. Labelled 2; and none, labelled 3
Farm distance from water source	Categorical	What is the distance from your farm to the nearest river/stream? Less than 1 km, labelled 1, 1–3 km, labelled 2; 4–5 km, labelled 3; and over 5 km, labelled 4
Type of land ownership	Categorical	What is the type of land ownership? Private (1: Yes, 0: No), communal (1: Yes, 0: No), leasehold (1: Yes, 0: No)
Length of residency	Categorical	How long has the respondent lived in his community? Less than 10 year, labelled 1; 11–20 years, labelled 2; 21–30 years, labelled 3; and over 30 years, labelled 4

3. Results

3.1. Socio-Demography of the Study Population

A total of 279 households were interviewed. Most of the households were male-headed (71%). The mean age of the respondents was 43 years with the youngest at 21 and the oldest at 76 years. The level of education was relatively high: 43% had secondary and tertiary education, and their average monthly household income was about US$ 300 (Table 2).

Table 2. Socio-economic and demographic characteristics of the respondents.

Characteristics	Description	Proportion (%)
Gender of household head	Male	71
	Female	29
Main source of income	Crop farming	86
	Business	7
	Pastoralism	3
	Formal employment	2
	Casual employment	2
Level of monthly income in US$	Up to US$ 100	40
	US$ 101–300	40
	US$ 301–500	15
	Over US$ 500	5
Access to credit	Respondent had access to credit	49
	Respondent had access to credit	51
Type of land ownership	Private	58
	Communal	14
	Leasehold	28
Source of extension	None	21
	Government	65
	Private	14
Frequency of Extension	None	21
	Weekly	1
	Monthly	8
	Quarterly	42
	Occasionally	28
Perception on water availability	Good	30
	Satisfactory	29
	Bad	41
Rating of understanding of Integrated Water Resource Management	Good	23
	Satisfactory	16
	Poor	18
	None	43

Although crop farming was the dominant economic activity, 14% of households reported non-cropping activities as the primary sources of income. The average household size was 6, and nearly each household had over one unit of livestock. The mean size of land owned by households in Tsavo sub-catchment was 4.6 hectares. However, respondents were mainly smallholder farmers with an average of 2.6 hectares of land under irrigation. Nearly half of these farmers had access to credit. Among sampled households, 58% have access to land through private tenure. The rest had access to farming land through communal or private leases. Nearly a third (32%) of respondents had direct contact with government and private extension services for the past one year. Given the relatively high levels of education and access to extension, it was expected that farmers are aware of the issues of water scarcity, and their impacts on farm output and the environment.

3.2. Perception of Environmental Conditions

Farmers responded affirmatively that water resources for irrigation are scarce. They identified deforestation, reduced rainfall, poor agricultural practices and population growth as the major causes of water scarcity. To cope with scarcity, majority of irrigators (59%) reported a reduction of acreage under irrigation. Some (22.5%) would access water from the boreholes, while a few (1%) would utilise stored rainfall runoff to supplement irrigation needs. Respondents had unfavorable view of the environmental status, with the majority (72%) rating Tsavo sub-catchment as degraded or very degraded. Similarly, 66% of respondents rated quality of water resources in the area as between bad and satisfactory compared to 34% who rated it as either good or very good. Water resource conflicts were reported as a major issue in the area, with 70% of respondents indicating that they had experienced water-related conflicts in the past one year. Other major environmental issues identified by the respondents were: illegal encroachment of riparian areas, over-abstraction of surface water resources and loss of biodiversity.

3.3. Farmers' Knowledge in Water Management

3.3.1. Knowledge of Integrated Water Resources Management (IWRM)

Farmers' knowledge relative to IWRM was tested by asking them to rate their understanding of the concept on a four-point likert scale of good, average, poor and no understanding (Figure 2). Majority of the respondents (55%) rated their understanding of the IWRM principles as either good, average or poor. Ninety percent of respondents stated that water is finite, 61% concurred that their participation in water management decision making is critical to sustainability, while 92% reported that their actions can protect water resources from further degradation. These findings suggest that most respondents in the Tsavo sub-catchment had average knowledge of IWRM principles.

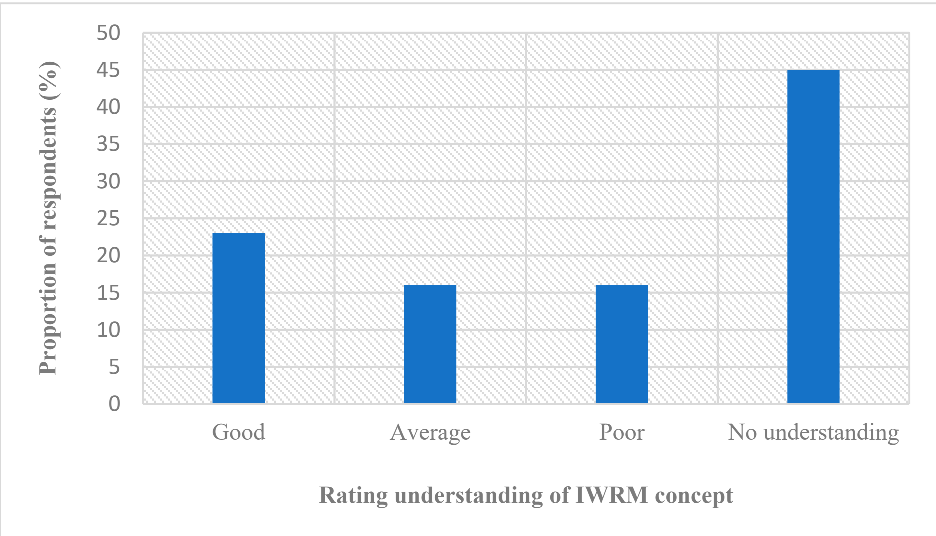

Figure 2. Rating the understanding of IWRM concept among respondents.

