Institutional Structures and Sustainability of Projects in Nyangores River Sub-Catchment Basin in Bomet County, Kenya

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Abstract

Integrated basin management approach has been applied in Nyangores River sub-catchment basin, since the year 2009 but with minimal success. Sub catchment degradation, organizational weakness, the flow and quality of water had started to diminish, creating challenges for local livelihoods, wildlife in the Maasai Mara Game Reserve, and in maintaining biodiversity and healthy ecosystem functioning. Water resources can be successfully managed only if the natural, social, economic and political environments, in which water occurs and used, are taken fully into consideration. The aim of this study is to determine the influence of institutional structures influence on sustainability of projects in Nyagores river sub-catchment basin in Bomet County, Kenya. The research designs used were descriptive survey and correlational research design. Stepwise and purposive sampling formed the sampling procedure. The results are presented descriptively using Tables while for qualitative data, narrative statements were used. Questionnaires, Interview guide and document analysis were used for data collection. The sample size was 371, from a targeted a population of 56,508 household heads and 10 informants, purposively selected from the water concerned institutions and ministries of Water and Agriculture. Total of 371 questionnaires were given out to the respondents and only 321, were duly filled and returned representing (86.5%). The objective was to establish the extent to which institutional structures influence sustainability of projects in Nyangores River sub-catchment Basin. The results indicated that there was a positive correlation r = 0.552, ($p < 0.05$). The null hypothesis was rejected and concluded that there is a significant relationship between the institutional structures and sustainability of projects in Nyangores river sub-catchment basin. R^2 was 0.304; hence, 30.4% of changes in sustainability of projects are explained by institutional structures. Recom-

mendations are; ensure a stringent policy for robust planning and management, and more robust forum for the stakeholders to complement the efforts of WRUA. It is suggested for further research, similar studies are done for the other adjacent river basins and to investigate ways of raising the level of community participation in the basin.

Keywords

Institutional Structures, Sustainability of Projects, River Sub-Catchment Basin

1. Introduction

Water Resource Management is arranged to co-ordinate improvement and the management of water, land and related asset for venture supportability so as to boost the resultant monetary and social government assistance in an even handed way without bargaining the manageability of essential biological systems (GWP, 2012). To pursue this target, Kenya has just moved to a River Basin Management approach through the establishment of the Water Act 2002 which gave the legitimate system to the executives and improvement of water assets, (UNEP, 2012). Nyangores River Sub-catchment is the sole basin in Bomet in which, integrated basin management approach has been applied since the year 2009. However, minimal success has been realized in the sustenance of the basin projects. Nyangores Water Resource Users Association (WRUA), a community based organization in collaboration with Water Resource Management Association (WRMA), is still increasingly facing numerous problems that may be summed up to include those resulting from sub catchment degradation and organizational weakness. The flow and quality of water has started to diminish creating challenges for local livelihoods with adverse effects on the health and wealth, threat to wildlife in the Maasai Mara Game Reserve, and jeopardize the maintenance of biodiversity and healthy ecosystem functioning.

Institutional Structures comprise of the humanly devised constraints and facilities that shape human interaction including the institutional hierarchy and organization, culturally ascribed values and level of human training. Institutional structures, enabling environment, management instruments and infrastructure development constitute the water resource management tools, for the sustainability of projects in a River Basin Management approach that include; agroforestry, water supply, income generation and waste disposal methods. Up to now evaluations have, in many cases, failed to account for sustainability concerns. Videira et al. (2000), all agree in their studies that the evaluation procedure of new plans and projects must evolve into a new, multi-dimensional and multi-stakeholder participatory approach, where monitoring has been done, it has revealed that limitations in our conceptualization of the basin may reduce the likelihood of achieving the basin scale objectives (Gawne et al., 2018). It is

on the basis of this background that the study intends to assess the influence of institutional structures on the sustainability of projects in Nyangores River sub-catchment basin.

The objective of the study was to determine the extent to which institutional structures influence sustainability of Projects in Nyangores river sub-catchment basin in Bomet county, Kenya. The research question was; to what extent do institutional structures influence sustainability of projects in Nyangores river Sub-catchment basin in Bomet, Kenya? Whereas the hypothesis was; H_0: There is no significant relationship between institutional structures and sustainability of projects in Nyangores river Sub-catchment basin in Bomet, Kenya.

2. Empirical Literature

2.1. Sustainability of Projects in River Sub-Catchment Basin

In this section, a review of empirical literature is done on the projects sustainability that included agro-forestry, income generating engagements, waste disposal mechanisms and soil and water conservation methods. An investigation by Chumbulla and Massawe (2018), on the job of neighborhood organizations in the production of an empowering domain for water venture supportability in Iringa District, Tanzania depended on a cross-sectional research configuration to permit information to be gathered at a solitary point in time. The plan took into account the expressive investigation, translation, just as assurance of connections between factors. Three towns were arbitrarily chosen inside Iringa Rural District. The rule for town choice was accessibility of a water venture. Sixty (60) families which were profiting by the task were arbitrarily chosen to make a sum of one hundred and eighty (180) families. Nine key witnesses, six from the town level and three from the area level were utilized to gather subjective information to enhance the data which was gathered through perception and organized poll overviews. Double calculated relapse model was utilized to decide the elements for the supportability of the ventures. The outcomes uncovered that about 93% of the respondents knew about the town by-laws and guidelines for ecological security. Just 6.7% of the respondents didn't know about these by-laws and guidelines. When the center gathering conversation were approached to clarify what may be the reason for impracticality of water asset extends in the region coming up next was the reaction. "individuals are simply difficult, no one in our town can say that he/she isn't educated about the presence of by-laws overseeing water asset use…the main test is that we can't refer to the particular guidelines… we generally be cognizant once we do anything around water sources".

Agro-biological systems are natural practices oversaw by networks over a wide scope of fields to create food, feed for domesticated animals and fiber. Largely, human practices shape environmental elements and elements of characteristic procedures that happen in agro-biological systems. As agroecosystems communicate with characteristic biological systems in agrarian scenes, spread harvests

that improve maintainability of the agro-environment traits may likewise by implication improve characteristics of neighboring normal biological systems. Ranchers world over decide to develop explicit spread yield types and to oversee them with a particular goal in mind dependent on their own exceptional needs and objectives. The last are impacted by natural, ecological, social, social and financial variables of the food framework which ranchers work (Snapp, 2005). Agro-ranger service in Kenya depicts land use frameworks where trees are developed in relationship with agrarian harvests fields or domesticated animals and there are generally both biological and monetary collaborations between segments of the framework. Ranchers have drilled agroforestry for a considerable length of time. Agro-ranger service as a land use framework in which trees and bushes are developed in relationship with crops in a similar land unit, can possibly capture land corruption and provincial destitution of dry grounds through assistance and creation capacities.

