INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Water Security Where Governmental Policies Conflict with Local Practices: The Roles of Community Water Management Systems in Ngaciuma-Kinyaritha, Kenya

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Abstract:
New institutions emanating from the water sector reforms are expected to achieve efficiency and effectiveness in the management of water resources, thus leading to enhance water security in all the catchment areas. For inclusion and ownership of their management programmes on the ground, community members are required to actively get involved in the planning and management processes. How would the existing Community Water Management Systems (CWMSs) be integrated in the legal and institutional frameworks guiding the development, supply, utilization and conservation of water resources under the jurisdiction of a Water Resource Users' Association (WRUA)? This study seeks to unveil some demographic, economic, social and cultural aspects that should have been taken into consideration by the Water Resources Management Authority (WRMA) when drafting a Sub-Catchment Management Plan for Ngaciuma-Kinyaritha WRUA, which came into existence in 2006. The study mainly uses descriptive statistics and a Profit regression to derive significant parameters determining domestic water security in the Ngaciuma-Kinyaritha Catchment. Most of the results reveal that domestic water security in this catchment clearly relies on CWMSs through their catchment management practices and water supply by-laws and tools. There is thus a need for the new WRUA and WSPs to improve their collaboration with CWMSs in the future.

Keywords*: Catchment Degradation, Catchment Rehabilitation, Community Water Management System (CWMS), Legal and Institutional Framework (LIF), Probit Regression*

1. Introduction

Catchment conservation and equitable distribution of benefits arising from community participation in the management of environmental resources has increasingly been advocated. The global community recommend an equitable involvement of both men and women as equal partners in development projects (Subramanian and Ramanathan, 2001; Lelo et al., 2002; Förch et al., 2005; World Bank et al., 2008). A World Bank review of 121 rural water supply projects concluded that community participation, with both genders play key roles, strongly enhanced project effectiveness and sustainability (Meinzen-Dick and Zwarteveen, 1997; Nishimoto, 2003).

Thence, community participation in managing and conserving the world's waters has ever since been stressed and widely accepted at various levels, be they international, national or local, though not by all governments. At the international level, for example, the Rio Declaration on Environment and Development (UNEP, 1992) stated: 'environmental issues are best handled with the participation of all concerned citizens, at the relevant level. . .' (Principle 10). One of the four principles put forward at the influential Dublin Water

Conference in 1992 was that 'Water development and management should be based upon a participatory approach. . .', and the World Water Vision 2000 noted the need for public participation if its 'vision' were to be effectively implemented (Cosgrove and Rijsberman, 2000). 'The real revolution in water resources management will come when all stakeholders, where possible, have the power to manage their own resources' (Ibid.). However none of these statements spelled out what 'community participation' meant or how it could be implemented in water conservation projects.

Malzbender et al. (2005) noted that there was a kind of tension between traditional water governance systems and the newly implemented South Africa's "National Water Act", though the latter was encouraging stakeholder involvement in rural water management. Likewise, since the beginning of the implementation of the Water Act 2002 in Kenya, several new institutions have been formed countrywide with the aim of managing water catchment areas (WRUAs and WRMA), or supplying water and sanitation services (WSPs and WSRBs) (Republic of Kenya, 2002). Yet, Lelo et al. (2005) revealed that the management of River Njoro Water catchment resulted into conflict between laws and policies on one end, and community priorities on the other. The main reason is that the newly formed institutions, which were expected to promote the involvement of the local communities in the planning and allocation as well as the management of their water resources, tended to ignore these customary-law institutions (Förch, et al., 2006; 2007; 2008; Ngigi and Macharia, 2007; K'akumu, 2008). Yet, these communal institutions informally owned certain structures known as "self-help" groups, especially in the rural areas, where private Water Services Providers (WSPs) are likely few. Hence, the role of community "self-help" groups remains significant in the provision of water services as well as managing the resources (Crow and Sultana, 2002; Were et al., 2006; Van Koppen, 2007; Kazbekov et al., 2009). Moreover, Community Water Management Systems (CWMSs) have ownership over some of the water networks in rural areas. They always guide the management and utilization of the water resources within their respective catchments, both for domestic and irrigation purposes. For instance, Onyango et al. (2005) noted that about 28% of all water supply systems in Kericho District of Lake Victoria South are owned by communal groups. A census of 135 springs in Kericho District revealed that 18% were managed by local self-organised groups, and 19% were managed by external groups, including roughly equal numbers of church organisations, development projects government agencies, international organisations and local authorities (Huggins, 2002). However, inclusivity of both genders in the management has been a challenge to most of these community-led projects (Zwarteveen and Meinzen-Dick, 2001).

