Institutional Change through Social Learning

Climate Change Policy Gaming in Kenya

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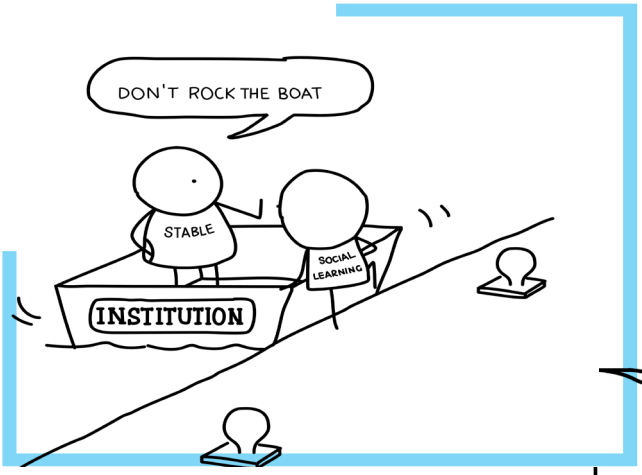
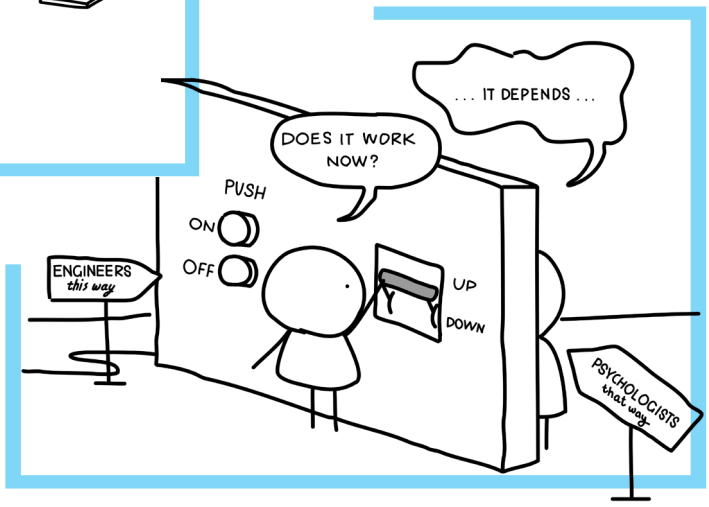


The future of Social Learning lies in valuing and financially supporting interdisciplinary research, especially when conceptual disciplinary distance exists.

Climate Change Policy Gaming in Kenya



Institutional Change through Social Learning

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TU Delft

Institutional Change through Social Learning: Climate Change Policy Gaming in Kenya

Dissertation

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by

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Dissertation: : Institutional Change through Social Learning: Climate Change Policy Gaming in Kenya

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Keywords: Water Governance, Institutional Change, Social Learning, Climate Change, Policy Gaming, Situation Awareness, Trust, Diversity, Cooperation, Team Interdependence

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Abstract

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The Situation

Increasingly, researchers have focused on catalysing the change of water institutions (rules, norms and legal frameworks) within socio-technical systems. This branch of research has identified a strong association between social structures comprising of multiple networks of actors, and the technology (construction of dams, irrigation schemes) that these structures develop. Research indicates that changes in water institutions occur when there is co-evolution of both the social structures and the technology that is employed to resolve the societal problem. However, the co-evolutionary development of both the social structures and the technology has not been evident in most of the African water institutions.

Until recently, most African water institutions adopted "command and control" approaches to water resources management (WRM). These approaches excluded the social structures, and technology had the sole responsibility of controlling nature. The "command and control" approaches were guided by a worldview that decisions should be based on predictable information to make incremental changes to the technical system. This worldview barely considered the ongoing parallel decisions made by established social structures, that have an impact on the sustainability of the proposed technical solutions. Therefore, humans were separated from nature and scientists had the critical role of addressing water, energy and food issues, through technical interventions.

An underlying assumption of the "command and control" approach is that nature is highly certain, predictable and can be engineered, through sound science. Consider, for instance, the Kenyan water institutions that seek to reduce floods and droughts through the construction of massive dams. Research indicates a disconnect between the technological innovations and social systems, as people increasingly cultivate, and construct along the river beds, exposing their assets to high flood risks. Moreover, there have been many instances where the dam water was released without any interaction with the social structures. This led to the destruction of crops, buildings, infrastructure and widespread outbreak of water-borne diseases. Incremental technical solutions have been proposed to address flooding (bypasses or increased storage to retain the flood waters). However, these short-term incremental technical solutions fail to answer long-term oriented questions, that should be reflected upon before making institutional changes, for instance:

1. Is the current Kenyan flood protection practice sustainable?
2. How can the resilience of socio-technical systems be strengthened?
3. Do we need new laws, regulations, values, and norms to solve the core problem?
4. Should we include other actors and expertise to resolve the issue?

Research indicates that complex and uncertain societal problems cannot be addressed by technical solutions that rely solely on predictions. Institutions that exclusively rely on predictions, repeat the same actions / habits or practices (also known as routine), with little reflection on the impact of these technological solutions upon the socio-technical system. Although routine is beneficial for stability and continuity of any institution, it may stifle reflection and thus reduce any opportunity for change. Consequently, when an institution does not change, it cannot innovate nor adapt to changing circumstances.

Social learning (SL) has been proposed to catalyse institutional change. SL is a change in societal understanding, achieved through social interactions, which eventually gets situated within broader social units. In principle, SL holds a promise in addressing the problem of routinized, non-adaptive institutions. Nevertheless, there is limited evidence on whether SL does indeed lead to institutional change.

The Complication

Research shows that SL is still at the initial stages of conceptualization and empirically understudied. Thus, it is not clear whether SL can catalyse institutional change. Most SL empirical studies demonstrate a low engagement with the relevant discipline-related body of theoretical knowledge, especially when conceptual disciplinary distance exists. Current empirical studies rarely measure learning or provide insights on what techniques may lead to SL.

Moreover, from the existing body of literature, few studies provide specific empirical design elements that may maximize SL, on a broader scale. Additionally, only a limited number of studies empirically and directly assess the epistemic dimension and SL impacts. Furthermore, most of the SL case studies and experiments are controlled and fail to offer insights to complex socio-technical systems that involve unexpected events, multiple actors with competing interests and different temporal and spatial scales. As a consequence, there is limited guidance on whether SL may challenge routine and ultimately lead to institutional change, in a specific socio-technical context.

The Question

The main research question is whether SL theory can catalyse institutional change, in the context of the Nzoia River Basin. SL comprises of three dimensions – cognitive (obtaining new knowledge or restructuring existing knowledge), relational and epistemic. The relational aspect entails an increased understanding of other actors' mindsets (respect for diversity), trust, and cooperation. The epistemic dimension includes normative epistemology, which is a change in norms, values, paradigms and idea convergence.

The Approach

In this dissertation, SL theory is used to catalyse institutional change. The selected research tool is policy gaming and the case study area is Nzoia River Basin in western Kenya. A climate-change water policy game, known as the Nzoia WeShareIt was designed, to resolve the social problem of hard to change, routinized water institutions. Specifically, the research assessed: (1) whether there was a change in understanding; (2) whether through social interactions, the Nzoia Basin institutions begun to question the underlying assumptions of their pre-conditioned responses, and (3) whether the reflection led to changes in norms, values, paradigms, and convergence of opinions.

The policy game was designed using the concept of epistemic artefacts. An epistemic artefact is different from a technical artefact because it is open-ended, thus creating room for unexpected events. The policy game was first modelled to represent routinized institutions that are programmed to repeat actions, based on cues. Thereafter, unexpected events were introduced, to challenge routine, leading to the questioning of underlying assumptions, and subsequently changes were made to prevailing institutions. The epistemic artefact was also used to predict "what are the right things to do." Therefore, Nzoia WeShareIt game tested various policy options and identified the most

likely SL changes that may diffuse to the broader social unit, and lead to the transformation of Nzoia River Basin institutions.

The Results

The results indicate that SL has the potential to change routine-based institutions and generate adaptive capacity. The outcomes also indicate the need for the following profound institutional changes in Nzoia River Basin:

1. *Artefacts:* Replace current WRM structures with configurations that respect the river, and support the sustainable management of the drainage basin, as a whole.
2. *Values:* Value water more than spatial, agricultural and energy-production plans and make water the structuring element within the Nzoia River Basin. This means that any proposed laws, regulations, practices and norms that intend to utilize the scarce water resources unsustainably, should not be supported.
3. *Underlying Assumptions:* Question underlying assumptions, and make transformations to existing laws, regulations, values, norms and actor-networks to build adaptive capacity.

Application of this dissertation

This dissertation contributes to science, policy and practice on SL, policy gaming and institutional change, with a particular focus on the Nzoia River Basin. Scientifically, it provides guidance and insights regarding the design and application of a water policy game. It also discusses the overall framework and methodologies for the subsequent measurement of the SL outcomes. The details on the input, process and outcome of Nzoia WeShareIt game approach can be customized and replicated in other river basins.

This research provides methodologies that SL and policy gaming experts could use to assess SL outcomes (cognitive, relational and epistemic). The scientific papers describe the design, application, and measurement SL outcomes, in detail, to enable researchers to replicate the study or customize it for another river basin. Besides, all the datasets and the in-game data are open and easily accessible through the 4TU repository. The datasets provide researchers with the opportunity to test the SL outcomes or use these datasets for further analyses.

In practice, the research results were applied in current policy-discourses and used to formulate specific advice to key policymakers in Kenya. The relevant policymakers could consider adopting the policy recommendations with the aim of improving existing laws, regulations, values, norms and actor-networks, to improve the adaptive capacity of Nzoia Basin institutions.

Samenvatting

Auteur: Abby Muricho Onencan

Thesis titel: Institutionele verandering door sociaal leren: klimaatveranderingsbeleidsspel in Kenia

Faculteit: Faculteit Techniek, Bestuur en Management, Technische Universiteit Delft

Sleutelwoorden: Water governance, epistemisch artefact, institutionele verandering, sociaal leren, klimaatverandering, beleidsspel, situationeel bewustzijn, vertrouwen, diversiteit, samenwerking, team interdependentie

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De Situatie

In toenemende mate hebben onderzoekers zich gericht op het versnellen van veranderingen in water instituties (regels, normen en het wettelijk kader) binnen socio-technische systemen. Deze tak van onderzoek ziet een sterk verband tussen sociale structuren bestaande uit meerdere actor-netwerken en de technologieën die zij ontwikkelen, zoals de bouw van dammen en aanleg van irrigatiestelsels. Onderzoek laat zien dat veranderingen in water instituties optreden wanneer er sprake is van co-evolutie van de sociale structuren en de techniek die wordt gebruikt om een maatschappelijk probleem op te lossen. Co-evolutionaire ontwikkeling van sociale structuren en techniek is echter niet evident in de meeste Afrikaanse water instituties.

Tot voor kort, werden de meeste Afrikaanse water instituties gekenmerkt door een "command and control" benadering in het waterbeheer. Deze benadering heeft geen aandacht voor het sociale aspect en technologie wordt ingezet om de natuur te beheersen. De "command and control" benadering is gebaseerd op een wereldbeeld waarin op basis van voorspelbare informatie beslissingen worden genomen over incrementele aanpassingen aan het technische systeem. Dit wereldbeeld heeft weinig aandacht voor de parallelle besluitvormingsprocessen in het sociale systeem die invloed hebben op de duurzaamheid van de voorgestelde technische oplossingen. Dientengevolge werd het menselijk aspect gescheiden van het natuurlijke aspect en wetenschappers kregen de rol om water-, energie- en voedsel- problemen op te lossen middels de technische interventies.

Een onderliggende aanname van de 'command and control' benadering is dat de natuur voorspelbaar en beheersbaar is via deugdelijk

ingenieursonderzoek. Een voorbeeld zijn de Keniaanse water instituties die het gevaar van overstromingen en droogtes trachten te bezweren middels de aanleg van grote dammen. Onderzoek laat zien dat hier sprake is van een scheiding tussen de sociale werkelijkheid en de technologie omdat de inwoners in toenemende mate het land in het rivierbed bewerken en bewonen en daarbij hun bezittingen aan hoge risico's blootstellen. Meermaals werden dammen geopend zonder enige interactie met het sociale systeem wat leidde tot het verlies van gewassen, huizen, en infrastructuur en tot de verspreiding van door water overgebrachte ziektes. Incrementele technische oplossingen werden vervolgens geïmplementeerd zoals omleidingen en reservoirs om overstromingswater tijdelijk op te vangen. Deze korte-termijn incrementele technische oplossingen schieten echter te kort voor lange-termijn vragen die zouden kunnen leiden tot institutionele veranderingen, zoals:

1. Is de huidige praktijk van bescherming tegen overstromingen in Kenia duurzaam?
2. Hoe kan de veerkracht van de socio-technische systemen die met overstromingen te maken hebben worden versterkt?
3. Zijn er nieuwe wetten, regelgeving, waarden en normen nodig om het probleem structureel op te lossen?
4. Moeten er andere actoren en expertise worden betrokken om het probleem op te lossen?