3.3.2. Determinants of Farmers' Knowledge of Integrated Water Resources Management

Ordinal logistic regression was used to assess factors influencing farmers' knowledge of the IWRM principles. The results show that for education, an increase of one more year in schooling resulted in 0.9 times increase for the odds of better understanding of IWRM compared to poor and no understanding, given that all of the other variables in the model are held constant (Table 3). For the type of livelihood, being a business person compared to a crop farmer leads to an odd of 3.2 times likelihood of having poor to no understanding of IWRM. Similarly, access to extension from the government results into an odd of 4 times likelihood of having good or average knowledge of IWRM compared to those who had no access to extension service; and not being a member of environmental network results into odds of 3.2, 5.1, and 6.7 times likelihoods of having poor or no understanding of IWRM for economic, social and no membership to groups, respectively (Table 4). These results are compatible with chi-square (χ2) test that shows that knowledge of IWRM among irrigators was significantly related to level of education (χ2 (2) = 26.24, p = 0.000), access to extension (χ2 (2) = 21.2; p = 0.000), and level of income (χ2 (3) = 12.1; p = 0.007). Farmer educational workshops and chief's forum (54.6%) were the main sources of water resources management information.

Table 3. Ordered logistic regressions for determinants of farmers' knowledge of IWRM principles.

Variable	Description	Coefficients	Odds Ratio
Education	No. of years in basic education	0.07 **	0.9
Main livelihood	Crop farming	-	
	Business	1.17 **	3.2
	Pastoralism	0.13	1.1
	Formal employment	1.16	3.2
	Casual employment	0.38	1.5
Level of monthly income in US$	Up to US$ 100	-	
	US$ 101–300	−0.07	0.9
	US$ 301–500	0.31	1.4
	Over US$ 500	2.08 ***	8.0
Access to extension	None	-	
	Government	1.01 ***	0.4
	Private	−0.70	0.5
Membership to group	Environment	-	
	Economic	1.17 ***	3.2
	Social	1.63 ***	5.1
	No membership	−1.90 ***	6.7

Note: *** significant at 1% level; ** significant at 5% level.

Table 4. Results of the binary logistic regressions for attitude towards water conservation practices.

Variable		Soil Conservation		Pollution Control		On-Farm RWH	
Monthly Income		**Coefficient**	**Odds Ratio**	**Coefficient**	**Odds Ratio**	**Coefficient**	**Odds Ratio**
	Up to US$ 100	-	-	-	-	-	-
	US$ 101–300	−0.29	0.75	−0.64	0.53	−0.19	0.83
	US$ 301–500	0.44	1.55	−2.06	0.13	−0.54	0.58
	Over US$ 500	−0.68	0.50	(empty)		0.47	1.61
Membership to network							
	Environmental	-	-	-	-	-	-
	Economic	0.59	1.80	0.33	1.39	0.97 **	2.64
	Social	0.78	2.18	−0.62	0.54	0.08	1.08
	None	0.20	1.22	0.97	2.64	0.65	1.92
Access to credit		−0.39	0.67	−0.58	0.56	−0.79 **	0.45
Access to extension							
	None	-	-	-	-	-	-
	Government	0.71 *	2.04	0.18	1.19	−0.11	0.89
	Private	0.87	2.38	1.37	3.94	−0.06	0.94
Farm distance from water sources							
	Less than 1km	-	-	-	-	-	-
	1–3 km	−0.71 **	0.49	−1.43 ***	0.24	0.32	1.38
	4–5 km	−2.00 ***	0.13	−2.34 **	0.10	0.49	1.63
	Over 5 km	−1.44	0.24	−0.08	0.92	1.55	4.70
Type of land ownership							
	Private	-	-	-	-	-	-
	Communal	−1.46 ***	0.23	−1.47	0.23	−0.51	0.60
	Leasehold	0.27	1.30	0.57	1.77	−0.66 *	0.52

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

3.4. Farmers' 'Attitude' Towards Water Resource Conservation

Results from the binomial regression model of the determinants of Attitude towards water resource management are presented in Table 5. The model analysed farmers' attitude towards soil conservation, pollution reduction, and on-farm surface water storage practices (Table 4). Most (75%) of the respondents were inclined to construct on-farm water storage systems. Only 3% of the respondents reported no willingness to engage water conservation practices.

Table 5. Results of the binary logistic regressions for water resource management practices.