This was obvious in Malawi, where Maharaj et al. (1999) reported that male-dominated committees for supplying piped water to 50 rural and peri-urban districts put the sustainability of this government program at the risk of collapse, committee members collecting fees irregularly, failing to adhere to agreed times for opening and closing taps, and mismanaging funds collected. Also, user groups and committee meetings were rarely held as most men worked away from their homes (Njonjo and Lane, 2002). To improve the management of water points, water users were encouraged to elect 60 per cent women and 40 per cent men to committees. At the same time, both men and women were sensitised on the benefits of involving women in committees. Under the new structure, projects bills were paid on time, membership grew, meetings became regular and attendance at these meetings increased substantially (Maharaj et al., 1999). Elsewhere, success in the Philippines Communal Irrigation Project was attributed to integration of women in project operations. As in Malawi, the involvement of women in membership increased payment of fees as women controlled household finances (Nishimoto, 2003).

In line with the above considerations, the Government of Kenya initiated a number of water sector reforms that saw the enactment of an inclusive law in the year 2002. The main goal of the Water Act 2002 was to integrate local communities in the legal and institutional frameworks for the management of water resources at catchment level. However, the enforcement of the new legislations required the formation of Water Resource Users' Associations (WRUAs) and registered Water Services' Providers (WSPs) in the catchment areas. In line with this separation of functions instituted by the Water Act 2002, a WRUA and a WSP were registered in Ngaciuma-Kinyaritha Catchment since the year 2006. Yet, communities are still facing challenges due to multiple water services pricing, unreliable water availability, fragile water supply systems' financing, and various environmental issues (WRMA, 2010). The new WRUA has not yet won public trust and need to consolidate its management according to the best practices in the sub-catchment to achieve the targets of the water sector reforms. Moreover, due to the vastness of the sub-catchment and the diversity of its topographical and ecological systems, the WRUA experiences many challenges to incorporate all the sub-catchment area under its management. The upper zone, which is the main source of water supply in the whole sub-catchment, is mainly dry and supplied with water by other catchments.

For these reasons, there are still several CWMSs operating therein but their legal status is far from being clear. Shall these CWMSs obtain a license from the Water Services Regulatory Board (WSRB) to continue providing water services to their members? Or shall they act as WRUAs to continue developing and managing their water resources to ensure water security in one way or another, even though informally or unlawfully? How would the people react to the ban of such institutions by the Water Resource Management Authority (WRMA)? These questions and others are the main subjects of this study dealing with CWMSs' contribution to domestic water security in Ngaciuma-Kinyaritha Catchment of Mount Kenya Region. The research, which was basically focused on socio-economic factors affecting domestic water security in Ngaciuma-Kinyaritha enabled us draw some useful lessons on the roles that CWMSs can play in the implementation of the water sector reforms through improved affordability of water cost and accessibility of water services, both in quality and quantity as well as catchment management. It elicited the contribution of water institutions to domestic water security, including that of CWMSs to water economic development and business success, social inclusion and equity in water use and catchment management as well as environmental soundness and sustainability, among others. The following sections present the materials and methods used in the study, as well as key findings arising from the analysis and their discussion.

2. Material and Methods

Material and methods presented in this section include the geographical setting of the study area, sampling strategy and sample size, methods of data collection and analysis that match the study objectives.

2.1. Geographical Setting of the Study Area

Ngaciuma-Kinyaritha is a sub-catchment of the Tana River emanating from the Mount Kenya Region. The latter is a water tower for three main basins of Kenya, namely Athi, Ewaso-n'giro and Tana catchments. Ngaciuma-Kinyaritha covers an area of 167 km^2, its population was estimated to about 65,000 heads in 2009, which represents a density of 390 persons/ km^2 (KNBS, 2010). The catchment is mainly located around Meru Municipality, in Imenti North District of Eastern Province of Kenya. The catchment is geographically bound by latitudes 37.5º E and 37.75º E, and 0.04º N and 0.15º N (Fig. 1).

The catchment area is mainly dominated by undulating terrains highly dissected by streams, and with altitudes ranging from 1,120 m to 2,600 m. Kinyaritha is one among other tributaries of Kathita, which drains in the Tana River. The other tributaries include Ngaciuma, Kambakia and Gachiege. It is dominated by basaltic volcanic rocks with volcanic tuffs and pyroclasts of Nyambeni eruption of the Pleistoscene (Agwata, 2006). As a result, soils in the catchment are geologically young, poorly consolidated and susceptible to erosion and mass movement, except for the forested parts. These soils are as well subject to high infiltration and seepage rates, especially on hillslopes (Förch, et al, 2008). This justifies the little or no significant permanent surface drainage in the upper catchment area, with exception of Lake Nkunga crater that is fed by three springs and has a sub-surface outlet.