Sociaal leren (SL) wordt voorgesteld om verandering van de "command en control" instituties te faciliteren. Dit is nodig vanwege de beperkingen van voorspellingen, de toenemende onzekerheden en toenemende complexiteit van het waterbeheer. SL is een verandering in maatschappelijk begrip die wordt bereikt door sociale interactie en wordt bestendigd in bredere maatschappelijke netwerken. In principe zou SL kunnen helpen bij het aanpakken van het probleem van de op routine gebaseerde, niet-adaptieve instituties in Kenia. Echter, SL onderzoek geeft weinig aanwijzingen hoe SL moet leiden tot institutionele verandering.

De Complicatie

Onderzoek laat zien dat SL een relatief jong wetenschapsgebied is, dat conceptueel en empirisch nog in ontwikkeling is. Dientengevolge is het niet duidelijk of SL tot institutionele verandering kan leiden. De meeste empirisch SL onderzoeken hebben bovendien een beperkte aansluiting met de relevante discipline gerelateerde SL theorieën, met name wanneer er sprake is van conceptuele disciplinaire afstand. Recente empirische studies richten zich niet op het meten van leerprocessen, noch op de vraag welke technieken leiden tot SL. In de wetenschappelijke literatuur is daarom weinig te vinden over specifieke empirische ontwerp-elementen die sociaal leren stimuleren.

Bovendien worden de meeste SL case studies uitgevoerd in een gecontroleerde onderzoeksomgeving, waardoor zij weinig zeggingskracht hebben in complexe socio-technische omgevingen waar sprake is van onverwachte gebeurtenissen, strijdige belangen en verschillende temporele en ruimtelijke schalen. Dientengevolge zijn er geen richtlijnen hoe empirische SL studies opgezet kunnen worden om te onderzoeken of en hoe een specifieke interventie routines ter discussie stelt en die uiteindelijk zou kunnen leiden tot institutionele veranderingen in die specifieke socio-technische context.

De Vraag

De hoofdvraag in dit onderzoek is of SL theorie kan leiden tot institutionele veranderingen in de context van het stroomgebied van de Nzoia rivier. SL omvat drie dimensies – cognitief (vergaren van nieuwe kennis of herstructureren van bestaande kennis), relationeel en epistemisch. Het relationele aspect betreft een verbeterd begrip van de ander (respect voor diversiteit), vertrouwen en samenwerking. De epistemische dimensie omvat de normatieve epistemologie die betrekking heeft op veranderingen in normen, waarden, paradigma's en de convergentie van ideeën.

De Aanpak

In dit proefschrift, gebruik ik SL theorie om institutionele veranderingen te bewerkstelligen. Ik introduceer het concept 'epistemisch artefact' om bestaande routines aan de kaak te stellen en de ontwikkeling van nieuwe instituties te stimuleren. Een epistemisch artefact verschilt van een technisch artefact want het heeft een open einde; het laat ruimte voor onverwachte gebeurtenissen. Onverwachte gebeurtenissen bevragen routines, leiden tot vragen over onderliggende aannames en vervolgens tot verandering. Ik ontwerp het epistemisch artefact in de vorm van een klimaatverandering waterbeleidsspel, genaamd 'Nzoia WeShareIt' met het doel vastgeroeste op routine gebaseerde waterinstituties te veranderen. Het model representeert de op routine gebaseerde instituties, die zijn ontworpen om op basis van een bepaalde prikkel tot actie over te gaan. Ik gebruik het beleidsspel als onderzoeksinstrument dat nagaat of veranderende omstandigheden kunnen leiden tot veranderingen in bestaande waterinstituties en de aannames achter de voorgeprogrammeerde actie kritisch beschouwen. Als er kritische vragen worden gesteld bij de aannames wordt nader onderzocht of deze reflectie leidt tot veranderingen in die normen, waarden, of paradigma's, en of dat leidt tot convergentie van ideeën.

Ik gebruik het epistemisch artefact om te voorspellen "wat de juiste dingen zijn om te doen". Het spel is het onderzoeksinstrument om de verschillende beleidsopties te testen en om de meest waarschijnlijke SL veranderingen te

identificeren; veranderingen die zich breder zouden kunnen verspreiden en leiden tot de transformatie van de instituties in het Nzoia stroomgebied.

De Resultaten

De uitkomsten laten zien dat SL de potentie heeft om op routine gebaseerde instituties te veranderen en adaptieve capaciteit te genereren. De uitkomsten geven aan dat de volgende diepgaande structurele institutionele veranderingen gewenst zijn:

1. *Artefacten:* Vervang de bestaande waterbeheer structuren door configuraties die de rivier respecteren en duurzaam management van het stroomgebied als geheel ondersteunen.
2. *Waarden:* Waardeer water hoger dan ruimtelijke, agrarische en energieproductie plannen en maak water het structurerende element binnen het Nzoia stroomgebied. Dit betekent dat geen enkele voorgestelde wet, regel, praktijk of norm met intenties tot niet duurzaam gebruik van de schaarse watervoorraad wordt gesteund.
3. *Onderliggende aannames:* Stel aannames ter discussie en maak aanpassingen aan bestaande wetten, regels, waarden, normen en actor-netwerken die leiden tot vergroten van de adaptieve capaciteit.

Toepassen van de inzichten

Dit proefschrift draagt bij aan de wetenschap, het beleid en de praktijk van SL, beleidspelen en institutionele verandering, in het bijzonder binnen het stroomgebied van de Nzoia rivier. Wetenschappelijk geef ik richting aan en inzichten in het ontwerp en de toepassing van een waterbeleidsspel. Ook bespreek ik het omvattende framework en de methodologie die het mogelijk maakt om SL uitkomsten te meten. De details betreffende de input, proces en uitkomsten van Nzoia WeShareIt kunnen worden aangepast en gebruikt in andere riviergebieden.

Het onderzoek draagt methoden aan die SL en beleidsspel experts kunnen gebruiken om uitkomsten van SL te meten (cognitief, relationeel en epistemisch). De wetenschappelijke papers beschrijven het ontwerp, de toepassing, en het meten van SL uitkomsten in detail om onderzoekers in staat te stellen de studie te herhalen of aan te passen voor andere stroomgebieden. Daarnaast zijn alle datasets en de in-game data beschikbaar en benaderbaar via de 4TU repository. Deze datasets geven onderzoekers de kans om de SL uitkomsten te testen of te gebuiken voor verdere analyses.

In beleid en praktijk gebruik ik het epistemisch artefact in het heersende beleidsdiscourse en formuleer ik specifieke beleidsadviezen aan de betrokken beleidsmakers in Kenia.

Preface

In 2010, as I sat in my first meeting with the Nile Basin Council of Ministers (Nile-COM) and their technical persons (the Nile Basin Technical Advisory Committee or the Nile-TAC), I thought to myself "How is it possible that for over ten years, the eleven Water Ministers were unable to agree on one provision in the Nile Basin Cooperative Framework Agreement (CFA)?" The CFA is a critical agreement that defines how riparian states will jointly manage the shared water resource. The agreement could not be finalized from 1999 to 2009, when the negotiations stopped, due to divergent opinions on the "water security clause." Despite many interventions, neither the Nile Basin political (Nile-COM), nor the technical wing (Nile-TAC), could resolve the deadlock.

Downstream riparians proposed the inclusion of the water security provision, in Article 14. The upstream countries rejected the proposal. The specific proposal requires the Basin States "not to adversely affect the water security and current uses and rights of other basin states." Some upstream countries negotiation objective was to develop a new dispensation that would repeal previous Nile Basin agreements. Therefore, the proposed provision, in their opinion, defeated the sole purpose of initiating the negotiations.

By 2010, the situation was tense. As the new Regional Manager of the Nile Basin Discourse (NBD), I was careful not to speak, and possibly 'fuel the fire' or be seen to take sides. All the eleven countries were talking, but none listened. Everyone knew what the other person would say before they spoke, and thus, stopped listening. Every argument seemed valid, and the differences were fundamental. We reached a CFA deadlock. For three years, I devotedly attended these high-level inter-governmental meetings, performing the repeated formal meeting practices, and time seemed to have stood still. There was no significant institutional change; everything seemed the same. It was an exasperating period for multiple Nile Basin stakeholders.

The Nile-TAC decided to continue technical cooperation with the hope that it culminates into socio-political cooperation. The lifespan for the Nile Basin Trust Fund (NBTF), managed by the World Bank, worth more than US$203 million, was almost coming to an end. NBTF development partners initiated impact assessments of the World Bank approach, which largely supported large scale transboundary infrastructural projects. In the meantime, plans to construct border dams and interconnection lines, to promote energy and food production,

continued, with limited cooperation from some members of the Nile-COM. It was then apparent that Nile Basin technical cooperation could not lead to socio-political cooperation. For a while, some technical cooperation processes were stalled, when political cooperation was not feasible.

At that time, my preoccupation was to implement a two-year NBD program aimed at facilitating discussions and convergence of varied Nile Basin perspectives. The two-year program worth US$ 4.5 million, was financed by the Department for International Development (DFID), United Kingdom. NBD generated grand ideas and SMART solutions to facilitate stakeholders to discuss fundamental issues that hindered Nile Cooperation. Our objective was to converge opinions that may lead to the signing/accession of the CFA, and its subsequent ratification. But as we progressed, it was apparent that the deliberative processes were not sufficient. We held regular national, sub-regional and regional forums in the eleven Nile Basin countries. In these forums various perspectives were expressed, but no concrete proposals, to resolve the CFA impasse, were made.

When working at NBD, I recognised the power of institutions in shaping the future of the Nile Basin. Institutions are repeated patterns of behaviour (routine) that shape a particular social order. One crucial aspect of institutions is the value system. In the Nile Basin, the technical system is valued more than the social system. If the saying: "you put money where your heart is" remains true, then the heart of Nile Basin formal institutions is the advancement of technical solutions, with limited provision to support social systems.

Using budget savings, I decided to change strategy and modify the DFID program, to conduct exchange visits to Egypt and Ethiopia, so that various policymakers may begin to change their understanding of other riparian states perspectives and arguments. After scrapping the formality and diplomacy that accompanies official Nile-COM, Nile-TAC and Nile-Forum meetings, the curtain was unveiled. I began to observe positive cognitive and relational changes between the riparian governments.

During the exchange visit in Minya Governorate in Upper Egypt, I asked the political wing what, in their opinion, was the problem with the current NBI approach – technical cooperation with limited socio-political cooperation. One stakeholder responded: "we cannot trust another country to store our water, grow our food crops and produce our energy, it is a fundamental public security concern." This statement defined the core problem of my PhD research.

Throughout my PhD research, I remained convinced, that the critical change required for the sustainable management of the Nile Basin water resources, is not tangible nor technical, it is intangible and institutional. Therefore, I chose to find a solution to the core problem, as defined by the Nile Basin stakeholders, during the two exchange visits to Minya Governorate in Upper Egypt and Bahir Dar in Ethiopia.

The core problem, as defined by the Nile Basin stakeholders, was lack of cognitive understanding of others riparian governments perspectives, low trust, interdependence complexities and weak cooperation. Most people around me assumed that the core Nile Basin problem was water security. According to this group of scientists and practitioners, the solution lies in large-scale water infrastructural developments and designing complex water allocation or benefit sharing predictive models. These solutions were already present in the Nile Basin. The NBTF had provided sufficient resources to develop state of the art technical and infrastructural water solutions. Nevertheless, these solutions had played a limited role in addressing the Nile Basin core problem.

Transition management scholarship demonstrates the need for the technical system to co-evolve with the social system, for institutions to change. The Nile Basin institutions are advanced in technical solutions and replete of equally evolved social-political structures to support technological innovations. The Nile basin needs a similarly developed social structure to be able to reflect on the proposed technical solutions, build relations (trust, respect for diversity and cooperation), and eventually make institutional changes in the form of new policies, laws, regulations, norms, values and practices.

This dissertation is an attempt to first make sense of my previous experience in the Nile Basin and then propose possible solutions. It entails understanding why the Nile Basin institutions repeatedly sought technical solutions for an obvious governance challenge that required a careful balance between social-political and technological solutions, despite failure to arrive at a CFA consensus. Why the supporting social structures were barely strengthened? Importantly: what can be done to resolve the impasse?

Since my sole aim was to devise an approach to facilitate the co-evolution of both the technical and social systems, my research would be incomplete, if I had not worked in the technical field. Therefore, undertaking my studies at the Delft University of Technology was a strategic move to understand the technical systems and the thinking behind the key persons who design these systems.

Having pursued Law as my first degree and furthering my studies in international development and sustainability studies, it was important that I move into an technology University, to be able to conceptualise and design the required epistemic artefact.

The Delft University of Technology increased my understanding of the differences and similarities between disciplines. Importantly, I began to notice subtle distinctions in knowledge construction and transmission, by various disciplines, and its effect on the nature and degree of institutional reflection and change. I now understand the importance and contribution of each discipline and the higher value of inter-disciplinary research.

At the end of my SL research, I concluded that the future of Social Learning (SL) lies in valuing and financially supporting interdisciplinary research, especially when conceptual disciplinary distance exists. There is a wealth of knowledge on institutional change, in various disciplines. However, it is piecemeal. The sum of all the parts provides a rich foundation for catalysing institutional change. The challenge is integrating the available information. Some disciplines are heavily individual-centric, others group-centric and only a few are systems-centric. Additionally, there is a wide range of conceptual distance between disciplines like psychology, law and engineering, and their language and approaches are diverse. Therefore, interdisciplinary research, using the system-based approach, is extremely challenging. To support interdisciplinary research, various disciplines need to understand its value, begin to raise more resources for SL research and dedicate sufficient time to support it.