Tang et al. (2014), in an examination on Farmers' Sustainable Strategies for Soil Conservation on Sloping Arable Lands in the Upper Yangtze River Basin, China, utilized quantitative techniques to explore the feasible Strategies for Soil Conservation on Sloping Arable Lands in the Upper Yangtze River Basin, China. Soil redistribution rates were evaluated by contrasting the reference esteem and the inventories for testing locales utilizing adjustment models, while soil redistribution on developed slanting grounds was likewise measured by attractive following. The basic incline length for the commencement of rills on slanting arable terrains was dictated by rehashed counterfeit precipitation reenactments on test overflow plots with focused angles, and the outcomes are factual midpoints with the chance of reoccurrence. Changing over the straight slope inclines to inconsecutive level patios was one of the many soil protection quantifies under the national activity of Soil Conservation in the Upper Yangtze River Basin. The investigation by Tang et al. (2014), found that dirt disintegration rate is firmly identified with neighborhood geography that is incline length and inclination, while patios demonstrated viable in forestalling sheet and rill disintegration by shortening the slant length and diminishing the slant angle. Be that as it may, local extraordinary rainfalls throughout the late spring season and thought spillovers will in general lead to the flimsiness of the patio structures (skirting on breakdown) and, subsequently, brings about a high measure of soil misfortune, accordingly, the upkeep of the porch structure and its capacities requires a lot of steady work and money related speculation.

The United Nations predicts that 1.8 billion individuals will encounter supreme water shortage in under 5 years, and stress that by 2025, two out of three people will be living in water-focused on districts. Effectively every five people worldwide can't get to their essential ordinary water asset, a reality as of late saw in Cape Town, South Africa which is in desperate need of water with genuine proportioning of the ware. Poor administration of assets, for example, spontaneous land clearing for development and deforestation of the water towers has

prompted genuine natural and biological corruption just as decreased water volumes. Soil and water preservation programs have picked up acknowledgment on the planet as methods for water the board (Gleick et al., 2009). Soil and land the board practices, for example, culturing and editing rehearses, straightforwardly influence the general soil disintegration issue and arrangements on a ranch. At the point when crop turns or shifting culturing rehearses neglects to control disintegration on a field, it requires a mix of approaches as a need. These are frequently sorted as; Agronomic, for example, plant or soil spread that is preservation cultivating techniques and form cultivating. Vegetative, for example, planting hindrances or strips, live fences and windbreaks. Auxiliary, for example, Fanya Juu, patios, banks, bunds, cut off channels, obstructions and in conclusion, generally the board, for example, territory terminations and particular clearing.

In a study to Identify Factors Affecting the Sustainability of Water Environment Treatment Public-Private Partnership Projects in China, Li et al. (2018), used various approaches that included structured interviews among the industry professionals, sustainability literature review, and survey based on questionnaire for indicator validation, done for a two-month period with a response rate of approximately 62%. In the study, water treatment projects involved social projects, that included sewage treatment, ecological repair, and landscape vegetation cover; such assets require professional knowledge, and therefore, guaranteed efficiency while fully depending on the government is quite difficult (An et al., 2018). Sustainability is perceived through the three lenses of economic, social and environmental aspects, often referred to as the triple bottom line. In this regard, sustainability of deliverables tied with the delivery processes is crucial as they often come with remarkable social and ecological impacts (Kivila, Martinsuo, & Vuorinen, 2017). Increasing number of developing countries are faced with water deficiency, for various reasons such as scarcity of natural water resources, populace increase, rising standards of living, and poorly developed infrastructure supply. Water sustainability is critical for both humans and environmental health (Al-Damkhi, 2009).

Water deficiency, if not addressed in a prompt and sustainable manner, will result in inevitably adverse effects on socio-economic and ecological development (Almedeij, 2007). The study found that sustainable development of public waste water projects can be achieved by ensuring full-cost pricing and taking into account the external costs from wastewater services. Reducing the drinking water consumed, again through the reuse and recycling of unconventional sources of water, has been noted as one of the goals of sustainable development. It evaluated and contrasted the environmental impacts attributed to the use of water supply from sources such as rainwater and gray water recycling, which provided alternatives to the traditional sources, via the comprehensive use of life-cycle assessment and hydrological modeling. Factors for the sustainability of water environment treatment were identified. Among them, the economic sus-

tainability dimension. The sustainable cash flow, as an indicator was ranked as the most important one since any project that lacks cash flow, cannot guarantee the financial resources needed in establishment and operation leading to a non-conducive condition. Furthermore, appropriate management of water pollution can increase the value of lands and the project and promote area-wide economic development (Li et al., 2018). The study concluded that a sustainable water treatment PPP project must not only ensure that the treatment technology used is sustainable but also avoid damage to the natural environment. To confirm the factors that influence the sustainability of water treatment PPP projects, a sustainability evaluation indicator system was constructed from the five dimensions. The leading indicator from the five dimensions was the economy, referring to the sustainable cash flow, followed by the society, to mean, public satisfaction, then resources and environment that meant the effect on water quality, engineering referred to the renewal of project facilities and project management to represent the structure of management organization.

A study was done to define and measure river basin sustainability: a case study of the Yellow River by (Wu, Darton, & Borthwick, 2016). Broad fieldwork was done to conduct stakeholder interviews and collect comprehensive data. The assessment was done to provide policy-makers and river decision makers with a detailed review of the river basin, that could be used as a basis for integrated river basin management articulation. The Yellow River is divided into three stages: the upper, middle and the lower Reaches of the Yellow River. The Lower Yellow River is known as the suspended river, due to accumulation of sediment which has raised the river bed to an average of 5m higher than the surrounding ground on both banks. The River basin stands at the center of evolving challenges in regard to water security, food supply, socioeconomic prosperity, as well as climatic dynamics. The management of river basin therefore needs to appreciate and incorporate the broad objectives to meet the needs and cope with uncertainties. Five perspectives were identified to describe the sustainability of river system: sufficiency of resource, elasticity to water-related risks, availability of water supply and other services, productive application of water, and justice between different users over temporal and spatial aspects. Such perspectives could be used to identify impacts on sustainability and to address impact generators, setting benchmarks and identify appropriate goals to improve sustainability. Gleick et al. (2009), used the term, basic water requirements, to describe water used for the four basic needs of human beings: water for drinking, for human hygiene purposes; for sanitation services; and water for domestic use such as food preparation. Gleick proposed that 50 litres of water is the minimum required per person per day, to meet these basic needs, no matter the individual's economic, social, or political status.