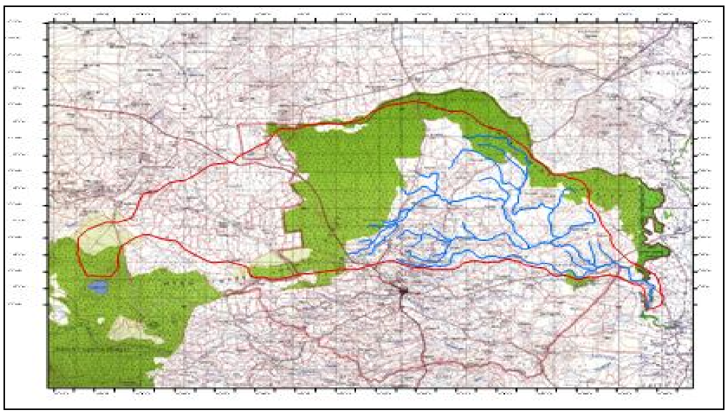

Figure 1: Map of the Ngaciuma-Kinyaritha Catchment (Förch et al., 2007)

Climatic conditions in Ngaciuma-kinyaritha range from humid to semi-humid with mean annual rainfall estimated from about 1,100 mm (in the lower zone) to 1,600 mm (in the upper zone), with an average of 1,315 mm, and annual temperatures ranging from 10^oC to 30^oC. The catchment lies under three coffee agro-ecological zones (AEZ), namely the Upper Midland AEZ 1 (UM 1), which is suitable for the coffee-tea cropping; the Upper Midland AEZ 2 (UM 2), which is the main coffee zone; and, the Upper Midland AEZ 3 (UM 3), the marginal coffee zone (Jaetzold et al., 2007).

Socio-economic activities are dominated by farming for both subsistence and commercial purposes. Subsistence farming includes bananas, maize, beans, potatoes, yams, arrow roots, sweet potatoes, finger millet, peas, cowpeas, sugarcane, and a wide variety of fruits and horticultural crops. Commercial farming involves the cultivation of horticultural crops, macadamia nuts, coffee and fruits. Lumbering is another source of income where trees such as eucalyptus, cypress and grevillea and other indigenous trees are grown for timber and firewood. The demand for more firewood coupled with the demographic pressure and economic activities have contributed to the reduction of the forest cover from 37% to 24% between 1987 and 2000, and to the depletion of wildlife in the forest reserve (Förch, et al., 2008).

Apart from Meru Town, which is the major commercial centre in the catchment, small market places spread across the catchment, including Gitimene (Naari), Muruguma, Kienderu, Chugu, Kauthene, Rwanyange, Ndiine, and Mugeene. These market centres are connected by earth roads, which are often affected by roadside erosions, gullies and other complications due to water disasters. The major tarmac roads, Meru-Maua and Meru-Nanyuki, traverse the catchment, and serves as a major linkage between Ngaciuma-Kinyaritha and the rest of the country.

2.2. Sampling Methods

Ngaciuma-Kinyaritha Catchment was purposely selected owing to the fact that it was among the pilot catchments selected by the WRMA for rehabilitation, and saw the emergence of a WRUA in 2006. The catchment was divided into three different hydro-ecological zones: Ngaciuma, Kinyaritha Minor and Kinyaritha Major. Some 177 households were selected in three zones using Gregg (2009) sample size formula [Equation 1]:

$$n = Z^2 * \frac{p(1-p)}{\varepsilon^2} = \frac{3.84 * p(1-p)}{\varepsilon^2}$$ [Equation 1]

Where,

- $\acute{\varepsilon}$ is the precision of the estimate within a particular confidence interval (in this case $\acute{\varepsilon}$=5%)
- Z is the Z-score for the selected significance level (Z=1.96 at 5%)
- p is the true proportion of the population represented by the sample (in this case 10%)

The above representative sample was estimated at 95% confidence interval based on a total number of households of 14,440. Survey units were randomly selected in the three sub-catchments indicated above using the table of random numbers. Hence, 87 farmers were selected in Kinyaritha Major, 45 in Kinyaritha Minor and 45 in Ngaciuma. These farmers belonged to about 32 CWMSs that were involved in this evaluation.

It shall however be noted that the researcher was only able to administer a total number of 165 questionnaires, owing to the fact that 4 farmers were not disposed to answer to the questions and returned the questionnaires at the very last minute, while 8 among them provided wilful misleading responses, leaving thus to a total number of 165 genuine respondents, 95.5% in Kinyaritha Major (83 instead of 87), 93.3% in Kinyaritha Minor (42 instead of 45) and 88.9% in Ngaciuma (40 out of 45). Thus, the final sample size reported below amounts to 165 farmers, who successfully replied to the questionnaires.

2.3. Methods of Data Collection

Data used in this study encompassed socio-economic data as well as physical data. Socio-economic data were collected during a household survey (based on 165 questionnaires), in-depth interviews (involving 36 local administration officers) and a Focus Group Discussion (FGD) held with 8 key informants from the 32 CWMSs. The questionnaires and interview guides were structured in such a way that they could provide both qualitative and quantitative data sets. They compounded both close and open ended questions administered on randomly selected 165 households. A pre-test of the questionnaires was done in order to make useful adjustments or clarifications of some questions that were not clear. A structured interview was conducted with 36 local administration officers contacted at each sub-catchment, namely Ngaciuma, Kinyaritha Minor and Kinyaritha Major. Other data were mainly collected through a Focus Group Discussions (FGDs) involving 8 representatives of CWMSs of the location.