At the start of my PhD, the project scope was the entire Nile Basin. However, as I advanced in the research, it became apparent that I could only test the solution in a smaller water catchment within the basin, facing similar challenges. Though the research provides insights to address the core problem, within the Nile Basin, I conducted the research in a smaller catchment (Nzoia River Basin). It is my hope that other Nile Basin scholars will continue the research, where I stopped. This may entail upscaling it to the larger basins (Lake Victoria and the Nile), to test the outcomes and provide concrete policy guidelines, aimed at catalysing institutional change.

Abby Muricho Onencan,
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Abbreviations

1.	AC	Adaptive Capacity
2.	ANOVA	Analysis of Variance
3.	CCA	Climate Change Act
4.	CDM	Clean Development Mechanism
5.	COP	Conference of Parties
6.	CSA	Climate-Smart Agriculture
7.	DD	Demographic Diversity
8.	DH	Demographic Homogenous group
9.	DRR	Disaster Risk Reduction
10.	eBRP+	electric Bus Rapid Transit Plus
11.	FAO	Food and Agricultural Organization
12.	GDP	Gross Domestic Product
13.	GHG	Green House Gas
14.	GoK	Government of Kenya
15.	GWP	Global Water Partnership
16.	GWP TEC	Global Water Partnership Technical Committee
17.	ICT	Information, Communication Technology
18.	INDC	Intended Nationally Determined Contribution
19.	IPCC	Intergovernmental Panel on Climate Change
20.	IWRM	Integrated Water Resources Management
21.	KPI	Key Performance Indicator
22.	LUCF	Land-Use Change and Forestry
23.	MANOVA	Multivariate Analysis of Variance
24.	MCM	Million Cubic Meters
25.	MDA	Multiple Discriminant Analysis
26.	MDS	Multi-dimensional scaling
27.	$MTCO^2e$	Million Metric Tons of Carbon Dioxide Equivalent
28.	MWI	Ministry of Water and Irrigation
29.	NAP	National Adaptation Plan
30.	(F/S) NC	First /Second National Communication
31.	NCCAP	National Climate Change Action Plan
32.	NCCRS	National Climate Change Response Strategy
33.	NEMA	National Environmental Management Authority
34.	NWSS	National Water Service Strategy
35.	NZOWASCO	Nzoia Water Services Company Limited
36.	OCHA	Office for the Coordination of Humanitarian Affairs
37.	OSU	Oregon State University
38.	PAD	Personal Attributes Diversity
39.	PAH	Personal Attributes Homogenous group

40.	PCA	Principal Component Analysis
41.	PTS	Propensity to Trust Scale
42.	SA	Situation Awareness
43.	SART	Situation Awareness Rating Technique
44.	SDG	Sustainable Development Goal
45.	SPSS	Statistical Package for Social Sciences
46.	SSI	Shared Superordinate Identity
47.	TFDD	Transboundary Freshwater Dispute Database
48.	TWC	Transboundary Water Cooperation
49.	TWINS	Transboundary Water Interaction Nexus
50.	UN	United Nations
51.	UNFCCC	UN Framework Convention on Climate Change
52.	US	United States
53.	USD	United States Dollar
54.	WASREB	Water Services Regulatory Board
55.	WFP	World Food Programme
56.	WRA(M)	Water Resources Authority (Management)

1. Introduction

1.1. Institutional Change of Complex Socio-Technical Systems

Increasingly, researchers have focused on catalysing institutional change in the water sector to increase reflection, learning and innovation [1-3]. North (1990) [4], (p. 3), defines institutions as "the rules of the game in a society, or more formally, the human-devised constraints that shape human interaction." Water institutions operate within a complex socio-technical system environment. Sheard defines complex systems as [5] (p. 296)

> "systems that do not have a centralizing authority and are not designed from a known specification, but instead involve disparate stakeholders creating systems that are functional for other purposes and are only brought together in the complex system because the individual "agents" of the system see such cooperation as being beneficial for them."

Socio-technical systems emphasise social (actors, networks, organisations) and technical systems, in the design, analysis and systems operation [1]. Transition management research has identified a strong association between social structures comprising of multiple networks of actors, and the technology (construction of dams, irrigation schemes) that these structures develop [1,6].

Research indicates that changes in water institutions occur when there is co-evolution of both the social structures and the technology that is employed to resolve the societal problem [1,7-9]. However, the co-evolutionary development of both the social and technical systems has not been evident in most of the African water institutions [10].

Until recently, most African water institutions adopted "command and control" approaches to water resources management (WRM) [10,11]. These approaches excluded the social structures, and technology had the sole responsibility of controlling nature [10]. The "command and control" approaches were guided by a worldview that decisions should be based on predictable information to make incremental changes to the technical system [11]. This worldview barely considered the ongoing parallel decisions made by established social structures, that impact on the sustainability of the proposed technical solutions [12]. Therefore, humans were separated from nature and scientists had the critical role of addressing water, energy and food issues, through technical interventions [10,13].

An underlying assumption of the "command and control" approach was that nature is highly certain, predictable and can be engineered, through sound science [10,11]. Consider, for instance, the Kenyan water institutions that seek to reduce floods and droughts through the construction of massive dams.

Research shows a disconnect between social structures and technology as people increasingly cultivate, and construct along the river beds, exposing their assets to high flood risks. Moreover, there have been many instances where the dam water was released without any interaction with the social structures. This led to the destruction of crops, buildings, infrastructure and a widespread outbreak of water-borne diseases. Incremental technical solutions have been proposed to address the floods (bypasses or increased storage to retain the flood waters) [12]. However, these short-term incremental technical solutions fail to reflect on the need for long-term oriented institutional changes [14,15].

Research suggests that complex and uncertain societal problems cannot be addressed by technical solutions that rely solely on predictions [12]. Institutions that exclusively rely on predictions, repeat the same actions / habits or practices (also known as routine), with little reflection on the impact of these technological solutions upon the socio-technical system [10,11,16]. Though routine is beneficial for stability and continuity of any institution, it may stifle reflection and any opportunity for change [16]. Consequently, when an institution does not change, it cannot innovate nor adapt to changing circumstances [17].

1.2. Routine and Institutional Change

Institutions consist of explicit formal laws (constitution and Acts of Parliament of a particular Nation State) and implicit informal rules or constraints (norms of behaviour, codes of conduct, conventions, supplementary laws) [18], (p. 154). The operation of two parallel institutions in one system, and the informal institutions exerting more authority than the formal, increases uncertainty and deepens complexity [19,20].

The Nation State including its local authorities are the primary enforcement mechanisms for formal laws and rules. Informal rules are endogenously enforced [20]. Endogenously enforced institutions, in some countries, have stronger authority than the prevailing written laws [19]. When the two parallel institutions are in conflict, the national written law should prevail. However, practice indicates that endogenous institutions may continue to exert more authority and operate parallel to the written laws, thus weakening the influence of formal institutions [19,20]. This complex legal pluralist system operates in some African and Asian states, and primarily affects land and water rights [21-24].

Routine was introduced by Herbert Simon [25] with reference to John Dewey [26] and William James [16], to address the challenge of legal pluralism. Miettinen and Virkkunen [16] (p. 437) define routine as “a stabilised way of

acting." Routine is an antidote to institutional failure [17]. Thus, routine stabilises the system, reinforces continuity, reduces complexity and increases certainty [16]. Routinised institutions limit the cognitive demands for decision-making to established cues, thus, decreasing complexity and uncertainty [27,28]. Routine is a central learning instrument and a useful transmitter of cultures, traditions, and know-how [29].

The impact of routine on organisational learning, continuity, and change, has been a critical concern of neo-institutional organisational studies [30,31]. Routine is increasingly becoming "conservative, rigid and resistant to change" [16]. Routine has led to institutional hardening and the weakening of institutions capacity to adapt [16,32]. John Dewey [26] propose that habits (also known as routine) should operate within a reflexive learning environment to confront permanency and adapt to changing situations. However, the concept of routine cannot satisfactorily explain continuity and change in institutions. It explains recursive social contexts but omits changing cultural contexts, individual agency, and shared moral agency to address water governance challenges [16].

1.3. Triple-Loop and Social Learning

Triple-loop learning has been used by SL experts to assess the level and nature of institutional change [14]. It was derived from the Argyris and Schon [33] double-loop learning concept. I utilise the "triple-loop-learning concept" to understand reflection and change in routinised institutions [12,14,15,34-37]. According to the concept, learning is represented by three loops, single, double and triple [37]. The single-loop denotes "incremental improvement of action strategies and daily routines without questioning the underlying assumptions [12]." The main question actors seek to answer is: "***are we doing things right***" [12,36,38]? If there is flooding, in single loop learning, the actors may correct the dam specifications (increase the height of the subsequent dam) to further reduce flood incidences, without questioning the flood risk management formal and informal institutions [12], (p. 550). Double-loop learning involves reframing issues by questioning the underlying assumptions ([12], (p. 549). The main question is: "***are we doing the right thing***" [12,36,38]? In double-loop learning, actors reflect on how they frame the flood protection assumptions, problems and goals [38]. Deeper reflection occurs at this stage, while the actors question the sustainability or effects of their present practices [12].

The current water discourse has shifted from single to double loop learning [12]. Some western countries have changed focus from "controlling floods'' [34] towards ''living with floods" [12], (p. 550). Reframing (double-loop learning) directs water managers away from increasing water supply to managing water

demand [12,39]. However, there has been little or no advances towards the final loop, where the society is transformed through a change in beliefs, values and worldviews [12], (p. 550).

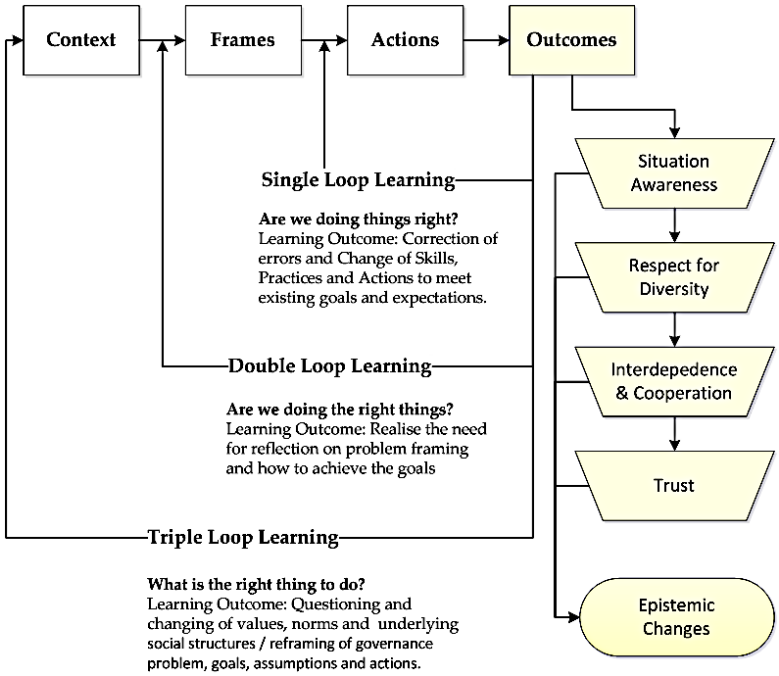


Figure 1.1. Triple-Loop Social Learning Sequence (modified from Hargrove [40])

Triple-loop learning leads to a profound structural change. It involves reconsideration and complete transformation of the prevailing institutions (legal frameworks, norms and rules, and their corresponding multi-actor networks and technical infrastructures) [15]. The main question in triple loop learning is: "***what is the right thing to do***"? The actors move beyond questioning their current practices, structures, values, and norms, towards seeking new actors, practices, regulations, governance structures and values [12,36,38]. Triple loop learning leads to transformation of the present state of affairs to achieve sustainable societal outcomes [12], (p. 550). Despite positive strides from single to double loop learning, there is limited evidence of profound water sector transformation (the final loop) [12].

Social learning (SL) has been proposed to achieve triple-loop learning and facilitate institutional change. SL is "a change in understanding that goes

beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks" [41]. SL scholars argue that the theory has enabled decisionmakers to question, nullify and overcome "stable and difficult-to-change" institutions and support the process of giving more value to natural capital [1], (p. 398). In principle, SL holds a promise in addressing the problem of routinized, non-adaptive institutions. Nevertheless, there is limited evidence on whether SL does indeed lead to institutional change [42].

This dissertation considers whether SL theory can catalyse institutional change. Based on the obtained insights, I recommend strategies that water managers can use to increase SL and catalyse institutional change. In this chapter, I first explain the research problem, objective and outline the research questions. This is followed by the research approach that I undertook. The research approach includes the perspective, key definitions, a typology of SL dimensions, SL outcomes which form the foundation for this dissertation, the methods, and research scope. Finally, I provide a summary of the thesis structure.

1.4. Research Problem and Questions

1.4.1. The Research Problem

Research indicates that SL is still at the initial stages of conceptualization and empirically understudied [43], (p. 1712). Thus, it is not clear whether SL can catalyse institutional change. Most SL empirical studies demonstrate a low engagement with the relevant discipline-related body of theoretical knowledge, especially when conceptual disciplinary distance exists [42]. Moreover, current empirical studies rarely measure learning or provide insights on what techniques may lead to SL [44]. Furthermore, few studies provide specific empirical design elements that may maximize SL, and lead to institutional change [1], (p. 398).