Variable	Collaborative Water Management		On-Farm RWH		Compliance to Abstraction Permit	
Monthly Income	**Coefficient**	**Odds Ratio**	**Coefficient**	**Odds Ratio**	**Coefficient**	**Odds Ratio**
Up to US$ 100	-	-	-	-	-	-
US$ 101–300	0.66 *	1.93	0.99	2.68	−0.43	0.65
US$ 301–500	−0.16	0.85	0.96	2.61	−0.20	0.82
Over US$ 500	−2.44 **	0.09	1.56	4.75	−0.38	0.69
Membership to network						
Environmental	-	-	-	-	-	-
Economic	−0.93 **	0.39	0.03	1.03	1.18 **	3.27
Social	−2.33 ***	0.10	−0.98	0.38	0.62	1.85
None	−1.51 ***	0.22	−0.77	0.46	0.75	2.11
Access to extension						
None	-	-	-	-	-	-
Government	2.11 ***	8.26	−2.41 ***	0.09	0.99 **	2.70
Private	1.80 *	6.05	−0.47	0.62	1.40	4.06
Type of land ownership						
Private	-	-	-	-	-	-
Communal	0.06	1.06	−0.26	0.77	1.19 ***	3.29
Leasehold	1.63 ***	5.08	−0.91	0.40	0.93 ***	2.52

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Socio-economic, institutional and farm characteristics were significant in influencing farmers' attitude to water conservation practices. Access to government extension, farm distance from a stream or spring and land tenure were predictive factors of willingness to engage in soil conservation practices. Farmers with access to government extension were twice more inclined to engage in soil conservation practices than those who had no access (odds = 2.04). In contrast, proximity to water sources, such as stream or spring had negative influence on farmers' willingness to implement soil conservation. Being situated less than a kilometre from water sources is associated with 0.49 and 0.13 times lower odds of willingness to engage in soil conservation activities for farmers situated 1–3 km and 4–5 km, respectively.

The connection between tenure rights and soil conservation is significant; farmers who had access to irrigated land through communal tenure had less favourable attitude towards soil conservation. Secure land tenure was associated with 0.2 and 1.3 times higher odds of willingness to support soil conservation practices than communal and leasehold tenure, respectively. In contrast, income was significant and positively correlated with farmers' preparedness to support water pollution reduction measures (odds = 0.13). Proximity to water sources has negative coefficient on farmer attitude towards pollution reduction, suggesting that farmers situated close to water sources have less favourable attitude towards pollution reduction practices. Being situated less than a kilometre from water sources is associated with 0.24 and 0.1 times lower odds of willingness to engage in pollution reduction strategies for farmers situated 1–3 km and 4–5 km, respectively. Members of economic networks are twice more willing to construct on-farm water storage facilities than non-members (odds = 2.64). However, the willingness to construct on-farm water storage systems was negatively influenced by access to credit (odds = 0.5), suggesting that farmers with access to credit are 0.45 times less likely to invest in on-farm water storage systems than farmers with no credit.

3.5. Practice in Water Resources Management

The practice in water resources management were categorised into two: water resources management practices and farmers' response to water scarcity during seasons of low stream-flows. These practices were supported by water policies and promoted by grassroot institutions.

3.5.1. Water Resource Management Practices

Thirty-seven percent (37%) of the respondents were already engaged in cooperative management of water resources, while 32% had indicated that they were abstracting within permitted levels. Only 1% had constructed on-farm water storage systems. Table 5 shows the results of the binomial regression model of the determinants of water resource management practices. These practices are modelled by three binary variables: collaborative water management, construction of on-farm surface water storage systems and compliance to water allocation permit. Membership to environmental network and access to extension had positive and significant influence on participation in cooperative water management. Being identified as a member of environmental network leads to odds of 0.39 and 0.10 likelihood of participating in collaborative management of water resources for economic and social networks, respectively. Similarly, those who have access to land through leasehold tenure have higher odds of participating in collaborative water management by 5.08 times than farmers with secure tenure. Access to government and private extension was associated with increasing the odds of engaging in collaborative activities by 8.26 and 6.05 times, respectively. However, farmers with higher income were less likely to participate in collaborative water management.

Access to government extension service was associated with decreasing the odds of constructing on-farm water storage facilities by 0.09 times. On the other hand, membership to economic network, access to extension and land tenure had significant and positive effect on compliance to water allocation permit. Members of economic network are twice more likely to comply with water allocation permit (odds = 3.27). Similarly, access to extension is associated with 2.70 times higher odds of compliance to water allocation permit. Moreover, land ownership through communal tenure and leasehold tenure is associated with 3.29 and 2.52 times higher odds of compliance to abstraction permit, respectively. It is important to note that regression results of this study coincide with the findings of chi-square tests (Table 6).

Table 6. Socio-economic factors influencing water resource management practices.

Socioeconomic Characteristics	Measures Taken for Water Conservation					
	On-Farm RWH		Collaborative Water Management		Compliance to Abstraction Permit	
	$\chi 2$	*p* Value	$\chi 2$	*p* Value	$\chi 2$	*p* Value
Level of education	17.1	0.004	15.2	0.009	11.6	0.04
Access to extension	31.8	<0.001	28.9	<0.001	8.1	0.017
Length of residency	35.0	<0.001	-	-	-	-
Size of household	30.6	0.004	-	-	-	-
Mean monthly household income	8.2	0.042	11.1	0.011	-	-
Access to credit	4.5	0.034	-	-	-	-
Type of land ownership	-	-	12.1	0.002	12.3	0.002