2.2. Institutional Structures and Sustainability of Projects in River Sub-Catchment Basin

Literature review is done to cover institutional structures that include training

among the participants, stakeholder involvement and hierarchy of institutional organization. In an investigation done in Arusha and Kilimanjaro of Tanzania by Lalika et al. (2015), on Exploring watershed preservation and water administration along Pangani River Basin, quantitative and subjective research approaches were utilized. Organized polls were the fundamental device to gather quantitative information while inside and open interviews with people and board of trustees individuals utilized for qualitative information. Quantitative information was investigated descriptively and qualitative information broke down by content examination approach including extreme discussion inside the center gathering. Discoveries demonstrated that, Water User Association, (WUA), crumbled because of disappointment of the pioneers to assemble ordinary gatherings, and further that the drivers for water decrease are ineffectual WUA, (41%), environmental change and fluctuation (23%), water reflection by outsiders (18%), populace increment (13%) and corruption of water conceal further add to water decrease.

Institutional jobs includes making hierarchical structure in different structures and capacities, waterway bowl and building institutional limit by creating human resource, (Integrated Water Resource Management, 2010). An administration board of trustees equitably chosen makes choices at the neighborhood level, and the seats of these panels establish the WRUA executives' council, while the WRUA gets directions from WRMA and the Ministry of Water and Irrigation, (Dell'Angelo et al., 2016). The connection between the distinctive choice levels is through criticism and shared impact, as opposed to carefully various leveled. Existing worldwide organizations tending to water assets are extremely feeble as far as guideline, yet moderately great at plan setting, sharing data, activating individuals, and, to a huge degree, in assembling assets, (Schubert, 2013). A gradually improved organization alone in all probability will be, best case scenario, ready to embrace emergency the board, however will be unable to take dynamic and preemptive strategy measures to counter the issues confronted, (Dellapenna et al., 2013).

In light of the interviews, Onyango et al. (2019), did a study on Understanding Institutional structures and their role on climate change adaptation: An instance of Mara River Basin, Kenya. It established that the government institutions most enabling structures fall in the enabling processes quadrant at 97%, here the government institutions are indicated as having strong coordination ability and are stable (98%) and they have rules and procedures that guide their activities and are measureable (95%). Conversely, the government's weakest structures are found in the developing processes quadrant at 48% within which participation in decisions, skills and knowledge stands at 40% while positive interpersonal relations and effective communication stands at 55%. In addition, the study found that in the Mara River Basin the majority of the institutions are tackling issues related to food security, access to clean water, environment and energy which are heavily dependent on the climate. Further, the local institutions have not been able to fully embrace the United Nations Framework Convention on Climate Change,

UNFCCC protocol on climate change adaptation or Kenya's National Climate Change Response Strategy nor put mechanisms in place to include climate change in their mandate.

In an investigation by (Bandaragoda, 2000), on a structure for institutional examination for water assets the executives in a stream bowl setting, in Colombo, Sri Lanka, six key research addresses significant in a quest for suitable institutional methodologies, as methodological rules, were inquired. Communitarian study exercises in the five chosen nations were planned for improving the administration of their rare water supplies for economical agribusiness, inside the imperatives of rivalry for water by different parts and water-use-related natural issues. The physical and social symptomatic investigations helped in assessing the current institutional system, just as in defining institutional change. The indicative examination on execution of flooded agribusiness helped in the turn of events and commencement of suitable activity intends to address the recognized imperatives against agrarian water the executives. It found that firmly identified with these common highlights are the man-made foundation for bridling water assets from the waterway framework to create characteristic assets inside the bowl. Notwithstanding the regular highlights of the bowl, the qualities of framework, for example, size and scale, innovation, and reason will in general decide the sort and character of foundations set up for water assets the board. As a result, the physical arrangement of the stream bowl reflects the institutional game plans.

To Investigate the Institutional Landscape for Urban Water Security in Nepal, led in Dharan and Dhulikhel, which spoke to tests of the intricate and different scope of water organizations at the network and the city level arranged at the lower regions of the Mahabharata Range, (Pandey, Maskey, Devkota, & Ojha, 2019). The examination was required by the joined difficulties of fast and impromptu urbanization, populace development, and environmental change that fuel the effects on water assets and water the executives. A blended way to deal with essential information assortment and examination was supplemented by an intensive writing audit of the job of organizations for water the executives. Throughout three years of field study, 28 people were talked with, 14 from every city. These included chosen officials and civil servants from the district, officials from Nepal Water Supply Corporation, Dharan and Dhulikhel Drinking Water User Committees, and water clients from upstream and downstream networks, water board individuals, ladies, and minimized individuals from target areas, for example, vagrant settlements in Dharan. Three center gathering conversations were likewise directed in every city; bunches included different and separated urban water clients and administrators, among others. An investigation of meetings with the partners of Dharan uncovered that there are different foundations occupied with the water the board of the town, notwithstanding, they don't facilitate and connect with one another. Or maybe they hold complaints against each other through smaller scale legislative issues, making a non-genial relationship. Foundations rehearses conflict with all the current strategies including the casual establish-

ments of different little water-client gatherings, ladies' systems, self-administration, for example, individual and institutional clients, filtered water, water big haulers, and nongovernmental associations in the two urban communities.

In a study that targeted the community water projects in Likii Water Resource Users Association, Dell'Angelo et al. (2016), focused on the community water partnership that were WRUA members of Likii in the Upper Ewaso Ng'iro River basin in Kenya. Semi structured interviews, in which active engagement of local stakeholders was imperative, and members of every community water partnership management committee were also interviewed. The study found that the management system in the upper Ewaso Ng'iro River basin of Mount Kenya can be described as a model of positive institutional transformation that involves the local stakeholders, encourage active engagement, capacity building, cascading centralized powers to the lower level actors, and equity in water allocation.