Notwithstanding the broad application of case studies to assess SL dimensions, processes and outcomes, SL as a research object is barely the focus of these studies, especially in WRM [43]. Additionally, few studies empirically and directly assess the epistemic dimension of SL and SL impacts [45-48]. Furthermore, most of the SL case studies and experiments are controlled and fail to offer insights to complex socio-technical systems that involve unexpected events, multiple actors with competing interests and different temporal and spatial scales [1]. As a consequence, there is limited guidance on whether SL

may challenge routine and ultimately lead to institutional change, in a specific socio-technical context.

1.4.2. The Research Question

The main research question is whether SL theory can catalyse institutional change, in the context of the Nzoia River Basin. Internationally, Nzoia River is important because it is the second largest Lake Victoria tributary (after Kagera River) [49]. Furthermore, it is considered a complex socio-technical system, that can realistically be assessed within the research duration. The basin is located in Western Kenya.

SL comprises of three dimensions – cognitive (obtaining new knowledge or restructuring existing knowledge), relational and epistemic [50]. The relational dimension entails an increased understanding of other actors' mind-sets (respect for diversity), trust, and cooperation [47]. The epistemic dimension includes normative epistemology, which is a change in norms, values, paradigms and idea convergence [42].

A climate-change water policy game, known as the Nzoia WeShareIt was designed, to resolve the social problem of hard to change, routinized water institutions. A policy game is defined by Mayer [51] (p. 825) "as experimental rule-based, interactive environments, where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game."

Specifically, the research assessed: (1) whether there was a change in understanding; (2) whether through social interactions, the Nzoia Basin institutions begun to question the underlying assumptions of their pre-conditioned responses, and (3) whether the reflection led to changes in norms, values, paradigms, and convergence of opinions.

To assess SL outcomes, I formulated the following sub-questions:

1. What is the contribution of WeShareIt game to cognitive learning of policymakers in Nzoia Basin?
2. What is the contribution of WeShareIt game to relational learning of policymakers in Nzoia Basin?
3. What is the contribution of WeShareIt game to the generation of epistemic institutional changes?

1.5. Research Approach

SL study in water resources management (WRM) is inherently multidisciplinary, with contributions from civil engineering, policy, research on learning, policy analysis, social sciences, psychology, planning, energy, systems sciences, agriculture and other disciplines [42]. Due to its multidisciplinary nature, it is important that a comprehensive interdisciplinary approach is adopted, to increase the chances of designing an experiment that may catalyse institutional change.

I explain the study approach in six segments. First, I discuss the system-centric approach to SL adopted in this research, then the perspective I adopted to design the policy game, followed by the typology of SL outcomes, the research scope, the method I employed, and finally the application of the research.

1.5.1. System-Centric Approach to Social Learning

This dissertation is positioned within the system-centric field of SL, to comprehend different components of water systems, how they interact with each other and their effects on the whole [52,53]. Of primary importance, to this PhD research is the systems thinking ontological position, that enables SL scholars to engage in action research. This is separate from the ethnographic position, where the researcher disconnects from the system with the sole purpose of remaining independent and not be influenced by the system [54]. The advantage of action as a form of enquiry is the opportunity for the system and the researcher engaging in the analysis to learn by doing. Therefore, systems research drastically transformed the role of SL scholars from independent researchers to active researchers who engage and are changed, through action enquiry [42,55].

1.5.2. The Research Perspective: Epistemic Artefacts

Traditional epistemology's understanding of knowledge offers some insights on how to address the problem of institutional routine. In traditional epistemology, knowledge is symbolically represented. This group of knowledge is known as declarative knowledge; represented by theories, concepts, models, and facts. Therefore, in traditional epistemology, knowledge carriers are symbols. On the contrary, in organisational behavioural theories, knowledge is defined by competencies. The carriers of competencies are established ways of action, also known as routine. Symbols are adaptive to change; they are disconnected from the real world, creating a safe distance for objective inquiry, reflection, adaptation, and change. Routine is part of daily action and devoid of

objective inquiry and change. Competencies are synonymous to computer programs, with automated decisions, based on sequential steps. Routine provides limited room for reflection and change [16]. The starting point of institutional change is replacing competencies/routine, as knowledge carriers, with symbols [16,56].

In 1997, Rheinberger [56] introduced the concept of epistemic artefacts to challenge routine. Epistemic artefacts "are open-ended projections oriented to something that does not yet exist, or to what we do not yet know for sure" [16] (p. 438). Epistemic artefacts are an object of inquiry and have predictive value. Thus, users can generate new ideas and information. These innovative ideas may result in a change of traditions, norms, values, and beliefs.

One unique characteristic of an epistemic artefact, compared to a technical artefact, is its ability to incorporate unexpected events [16]. Rheinberger [56] distinguishes technical objects that exhibit permanency, and clearly defined, replicable and black boxed institutional rules with the open-ended epistemic artefacts. In an experiment, technical objects are defined and inflexible, whereas epistemic objects are open-ended and adaptable to unexpected events.

Construction of epistemic artefacts to solve a social problem is an emerging area of research [16,56,57]. While the epistemic artefact concept is designed to improve experimentation in natural sciences, Miettinen and Virkkunen [16] suggest that it should also analyse routine. The analysis entails making critical routine aspects the objects of inquiry, thus creating an enabling environment for innovative and unconventional ways of acting.

I designed a climate-change water policy game known as Nzoia WeShareIt, as an epistemic artefact, to address the problem of non-reflexive institutions [16,56,57]. The game consists of multiple rounds with unexpected events. For instance, the first three rounds support routine, leading to repeated actions, and in the fourth round, an unexpected event (drought) is introduced. The drought reduces the player's resources to half. Through the game, I assessed whether the disaster supports SL. Moreover, the game predicts possible future changes in norms, values, and paradigms, based on the observed changes.

1.5.3. Typology of Social Learning Outcomes

The typology of SL outcomes forms the foundation for this PhD research with its genesis from the SL theory. Early conceptualisation of SL theory by Bandura [58] focus on change in individual understanding as a result of observation of people's behaviour and experiencing direct reinforcement. Vygotsky [59] also supports the view that the change in cognition occurs in individual learners as they interact with their social environment. According to Garmendia and Stagl [43], in the initial conceptualisation of SL, the learner is the

individual, while later schools of thought refer to collective learning by "social aggregates."

There is no shared definition for SL, with various proposed definitions and emerging scholarly debates [10,41,46,60]. SL scholars agree that learning occurs through social interactions, in collaborative/deliberative settings. In these collaborative settings, multiple actors, build relationships, while interacting adaptively and interdependently, towards the achievement of a shared goal [35,37,43,45,60-69]. The learning is collaborative and leads to a change in action, attitude, belief, capacity or skill of the social group [12].

Despite not having a generally accepted definition, common elements are increasingly emerging from the diverse perceptions of SL [41,45,65,70]. These common elements of SL are:

1. *The Change:* There is a change in understanding;
2. *The Mode:* The learning happens in the course of societal interactions in deliberative settings; and
3. *The Scale:* This form of learning may start at the individual, network or group setting, but must eventually situate in broader societal units [41]."

Brymer et al. [50], conceptualise SL to comprise of three dimensions (cognitive, relational and epistemic). Cognitive learning occurs when new knowledge is obtained, or existing knowledge is restructured [47]. Relational learning is defined by Baird [47] as improved understanding of other actors mind-sets, increased trust, and enhanced cooperation (please refer to Table 1.1 for the definitions of these SL outcomes). Many WRM SL scholars, agree that relational learning refers to increases in trust, cooperation, interdependence and respect for diversity [12,15,35,37,45,50,62-65,67,68,71,72]. Garmendia and Stagl [43] conceptualise the epistemic dimension of SL to consist of normative and moral components. Normative epistemology is experiential, collective (group/ network/system centric) changes in belief, action, attitude, capacity or skill [12]. According to Brymer et al. [50], the epistemic dimensions comprises changes in ways of knowing and rationalisation of knowledge and validity. den Haan and van der Voort [45] equate normative epistemology to changes in values, norms, paradigms, and a confluence of opinions.

Table 1.1 is a typology of the SL outcomes, which form the basis for this dissertation. I adopted the typology of SL outcomes from Baird et al. [47], Brymer et al. [50], and den Haan and van der Voort [45]. Furthermore, Table 1.1 contains the definitions of all the SL outcomes (Situation Awareness (SA), Diversity, Trust, Team Interdependence, Cooperation, and Epistemology). Table 1.1, also, contains a description of the variables that I used to measure the SL outcomes and the data collection methods, that I employed.

From the typology, I extrapolated five SL outcomes, as the theoretical basis for the empirical research. The cognitive dimension focuses on SA theory to

design the assessment framework. The relational dimension focuses on theories related to Diversity, Trust, Interdependence, and Cooperation to design the respective assessment frameworks. The epistemic dimension focuses on overall changes in epistemic cognition and normative epistemology (change in norms, paradigms, values, and convergence of opinions) [45,47].

Table 1.1. Typology of SL outcomes

Modified: Baird et al. [47], Brymer et al. [50] and den Haan & van der Voort [45]

	SL Outcomes	**SL Outcomes Defined**	**SL Variables**	**Data Methods**
Cognitive Dimen.	Situation Awareness	The "perception of the elements in the environment […], the comprehension of their meaning and the projection of their status in the near future" [73].	• Knowledge of values, beliefs, practices, and facts. • Understanding of the core problems' driving factors • Knowledge of alternate solutions	pre and postgame questions In-game data
Relational Dimension	Diversity	Distribution of demographic attributes (age, racio-ethnicity, sex, education level) and underlying personal attributes (values, cognitive, functional, personality, capabilities, knowledge) [74].	• Perception of other actors • A deeper understanding of other actors' mindsets • Increased understanding of the benefit of diversity	pre and postgame questions In-game data
	Trust	A trusting relationship occurs when the trustor (A) possesses "definite feelings of assurance and hope that the trustee (B) will act in the trustor's favour to do X and not take advantage of the relationship to the detriment of the trustor" [75] (p. 1).	• Expression of trust • Trust formation • Enhanced trust • Trust sustenance	pre and postgame questions In-game data
	Interdependence	Degree in which a state or a devolved government interacts adaptively and interdependently with other riparian states or governments who share a water resource, to jointly and sustainably manage the shared water resources [76-78].	• Identification of prospects for joint actions • Niche development • Establishment of relationships	pre and postgame questions Debriefing In-game data Session videos
	Cooperation	The voluntary act by two or more riparian governments to jointly engage in an exchange which benefits all parties through the sharing of river basin water resources, and the creation of new resources or both [79].	• Shared Goal • Collaborative relationships • Enhanced cooperation • Changes in social network structure	postgame questions Debriefing In-game data Session videos
Epistemic Dimension	An overall change in epistemic cognition	A change in understanding of "the beliefs people hold about the nature of knowledge and knowing and the application and influence of such belief when considering scientific and socio-scientific everyday problems [57]."	• Ways of knowing • Changes in the rationalisation of knowledge & validity	Debriefing Observations
	Changes in Normative Epistemology		• Norms change • Paradigm change • Values change • Converging of opinions	Session videos In-game data

In this dissertation, I adopt the triple-loop learning stepwise process, where the policymakers, through the game, move sequentially from the single-loop (incremental actions to improve existing routines), to the double-loop (questioning underlying assumptions, change of mind-frame, and reframing of the issue), and finally to the triple-loop (abandon routine and make institutional changes) [40]. The sequential steps start from questioning the policy actions, then mental models, and finally the institutional context (Figure 1.1). I adopted the triple-loop learning concept because it incorporates the third loop, which is essential for assessing epistemic institutional changes. In addition, it is a simple approach that measures the external change in understanding, which is easier to evaluate than internal learning. The learning cycle leads to three main outcomes, cognitive, relational (diversity, cooperation and trust) and epistemic changes. I assess epistemic changes as both outcomes and impacts.

SL research acknowledges the difficulty of measuring the internal change in understanding [37]. Reed et al. [41] explain that the change in understanding is distinct from the SL outcomes and processes and should not be confused or intermingled with the process and outcome. Therefore, positive SL outcomes do not automatically lead to a change in the group's understanding which eventually gets situated in the broader social context. Reed et al. [41] further explain the existence of extenuating factors that may contribute to the observed positive outcomes. Thus, there are three main assumptions I made in this dissertation. First, there were no extenuating circumstances, and results were solely due to the introduction of the epistemic artefact. Secondly, I assumed that SL outcomes automatically led to SL. Thus, I adopted Medema et al. [37], (p. 2) approach of identifying common SL outcomes, where the detailed analysis mainly assesses external factors that have generally been accepted by SL experts as "tangible substitutes." Tangible substitutes equate the observed SL outcomes to SL, even though the two are different. Thirdly, I assumed that what the policymakers learn in the game environment may eventually diffuse to the wider Nzoia river basin [45,51,80]. Based on the assumption, I conceptualised the policy game as a transient object that catalyses SL and enhances the realisation of SL outcomes [45,80].