Secondary data were mainly collected using a documentary review on the Tana Catchment Management Strategy (CMS) and Ngaciuma-Kinyaritha Water Resource Users' Association (NGAKINYA WRUA) Sub-Catchment Management Plan (SCMP) (Forch et al., 2007; 2008; WRMA, 2010). Other secondary data were collected from libraries and the internet, mainly from the Kenya Meteorological Department (KMD), the Ministry of Water and Irrigation (MWI), the Water Resource Management Authority (WRMA), the Meru Water Supply and Sewerage Service (MEWASS) and other public bodies. Finally, computational data were collected using GPS, photographic devices, satellite images and topographic maps. The consolidation of these data provided a background on the roles of CWMSs, WRUAs and WSPs in assuring water security in Ngaciuma-Kinyaritha Catchment (Ochieng, 2005).

2.4. Methods of Data Analysis and Results Interpretation

Data collected were pre-processed and then processed using the Statistical Package for Social Science (SPSS) and MS Excel spreadsheets. The pre-processing was done through activating Data View and Variable View spreadsheets in SPSS and data input in MS Excel spreadsheets. This was followed by the coding of information and data entry into files. Data outliers, mistakes and errors were checked, identified and cleaned. A final assessment of the overall quality of the dataset concluded this exercise to enable the actual data analysis.

The analysis involved both qualitative and quantitative techniques along with a triangulation of data and methods. The only qualitative technique used in this study involved pattern/ content analysis, the remaining part of the analysis being quantitative. Pattern/ content analysis unveiled key socio-economic factors affecting domestic water security in the selected catchment, based on similarities among different categories enumerated by local stakeholders. Quantitative techniques of data analysis mainly revolved around a multinomial logistic regression, namely Probit regression, for assessing the most significant socio-economic factors impacting on domestic water security. It was often supported by descriptive and inferential statistics (frequencies, means, cross-tabulations and a one-way Analysis of Variance). The following sub-sections present the procedure to used for the selection and presentation, calibration and validation of the Probit model.

<u>2.4.1. Model Selection and Presentation</u>

The Probit regression model used in this study can algebraically be presented as follows:

$$ln\ DWS_{ij} = A + \alpha_0 SDS + \alpha_1 WPS + \alpha_2 WRM + \alpha_3 EBS + \alpha_4 FWP + \varepsilon_i$$ [Equation 2]

Where,

- *ln DWS* is the natural logarithm of Domestic Water Security
- *SDS* stands for Socio Demographic Status;
- *WPS* represents Water services Provision and Sustainability;
- *WRM* corresponds toWater Resource Management and social inclusion;
- *EBS* is the acronym for Economic development and Business Success; and
- *FWP* is referred to as Farming Water development and Profitability
- α_n are estimate parameters
- ε_i is the error term and supposed to be a “white noise” (mean = 0; variance $= \sigma^2$)

2.4.2. Model Estimation and Validation

An exponential or power fit model was the best in explaining the elasticity of domestic water security by the relevant socio-economic factors. The model was linearized by introducing the natural logarithm (*ln*). Thereafter a Probit estimation was run using SPSS spreadsheet. The model validity was assessed based on a Pseudo $R^2 > 0.25$. Explanatory variables having the most significant parameters were validated at 99% confidence level (Z>2.58), 95% confidence level (Z>1.96) and 90% confidence level (Z>1.65). These parameters represented the most influential socio-economic factors explaining domestic water security in Ngaciuma-Kinyaritha Catchment.

3. Results and Discussion

This section presents and discusses findings on key socio-economic factors affecting water security in Ngaciuma-Kinaritha Catchment. First, it provides a descriptive background of respondents to establish their demographic, economic, social and cultural characteristics that are related to water security in this catchment. These findings are then incorporated in a Probit model to derive the most significant factors that determine water balance in Ngaciuma-Kinyaritha.

3.1. Key Findings of the Study

3.1.1. Descriptive Statistical Analysis

Water security in Ngaciuma-Kinyaritha was said to be mainly affected by the following five key indicators, namely: (1) socio-demographic status; (2) water services provision and sustainability; (3) water resource management and social inclusion; (4) economic development and business success; and (5) farming water development and profitability. A Probit model corresponding to the grouping variable “Domestic Water Security” was used to assess the most significant predictors. The following sub-sections present and discuss these results.

The survey conducted in Ngaciuma-kinyaritha encompassed farmers among whom 39% female and 61% male, with about 75% having less than 1 hectare of land (<2.5 acres) (Fig. 2).