Success in the institutional system ought to be established on an active process of social learning that involves reflective participation and engagement of actors at various scales. Institutional design many a times may prevent the systems from adapting and coming up with solutions, (Pahl-Wostl et al., 2013). Such situations could be described as undergoing institutional lock-in. Collective learning provides an acceptable option for improving control steps and raising adaptive ability. In systems with many players, such as river basin management, the probability is high, that conflicts, instead of collective learning will greatly influence institutional building, and conflict can compromise the opportunity for collective action. From the in-depth interviews with Community water partnership, and the leadership of WRUA, together with a review of the by-laws and other available documents, it was revealed that bottom-up representation is a critical feature of the Likii sub-catchment basin management, (Dell'Angelo et al., 2016). It involves a process by which the chair of every Community water partnership management committee would represent the Community water partnership in the WRUA management committee, forming the higher legislative body. This provides a procedure by which the people affected by the legislation can engage in establishing or adjusting them. The study concluded that reflexive management is challenging, and the rate and magnitude of change calls for a deep and constant participation of the stakeholders and realignment of institutional approaches. Going forward, water management in Mount Kenya will mostly relay on the way and extent of collaboration including sharing of information and on how adaptive to socio-environmental change the institutions are.

2.3. Theoretical Framework: Game Theory
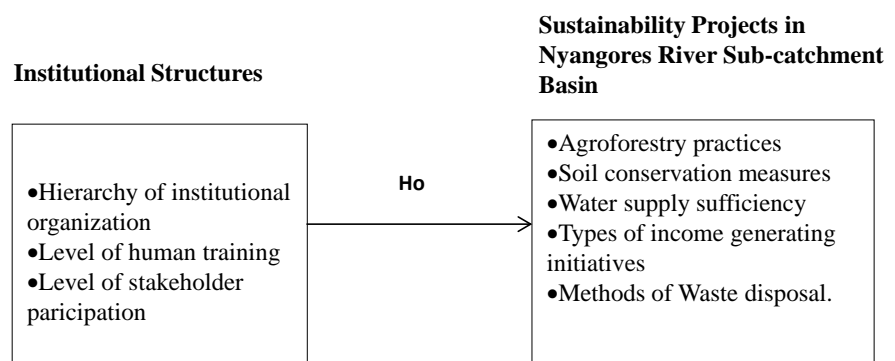
The proponents of game theory were Joh Von Neumann, John Nash and Oskar Morgenstern in the year, 1944. The two main assumptions are Rationality of agents and Nash equilibrium. It is a distinct and interdisciplinary approach which studies rational choices of strategies and treats the interactions among people as if it were a game, with known rules and payoffs, in the study of human

behavior, and in which everyone is trying to win. Nash equilibrium is a solution concept of a non-cooperative game involving two or more players. The assumption is that each player knows the equilibrium strategies of the other players, and no player has anything to gain by changing only his or her own strategy, (Malczewski, 2006). With efficiency in the information gathering and sharing within the basin, each player understands the sustainability strategies available. If each player has chosen a strategy and none can benefit by changing strategies while the others kept theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitutes a Nash equilibrium. Game theory was originated from economics, one of social sciences and has since been used in many different fields like biology and applied to the realm of nature as well, (McCain Roger, 2010). It presents a technical analysis of strategies concerned with the interaction of decision makers in the game. The behavior of a decision maker in game theory models is referred to as strategic and the action performed while making any move is called a strategy. Strategy considers how agents act, what they prefer, how they make their decisions, and their behaviors. These interactions could be complex since the action of even a single agent could influence other agents and vice versa. Game theory can thus be considered as a powerful and alternative tool for analyzing strategic interaction between economic development, in this case, land use and development, environmental protection, including water-quality protection and eutrophication control. Sustainability programmes in the sub-basin have both long term and short-term benefits that can be described as payoffs as a result of community members' actions and interactions. While game theory is a tool for analyzing interactions, the current study applies the theory to explain the sustainability of projects in Nyangores River sub-catchment basin programmes.

2.4. Conceptual Framework

The conceptual framework, in this case, is used as a model to illustrate the relationship and the interactions between the variables under study and to operationalize it while keeping the research focused on its objective, as shown in Figure 1.

Institutional Structures

Sustainability Projects in Nyangores River Sub-catchment Basin

•Hierarchy of institutional organization
•Level of human training
•Level of stakeholder paricipation

Ho

•Agroforestry practices
•Soil conservation measures
•Water supply sufficiency
•Types of income generating initiatives
•Methods of Waste disposal.

Figure 1. Conceptual framework.

Figure 1 refers to the conceptual framework to display the conceptualized interactions of the independent variable, the institutional structures with its corresponding indicators on the left hand side of the framework and the dependent variable, sustainability of projects in Nyangores River sub-catchment basin, with its indicators on the right hand side.

3. Methodology

This study adopted pragmatism paradigm based on the fact that it applies both deductive and inductive approaches to quantitative and qualitative data as recommended by (Cresswell, 2008).

This study adopted descriptive survey research design and correlation research design, since both descriptive and inferential data analysis were required in this study. Descriptive survey research design was used to analyze the data while correlation research design was used to test hypothesis and for regression analysis. Quantitative methods maximized the objectivity, replicability, and generalizability of findings, and facilitate prediction, while qualitative methods allowed the researcher to have an open mind since the design unfolded with the study. Descriptive survey research design provided an opportunity to collect empirical research data by various methods and describe the phenomenon in its state without manipulation, (Bryman, 2008). It, therefore, facilitated the discovery and understanding of the experiences, perspectives and thoughts of the respondents in their social environment.

3.1. Target Population

The target population of the study consisted of household heads in two sub-counties in Bomet which harbours the Nyangores River sub-catchment basin. Bomet central has a population of 30,184 households while Chepalungu Sub County, holds 26,324 households. Together, this gives a total of 56,508 households, (KNBS, 2009), on which sampling was done. Mugenda (2008), proposed that 30% of a population size is a sufficient representation for studies in social science research. A sample size of 371 house-hold heads from the target population in addition to purposive sampling of 10 informants, two from each of the other stakeholders: Water Resource Users Association, (WRUA), a community based organization and Water Resource Management Authority, (WRMA), which is a statutory body that established and works with WRUAs, Ministries of Water and Natural Resources, Agriculture and Livestock and the local Administration that summed up to 381 sample size.

3.2. Research Instruments

Questionnaire, interview guide and document analysis were the main instruments for data collection, in which, the questionnaire was used with the house-hold heads, interview guide to collect in-depth information from key informants, and document analysis was to collect information from annual reports, program targets and achievements. The questionnaires were piloted using 38 respondents,

10% of 381 sample size. Validity of the instruments was obtained using content validity index and reliability of the instruments obtained through pretest-retest method. Data analysis was done using descriptive statistics for quantitative and qualitative data and inferential statistics to test hypothesis using Pearson product moment correlation coefficient and regression analysis.