3.5.2. Farmers' Response to Water Scarcity

Farmers' response to water resource scarcity is modelled by three variables: use of boreholes to supply irrigation, reduction of acreage under irrigation, and suspension of farm operations (Table 7). Levels of income, attendance to farmers' educational meetings, and proximity to stream or spring are the key predictive factors of using boreholes to supply irrigation during dry season. Farmers with average monthly income in excess of US$ 500 had higher odds of augmenting irrigation water supply with boreholes during dry season by 31.26 times than farmers with a monthly income of US$ 100. Moreover, farmers with access to credit were twice more likely to use boreholes than those who lack access (odds = 1.90). Further, attendance to farmers' educational meetings was associated with 2.60 times higher odds of using boreholes for irrigation than non-attendance. Being situated more than five kilometres away from water sources was associated with 7.8 times higher odds of using boreholes as a source of irrigation water supply during dry season than farmers situated less than a kilometre from streams or springs. Communal or leasehold tenure was associated with 2.73 and 2.27 times higher odds of using boreholes during dry season, respectively, than secure tenure.

Table 7. Results of the binary logistic regressions for responses to water scarcity.

Variable	Using Boreholes		Reducing Farm Size		Suspending Irrigation	
Monthly Income	**Coefficient**	**Odds Ratio**	**Coefficient**	**Odds Ratio**	**Coefficient**	**Odds Ratio**
Up to US$ 100	-	-	-	-	-	-
US$ 101–300	1.18 ***	3.26	0.40	1.49	0.38	1.46
US$ 301–500	0.88*	2.41	−1.08 *	0.34	−0.67	0.51
Over US$ 500	3.44***	31.26	−4.7 ***	0.01	−0.62	0.54
Membership to network						
Environmental	-		-	-	-	-
Economic	0.56	1.76	-0.10	0.91	−1.02 *	0.36
Social	−0.77	0.46	0.37	1.44	−0.42	0.65
None	−0.40	0.67	0.87	2.38	−0.48	0.62
Access to credit	0.64 *	1.90	−0.95 **	0.39	−0.42	0.66
Attendance to workshop	0.96 ***	2.60	−0.31	0.73	0.07	1.07
Access to extension						
None	-	-	-	-	-	-
Government	0.19	1.21	1.40 ***	4.04	−1.26 ***	0.28
Private	−0.35	0.70	1.21	3.35	−0.84	0.43
Farm distance from water sources						
Less than 1 km	-	-	-	-	-	-
1–3 km	0.28	1.33	−1.19 ***	0.30	0.38	1.46
4–5 km	−0.87	0.42	−1.83 ***	0.1	1.45 ***	4.25
Over 5 km	2.05	7.80	−3.18 ***	0.04	1.11	3.02
Type of land ownership						
Private	-	-	-	-	-	-
Communal	1.00 **	2.73	0.82	2.27	−0.39	0.68
Leasehold	0.82 **	2.27	−1.82 ***	0.16	−0.59	0.56

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

While farmers with higher income and access to credit are less likely to reduce the acreage under irrigation, those with access to government extension had a contrary opinion. Access to government extension is positively correlated with a reduction of farm size during drought (odds = 4.04). However, leaseholders had lower odds of reducing the acreage under irrigation by 0.16 times than farmers with secure and communal tenure. Proximity to water sources had negative and significant effect on reducing the acreage under irrigation during dry season, suggesting that farmers situated close to water sources are less likely to reduce the size of land under irrigation. Membership to economic network and access to government extension have negative predictive influence on farmers' decision to suspend farm operations.

The knowledge of IWRM principles among irrigators was statistically significant in relation to attitude and practice variables. Chi-square ($\chi2$) tests show the relationship between irrigators' knowledge of water resources management and their inclination to engage in soil conservation ($\chi2$ (2) = 21.8, p = 0.000), and pollution reduction measures ($\chi2$ (2) = 40.6, p = 0.000). Similarly, the association between knowledge of IWRM and participation in cooperative management of water resources ($\chi2$ (2) = 40.7, p = 0.000), and compliance to abstraction permit ($\chi2$ (2) = 24.5, p = 0.000) was statistically significant.

4. Discussion

Farmers' knowledge, attitude and practice regarding water resources management is culture-dependent being impacted by demographic, socio-economic and institutional factors (Tables 3–7). Privileged groups, such as wealthier and better educated individuals are better able to understand local environmental challenges and more likely to express concerns about the deteriorating environmental conditions, suggesting their sensitivity to changes in water quantity and quality. Similarly, individuals with low education and income may encounter various stressors that limit their knowledge and engagement in water management issues. This finding is supported by previous studies [25,26,28,49]. Our findings further suggest that participation in community networks can enhance knowledge and understanding of water issues. Participation in community networks can improve issue awareness and cultivate support for water policies and sustainable technologies and practices. However, low social capital exerts significant, but negative influence on social learning and sharing of information. These results are consistent with other findings [25,26,50,51] that knowledge of water issues can be effectively disseminated in social networks.