1.5.4. The Research Scope

I selected a small study area, the Nzoia River Basin, instead of the original Nile Basin, due to practical, time and financial constraints. One key selection criterion is the ability of the smaller basin to exhibit similar complexity as the larger basin. This criterion ensures that the study outcomes are scalable to the larger basin.

Nzoia basin is approximately 12,900 km² [81]. The source of the Nzoia river is Mount Elgon and Cherangani Hills [82]. The Nzoia River is shared by six county governments: Bungoma, Busia, Kakamega, Trans Nzoia, Siaya, and Uasin Gishu [83]. The basin is divided into lower, middle and upper Nzoia sub-catchments (Figure 1.2), and is home to one of the major forests and protected nature zones, in Kenya.

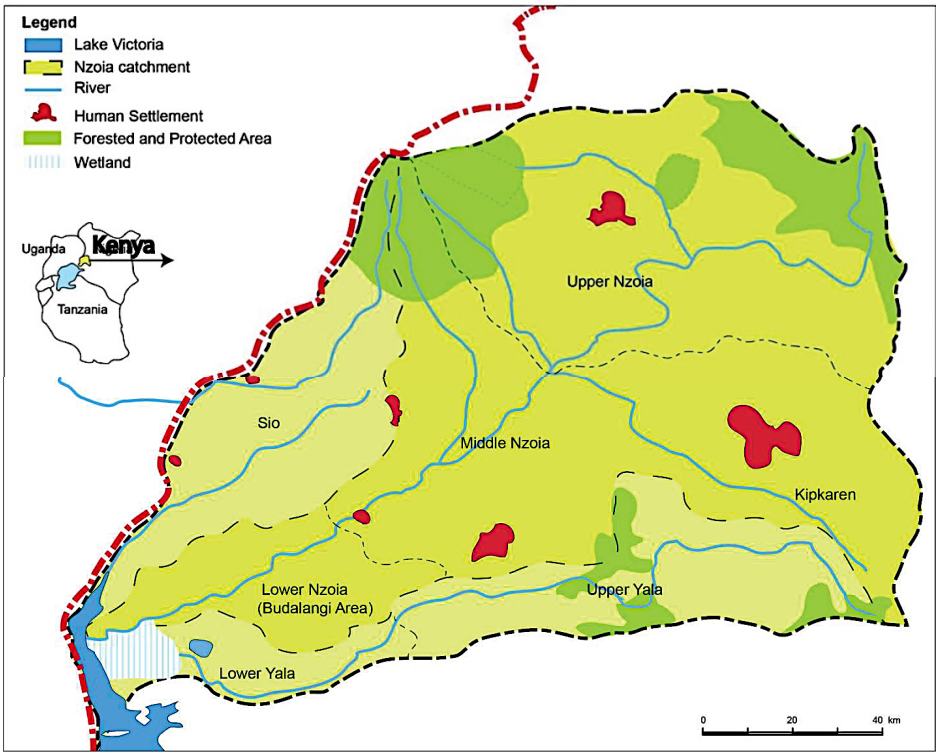


Figure 1.2. Map of Nzoia River Basin in Western, Kenya. Source: Balica (2012), [84]

Several Nzoia river basin climate-change models confirm increased rainfall by 2050 [85] and project an increase in base flow and runoff [86-88], and temperature [85,86]. Thus, the incidence of future droughts and floods is high [85,89]. Floods destroy crops, buildings, homes, infrastructures and pose a threat to human life, and livelihoods [89]. Droughts lead to increased food and water insecurity [90]. Moreover, the basin's natural resources are currently under extreme pressure due to high human population [85,91]. Additionally, the high dependence on rainfed agriculture increases community vulnerability [91]. Community vulnerability is heightened by the highly seasonal river that

depends on rainfall recharge [85]. Studies indicate that changes in rainfall, runoff, base flow, and temperature, will not affect the seasonal patterns [85].

Nzoia River Basin is susceptible to climate-change induced floods and droughts [85,86]. Floods affect the downstream riparian county governments, Busia and Siaya, mainly in the Budalangi floodplains. Also, the other downstream and middle stream counties, living and farming along the riverbed, experience regular floods [92]. Despite increased run-off in rainy seasons, the area is susceptible to droughts in the dry seasons, due to high temperatures and limited storage capacity [85].

1.5.5. The Research Method

Policy gaming is the select research method. There is an increasing interest in using policy games to enhance SL in WRM [37,45,72,93,94]. Policy games are designed to inform policy, through research, the democratisation of a process, mediation, clarifying values or arguments, training, education, awareness raising or testing upcoming policies [45,80,95-97]. I selected to use gaming as an research tool, because games can incorporate, in the policy arena, the strategic interactions of multiple actors within a simulated complex system. The complex system comprises of socio-political and techno-physical systems. Furthermore, games can harness the power of role play and real-time feedback mechanisms [37,45,51,93,98]. Since SL is catalysed through learning-by-doing, games facilite this process through step-wise actions that induce interaction and experiential learning. During the game sessions, policymakers deliberate, communicate their values and arguments and mediate any arising conflicts. Also, games provide a safe environment to make tradeoffs and test planned policies and actions [45,51,98]. Additionally, a game provides opportunities for relationship-building, trust-formation and joint action [37,45,94].

The game is designed to take decision makers through several rounds. A session comprises of a maximum of eight rounds. The rules remain the same for the first three rounds to establish and reinforce routine. The main routine is managing the water resources using past actions (unilateral actions) and allocating water for food, energy and nature with the sole aim of meeting the needs of county government residents. However, after the third round, routine is interrupted when an unexpected event is introduced – a slow-onset, climate change induced disaster. This unexpected event is presented to catalyse reflection. Interruption of routine enables decisionmakers to question, nullify and overcome routinised institutions and support the process of change.

After the game sessions, I used the game data, to assess cognitive, relational and changes in epistemology (changes in norms, paradigms, values and/or converging of opinions).

1.5.6. Research Application and Assessment

I initiated the research in September 2013 (Figure 1.3). The initial needs assessment was conducted between September 2013 and September 2014. In this period, I received a grant from BothENDS to conduct a Nile Basin scenario construction workshop. BothENDs is a non-governmental organisation with offices in Amsterdam, the Netherlands, that promotes learning, aimed at transformative changes, in WRM institutions, with a special focus on developing economies. I used the grant to conduct the initial research activities that culminated in the production of Nile Basin by 2050 scenarios.

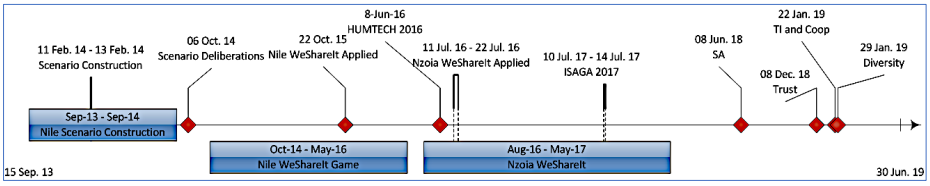


Figure 1.3. Research Timeline

The Nile Basin scenarios were presented to over 400 participants and Ministers of water during the Nile Basin Development Forum (NBDF) in October 2014. The recommendation from the eleven Nile Basin Ministers of water was to develop tools and methodologies that enhance trust and support cooperation. Based on the recommendation; the Nile WeShareIt water policy game was developed (October 2014 to October 2015). The Kenyan Ministry of Water and Irrigation played Nile WeShareIt, on 22 October 2015. The Ministry suggested customisation of the epistemic artefact for a smaller basin, in Kenya.

Consequently, Nzoia WeShareIt was developed between November 2015 and July 2016. Nzoia WeShareIt was played with participants from four county governments in July 2016, in seven game sessions. The data collected during the game sessions formed the basis for the four publications that assess the contribution of the policy game to SL outcomes.

The empirical bases of this dissertation are: in-game data, pre-game data, post-game data, session observation notes, and the debriefing session notes. I collected the data from a total of seven sessions conducted in four county governments (Bungoma, Busia, Trans Nzoia and Kakamega). The period of data collection is July 11 – 22, 2016. The Nzoia WeShareIt game is inspired by the original Nile WeShareIt game, which I designed for the Nile river basin where different upstream and downstream countries had to negotiate to earn 'happy faces' [86-88,90,99,100]. Later, I customized WeShareIt for Nzoia river basin [88,89,100].

1.6. Structure of the Thesis

I first provide background information on floods and droughts in the Nzoia River Basin. Then I conduct a literature review of three core theories underpinning this research: Institutional Change, SL and policy gaming (Chapter 2). Since the thesis is based on paper publications, I present the methodological part of the published papers and the Game Design Concept Report [88] in Chapter 3. After that, I present a set of papers (Table 1.2) that assess SL outcomes, in Chapter 4 – 7.

Chapter 4 assesses the contribution of the experiment to the cognitive dimension of SL, through the use of SA theory. Chapter 5 to 7 assess the relational dimension of SL, starting with respect for diversity (Chapter 5), then team interdependence and cooperation (Chapter 6) and finally Trust (Chapter 7). The four papers are published in peer-reviewed, open access, scientific journals.

Table 1.2. Overview of the chapters on SL outcomes and journal publication details.

Ch.	SL Dimension / SL Outcome	Title of Publication and Citation	Author, Year, and Citation
4	Cognitive/ Situation Awareness	From Paris Agreement to Action: Enhancing Climate Change Familiarity and Situation Awareness	AM Onencan, and B. Van de Walle (2018) [86]
5	Relational / Respect for Diversity	Influence of Personal Attributes and Demographic Diversity on Nzoia Basin Negotiation Outcomes	AM Onencan, B. Enserink, and B. Van de Walle (2019) [101]
6	Relational / Team Interdependence and Cooperation	Sustainability Indicators: Monitoring Cross-County Water Cooperation in the Nzoia River Basin, Kenya	AM Onencan, B. Enserink, and B. Van de Walle (2019) [102]
7	Relational / Trust	A Study of Trust and Cooperation in the Nzoia River Basin Using a Water Policy Game	AM Onencan, B. Enserink, and B. Van de Walle (2018) [103]

Finally, I provide a synthesis of the thesis and a reflection of the research work (Chapter 8). Chapter 8 also contains an analysis of the epistemic dimension based on the identified changes in players rationalisation of knowledge and their values and arguments. Epistemic changes, whether normative or otherwise were measured in all the four papers. Later in Chapter 8, I discuss whether the climate change game had any influence on epistemic learning and how this information can inform research, policy and practice.

In summary, the research findings presented in this dissertation comprise of four parts (Figure 1.4): (1) an analysis of the core theoretical framework within which the entire research is embedded with a focus on SL and policy gaming; (2) the process and content of designing the conceptual framework for the Nzoia WeShareIt epistemic artefact; (3) testing the epistemic artefact with identified cognitive, relational and epistemic SL outcomes; and (4) a synthesis of the thesis and reflection on the value of using an epistemic artefact to catalyze SL within the Nzoia River Basin.

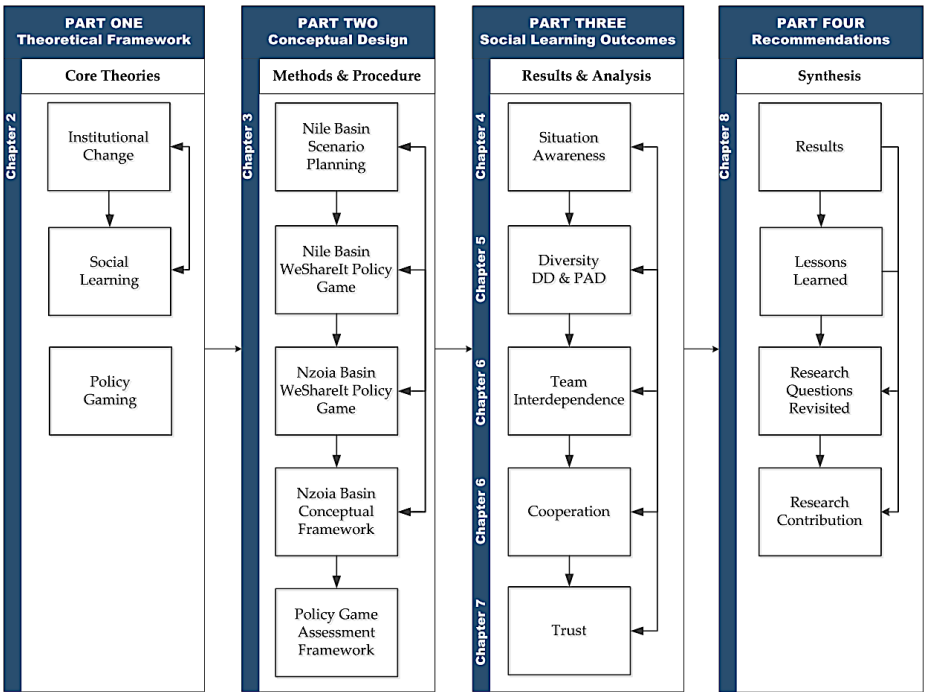


Figure 1.4. The Outline of the Research

The results provide information on measuring SL outcomes, that form a foundation for further discussions. An emerging discussion that was not within the scope of the research is whether the identified change in understanding by the small case study eventually diffused to the broader community. Chapter 8 discusses some of the proposed future research areas that SL scholars should consider. Overall, this dissertation generates useful insights for water experts interested in catalysing institutional change, and contributes to empirical analyses of current SL interventions.