4. Results and Discussions

4.1. Introduction

The study results are analyzed and discussed thematically based on the study objective. These themes are: Questionnaire Return Rate, Demographic information of the respondents, Sustainability of Projects in Nyangores River Sub-catchment Basin, institutional structures and Sustainability of Projects in Nyangores River Sub-catchment Basin.

4.2. Questionnaire Return Rate

A total of 371 questionnaires were given out to the respondents to fill, but only 321(86.5%), were duly filled and returned. This rate of return was due to the researcher's effort to continuously encourage the respondents to fill in the questionnaires and the research assistance to reach the respondents and pick the dully filled questionnaires. Nulty (2011), suggests that a questionnaire return rate of 75% is sufficient for data analysis and drawing conclusions and inferences. This realization enabled the researcher to proceed with the data analysis and make inferences, accordingly.

4.3. Background Information of the Respondents

The study was interested to understand the characteristics of the people participating in the research. The respondents' background information was based on gender, length of stay within the basin area and the role played in WRUA. Data was collected on whether the respondent was a male or female, to show the gender distribution among the heads of the families within the basin area, as it has a bearing on decision making on the basin activities, within the family, that influence sustainability of projects in Nyangores River Sub-catchment Basin. Table 1 represents the background information of the respondents.

Table 1. Background information of the respondents.

Gender	Frequency	Percent
Male	209	65.1
Female	112	34.9
Total	**321**	**100.0**
Sub county of Respondents		
Bomet Central	189	58.9
Chepalungu	132	41.1

Continued

Total	**321**	**100.0**
Length of Respondents Stay		
1 to 5 years	47	14.6
6 to 10 years	61	19.0
11 to 15 years	27	8.4
16 to 20 years	15	4.7
Over 20 years	171	53.3
Total	**321**	**100.0**
Role of Respondents		
WRUA member	185	57.6
WRUA committee	17	5.3
Business member	90	28.0
Government officer	18	5.6
Institutional employee	11	3.4
Total	**321**	**100.0**

The results in Table 1 indicate that 235 questionnaires were given to respondents in Bomet Central, out of which, 209 (88.9%) were dully filled and returned. In Chepalungu sub County, questionnaires were given to a sample of 136 respondents out of which 112 (82.4%), were dully filled and received. Nulty (2011), suggests that a questionnaire return rate of 75% is sufficient for data analysis and drawing conclusions and inferences. This realization enabled the researcher to proceed with the data analysis and make inferences, accordingly.

Descriptive Analysis of Sustainability of Projects in Nyangores River sub-Catchment Basin

The views of the respondents in regard to the sustainability of projects was analyzed quantitatively using a likert scale in which, 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Srongly Agree. Table 2 shows the results.

Based on Table 2, the combined mean and standard deviation are 2.903 and 0.674, respectively, for the variable, institutional structures. In part a) on the waste disposal methods within the basin area, scored a sub-composite mean of 2.84, well below the combined value of 2.903. This implies that the waste disposal methods in Nyangores river sub-catchment basin have not positively influenced the sustainability of projects. This is in line with WRUA secretary's assertion that, "Waste disposal is done by KTDA but insufficient", and further fails to meet the threshold of raising the land value, comparable to the findings in a study by Li et al. (2018), who found that appropriate management of water pollution can increase the value of lands and the project and promote area-wide economic development. In part b), on income generating activities, the data gave a sub-composite mean value of 3.11 much higher than the combined

Table 2. Sustainability of projects in Nyangores River Sub-catchment Basin.

	SD	D	N	A	SA	Mean	SD
a) Waste Disposal Methods							
1) All the waste, within the basin area, is treated before disposal.	71	77	41	70	62	2.92	1.455
	22.1%	24.0%	12.8%	21.8%	19.3%		
2) Water re-use is often practiced to conserve water.	79	80	43	81	38	2.75	1.379
	24.6%	24.9%	13.4%	25.2%	11.9%		
Sub composite mean						2.84	
b) Income generating activities							
3) There are many high income-generating initiatives within the basin area.	63	78	53	99	28	2.85	1.291
	19.6%	24.4%	16.5%	30.8%	8.7%		
4) Besides domestic use, water is also used in other productive projects.	72	55	35	122	37	2.99	1.384
	22.4%	17.2%	10.9%	38.0%	11.5%		
Sub-composite mean						2.92	
c) Water supply sufficiency							
5) Water for domestic use is always safe and fit for human consumption	52	67	44	115	43	3.09	1.322
	16.2%	20.9%	13.7%	35.8%	13.4%		
6) There is sufficient water supply all the time for all purposes	76	76	38	91	40	2.82	1.393
	23.7%	23.7%	11.8%	28.3%	12.5%		
7) Water supply is inadequate during low rain season	65	129	36	53	38	2.60	1.301
	20.2%	40.2%	11.3%	16.5%	11.8%		
Sub-Composite mean						2.84	
d) Soil and water conservation measures							
8) Most basin activities disregard soil conservation measures.	39	103	52	72	55	3.00	1.312
	12.1%	32.2%	16.2%	22.4%	17.1%		
9) Soil is always conserved while undertaking farm practices.	42	68	34	136	41	3.21	1.278
	13.1%	21.2%	10.6%	42.4%	12.8%		
Sub-Composite mean						3.11	
e) Agroforestry Practices							
10) Agroforestry practices are not prioritized.	37	139	41	63	41	2.79	1.249
	11.5%	43.3%	12.8%	19.6%	12.8%		
11) Agroforestry practices are well in place.	76	54	45	114	32	2.91	1.367
	23.7%	16.8%	14.0%	35.5%	10.0%		
Sub-Composite mean						2.85	
Combined composite mean and standard deviation						2.903	0.674

composite mean of 2.903. It shows that these income generating engagements have positively contributed to sustenance of water resource projects in Nyangores river basin. This confirms the assertion of the WRUA secretsry during the