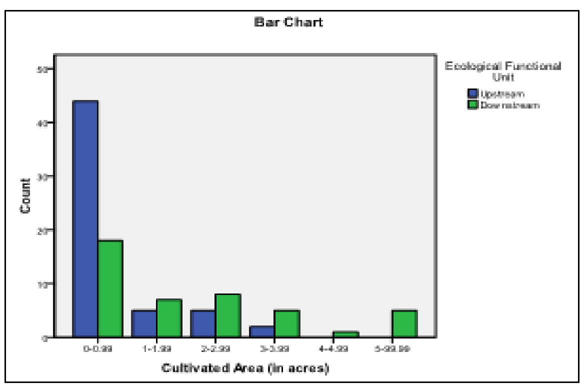

Figure 2: Farming area cultivated in Ngaciuma-Kinyaritha

The average farmer’s age was 42 years old, the youngest being 17 years old and the oldest 72 years of age. Regarding their occupation, 71% peasant farmers, 17% commercial farmers and livestock keepers, 8% teachers/ private workers, and 4 % public servants (Fig. 3).

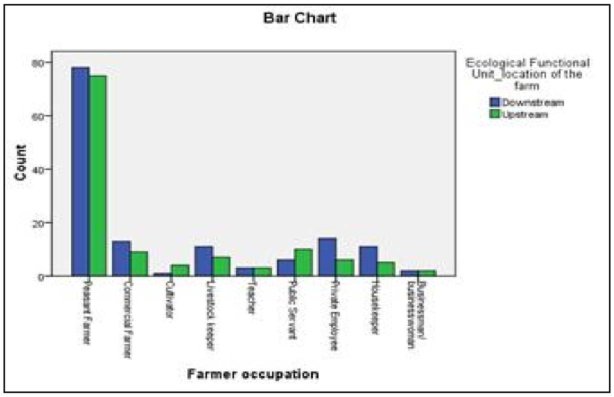

Figure 3: Farmers' occupation in Ngaciuma-Kinyaritha

Farmers' socio-economic status was also featured by their educational credentials, which were dominated by primary education (56%), followed by secondary education (14%) and professional and tertiary education (8%). Only 22% confessed not having followed any kind of formal education (Fig. 4).

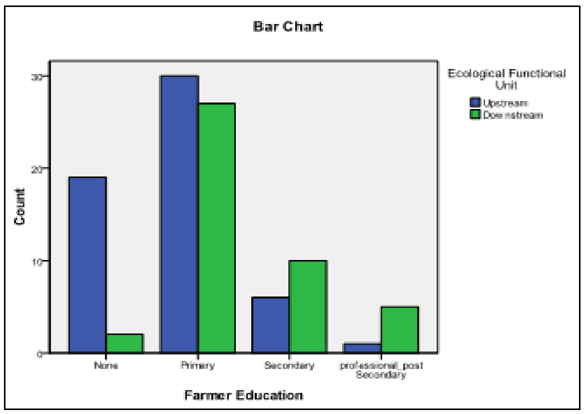

Figure 4: Farmers' level of education in Ngaciuma-Kinyaritha

The total farmer's income estimated per annum amounted to a minimum of Ksh. 78,090, a maximum of 105,093 and an average of Ksh. 92,840.63, with a standard deviation of Ksh. 14,564.61, a median of Ksh. 94,091 and a mode of Ksh. 103,091. Farming incomes were mainly supplemented by off-farm incomes and remittences ranging from Ksh. 30,000 to 50,000 per annum. Considering the fact that their daily income ranged between Ksh. 216.92 (that is US $ 2.71) and Ksh. 291.925 (US $ 3.65) one can really say that Ngaciuma-Kinyaritha community of farmers live above the poverty line of US $ 1 a day. Besides, despite seasonal water crises, an average household was using about 200 litres of water daily with an estimated 40 litres per head per day (Fig. 5).

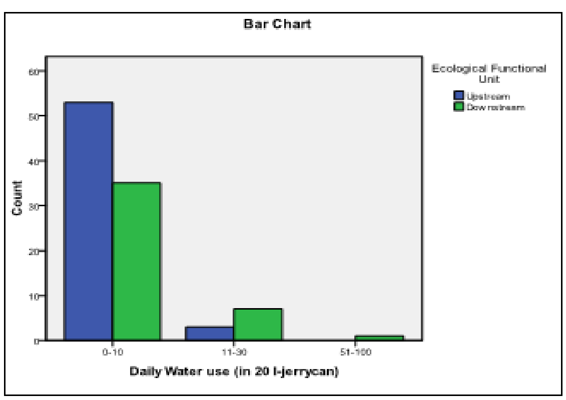

Figure 5: Farmers' daily water use in Ngaciuma-Kinyaritha

<u>3.1.2. Logistic Probit Regression Model for Domestic Water Security</u>

3.1.2.1. Domestic Water Security and Socio-Demographic Status

Table 1 below indicates that key socio-demographic variables predicting domestic water security in Ngaciuma-Kinyaritha are mainly the farmer's age (Z= 9.01; p –value =99%); education (Z= 51.72; p –value =99%); household size (Z= -49.31; p –value =99%); farm size (Z= -1.78; p–value = 90%); cultivated farming area (Z = 9.01; p –value =99%); and, farming income (Z= - 49.57; p –value = 99%). These results mean that the most experienced and educated farmers as well as those having big farming areas that are cultivated are likely to get involved in community water services to secure more water for their households compared to the lowly ones. However, wealthy farmers having big families and uncultivated big lands tend to ignore the services of CWMSs for their domestic water security.