The predictors of attitude and practices in sustainable water resource management were similar to the ones determining knowledge of water resource management (Tables 3–5). These included levels of income, participation in community networks and extension services. However, proximity to a water source (stream or spring), land tenure and access to credit were the most significant explanatory variables for attitude and practice in water resources management (Tables 4–7). The role of extension services in building understanding and support for sustainable agricultural practices is well demonstrated [52]. We found that farmers with access to extension had better knowledge of water issues, and were more inclined to engage in soil conservation practices. Similarly, access to extension services improved participation in collaborative management of water resources and compliance with water permit, and such farmers were more likely to scale down farm operations during dry season in response to water scarcity (Tables 4–7). Access to extension can improve knowledge of water management issues, local climate and agronomy that can ultimately enable farmers to adjust their practices [53]. This finding highlights the importance of extension services in cultivating support for water policies and sustainable practices. While it is beyond the scope of water authorities to review farmer extension systems and design farm water management programmes, they can use and enrich existing extension services by disseminating and enhancing understanding of water resource management issues among farmers in the Tsavo sub-catchment. Our results further showed that, among water conservation practices in the sub-catchment, on-farm water storage was the least common. Moreover, farmers with access to government extension were less likely to adopt on-farm water storage-based production systems. This result is surprising because with greater access to government extension, farmers would be expected to demonstrate better knowledge of on-farm water storage, including recognition of its benefits that might improve adoption rate and farm performance. More interestingly, access to credit had negative significant influence on willingness to invest in on-farm water storage systems (Table 4), suggesting that farmers are risk averse and less likely to commit short-term credit on long-term investment [54].

Social networks serve as serve as platforms for exchange of information and experiences which ultimately build trust and norms of reciprocity among members. This is comparable to other studies [51,55] that communication within networks enhances sustainable management of water resources. These results resonate with our study which showed that social network enhanced compliance to water allocation regulations and participation in cooperative management (Table 5), and such farmers were likely to use boreholes to supplement irrigation needs during dry season in response to water scarcity (Table 7). This is further supported by a previous study [56] that networks support their members to access extension services, lobby for better policies and overcome financial challenges.

The study has also shown the importance of farm location in predicting attitude and practices towards water management. Farmers situated close to spring or stream had less favourable attitude towards pollution reduction measures (Table 4), suggesting the association between crop habitat and occurrence of pests and diseases. This finding is comparable to a study by [57] that crop habitat might constrain pest management efforts and necessitate heavy use of farm chemicals that ultimately result in land and water pollution.

The role of land right security in farmers' decision to invest in land management has been demonstrated [58]. We found that farmers who rent agricultural land under tenure rights that permit cultivation for a specified period were less inclined to engage in soil management and water harvesting practices (Table 4). This finding is consistent with common knowledge and established literature [59] that poorly defined land rights can limit sustainable investments in agricultural land and water management. Although clearly defined land rights may bolster incentives for investment in land and water resources, literature on property rights and sustainability shows mixed results on investment outcomes [60]. This suggests that well-defined land rights do not guarantee sustainable investment in agricultural land and water management. This finding is comparable to our result showing that farmers who rent agricultural land under insecure property rights were more likely to invest in boreholes to supplement irrigation needs (Table 7). Our results further suggest the connection between land rights and participation in collaborative water management and compliance to water allocation regulations (Table 5). Farmers who rent agricultural land were more likely to collaborate with other stakeholders and comply with water permits, probably to win trust of the landowners and avoid confrontation with the water authority. This finding is supported by previous literature [51] that collaboration approaches to water management can serve as 'catalysts of trust' and build support for policies and sustainable practices.

Other social factors influencing practice in water resources management included length of residency and household size. Length of residency as a surrogate of age and farming experience is associated with better knowledge and understanding of the local environment due to interactions with ecosystems over the years. Such farmers accrue more information that can allow them to adjust farming practices to changes in environmental conditions. Although this finding is aligned with previous literature [43], it is at odds with other studies [61] that youthful farmers are more receptive to alternative farm technologies and practices. Household size as a proxy to labour availability is associated with investment in on-farm surface water storage. This suggests that large household is more likely to adopt labour-intensive technologies. This is consistent with previous studies [62,63] that large households are more likely to overcome labour constraints and adopt new farming practices.

This study has highlighted the link between knowledge of IWRM and attitude and practice in water resource management. Thus, better knowledge and understanding of water resource management issues appears as a pre-condition for sustainable water resource management. This information is useful to policy-makers and water managers in their attempt to build trust and support for water policies and sustainable practice. Promoting awareness and understanding of water policies, and improving farmers' participation in water management decision-making processes would be a logical starting point for any water resource management intervention. Key messages of awareness campaigns should focus on water resource conservation, but also ecosystem conservation and integrated water resources management. These campaigns can be done through farmer educational meetings and Chief's baraza (forums). Further, this study provides evidence base for rethinking water resource policies and strategies to improve their acceptability. Water policies focusing on balancing irrigation water supply with the necessity to safeguard ecosystems and address vulnerabilities to climatic and non-climatic stressors are most likely to get wide support among farmers in the Tsavo region. In light of the study results, future water resource management interventions should take into account underlying institutional and socio-economic factors, including livelihood challenges facing irrigators in the Tsavo sub-catchment.

5. Conclusions

This study has analysed how irrigators in the sub-catchment are engaged in water management, specifically what they know and value, and their practices in water management; and explores how this can inform water resource planning. Ordinal regression model was used to assess knowledge of IWRM principles, while binary logistic regression was used to estimate the predictors of attitude and practice regarding water resources management. The results show that knowledge, attitude and practice are culture-dependent being impacted by local networks, access to extension, attendance to farmers' education meetings, level of income, access to credit, land tenure and proximity to stream or natural spring. Farmers have better knowledge of IWRM if they are better educated, more affluent, belong to a local network, and have access to extension services. The predictive factors for attitude and practices towards sustainable water resource management are similar to the ones predicting knowledge. These include levels of income, membership to local networks and access to extension. However, proximity to water sources (stream or spring), land tenure and access to credit were the most significant explanatory variables for attitude and practices. Since knowledge of water management issues informed attitudes and practices, improved awareness and targeted extension support are necessary in the development and implementation of policy decisions on water resources management. Although this study has highlighted the need for targeted extension services and awareness, future education-based interventions must move beyond information sharing and spreading awareness and focus on specific policy decisions and water management practices. These interventions should mainly target farmers who have demonstrated favourable attitude towards water resource management practices, such as on-farm surface water storage.