interview when he said, "Income generation projects that include Fruits like avocado and bee keeping are encouraged and supported." It Further, indicates that a refocus in income generating initiatives, may improve the sustainability of projects in the river basin, which agrees with Li et al. (2018), who found that cash flow, as an indicator was ranked as the most important one since any project that lacks cash flow, cannot guarantee the financial resources needed in establishment and operation leading to a non-conducive condition. Part c) that measured the state of water sufficiency for the respondents, the sub-composite mean was 2.84 which is lower than the combined mean value of 2.903. This points out that the respondents opined that there is insufficiency of water, a situation that does not positively influence the sustainability of projects in Nyagores river sub-catchment basin, in spite of the efforts made as alluded to from documents analysis, (photos) that showed Water harvesting at homes and institutions such as Tenwek Day Secondary School and eco-friendly actions under the green zone program, as recorded. This concurs with, Al-Damkhi et al. (2009), who noted that increasing number of developing countries are faced with water deficiency, for various reasons such as scarcity of natural water resources, populace increase, rising standards of living, and poorly developed infrastructure supply. Further, noted that water sustainability is critical for both humans and environmental health. Part d), regarding the soil and water conservation measures within the basin area, the sub-composite mean value was 3.11, greater than the combined mean value of 2.903. This illustrates that the measures put in place to conserve the soil have positively contributed to the sustenance of projects in Nyangores River in terms of quality and quantity. It suggests that the basin activities, particularly in the farms, need to be focused on soil conservation as a method of projects sustenance. Evidently, ignoring conservation measures will be detrimental to sustenance. Similarly, in part e) that sought data related to agroforestry practices within the basin area scored a sub-composite mean value of 2.85 less than the combined mean value of 2.903, which consequently suggest that the agroforestry practices have not been given adequate focus to support the sustenance of water resource projects within the basin in Nyangores. However, the WRUA secretary, during the interview noted, "WRUA gives seedlings to its members including bamboo trees to plant around the water springs while the county government also provides seedlings from their nurseries for riparian protection, also used to rehabilitate degraded sites" This illustrated that agroforestry practices require a concerted effort from all the stakeholders, County government, Water Resource Users Association, WRUA members, NGOs and even the local leaders and politicians.

4.4. Descriptive Analysis of Institutional Structures and Sustainability of Projects in Nyangores River Sub-Catchment Basin

The objective of the study was to determine the extent to which institutional structures influence sustainability of Projects in Nyangores river sub-catchment

basin in Bomet county, Kenya. The respondents were therefore asked to state their opinion by indicating the extent to which they agree or disagree with ten items derived from the indicators of this variable, and structured on a five point likert scale of 1 to 5, where: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly agree. The results are shown in Table 3.

The variable under study, Institutional Structures, from Table 3, gave a combined mean and standard deviation of 2.60 and 0.934, respectively. In part a), on the hierarchy of institutional structures, the sub-composite mean was 2.70. This mean of 2.70 is an average score given the likert scale of 1 to 5, used. It implies

Table 3. Descriptive analysis of institutional structures and sustainability of projects in Nyangores River Sub-catchment Basin.

Statements	SD	D	N	A	SA	Mean	SD
a) Hierarchy of institutional organization							
1) WRUA plays important role in water resource management.	64	70	49	96	42	2.94	1.357
	19.9%	21.8%	15.3%	29.9%	13.1%		
2) There is a great harmony among the various institutions concerned with the projects.	67	88	54	98	14	2.70	1.226
	20.9%	27.4%	16.8%	30.5%	4.4%		
3) Basin community members are happy with the hierarchy of WRUA structure.	78	101	51	66	25	2.56	1.271
	24.3%	31.4%	15.9%	20.6%	7.8%		
4) There is a clear order of steps or hierarchy of procedure when dealing with WRUA	72	92	64	79	14	2.60	1.357
	22.4%	28.7%	19.9%	24.6%	4.4%		
Sub-composite Mean						2.70	
b) Level of human training							
5) The trainings given have greatly improved the water management practices within the basin area	75	81	67	73	25	2.66	1.272
	23.4%	25.3%	20.9%	22.7%	7.8%		
6) Community member are regularly trained and sensitized on water resource management practices.	86	89	64	60	22	2.51	1.255
	26.8%	27.7%	19.9%	18.7%	6.9%		
7) WRUA Members are well trained on water resource management issues.	80	91	60	71	19	2.56	1.244
	24.9%	28.4%	18.7%	22.1%	5.9%		
8) My sector of the basin is fairly well represented in the WRUA consultations	135	86	25	55	20	2.19	1.310
	42.1%	26.8%	7.8%	17.1%	6.2%		
Sub-Composite Mean						2.58	
c) Level of stakeholder participation							
9) My sector representatives are actively involved in the River Basin programmes.	81	120	39	56	25	2.45	1.254
	25.2%	37.4%	12.2%	17.4%	7.8%		
10) There are many species of indigenous plants and animals.	63	81	62	91	24	2.79	1.257
	19.6%	25.2%	19.3%	28.3%	7.5%		
Sub-composite mean						2.48	
Composite mean and Composite Standard Deviation						2.60	0.934

that the indicator, hierarchy of institutional structures, has not positively influenced the sustainability of projects in Nyangores sub-catchment basin. However, the WRUA secretary stated that, "We collaborate with various institutions; USAID, NEMA, WRMA, CAAC, LVBC, County and National governments. It suggests that the hierarchy in place within the basin calls for a diagnostic analysis in line with the findings in a study by Bandaragoda (2000), on A framework for institutional analysis for water resources management in a river basin context, in Colombo, Sri Lanka, in which the physical and social diagnostic analyses helped in evaluating the existing institutional framework, as well as in formulating institutional change to make it more clearly defined and operationalized to avoid overlap and duplication of roles and responsibilities. In part b), on the level of human training, the sub-composite mean was 2.58. The level of human training, therefore has not positively and adequately influenced the sustenance of projects in Nyangores river sub-catchment basin, since the sub-composite mean was not well above the average score. Part c), captured data on the level of stakeholder participation, which focused on representation and involvement, at the decision and implementation levels. The sub-composite mean was 2.48. Again, such a mean is not high enough, on a scale of 1 to 5, to signify any noticeable positive influence of stakeholder participation on the sustainability of projects in Nyangores river basin. A study done in Kenya, revealed that bottom-up representation is a critical feature of the Likii sub-catchment basin management (Dell'Angelo et al., 2014). It found that this provides a procedure by which the people affected by the legislation can engage in establishing or adjusting them. Respondent 1 noted that, "WRUA Structure has the management committee formed by the departmental executive members". This will make consultations and interaction among the members and with the leaders and experts, possible and fruitful

4.4.1. Correlation Analysis of Institutional Structures and Sustainability of Projects in Nyangores River Sub-Catchment Basin

The correlation analysis was done using the Pearson Product Moment technique to determine the relationship between the institutional structures and sustainability of projects in Nyangores river sub-catchment basin. Using the Statistical Package for Social Science, (SPSS), to analyze the data, the obtainable values in this correlation range from -1, (perfect negative correlation) to $+1$, (positive perfect correlation), and no correlation when the obtained value is 0.000. Otherwise, the correlation values, 0.001 to 0.250 indicate a weak correlation, 0.251 to 0.500 indicate a moderately strong correlation, 0.501 to 0.750, indicate a strong correlation and 0.751 to 1.000 indicate a very strong correlation. The results are as shown in Table 4...