3.1.2.2. Domestic Water Security and Water Services' Provision and Sustainability

Results of the logistic regression (probit) of domestic water security by water services' provision and their environmental sustainability revealed that distance to water source (Z= -5.059; p –value = 99%), the lack of affordability of water services (Z= -3.302; p –value = 99%) and unpreparedness to drought and other water disasters (Z= -5.902; p –value = 99%) tend to undermine domestic water security in Ngaciuma-Kinyaritha Catchment. However, the assurance of water quality (Z = 4.148; p –value = 99%) by the existence of an authority overseeing the water supply system management (Z= 6.444; p –value = 99%) and of a water catchment management authority (Z= 6.376; p –value = 99%) as well as effective measures for conserving the soil (Z= 46.178; p-value= 99%) and water in adequate quality and quantity (Z= 146.404; p-value= 99%) constitute an asset toward ensuring water security to households. Table 2 summarizes these results.

PREDICTOR	*Estimate B*	*Standard Error (S.E.)*	*Z -Value*	*Sig.*
1. Gender	+0.310	0.419	0.739	0.460
2. Age (***)	+1.613	0.177	9.098	0.000
3. Occupation	+0.006	0.028	0.221	0.825
4. Education (***)	+0.001	0.000	51.724	0.000
5. Household size (***)	- 0.001	0.000	-49.310	0.000
6. Farm size (*)	- 0.022	0.012	-1.779	0.075
7. Cultivated area (***)	+ 0.000	0.000	16.514	0.000
8. Farming income (***)	-0.001	0.000	-49.568	0.000

Table 1: Probit of domestic water security and socio-demographics in Ngaciuma-Kinyaritha [a.]

Notes:

(*) indicates that the variable is significant at 90% confidence level

(**) indicates that the variable is significant at 95% confidence level

(***) indicates that the variable is significant at 99% confidence level

a. Pseudo R^2 is 0.777; Number of observations is 165

3.1.2.3. Domestic Water Security and Water Resource Management/ Social Inclusion

Water resources management and social inclusion were found to be very crucial in assuring water security to households living in Ngaciuma-Kinyaritha Catchment. Results of the probit as presented in Table 3 indicate that domestic water security is affected by almost all the predictors of Water resources management and social inclusion retained in the study, except by: (1) compliance to laws and regulations governing the water supply system or catchment management (Z= 1.410; p-value= 0.80); (2) registration or permit prior supplying water or managing the catchment (Z= 0.567; p-value= 0.25); (3) differentiation between poor and rich in the tariff and quality of water service delivery (Z= 1.019; p-value= 0.70); (4) increase of water use for irrigation and keeping animals (Z= 0.103; p-value= 0.05); and (5) decreased cases of flood damages (Z= 1.363; p-value= 0.80).

3.1.2.4. Domestic water security and Economic Development/ Business Success

Table 4 indicates that the strategic coverage of the whole catchment by a water supply network (Z= - 11.138; p-value=99%), the implementation of water use charges and tariffs (Z= 5.149; p-value=99%), new investments in irrigation schemes in the catchment area (Z= 5.281; p-value=99%) , as well as increased economic activities due to water development (Z= 23.028; p-value=99%) and reduced water cost seasonality (Z= 11.205; p-value= 99%) were found among major triggers of economic development and business success in Ngaciuma-Kinyaritha Catchment.

PREDICTOR	Estimate B	Standard Error (S.E.)	Z -Value	Sig.
1. Sources of daily water Vendors	+0.000	0.000	0.590	0.555
2. Distance to secure water source (***)	- 0.001	0.000	-5.059	0.000
3. Water availability	+0.000	0.000	1.516	0.130
4. Water supply reliability	+0.000	0.000	0.552	0.581
5. Water quality (***)	+0.000	0.000	4.148	0.000
6. Water services cost (***)	- 0.000	0.000	-3.302	0.001
7. Water supply system management authority (***)	+ 0.001	0.000	6.444	0.000
8. Water catchment management authority (***)	+ 0.001	0.000	6.376	0.000
9. Environmental pollution control	+ 0.000	0.000	0.708	0.479
10. Drought prevention/ disaster preparedness (***)	- 0.001	0.000	-5.902	0.000
11. Awareness created on environmental degradation	+ 2.397	2.293	1.046	0.296
12. Traditional soil and water conservation methods	+ 0.000	0.000	1.224	0.125
13. Modern soil and water conservation measures	+ 2.302	1.449	1.588	0.112
14. Traditional water hygienic measures	+ 8.533	14.378	0.593	0.722
15. Traditional methods replaced by modern methods (***)	+ 0.254	0.001	260.804	0.000
16. Soil conservation effective (***)	+ 0.045	0.001	46.178	0.000
17. Water conservation effective (***)	+ 0.173	0.001	146.404	0.000

Table 2: Probit of domestic water security and services sustainability in Ngaciuma-Kinyaritha [a.]