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References

1. Intergovernmental Panel on Climate Change. *Climate Change 2014: Synthesis Report*; Pachauri, R.K., Mayer, L., Eds.; Intergovernmental Panel on Climate Change: Geneva, Switzerland, 2015.
2. Summary for Policymakers of IPCC Special Report on Global Warming of 1.5 °C Approved by Governments. Available online: https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/ (accessed on 21 May 2019).
3. The Future of Food and Agriculture—Trends and Challenges. Available online: http://www.fao.org/3/a-i6583e.pdf (accessed on 21 May 2019).
4. Vörösmarty, C.; McIntyre, P.; Gessner, M.; Dudgeon, D.; Prusevich, A.; Green, P.; Glidden, S.; Bunn, S.; Sullivan, C.; Liermann, C.; et al. Global threats to human water security and river biodiversity. *Nature* **2010**, *467*, 555–561. [CrossRef] [PubMed]
5. World Bank. *Poverty and Shared Prosperity: Piecing Together the Poverty Puzzle*; World Bank: Washington, DC, USA, 2018; Available online: https://www.worldbank.org/en/publication/poverty-and-shared-prosperity (accessed on 19 July 2019).
6. FAO. *Food Security and Nutrition in the World*; IEEE: Piscataway, NJ, USA, 2018. [CrossRef]
7. De Fraiture, C.; Molden, D.; Wichelns, D. Investing in water for food, ecosystems, and livelihoods: An overview of The Comprehensive Assessment of Water Management in Agriculture. *Agric. Water Manag.* **2010**, *97*, 495–501. [CrossRef]
8. Molden, D.; Oweis, T.; Steduto, P.; Bindraban, P.; Hanjra, M.; Kijne, J. Improving agricultural water productivity: Between optimism and caution. *Agric. Water Manag.* **2010**, *97*, 528–535. [CrossRef]
9. African Union (AU). Maputo Declaration on Agriculture and Food Security. In Proceedings of the Assembly of the African Union, Second Ordinary Session, Maputo, Mozambique, 10–12 July 2003.
10. Republic of Kenya. *Agricultural Sector Development Strategy 2010–2020*; Government Press: Nairobi, Kenya, 2010.
11. Fisher, B.; Christie, M. Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. In *The Economics of Ecosystems and Biodiversity*; Kumar, P., Ed.; Ecological and Economic Foundations: London, UK, 2010; Chapter 1; pp. 1–40.