The correlation results in Table 4, shows a correlation index between institutional structures and sustainability of projects in Nyangores river sub-catchment basin is, "r" = 0.552 and a propability value, $p = 0.000 < 0.05$. This implies that there is a significant relationship between institutional structures and sustainability

Table 4. Correlations results between institutional structures and sustainability of projects in Nyangores River Sub-catchment Basin.

Variables		Sustainability of Project	Institutional Structures
Sustainability of Projects	Pearson Correlation	1	0.552
	Sig. (2-tailed)		0.000
	n	321	321
Institutional Structures	Pearson Correlation	0.552	1
	Sig. (2-tailed)	0.000	
	n	321	321

of projects in Nyangores river sub-catchment basin, leading to a rejection of the null hypothesis, (H_0: There is no significant relationship between institutional structures and sustainability of projects in Nyangores river sub-catchment basin), and acceptance of the alternative hypothesis and hence the research findings conclude that there is a significant relationship between institutional structures and sustainability of projects in Nyangores river sub-catchment basin. Bandaragoda (2000), in a study done in Colombo, Sri Lanka, found that firmly identified with the common highlights are the man-made foundation for bridling water projects from the waterway framework to create characteristic assets inside the basin. Added that the regular highlights of the basin, the qualities of framework, for example, size and scale, innovation, and reason will in general decide the sort and character of foundations set up for water resource control board. As a result, the physical arrangement of the stream basin reflects the institutional game plans.

4.4.2. Regression Analysis between Institutional Structures and Sustainability of Projects in Nyangores River Sub-Catchment Basin

Test of Hypotheses

Linear regression analysis was adopted to enable investigate how institutional structures influence sustainability of projects in Nyangores river sub-catchment basin. The reason for using regression model was to establish how institutional structures as a predictor significantly or insignificantly predicted the sustainability of projects in Nyangores river sub-catchment basin. These are further discussed in the subsequent sub-themes:

1) Model Summary of Institutional Structures and Sustainability of Nyangores River Sub-catchment Basin

The model summary sought to determine how institutional structures as a predictor significantly or insignificantly predicted the sustainability of projects in Nyangores river sub-catchment basin. The following hypotheses were tested;

H_0: Institutional structures do not significantly influence the sustainability of projects in Nyangores river sub-catchment basin.

H_1: Institutional structures significantly influence the sustainability of projects

in Nyangores river sub-catchment basin.

The null hypothesis, (H_0) was tested using the following linear regression model:

$$y = a + b_1 X_1 + e$$

where;

y = Sustainability of projects

X_1 = Institutional structures

a = Regression constant

b_1 = Regression coefficient

e = Error term

The regression model summary is presented in Table 5.

The model summary in Table 5 shows that there is a positive correlation, (R = 0.552) between institutional structures and sustainability of projects in Nyangores river sub-catchment basin and those predicted by the regression model. R^2 = 0.304, indicate the amount of variation in sustainability of projects that is explained by institutional structures. This implies that institutional structures explains 30.4% change in sustainability of projects in Nyangores river basin, institutional structures therefore, if adequate investment is made, with all the aspects of the resources, a great deal of improvement will be realized along the sustainability of projects in the basin area. The significance of institutional structures in river basin projects sustenance is further illustrated by, Dell'Angelo et al. (2014)

Table 5. Model summary of institutional structures and sustainability of Nyangores River Sub-catchment Basin.

	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sig. F Change
1	0.552[a]	0.304	0.302	0.51583	0.000

ANOVA

	Model	Sum of Squares	df	Mean Square	F	Sig.
	Regression	37.114	1	37.114	139.481	0.000[b]
1	Residual	84.881	319	0.266		
	Total	121.995	320			

Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.957	0.085		22.986	0.000
Institutional Structures	0.364	0.031	0.552	11.810	0.000

a. Dependent Variable: Sustainability of Projects; b. Independent Variable: Institutional Structures.

who found that the process by which the chair of every Community water partnership management committee would represent the Community water partnership in the WRUA management committee, forming the higher legislative body, the people affected by the legislation can engage in establishing or adjusting them. The study concluded that reflexive management is challenging, and the rate and magnitude of change calls for a deep and constant participation of the stakeholders and realignment of institutional approaches. Going forward, the study adds, water management in Mount Kenya will mostly relay on the way and extent of collaboration including sharing of information and on how adaptive to socio-environmental change the institutions are.

The Analysis of variance was used to establish whether the model was a good fit for the data in determining the influence of institutional structures on sustainability of projects in Nyangores river basin. The ANOVA results in Table 5 shows a significance level, $p = 0.000 < 0.05$, and therefore the model was a good fit in predicting the influence of institutional structures on sustainability of projects in Nyangores river basin. This implies that the regression model result is significantly better predictor of sustainability of projects in Nyangores river basin. The simple linear regression coefficient results in Table 5 indicate that there was a significant influence of institutional structures on sustainability of projects in Nyangores river sub-catchment basin. The coefficient of the constant term, ($\beta_0 = 1.957$, $p < 0.05$), and institutional structures ($\beta_1 = 0.364$; $p < 0.05$) were found to be statistically significant. Regression model for institutional structures was; $y = 1.957 + 0.364X_2$

5. Conclusion

In determining the influence of institutional structures on sustainability of projects in Nyangores River sub-catchment basin, the analyzed results showed a strong positive correlation between the two variables, and a significant change predicted by institutional structures on sustainability of projects in Nyangores River sub-catchment basin. It is therefore, concluded that the WRUA community members need a more effective representation, training and harmonious relationship among the stakeholders to optimize on sustainability of projects.