Note:

(*) indicates that the variable is significant at 90% confidence level
(**) indicates that the variable is significant at 95% confidence level
(***) indicates that the variable is significant at 99% confidence level

a. Pseudo R^2 is 0.546; Number of observations is 165

3.1.2.5. Domestic Water Security and Farming Water Development / Profitability

Almost all the factors affecting water development and profitability retained in this study were significant at 99% confidence level in predicting water security, except water recycling in production (Z= 0.221; p-value = 0.15). These included (i) water conservation and harvesting for farming (Z= 79.53; p-value = 99%); (ii) reduced water cost in farming (Z= - 37.18; p-value = 99%); (iii) increased in yield in farming (Z= -288.16; p-value = 99%); (iv) decreased risk of loss in production (e.g. crop yield failure (Z= 1.779; p-value= 90%); (v) farmer's adherence to CWMSs (Z= 10.19; p-value=99%), and; (vi) farmer's willingness to pay for more effective and efficient water resources management in the catchment (Z=128.52; p-value= 99%) (Table 5). Nonetheless, increased in yield in farming and decreased risk of loss in farming production were found to be major threats to domestic water security

PREDICTOR	Estimate B	Standard Error (S.E.)	Z - Value	Sig.
1. Water supply system/ catchment management compliance to laws and regulations	+15.166	10.754	1.410	0.158
2. Water supply / catchment management registered/ permitted	+7.583	10.206	0.567	0.743
3. Water supply system/ catchment management respects local culture (**)	+3.275	1.568	2.088	0.037
4. Water supply system/ catchment management gender sensitive (different roles for women, youths and men) (***)	+4.570	1.585	2.883	0.004
5. Poor/ rich status take into account in tariffs/ service delivery	+1.306	1.282	1.019	0.308
6. Contribution to life improvement (***)	+171.036	9.256	18.478	0.000
7. Increased water used for irrigation/ keeping animals	+1.070	10.396	0.103	0.918
8. Decreased frequency of drought (***)	+8.428	0.625	13.489	0.000
9. Decreased cases of flood damages	+1.506	1.105	1.363	0.173
10.Reduced distance for fetching water (***)	+11.532	4.359	2.646	0.008
11.Reduced time for fetching water (***)	+19.330	4.821	4.010	0.000
12.Reduced cases of water borne diseases (***)	+3.403	1.197	2.842	0.004
13.Public consultation/ involvement in decision-making (***)	+7.335	0.575	12.746	0.000
14. Decreased cases of conflict on water use (***)	+3.306	1.123	2.943	0.003
15. Decreased cases of conflict on other natural resource appropriation (***)	+9.180	0.702	13.080	0.000

Table 3: Probit of domestic water security and resource management in Ngaciuma-Kinyaritha [a]

Notes:

(*) indicates that the variable is significant at 90% confidence level
(**) indicates that the variable is significant at 95% confidence level
(***) indicates that the variable is significant at 99% confidence level
a. Pseudo R^2 is 0.632; Number of observations is 165

3.2. Discussion

This study has revealed various socio-economic factors can enhance the provision of water services and management of resources in Ngaciuma-Kinyaritha Catchment using both formal and informal water management systems. This was in order to guide water resources management authorities to incorporate CWMSs in the legal and institutional frameworks of the water sector of Kenya to enhance their efficiency, effectiveness and sustainability. This is in order to provide avenues for 'informal' systems to fit into 'formal' statutory bodies, which are yet to be explored.

PREDICTOR	*Estimate B*	*Standard Error (S.E.)*	*Z -Value*	*Sig.*
1. Water supply network covers the whole catchment (***)	- 31.646	2.841	- 11.138	0.000
2. Water rationing	- 1.235	9.149	- 0.14	0. 974
3. Promotion of rainwater harvesting	0[b]	-	No Value	-
4. Use of water charges (tariff/ price) (***)	+ 15.909	3.090	5.149	0.000
5. Use of pollution control thresholds	0[b]	-	No Value	-
6. New investments in irrigation schemes (***)	+ 6.012	1.138	5.281	0.000
7. New investments in water trading	0[b]	-	No Value	-
8. Promotion of small industries/ craftsmanship	+ 0.02	9.88	0.002	0.998
9. Increased economic activities due to water development (***)	+ 0.029	0.001	23.028	0.000
10. Reduced seasonal variability of water cost (***)	+ 0.014	0.001	11.205	0.000

Table 4: Probit of Domestic water security and economic development in Ngaciuma-Kinyaritha [a.]