12. Mutabazi, K.; Hatibu, N.; Senkondo, E.; Mbilinyi, B.; Tumbo, D. *Economics of Rainwater Harvesting for Crop Enterprises in Semi-Arid Areas: The Case of Makanya Watershed in Pangani River Basin, Tanzania*; Soil-Water Management Research Group: Nairobi, Kenya, 2005.
13. Jägermeyr, J.; Pastor, A.; Biemans, H.; Gerten, D. Reconciling irrigated food production with environmental flows for Sustainable Development Goals implementation. *Nat. Commun.* **2017**, *8*, 15900. [CrossRef] [PubMed]
14. Van Koppen, B.; Giordano, M.; Butterworth, J. (Eds.) *Community-Based Water Law and Water Resource Management Reform in Developing Countries*; CABI: New York, NY, USA, 2007.
15. Ricart, S.; Rico, A.; Kirk, N.; Bülow, F.; Ribas-palom, A.; Ricart, S.; Rico, A.; Kirk, N.; Bülow, F.; Ribas-palom, A. How to Improve Water Governance in Multifunctional Irrigation Systems? Balancing Stakeholder Engagement in Hydrosocial Territories. *Int. J. Water Resour. Dev.* **2018**, *627*, 1–34. [CrossRef]
16. Lacroix, K.E.M. Building Common Ground for Environmental Flows Using Traditional Techniques and Novel Engagement Approaches. *Environ. Manag.* **2016**, *57*, 912–928. [CrossRef] [PubMed]
17. Power, A. Ecosystem services and agriculture: Tradeoffs and synergies. *Philos. Trans. R. Soc. B Biol. Sci.* **2010**, *365*, 2959–2971. [CrossRef] [PubMed]
18. Molle, F. Water for food, water for Life: A comprehensive assessment of water management in agriculture. *Nat. Sci. Soc.* **2008**, *16*, 274–275. [CrossRef]
19. Vaux, H. Water for agriculture and the environment: The ultimate trade-off. *Water Policy* **2012**, *14*, 136–146. [CrossRef]
20. Mekdaschi, S.; Liniger, H. *Water Harvesting: Guidelines to Good Practice*; Centre for Development and Environment (CDE): Bern, Switzerland, 2013.
21. Rockström, J.; Falkenmark, M. Agriculture: Increase Water Harvesting in Africa. *Nature* **2015**, *519*, 283–285. [CrossRef] [PubMed]
22. Rockström, J.; Folke, C.; Gordon, L.; Hatibu, N.; Jewitt, G.; Penning de Vries, F.; Rwehumbiza, F.; Sally, H.; Savenije, H.; Schulze, R. A watershed approach to upgrade rainfed agriculture in water scarce regions through water system innovations: An integrated research initiative on water for food and rural livelihoods in balance with ecosystem functions. *Phys. Chem. Earth Parts A/B/C* **2004**, *29*, 1109–1118. [CrossRef]
23. Biazin, B.; Sterk, G.; Temesgen, M.; Abdulkedir, A.; Stroosnijder, L. Rainwater harvesting and management in rainfed agricultural systems in Sub-Saharan Africa—A review. *Phys. Chem. Earth Parts A/B/C* **2012**, *47–48*, 139–151. [CrossRef]
24. Ngigi, S.N.; Denning, G. *Assessment of Water Resources Management for Smallholder Farming Systems Adaptation of African Agriculture to Climate Change in Sub-Saharan Africa*; World Scientific and Engineering Academy and Society (WSEAS): Stevens Point, WI, USA, 2008.
25. Dean, A.; Fielding, K.; Newton, F. Community knowledge about water: Who has better knowledge and is this associated with water-related behaviours and support for water-related policies? *PLoS ONE* **2016**, *11*, e0159063. [CrossRef] [PubMed]
26. Dean, A.; Lindsay, J.; Fielding, K.; Smith, L. Fostering water sensitive citizenship–community profiles of engagement in water-related issues. *Environ. Sci. Policy* **2016**, *55*, 238–247. [CrossRef]
27. Baldwin, E.; Washington-Ottombre, C.; Dell'Angelo, J.; Cole, D.; Evans, T. Polycentric governance and irrigation reform in Kenya. *Governance* **2015**, *29*, 207–225. [CrossRef]
28. Jacobs, M.; Buijs, A. Understanding stakeholders' attitudes toward water management interventions: Role of place meanings. *Water Resour. Res.* **2011**, *47*. [CrossRef]
29. Dell'Angelo, J.; McCord, P.; Gower, D.; Carpenter, S.; Caylor, K.; Evans, T. Community water governance on Mount Kenya: An assessment based on Ostrom's design principles of natural resource management. *Mt. Res. Dev.* **2016**, *36*, 102–115. [CrossRef]
30. Ogada, J.O.; Krhoda, G.O.; Van Der Veen, A.; Marani, M.; van Oel, P.R. Managing Resources through Stakeholder Networks: Collaborative Water Governance for Lake Naivasha Basin, Kenya. *Water Int.* **2017**, *42*, 271–290. [CrossRef]
31. Mwihaki, N.J. Decentralisation as a Tool in Improving Water Governance in Kenya. *Water Policy* **2018**, *20*, 1–14. [CrossRef]
32. Spijkers, O.; Li, X.; Dai, L. Public Participation in China' s Water Governance. *Chin. J. Environ. Law* **2018**, *2*, 28–56. [CrossRef]