Recommendation

The study established that institutional structures significantly and positively influenced the sustainability of projects in Nyangores river sub-catchment basin. This calls for a robust and domesticated curriculum guide, centered on community participation that will place the members as the owners of the decisions and take the responsibility of implementation as well. This will further ensure a harmonious working relation among the various stakeholders and institutions. The study found that the WRUA community members are not equally represented in the WRUA institutional structure which has led to some pocket areas, within the basin, lagging behind. This calls for a more robust representation of the

community in the WRUA consultation and decision making organs to facilitate effective communication of essential information including M&E results.

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Conflicts of Interest

This article being part of the PhD thesis, the authors declare that there is no conflict of interest.

References

Al-Damkhi, S. A., Abdul-Wahab, & Al-Nafisi, S. A. (2009). On the Need to Reconsider Water Management in Kuwait. *Clean Technologies and Environmental Policy, 11,* 379-384. https://doi.org/10.1007/s10098-009-0201-z

Almedeij, J. (2007). The Future Sustainability of Water Supply in Kuwait. *Water International, 32,* 604-617. https://doi.org/10.1080/02508060.2007.9709692

An, X. W. et al. (2018). Compensation Mechanism for Urban Water Environment Treatment PPP Project in China. *Journal of Cleaner Production, 201,* 246-253. https://doi.org/10.1016/j.jclepro.2018.08.003

Bandaragoda, D. J. (2000). *A Framework for Institutional Analysis for Water Resources Management in a River Basin Context.* Working Paper 5, International Water Management Institute.

Bryman, A. (2008). *Social Research Methods* (p.748). Oxford University Press.

Chumbulla, J. J., & Massawe, F. A. (2018). The Role of Local Institutions in the Creation of an Enabling Environment for Water Project Sustainability in Iringa District, Tanzania. *Environmental & Socio-Economic Studies, 6,* 1-10. https://doi.org/10.2478/environ-2018-0023

Cresswell, J. W. (2008). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research* (3rd ed.). Pearson Education Inc.

Dell'Angelo, J. et al. (2014). Community Water Governance on Mount Kenya: An Assessment Based on Ostrom's Design Principles of Natural Resource Management. *Mountain Research and Development, 36,* 102-115.

Dell'Angelo, J. et al. (2016). Community Water Governance on Mount Kenya: An Assessment Based on Ostrom Design Principles of Natural Resource Management. *Mountain Research and Development, 36,* 102-115. https://doi.org/10.1659/MRD-JOURNAL-D-15-00040.1

Dellapenna, J. et al. (2013). Thinking about the Future of Global Water Governance. *Ecology and Society, 18,* Article No. 28. https://doi.org/10.5751/ES-05657-180328

Gawne, B. et al. (2018). Different Conceptualizations of River Basin to Inform Management of Environmental Flows. *Frontiers in Environmental Science, 6,* Article No. 111. https://doi.org/10.3389/fenvs.2018.00111

Gleick, P. H. et al. (2009). *The World's Waters* (Vol. 6). Island Press.

GWP (2012). *Integrated Water Resource Management*. TAC Background Paper No. 4, Global Water Partnership.

Integrated Water Resource Management (2010). *IWRM-Building Bridges over Troubled Waters. China-UK. Department for International Development* (Vol. 1 pp. 35-38).

Kivila, J., Martinsuo, M., & Vuorinen, L. (2017). Sustainable Project Management through Project Control in Infrastructure Projects. *International Journal of Project Management, 35,* 1167-1183. https://doi.org/10.1016/j.ijproman.2017.02.009

KNBS (2009). *Kenya Population and Housing Census*. Nairobi.

Lalika, M. C. S. et al. (2015). Exploring Watershed Conservation and Water Governance along Pangani River Basin, Tanzania. *Land Use Policy, 48,* 351-362. https://doi.org/10.1016/j.landusepol.2015.06.010

Li, H. M. et al. (2018). Identify Factors Affecting the Sustainability of Water Environment Treatment Public-Private Partnership Projects in China. *Journal of Cleaner Production, 201,* 246-253.

Malczewski, J. (2006). Multi-Criteria Decision Analysis for Collaborative GIS. *International Journal of Geographical Information, 20,* 703-726. https://doi.org/10.1080/13658810600661508

McCain Roger, A. (2010). Game Theory. In Revised (Ed.), *A Nontechnical Introduction to the Analysis of Strategy* (pp. 471-503). World Scientific Publisher.

Mugenda, A. G. (2008). *Social Science Research: Theory and Principles* (Vol. 56, pp 23-34). African Centre for Technology Studies.

Nulty, D. D. (2011). The Adequacy of Response Rate to Online and Paper Surveys: What Can Be Done? *Assessment and Evaluation in Higher Education, 33,* 639-655.

Onyango, G. M. et al. (2019). Understanding Institutional Structures and Their Role on Climate Change Adaptation: A Case of Mara River Basin, Kenya. *International Journal of Liberal Arts and Social Science, 7,* 1-14.

Pahl-Wostl, C. K. et al. (2013). Missing Links in Global Water Governance: A Process Oriented Analysis. *Ecology and Society, 18,* Article No. 33. https://doi.org/10.5751/ES-05554-180233

Pandey, C. L., Maskey, G., Devkota, K., & Ojha, H. (2019). Investigating the Institutional Landscape for Urban Water Security in Nepal. *Sustainability, 12,* 173-181. https://doi.org/10.1089/sus.2019.0007

Schubert, S. A. (2013). Comparing Global Coordination Mechanisms on Energy, Environment and Water. *Ecology and Society, 18,* Article No. 22. https://doi.org/10.5751/ES-05440-180222

Snapp, S. S. et al. (2005). Evaluating Cover Crops for Benefits, Costs and Performance within Cropping System Niches. *Agronomy Journal, 97,* 322-332. https://doi.org/10.2134/agronj2005.0322a

Tang, Q. et al. (2014). Farmers' Sustainable Strategies for Soil Conservation on Sloping Arable Lands in the Upper Yangtze River Basin, China. *Sustainability, 6,* 4795-4806. https://doi.org/10.3390/su6084795

UNEP (2012). *Status Report on the Application of Integrated Approaches to Water Resource Management* (pp. 11-17). UNEP-DHI Centre.

Videira, N., Kallis, G., Antunes, P., & Santos, R. (2000). Integrated Evaluation for Sustainable River Basin Governance. *Ecological Economics, 68,* 931-939. https://doi.org/10.1016/j.ecolecon.2008.12.004

Wu, H., Darton, R., & Borthwick, A. (2016). Defining and Measuring River Basin Sustainability: A Case Study of the Yellow River. *WIT Transactions on the Built Environment, 168,* 383-394. https://doi.org/10.2495/SD150331