2. Positioning the PhD Research

This chapter consists of four parts, The first part provides background information on drought and flood management in the Nzoia River Basin. In the next part, I explain gradual institutional change theory, the challenge posed by stable routinized institutions, the institutional change paradox and modes of institutional change. Thereafter, I discuss the SL discourse and the discipline related boundary spanning challenges. Finally, I review SL water games and identify the research gaps from these studies.

2.1. Drought and Flood Management in Nzoia River Basin

2.1.1. The Nzoia River Basin

Kenya is one of the thirteen countries that lie along the equator, thus experiences half days (12 hours) and half nights (12 hours), throughout the year [104]. It also has diverse temperature zones, depending on the location. The highlands (especially near mountain Kenya and mountain Kilimanjaro) are cooler and greener on the windward side, whereas the leeward side is extremely hot and dry. The Northern part and coastal regions of the country (near Lake Victoria, Lake Tana, Lake Baringo, and the Indian Ocean), experience extremely high temperatures throughout the year. The eastern and western parts of Kenya, have a moderate climate, thus, most farming is conducted in these parts of the country [84,105].

The Nzoia River Basin is characterized as mainly flat in the lower sub-catchments, and steep and hilly in the middle and upper sub-catchments [84]. The river is highly seasonal with discharges varying from 1583 Cumecs in the short-rain season (October – December) and 2405 Cumecs in the long-rain season (March – May) [105]. Its major tributaries consist of: Ewaso Rongai, Little Nzoia, Kuywa, Koitogos (Sabwani), Kibisi, Moiben and Kipkaren [84]. The climate is generally characterized as tropical-humid. There is lesser rainfall in the lower Nzoia sub-catchment [84,105] (mean yearly rainfall - 1076 mm) compared to the basin highlands (mean yearly rainfall - 2235 mm) [84]. The basin's annual average rainfall ranges between 1120 mm and 1980 mm [105]. The Nzoia River Basin annual precipitation volume is approximately $1740x10^6m^3$. The highland is cooler (mean temperature of 16°C) whereas the lowlands are warmer (mean temperature of 28°C) [84]. Research indicates that the Basin has a vast and untapped hydropower potential, in the upper and middle sub-catchments [105].

The largest water use, in the basin, is agriculture. Basin residents mainly conduct small scale farming, where they grow multiple food and cash crops. The main food crops are maize, millet, sorghum, beans, groundnuts, cassava, sweet potatoes, and bananas. The main cash crops are sugarcane, horticultural crops, sunflower, rice (especially in the lower sub-catchment in Budalangi area), coffee and tea [85]. The current basin challenges are deforestation (especially in the highlands), flooding (mainly in the lower sub-catchment), degradation of the wetland, sedimentation and soil erosion [84].

2.1.2. Nzoia River Basin Climate Change Predictions

Globally, the Intergovernmental Panel on Climate Change (IPCC) projects increases in near-surface mean air temperatures [106]. Furthermore, climate variability will intensify, and increase the severity of droughts and floods. River Basins like the Nzoia, will be largely affected, due to poor land use practices, deforestation, intensive cultivation along the river plains and construction of houses, public amenities and infrastructure in flood and drought prone areas [85]. The IPCC also projects changes in runoff and water availability due to variability in evapotranspiration and precipitation [106].

According to climate change predictions, Kenya will experience a mean annual temperature increase of between 0.8 °C and 1.5 °C, by 2030. The predicted increase of mean annual temperatures, by 2060, is between 1.6 - 2.7 °C [107], and by 2011, a further increase up to 4 °C [108]. In addition, there will be an increment in the frequency by 19–45% and 45–75% of hot days and nights, respectively. The increase in hot days and nights will lead to a subsequent decrease in "cold" days and nights [92,107].

The 2015 Government of Kenya (GoK), Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC) states that: "cold days and nights are expected to become very rare" [107] (p. 4) and there will be a change in rainfall. Coffee, tea and horticultural crops, require cold climate zones, especially tea. Therefore, the change from cold to hot days will immensely affect the cash crop industry, with tea being the most affected. Nzoia basin also produces coffee, tea and horticultural crops, and thus will be affected. In addition, the increase in hot days may lead to reduced water and rainfall. Reduced water availability will largely impact the agricultural sector, that heavily relies on rainfall, and rivers that depend on rain recharge. Unless enough water is stored during the rainy season, there might not be sufficient water for domestic, industrial and other uses during the prolonged dry spells. The climate change projections also reveal that the increase in hot days will affect the lowlands more than the highlands [85]. Therefore, the lower

Nzoia sub-catchment is more susceptible to droughts during the prolonged dry spells.

The percentage of rainfall change is unknown due to disagreements between various climate change models [81,92,107,109]. The change in rainfall is projected to range between a decrease of 5% to an increase of 17% by 2030. The most significant increase will be in the months of October to December, and by 2060 there will be a 26% increment in rainfall [107]. The Government of Kenya (2015) report, affirms the rainfall increase, during the short rains (March and April). The increase will primarily affect the western Kenya region, including the Nzoia River Basin, leading to flooding and other climate change-induced disasters [107,110].

2.1.3. Impact of Nzoia River Basin Floods and Droughts

Residents of the densely populated Lake Victoria basin "live under constant threat of flooding every year" [92], (p. 111). The most recent flood occurred in 2018. According to the Kenyan Red Cross [111], the 2018 flood led to 7,161 families losing their houses and being internally displaced in 39 county governments. Within the 39 affected counties were two Nzoia River basin downstream county governments (Busia and Siaya) [112]. The Office for the Coordination of Humanitarian Affairs (OCHA), report 72 deaths, 33 injured and at least 211,000 persons were internally-displaced by the 2018 floods. The floods also led to massive economic losses, disruption of livelihoods, deformation of houses, infrastructures were damaged (roads, schools and health facilities), submerging farms (more than 8,450 acres) and drowning of 6,000 cattle [113].

In 2006, the floods near the Lake Victoria killed one thousand people (260 in Kenya) and displaced approximately 850,000 persons in East Africa (300,000 from Kenya). Amongst the 300,000 displaced persons, 250,000 needed emergency relief. The 2006 floods led to 400 million USD million loss in property in East Africa (250,000 for Kenya alone). Most of the affected persons were from the downstream counties in Nzoia Basin [89,92]. Prior to the 2006 floods was the 2005-2006 droughts that led to massive losses of livestock, and wildlife, thus significantly impacting on the tourism sector [114].

The prolonged 2008 - 2011 drought led to a famine in Somalia and the Coastal and Northern part of Kenya [111]. The World Bank [109] report that the 2008 - 2011 drought costed US $ 12.1 billion, destroyed durable and physical assets worth US $ 805.6 million, US $ 11.3 billion economic losses and, 0.6 % decline in Gross Domestic Product (GDP). Evidence shows that Nzoia River Basin is prone to seasonal droughts. Furthermore, humanitarian assistance to Kenya for the 2008 - 2011 drought costed US $ 276 million, per annum [109].

Nzoia data on the impacts of flood and drought, is scarce [84], (p. 83). Moreover, drought is more nuanced than floods leading to less national focus on the collection of data. Currently, drought impacts are mainly quantified in terms of damage to infrastructures [109], and less on the socio-economic impacts [84].

Water is the most affected sector, during the drought and flood events. For instance, the 2008 – 2011 drought damaged transmission systems, pumping units, storage facilities and sanitations structures worth US$773 million [109]. The Nzoia River Basin Community Flood and Drought Management Committee (CFDMC) was instituted, to manage the recurrent droughts and floods [115].

2.1.4. Weak Adaptive Capacity of Kenyan Water Institutions

Based on the 2015 GoK SNC to the UNFCCC [107], and the 2018 World Bank report [109], Kenyan floods and droughts are predictable. Every 10 years there is a major drought, and in every three or four years there are moderate droughts and floods. Furthermore, climate change projections confirm that there will be increased floods and droughts [81,92,107,109]. Compelling past evidence and climate change projections confirm that the region is highly prone to slow-onset disasters, that can be managed [92,108,109,116]. However, the Disaster Risk Reduction (DRR) institutions are still at the single loop learning stage. Even though past interventions are not working, relevant DRR institutions adjust the parameters of past actions and repeat the same actions without questioning previous assumptions and beliefs.

Consider, for instance, the 2016 Water Act [117] calls for three flood and drought management actions. First, to control the flood, public water works should be developed. Second, strategic interventions for water emergencies, should be implemented during the drought seasons. Third, flood mitigation regulations, standards and procedures, should be formulated. These three proposals heavily focus on hazard reduction, to resolve the flood and drought challenges. Moreover, the Kenya Water Resources Authority National Master Plan 2030 [118], mainly proposes technical solutions (dams, storage facilities, and bypasses), to address the frequent floods and droughts challenges, with limited focus on strengthening climate change adaptation.

Adaptive capacity (AC) is proposed to effectively address floods and droughts [12]. Phoung [61], (p. 1) define AC "as the ability of people and institutional systems to cope with incremental and rapidly changing conditions." Kenyan disaster events leave no evidence of improved AC by institutions and the actors [89]. Despite numerous DRR solutions, disaster losses have significantly increased [109]. Kundzewicz et al. [119] explain that even though globally rivers have been tamed, the community's AC was not

enhanced, and the community's assets were constructed in exposed areas (flood plains or drought prone areas). Mugambi [116], (2) explain the weak Kenyan AC problem:

> "some disasters are so common in the country such that one can almost predict their occurrence with precision. What of the annual flooding in the Budalangi area of western province, the Nyando plains of Nyanza province and the droughts of the north-eastern parts of the country among others. Incidentally, such common forms of disaster have tended to catch the government unaware. This is a clear cause for alarm because when the unfamiliar disaster strikes, it is difficult to fathom the kind of confusion it can cause to both the government and other actors."

Instead of building AC to address the core problem, government actions continue to focus on hazard reduction. After every flood and drought event, the government increases investments in dams to further reduce incidences of floods and droughts. Most of these disaster events have left the Nzoia River basin institutions and residents more vulnerable than before, and their AC is worsening.

In addition, little coordination of sectoral projects and programmes has led to non-alignment of adaptation and DRR interventions. The Water Services Regulatory Board (WASREB) 2016/2017 Impact Report, explains the challenge of non-alignment of climate change adaptation measures and proposes technical solutions [120], (p. 31). The non-aligned climate change commitments include:

1. *Increased solar, geothermal and wind energy production* [121,122]. There is still more focus on increasing hydro-electric production, through the construction of larger dams.
2. *Improved resource and energy efficiency* [121,122]. Water Service Providers (WSPs) use inefficient energy sources to extract, store and distribute water resources [86,89,91]. Poor land practices have led to dam siltation, thus reducing the efficiency of most dams [120], (p. 31).
3. *Increased tree coverage (more than 10% of land mass)* [121,122]. Water Resources Authority National Master Plan 2030 [118] barely focuses on flood protection through the increase of tree coverage. The master plan's primary focus is the construction of water infrastructural projects. As the Government is constructing more water infrastructures, the commercial sector is encroaching the water towers, unencumbered, thus threatening their sustainability [120], (p. 30).
4. *Improved waste management* [121,122]. Kenyan citizens are polluting the rivers due to poor waste management policies and practices. Moreover, inadequate sewerage infrastructure has led to further pollution of rivers [120], (p. 31). River pollution has increased water scarcity due to less safe water. In addition, poor waste management has blocked the river waterways, leading to flooding.

The availability of climate change information has not translated into joint action in the Nzoia River Basin, due to two main reasons [91]. First, past actions (routine) still dominate future decision-making [123], (pp. 94-105). Nzoia policymakers use the past to reduce complexity leading to repeated actions, based on ascertained previous outcomes. The use of history to reduce complexity solves the social dimension dilemma of discounting unknown plausible futures with the time dimension (the familiar past) [124] (p. 23). However, the practice of replacing the current social complexities with the past circumvents the social process of constructing meaning of the present and future uncertainties like Climate Change. Repeated actions rely on the familiar world (the past) and assume that the already established familiarity will endure into the future, unchanged [123], (pp. 94-105). Climate-Change is creating deeper complexities and increasing uncertainty levels, and the familiar past will not be able to solely solve future challenges. The second challenge is the lack of alignment between sectors, due to limited institutional capacity.

2.2. Endogenous and Exogenous Institutional Change

2.2.1. Abrupt and Gradual Institutional Changes

Once an institution is established, it can either abruptly change or undergo gradual and subtle changes over long durations of time. Consider, for instance, the Kenyan 2002 Water Act [125] was completely overhauled in 2012 [126], and later in 2016 [117]. However, between 2002 and 2016, there were numerous changes that did not replace the law that is in force, they amended (supplementary) or added (regulations), to the existing Water Act. Changes to formal institutions are codified (written). Codification, facilitates tracking of institutional changes over time. However, changes to informal institutions are nuanced, and may go unnoticed for long periods of time.

Transformative institutional changes can be slow and incremental or abrupt. Mahoney and Thelen [127], (p. 2), explain that incremental institutional changes may lead to transformations. The theory of gradual institutional change was developed because there was a noted gap in explaining transformations that develop gradually over long periods of time. Mahoney and Thelen [127], argue that before the theory of gradual institutional change, there was a comprehensive body of knowledge on institutional formation and abrupt institutional change. They further argue that the theory of gradual institutional change was formulated to address progressively slow transformations. Most institutional research work's emphasis is on exogenous changes that lead to

abrupt institutional changes. The theory of gradual institutional change stresses the importance of endogenous actions that incrementally lead to institutional changes. In this dissertation, I assessed whether the Nzoia Basin (through Nzoia WeShareIt policy game) experienced both exogenous and incremental institutional changes.