33. Rolston, A.; Jennings, E.; Linnane, S. Water matters: An assessment of opinion on water Management and community engagement in the Republic of Ireland and the United Kingdom. *PLoS ONE* **2017**, *12*, e0174957. [CrossRef] [PubMed]
34. Global Water Partnership (GWP). *Integrated Water Resources Management. Technical Advisory Committee*; Background Paper No. 4; Global Water Partnership Secretariat: Stockholm, Sweden, 2000.
35. Ashoori, D.; Bagheri, A.; Allahyari, M.S.; Michailidis, A. Understanding the Attitudes and Practices of Paddy Farmers for Enhancing Soil and Water Conservation in Northern Iran. *Int. Soil Water Conserv. Res.* **2016**, *4*, 260–266. [CrossRef]
36. Aydogdu, M.H.; Bilgic, A. An Evaluation of Farmers' Willingness to Pay for Efficient Irrigation for Sustainable Usage of Resources: The GAP-Harran Plain Case, Turkey. *J. Integr. Environ. Sci.* **2016**, *13*, 175–186. [CrossRef]
37. Ali, A.; Okeyo, B.; Tewodros, T.; Handa, C.; Wanzala, W.; Gerd, F.; Rugger, W.; Jane, N.; Neema, M. Water use conflicts in East Africa: Lessons Learnt from International DAAD Alumni Expert Seminars on Integrated Water Resources Management within Tsavo River Catchment. *Afr. Acad. Sci.* **2014**, *18*, 11.
38. Republic of Kenya. *Tsavo conservation Area Management Plan 2008–2018*; Kenya Wildlife Services: Nairobi, Kenya, 2008.
39. Republic of Kenya. *The Water Resources Management Regulations*; Water Resources Authority: Nairobi, Kenya, 2007.
40. Jaetzold, R.; Schmidt, H. *Farm Management Handbook of Kenya*; Ministry of Agriculture: Nairobi, Kenya, 1983; Volume 2.
41. Republic of Kenya. *National Environment Management Authority (NEMA)*; State of Environment Reports; Government Press: Nairobi, Kenya, 2013.
42. Republic of Kenya. *National Population and Housing Census Report*; Kenya National Bureau of Statistics: Nairobi, Kenya, 2009.
43. Tran, H.; Nguyen, Q.; Kervyn, M. Factors influencing people's knowledge, attitude, and practice in land use dynamics: A case study in Ca Mau Province in the Mekong Delta, Vietnam. *Land Use Policy* **2018**, *72*, 227–238. [CrossRef]
44. World Health Organisation (WHO). *Advocacy, Communication and Social Mobilization for TB Control: A Guide to Developing Knowledge, Attitude and Practice Surveys*; World Health Organization: Geneva, Switzerland, 2008.
45. Caribbean Institute of Media and Communication. *Report on Climate Change Knowledge, Attitude and Behavioural Practice Survey*; University of the West Indies: Kingston, Jamaica, 2012; pp. 1–157.
46. Warner, L.A.; Lamm, A.J.; Kumar, A. Landscape and Urban Planning Florida Residents' Perceived Role in Protecting Water Quantity and Quality through Landscape Practices. *Landsc. Urban Plan.* **2018**, *171*, 1–6. [CrossRef]
47. Okumah, M.; Yeboah, A.S.; Nkiaka, E.; Azerigyik, R.A. What Determines Behaviours towards Water Resources Management in a Rural Context? Results of a Quantitative Study. *Resources* **2019**, *8*, 109. [CrossRef]
48. Paneque, P.; Lafuente, R.; Vargas, J. Public Attitudes toward Water Management. *Water* **2018**, *10*, 369. [CrossRef]
49. McDuff, M.M.; Appelson, G.S.; Jacobson, S.K.; Israel, G.D. Watershed management in North Florida: Public knowledge, attitudes and information needs. *Lake Reserv. Manag.* **2008**, *24*, 47–56. [CrossRef]
50. Gilbertson, M.; Hurlimann, A.; Dolnicar, S. Does water context influence behaviour and attitudes to water conservation? *Aust. J. Environ. Manag.* **2011**, *18*, 47–60. [CrossRef]
51. Dean, A.J.; Fielding, K.S.; Lindsay, J.; Newton, F.J.; Ross, H. How Social Capital Influences Community Support for Alternative Water Sources. Sustain. *Cities Soc.* **2016**, *27*, 457–466. [CrossRef]
52. Meijer, S.S.; Catacutan, D.; Ajayi, O.C.; Sileshi, G.W.; Nieuwenhuis, M. The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in Sub-Saharan Africa. *Int. J. Agric. Sustain.* **2015**, *13*, 40–54. [CrossRef]
53. Nhemachena, C.; Hassan, R. *Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa*; IFPRI Discussion Paper No. 00714; International Food Policy Research Institute: Washington, DC, USA, 2007.
54. Karidjo, B.; Wang, Z.; Boubacar, Y.; Wei, C. Factors influencing farmers' adoption of Soil and Water control Technology (SWCT) in Keita Valley, a Semi-Arid Area of Niger. *Sustainability* **2018**, *10*, 288. [CrossRef]
55. Meinzen-Dick, R.; Janssen, M.A.; Kandikuppa, S.; Chaturvedi, R.; Rao, K.; Theis, S. Playing Games to Save Water: Collective Action Games for Groundwater Management in Andhra Pradesh, India. *World Dev.* **2018**, *107*, 40–53. [CrossRef]

56. Ochieng', J.; Owuor, G.; Bebe, B. Determinants of adoption of management interventions in indigenous chicken production in Kenya. *Afr. J. Agric. Resour. Econ.* **2012**, *7*, 1.
57. Karp, D.S.; Chaplin-Kramer, R.; Meehan, T.D.; Martin, E.A.; DeClerck, F.; Grab, H.; Gratton, C.; Hunt, L.; Larsen, A.E.; Martínez-Salinas, A.; et al. Crop pests and predators exhibit inconsistent responses to surrounding landscape composition. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, E7863–E7870. [CrossRef]
58. Twerefou, D.K.; Osei-Assibey, E.; Agyire-Tettey, F. Land tenure security, investments and the environment in Ghana. *J. Dev. Agric. Econ.* **2011**, *3*, 261–273.
59. Nkomoki, W.; Bavorová, M.; Banout, J. Adoption of sustainable agricultural practices and food security threats: Effects of land tenure in Zambia. *Land Use Policy* **2018**, *78*, 532–538. [CrossRef]
60. Fenske, J. Land tenure and investment incentives: Evidence from West Africa. *J. Dev. Econ.* **2011**, *95*, 137–156. [CrossRef]
61. Alcon, F.; Tapsuwan, S.; Brouwer, R.; de Miguel, M.D. Adoption of Irrigation Water Policies to Guarantee Water Supply: A Choice Experiment. *Environ. Sci. Policy* **2014**, *44*, 226–236. [CrossRef]
62. Marenya, P.P.; Barrett, C.B. Household-Level Determinants of Adoption of Improved Natural Resources Management Practices among Smallholder Farmers in Western Kenya. *Food Policy* **2007**, *32*, 515–536. [CrossRef]
63. Nkonya, E.; Pender, J.; Kaizzi, C.; Kato, E.; Mugarura, S.; Ssali, H.; Muwonge, J. *Linkages between Land Management, Land Degradation, and Poverty in Sub-Saharan Africa: The Case of Uganda*; IFPRI Research Report No. 00159; International Food Policy Research Institute: Washington, DC, USA, 2008.