Notes:

(*) indicates that the variable is significant at 90% confidence level
(**) indicates that the variable is significant at 95% confidence level
(***) indicates that the variable is significant at 99% confidence level
a. Pseudo R^2 is 0.571; Number of observations is 139
b. The cut value is 0.500

PREDICTOR	*Estimate B*	*Standard Error (S.E.)*	*Z -Value*	*Sig.*
1. Water conservation and harvesting for farming (***)	0.108	0.001	79.53	0.000
2. Water recycling in production	0.006	0.028	0.221	0.825
3. Reduced water cost in farming(***)	- 0.084	0.002	-37.181	0.000
4. Increased in yield in farming (***)	- 1.72	0.006	-288.16	0.000
5. Decreased risk of loss in production (*)	0.022	0.012	1.779	0.075
6. Farmer's adherence to community water management system (***)	0.008	0.001	10.198	0.000
7. Farmer's willing to pay for more effective and efficient management of water resources in the catchment area (***)	0.095	0.001	128.522	0.000

Table 5: Probit of domestic water security by water development in Ngaciuma-Kinyaritha [a.]
Notes: a. Adjusted R^2 is 0.968; Number of observations is 165

As shown above, farmers' adherence to community water management systems (CWMSs) is significant at 99% confidence level to enable the development of the existing water resources and increasing farming water profitability. However, water trading, rationing, recycling in production and pollution control as well as the promotion of small industries and craftsmanship by these watershed institutions were not found relevant. Farmers did also not laud the use of traditional technologies as being crucial for securing domestic water in normal times as well as times of disaster, except where they were being replaced by modern methods (Z= 260.804; p-value= 99%). But the existence of a water supply and catchment management system was indispensable for ensuring domestic water security, as far as it abode to the existing cultural habits and social organization, and was able to contribute to community welfare in normal times and time of disaster (mainly drought). Such an institution did not need to be registered or permitted by relevant water authorities, if they were owned by all community members.

Although theoreticians may articulate ideal legal and institutional frameworks, in reality such frameworks commonly suffer from incongruities that exist between institutional functions, practices, objectives and bio-geographic properties (Gleick, 2003; Falkenmark and Rockström, 2004; Moss, 2004). Water frameworks have to help achieve river basin objectives, work within the limitations imposed by inherent conditions, fit other economic and infrastructural devices, and often build on existing progress made. The scope for re-thinking a wholly new institutional matrix may be severely restricted but these results demonstrate the importance of integrating CWMSs in ensuring social inclusion in water supply and catchment management in Ngaciuma-Kinyaritha Catchment (Maganga and Juma, 2000). If informal arrangements are not carefully dove-tailed into higher-level formalities and other allocation devices, new legislative and institutional frameworks will probably only partially succeed. (Lankford et al, 2004).

This study also confirms that CWMSs play a key role in assuring the "sustainability" of water resource management, not only by evoking governmental regulations but also by subjecting their members to the leadership of governmental authorities. CWMSs are therefore expected to empower community members to take their own destiny at hand while managing their water resources within the frameworks established by the government (Pelling, 2006; Perret et al., 2006). If the mainstream policies and laws will continue to regard customary laws as a transient system they are likely to die out of the shelves of public service (Biswas, 2004; Vishnudas, 2006). This was clearly noted by Malzbender et al (2005) while looking at traditional water governance in South Africa. It was observed that traditional leaders had an important role to play in narrowing the gap between policy and its practice. There was sufficient evidence on the ground suggesting that the integration of traditional systems of control and management of water into formal structures was provided for by the National Water Act in South Africa. Similarly, well functioning traditional structures could ensure effective and efficient water services and contribute to water service delivery in Kenya in general, and Ngaciuma-Kinyaritha Catchment of Mount Kenya Region, in particular.

4. Conclusion and Recommendations

As pointed out in this study, the Republic of Kenya is facing such transitional problems in the water sector. Clearly, there is need for coherent responses to water scarcity by strengthening all the institutions involved in the allocation, supply and management of water resources. These results demonstrate water security in Ngaciuma-Kinyaritha Catchment is on stake and needs to be urgently addressed by taking into consideration the roles of all community members and institutions in ensuring social inclusion in water supply, catchment management and water disaster preparedness. Though informal, CWMSs, also known as self-help groups, play a very important role in assuring social consensus for the "sustainability" of their water resources management. Not only do they partly achieve the targets of the water sector reforms, but also empower local community members to take their own destiny at hand, without waiting for governmental interventions. Moreover, under their leadership, community members are more inclined to be subject to governmental regulations and authorities, namely WRMA and WRUA, in order to achieve to their full potential the targets of the water sector reforms in Ngaciuma-Kinyaritha Catchment.

It is therefore our wish that the new statutory provisions in Kenya will reach out to the whole society, and that customary water laws of the various communities would be integrated into the practice and spirit of the law to enable communities become more resilient to environmental changes instead of contending with the water sector reforms. Finally, the prevailing systems of customary water law involves not just utilization of water but is closely linked to other external factors like markets for local products, injection of external capital (like irrigation), prevailing inheritance, legal system (system of local governance) and availability of mainstream courts operating outside the control of customary law institutions. Law reformers will have to contend with this diversity and conflicting interests and how it will affect the basin-wide water resources management.

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