One of the rationale given for more emphasis on abrupt transformative institutional changes, is the incongruency between the time taken for incremental institutional changes (long-term) and research project duration (short-term) [127]. However, new insights in path dependence literature indicate the need for further analyses on endogenous institutional changes [4,128-135]. Mahoney [131] assert that self-reinforcing "lock-in" phenomena, is rare. The rareness of path-dependence phenomena, explains the possibility for gradual institutional change [127]. Thus, most of the changes experienced, are as a result of gradual institutional transformations, and few can be attributed to abrupt changes. Pierson [135] characterizes institutional causal processes as slow-moving, which further justifies that most institutional changes are incremental and slow. Streeck and Thelen [136], provides a typology of gradual institutional change patterns. Mahoney and Thelen [127] build on the established classification by locating the institutional change sources, and providing the foundation for the theory of gradual institutional change.

2.2.2. Stability, Exogenous Shocks and Institutional Change

Mahoney and Thelen [127] explain that leading institutional analyses insufficiently explain institutional change [127,137]. The diverse definitions of an institution, all denote some form of stability and permanency. Stability is considered the enduring nature of an institution and is essential for structuring human behaviour. Stability supports continuity; thus, most neo-institutionalists studies focus on explaining and supporting continuity, with little attention on change [127]. One major assumption is that: current practices and habits need no transformation. Thus, neo-institutionalist studies barely focus on the emergence of new institutions [16]. Notwithstanding limited focus on change, leading institutional analyses approaches explain institutional change, in different ways.

Rational-choice institutionalists perceive institutions as societal mechanisms aimed at coordinating action, and sustaining equilibria [138-140]. Therefore, each player's action is the best choice, leading to the sustenance of a self-enforcing institution [141,142]. Since rational-choice theory is self-enforcing, and focuses on logical reproduction (through routine), it leaves no room for conceptualizing gradual institutional change. The only envisaged change is exogenous [127]. An emerging branch of rational choice studies perceives the

final abrupt change as a sum total of gradual changes – thus redefining certain exogenous parameters into endogenous variables /quasi-parameters [141]. However, it is not clear how exogenous changes can be distinguished from endogenous quasi-parameters, and the causal loops that led to the final change [127]. Therefore, rational-choice institutionalists approach fails to comprehensively explain endogenous institutional change [127,143].

Sociological institutionalism provides an important body of knowledge, especially on informal institutions. Routine and self-reproduction are recurring institutional themes. Therefore, institutions naturally resist change that counters their self-reproductive nature. Reproduction may occur through socialization or cognitive programming – and underlying assumptions are rarely questioned [144,145]. Sociological institutionalists advance the concept of pervasive reproduction across domains, leading to the production of "isomorphic" new organizations [146]. Therefore, no matter where the actors are situated, they use "existing scripts" [127] to reconstruct the same institutions, in a new organization [31,147]). Thus, stability, pervasiveness, preservation and continuity of an institution have a strong basis in sociological institutionalism theories. However, these body of fails to explain transformation, change, and innovation, except through exogenous actions or forces [30,148,149]. Sociological approach to institutional change fails to account for human agency in routine change. It does not consider the contribution of humans to routine change (subjective reasoning, moral considerations and future-oriented perspectives), [16].

Historical institutionalists also focus on continuity with little attention on change. Pervasive institutional practices, norms and routines over long stretches of time, is the foundation of this body of knowledge [131,134,135]. Institutions, according to historical institutionalists, are born from historical power-political struggles. Therefore, since they were born out of power struggles, institutions are maintained by power until there is a historical "critical juncture," where the rules or constraints are lifted, thus creating room for change [150]). Historical institutionalists provide detailed analyses of structure versus agency; structure is more prevalent in stable political periods. However, when there is a "critical juncture," stability is interrupted, thus creating space for agents to steer historic institutional change [151]. Historical institutionalism storyline is based on persistence and continuity, until an institution faces a moment of weakness when "enduring historical pathways are periodically punctuated by moments of agency and choice" [127]. Historical institutionalists also focus on exogenous institutional changes and limit institutional change to a complete, abrupt replacement of one institution with another, providing no explanation for endogenous institutional changes.

In summary, neo-institutionalists provide a solid background to explain institution formation and continuity. However, there is little guidance on how institutions change. The few instances where these theories explain institutional change, the focus is mainly on exogenous changes, with no explanation or recognition of endogenous incremental changes. What is lacking in neo-institutionalist theories is a comprehensive explanation of endogenous changes. Gradual institutional change theory addresses this challenge, and I used the theory, as a lens to assess exogenous and endogenous institutional changes, in complex socio-technical systems. One useful contribution of the theory is the institutional change framework and the four modes of institutional change, explained in the next sub-section.

2.2.3. Institutional Change Modes

Gradual institutional change theory delineates four modes of institutional change [127,136]. These four modes are:

1. *Displacement:* an overhaul of current rules and replacing them with new rules;
2. *Layering:* the introduction of new rules that operate alongside the old rules;
3. *Drift:* institutional changes occasioned by societal shifts; and
4. *Conversion:* maintenance of the same rules, with a different interpretation.

In displacement, there is a removal of old rules and a subsequent replacement, with new rules. In layering, new rules are introduced that co-exist with the old rules. In drift and conversion, there is no removal of old rules, neither are new rules introduced. In drift, no internal rule change occurs, however, external changes lead to changes in institutional outcomes. In conversion, old ambiguous rules are interpreted differently leading to institutional outcome changes.

I explain the mode of gradual institutional change using the Kenyan constitutional reforms. Displacement can be abrupt or gradual. It entails the complete overhaul of one institution and replacing it with another. After the 2007 Kenyan election violence, in March 2008, a Committee of Experts was formed to initiate the constitutional reform process. The process of constitution review was concluded on 27 August 2010 [152], when a new constitution was promulgated, leading to the removal of the previous constitution, and the adoption of a new constitutional dispensation. This demonstrates incremental institutional change. Before that, there was another constitutional displacement in 1969 [153], which replaced the original 1963 independence constitution [154].

Prior to the 2010 constitution displacement [152], the 1969 [153] constitutional dispensation had undergone 12 amendments. Constitution reviews, additions or amendments fall within the layering category, because new constitutional rules were introduced, to operate concurrently with the old rules. In 1976, the constitution was amended to empower the president to pardon election malpractice offenders. The 1982 amendment declared Kenya a single party state, and a secret ballot was replaced by the mlolongo voting system. In 1991, Kenya transitioned from a single-party to a multi-party state. These changes to the constitution, were piecemeal, and the new rules co-existed with the old ones, to address a critical issue that may not require complete displacement [134,155].

Drift occurs when changes in the social environments lead to institutional reforms, without any change to existing rules. Kenyan politics have for a long time been tribal-based. The power of a politician is determined by the number of persons eligible to vote within his constituency, or tribe, if he has wider influence beyond his constituency. However, with urbanization, there are immense changes in the population dynamics, with most people moving to the cities, especially Nairobi. Therefore, the rural-urban population dynamics are changing the election landscape, even though the election rules remain unscathed. This may lead to drift institutional change, if there is inaction by the electoral commission to revise election boundaries, or election rules. Thus rural-urban migration changes may alter electoral institutional outcomes.

Conversion refers to the change in the interpretation of the existing ambiguous rules [134]. Conversion is an institutional change innovation, when the opposing group is unable to displace or layer the current rules. It enables this group to use existing rules differently to address the situation [156]. The opposing group use the current ambiguous provisions in their favour through conversion [127].

When I assessed the institutional changes, as a result of the Nzoia WeShareIt game intervention, I focused on the four modes of institutional change, as explained below:

1. *Displacement:* I assessed whether there is an overhaul of current Nzoia River Basin rules and identified the new rules, that emerged. I also assessed whether the change was exogenous or endogenous;
2. *Layering:* I assessed whether there was an introduction of new basin management rules that operate alongside the old rules;
3. *Drift:* I analysed whether there were any institutional changes occasioned by societal shifts; and
4. *Conversion*: I assessed whether the actors interpreted existing ambiguous rules differently, to attain their goals.

2.2.4. Non-adaptive Capacity: The Problem of Institutional Stability

An understanding of institutional change as embracing both endogenous and exogenous changes, is contrary to the neo-classical institutional configurations – stable, pervasive, self-reproducing, routine based. Endogenous institutional configurations entail adaptive, dynamic, heterogenous institutions, that have the capacity to incorporate endogenous changes. Consequently, neo-institutionalist cannot explain endogenous changes, their institutional configurations do not allow for such changes [127]. Rational-choice, sociological and historical institutionalists perceive institutions as power and resource distribution mechanisms [127,157-162]. Gradual institutional change theorists argue that most institutions continuously face resource distribution tensions, leading to the genesis of new institutions by coalition groups, and subsequent conflicts and compromises between different interest groups [155,163].

Gradual institutional change theorists oppose the idea of institutional stability and affirm that "there is nothing automatic, self-perpetuating, or self-reinforcing about institutional arrangements." The theory also negates the idea that institutions are "cognitive templates that individuals unconsciously enact" [127]. Gradual institutional change theorists argue that; if institutions are self-enforcing cognitive templates, then there is no justification for imposing sanctions on free-riders, to enhance collective action [127], as proposed by rational-choice institutionalists [164]. The theory provides a good foundation to understand the heterogenous and dynamic environments in which institutions operate, where there are continuous contestations, for collective and scarce resources [134]. The theory also explains institutional compliance to actors' contestations, through endogenous and exogenous feedback effects [165].

Gradual institutional change theorists explain heterogeneity in institutions, but do not explain heterogeneity in institutional learning loops. The theory does not explain unlearning, non-adaptive institutions, and non-dynamic institutions. These institutions continue to change their rules, norms and practices, but the changes do not lead to triple loop learning. Therefore, though the institution is constantly changing, it is trapped in the single-loop learning phase or may progress to double loop learning, but never advances to triple loop learning [12].

In addition, the theory negates the strong body of knowledge that confirms that there are institutions where actors' actions are self-enforcing through routine, and the underlying assumptions barely questioned – whether they lead to resource imbalance or not. However, WRM SL scholars confirm the existence of many water institutions that do not question the underlying assumptions of their actions [12,34,63,166,167]. It is no doubt that institutions are dynamic, heterogenous and face power – resource contestations. However, the assumption that institutions possess the adaptive capacity to adequately respond to the prevailing system complexities, is not shared by WRM SL

scholars [12,15,35,63-68,166,167]. In addition, even though the theory explains endogenous institutional change, it does not address the problem of pervasive self-enforcing institutions that continue to reproduce the same script, even after a power change. Gradual institutional change also assumes that disadvantaged actors are willing, possess the capacity and social capital to self-organize and incrementally advocate for change. These capabilities may be present in some social contexts, but not in all social contexts, and even if present, the intensity and persistence will vary spatially and temporally.

Despite the identified gaps, the theory of gradual institutional change is key in positioning this dissertation and providing the needed lens for understanding institutional dynamism and endogenous change. According to the theory, endogenous change occurs when there are power-distributional implications. Changes occurs when there is a "soft spot" or "gap" that creates an "analytic space" for the design of new institutions. The new institutions contest with the existing institutions leading to a compromise. Therefore, the theory envisions a complex heterogenous institutional landscape comprising of multiple actors, with multiple interests and objectives, that form coalition groups. Opposing coalition groups contest for power-distributional outcomes, leading to political conflicts that drive endogenous institutional change [127].

Clearly, various institutional formation and change theories provide useful lenses for understanding the process of change, and the limitations that institutions face in the change process. However, since learning occurs in a social context, through contestation and institutional adaptation, an institution should adapt to feedback effects received from contesting coalition groups. Therefore, a key element of endogenous institutional change is a reflexive institution that is capable of learning to adapt to the complex heterogenous and constantly changing institutional social environment. As explained in Chapter 1 (Section 1.1), most institutions are not reflexive, therefore do not have the capacity to adapt to the feedback effects. SL theory has been proposed to span complex institutional boundaries and address the problem of non-adaptive water institutions that are not prepared for future water challenges [12,14,34,42,66]. To better understand institutional learning, this dissertation will reflect on the SL discourse, in the subsequent section.

2.3. The Social Learning Discourse

Application of the SL theory is in various policy fields, and one major field is WRM [37,68,167,168]. Mostert et al. [35], (p. 293) recommend SL to address Integrated Water Resources Management (IWRM) challenges. Bos et al. [1] used the theory to design a framework for the water sector in Australia. Mostert et al. [68] applied the SL theory to ten (10) river basins under the European HarmoniCOP project and developed 71 factors that foster or hinder social learning. As a result of this project, Mostert et al. [68] proposed further research on SL facilitation and the role of interactions and power dynamics. Garmendia and Stagl [43] designed a SL conceptual framework and applied it in three European natural resource management (NRM) case studies. Pahl-Wostl and Hare [62] applied SL theory to develop a new strategy for the Swedish urban water management system. Cundill et al. [169] monitored three SL case studies, focusing on NRM in South Africa and proposed further research on the relationship between societal change catalysed by SL and agency. Yuen and Jovicich [38], (p. 568) applied SL in four south-east Australian case studies and recommended that SL should be comprehended, thereby giving it a more prominent role.

In WRM, there are many societal contexts that provide varied learning experiences, due to the existence of many boundaries [86,87,100,170]. Mostert et al. [35] state that the water sector consists of the following boundaries, which form a basis for the numerous WRM SL contexts:

1. *Physical*. (water quality – water quantity; groundwater - surface water; land resources - water resources; and timescales – geographical scales);
2. *Administrative*. (central government, county government; and water service boards);
3. *Social*. (state – non-state actors; formal-informal; markets-networks-hierarchies); and
4. *Cognitive*. (different disciplines; laymen – experts; citizen scientists – researchers) [35].

In this section, I mainly focus on the discipline related cognitive boundaries, which is one of the opportunities and also a major bottleneck in the application of SL. SL scholars draw insights from a number of disciplines to challenge existing water institutions. The process of borrowing concepts and methodologies from other disciplines, has led to the development of the current SL discourse. In this section, I discuss the SL discourse, including an analysis of weaknesses of past SL approaches aimed at catalysing institutional changes.

2.3.1. *The Three Clusters of Social Learning Scholarship*

Rodela [42] conducted an extensive survey of 98 SL studies to identify the general SL trends, themes and interdisciplinary influences. The study grouped SL scholarship under the following three categories: system-centric, network-centric and individual centric. Figure 2.1 illustrates the main theories that have been cited by SL scholars in policy analysis, system sciences and research on learning (individual learning and group learning theories), on the input and process side of SL.

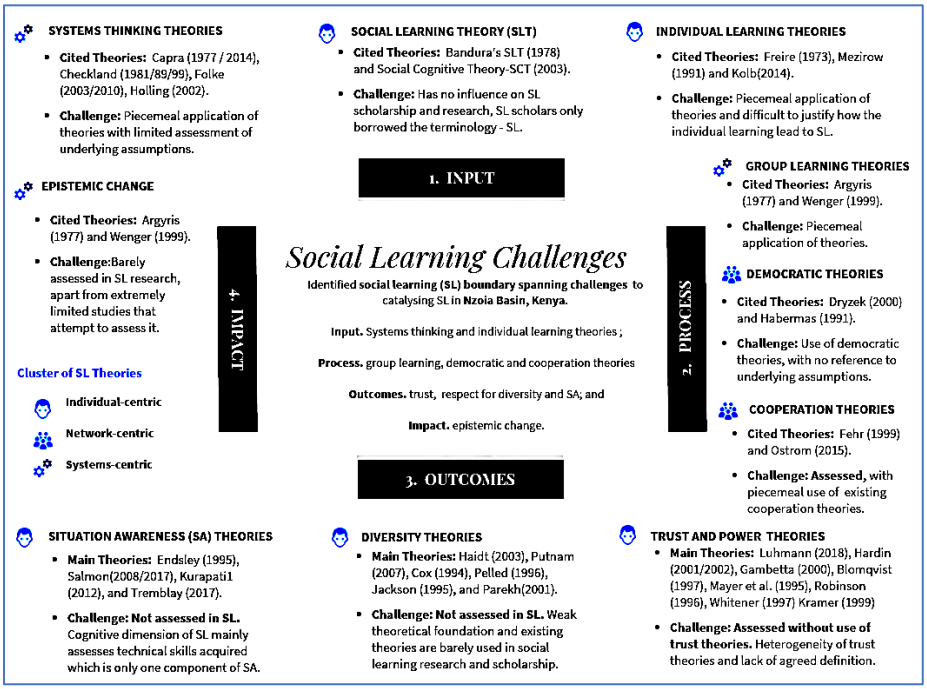


Figure 2.1. Social Learning Interdisciplinary Boundary Spanning Challenges

In addition, Figure 2.1 lists some of the theories that have been used to conceptualize and guide the measurement of the SL outcomes and impact. The theories either adopt system-centric, network-centric and/or individual centric dimension of SL. SL input is mainly drawn from system-centric, and individual centric theories. However, the SL process is mainly conceptualized using system-centric, and network-centric theories. The main problem occurs at the outcome phase, where SL is measured using individual centric theories of

learning, which do not match the ultimate system-centric impact assessment approach. Heterogeneity is one of the main challenges facing SL scholarship.

Boundary spanning has implications on the understanding of the SL discourse. Rodela [42] uncover the borrowed interdisciplinary concepts and methodologies, and how SL scholars use these borrowed approaches to shape the current discourse. SL scholars' theoretical choices, determined what they borrowed and how they used it. Consequently, SL discourse is shaped by interdisciplinary borrowing, and spanning of many discipline-related boundaries. SL is mainly influenced by policy analysis, system sciences and research on learning. SL influence by various disciplines is discussed in the ensuing subsections.

2.3.2. Social Learning Scholarship in Water Policy

Some SL scholars draw their insights from policy studies, to steer transition from conventional top-bottom WRM, toward bottom-up WRM. Commonly cited policy analysis theories are Habermas [171] (communicative action) and Dryzek [172] (deliberative democracy) [42]. Habermas [171] communicative action theory explains the importance of a bottom-up approaches to WRM. According to the theory, civic engagement enhances civic values, trust, cooperation, social capital, the quality of the decision, legitimacy and ownership of the final outcome [42], (p. 161). The democratic theory has been used by SL scholars to explain the civic engagement elements, that catalyse change, and what kind of transformation is expected [173,174]. Though Habermas [171] theory of communicative action provides a valuable lens for the process of catalysing WRM change, it has a number of limitations, that are barely cited by SL scholars [42].

Rodela [42] indicate that SL scholars, borrowing from democratic theories, pay little or no attention to the underlying assumptions, apart from a few exceptions [175]. The first criticism of the Habermas [171] theory of communicative action is the assumption of actors' abilities and rationality. The theory places a large burden on SL experimentation or case study participants, by assuming that they: have informed positions on the WRM issue under discussion; are willing to make time; will participate and actively defend their position, will rationally deliberate on the issues and reach a common understanding [42,176,177]. Though the theoretical ideals are important in providing a lens for communicative interactions, in reality, these conditions may not be present [176]. Therefore, when the assumptions fail, decisions made are not rational and neither do the participants arrive at a common understanding [42]. In other discourses, the normative aspects of deliberative democracy are

applied with a critical lens [178,179] or the ideals are applied and the assumptions rebutted through conflicting results [180].

The second criticism of the Habermas [171] theory of communicative action is the assumption that democratic processes occur in a vacuum, with no influence from external driving forces [181,182]. Reed et al. [41] criticized SL scholarship that reported positive SL outcomes without taking account of externalities, that may have impacted on the outcome. To address this challenge, I propose in this dissertation a controlled experiment, with a pre-game assessment to identify the level of learning before the intervention and any externalities that may influence the decisions made during the game session. Additionally, while modelling the Nzoia River basin policy context, I took account of the externalities, that normally impact on the policy decision-making in that societal context. The insights of the controlled experiment would inform SL scholars, whether the outcomes of a planned intervention may work within a particular social context [42].

2.3.3. Social Learning Scholarship in Psychology

Psychologists are important in the SL discourse because they entrench learning in a social context, and explain continuous learning, through the life experiences in the family, school, work, public spaces and many other contexts. The societal context creates the mental models and impulses for experiential learning [183]. Therefore, different social contexts create different learning conditions, through the varied impulses, and mental models that they espouse.

Nonetheless, behavioural psychology, including Bandura's [58] social learning theory (SLT), has no influence on the SL scholarship and discourse [42,50]. SLT is largely cited by SL scholar, but barely used to inform the design and analysis of SL experiments [42]." Brymer [50] is an exception, where SLT is used to explain the relationship between cognition and behaviour, to design the assessment framework, and incorporate epistemic learning in the analysis.

Though SL has its roots in psychology, SL scholars mainly borrow the terminology, but do not incorporate insights from the discipline. SL scholars argue that SLT focuses on individuals and is thus not valid in natural resources management (NRM) contexts. Pahl-Wostl et al. [66] explain that SLT was developed for individual learning and does not consider group learning processes, in a societal context.

Nevertheless, Bandura's subsequent studies on Social Cognitive Theory (SCT) has useful insights for SL studies, that may inform the intervention strategies on acquisition and maintenance of behavioural patterns [184,185]. Muro and Jefferey [60] explain that the SCT is important in establishing relations between cognition, individual action and the social context. Furthermore, Muro

and Jefferey [60] and Pahl-Wostl et al [66] argue that organizational development studies are useful, because they extend SL's application from the psychological individual centric approach towards group / network-centric approaches to learning. Recent psychological studies indicate that psychology has advanced beyond individual centric decision-making, towards the group and even the organizational [186].

2.3.4. SL Scholarship in Organizational Development and Adult Education

SL scholars also draw their insights from organizational development and adult education studies theories to understand adult learning processes in WRM. The most commonly used theories are Mezirow's [187] theory on transformative learning, Kolb's [188] theory on experiential learning and Wenger's [189] Communities of Practice (CoP).

SL scholarship on adult learning contains limited empirical evidence to support the operationalization of learning, in comparison to conventional adult learning literature [187]. Therefore the empirical evidence provided by an Organizational Development or Adult Education scholar to demonstrate learning, is much more in-depth than what is presented in SL scholarship. As a consequence, SL scholarship is not easily positioned within organizational development and adult education studies. In addition, it is difficult to conceptualize the assertions on changes in understanding [42]. There is an established body of knowledge that demonstrates how this assertions should be conceptualized, and assessed. Most SL scholarship does not use this established body of knowledge to justify their SL assertions. Moreover, SL scholars who adopt Wenger's [189] communities of practice (CoP) model, use it to explain the interactive SL processes, and barely use the model to guide the SL design, leading to diverse applications of the model [42].

Another limitation of adult education and organizational development scholarship is its focus on individual learning. The SL scholars that adopted Mezirow's [187] theory on transformative learning, and Kolb's [188] theory on experiential learning explain individual changes of understanding [174,190]. These studies assume that individual learning automatically leads to SL. Alternatively, SL scholars who applied Wenger's [189] CoP and Argyris' [191] and Wenger [189], were able to identify changes in regimes or practices [192,193] because the theories shift emphasis from individual learning towards performance and collaborative practice outcomes. Muro and Jefferey [60] and Pahl-Wostl et al [66] conclude that group or network-centric learning theories are preferred for SL scholarship, than individual-centric learning theories.

2.3.5. *Social Learning Scholarship in System Sciences*

SL scholarship has a large influence from system dynamics studies [42,61,194-198]. SL scholars use system sciences to justify the need for holistic approaches that consider multi-actors, multi-perspectives, multi-objectives, and multi-scales. The most commonly cited system sciences studies is the complex adaptive systems theory by Holling [199] and Folke's [200] adaptive capacity theory. Systems theory explains how the sum of all the parts affect the whole. It also explains the complexity of a heterogenous socio-technical system of interactions and behaviour. Through systems theory, WRM experts appreciate the complexity created by interactions between multiple scales, non-linear multi-actor actions and horizontal networks of self-organization [199,200].

Research also indicate that some SL scholarship rely on Checkland's theory of systems thinking and the soft system methodology [201-206]. System sciences SL scholars focus on mean-making, assessment of the respondent's reflection regarding the WRM problem and emphasize the SL environment [10,169,197]. There are a number of projects that adopt systems thinking, to guide the design of the SL research and determine the SL methodologies. Cundill [169] applied soft systems thinking in three South African projects. Mostert et al. [68] and Tippett et al [167] applied systems thinking in ten European river basins under the Harmonicop SL project. Ison and Watson [207] used systems thinking in a SL WRM project in Scotland. Steyaert et al. [208] adopted the systems thinking approach in the SLIM project for the French Atlantic coastal wetlands.

SL scholars who adopt systems thinking, have identified the following advantages:

- Deconstruction, design and assessment of SL [207,208];
- Understanding of the role of economic, social, environmental, cultural and legal factors [209]; and
- Provision of a foundation for action research [210].

2.3.6. *Boundary Spanning Challenges*

As discussed in the previous subsections, SL boundary spanning is piecemeal and heterogenous. It is mainly characterized by insights drawn from respective theories without fully adopting the body of knowledge and the underlying assumptions associated with the theory. Boundary crossing is essential, to challenge conventional approaches to institutional change, that are insufficient, non-adaptive or outdated [211]. However, most of the SL scholarship demonstrate a low engagement with the body of theoretical knowledge, especially when conceptual disciplinary distance exists [42].

Another challenge is the emergence of three categories of SL discourse: system-centric, network-centric and individual-centric [42]. A few theories exist to assess system-centric and network-centric SL outcomes. For instance, it is a challenge to assess network-centric or system-centric trust because it is highly situational, contextual and dependent on individual-centric variables - A entrusting B in matters X. In addition, X is not only context specific, but also varies spatially and temporally. This presents an outcome and impact assessment challenge.

Research indicates that SL scholars, when borrowing relevant theories, pay little attention to research design aspects of the theoretical studies they borrow their insights from. Most SL scholars conduct selective borrowing from conventional theoretical frameworks to develop their own conceptual models, without verifying the underlying assumptions, with a few exceptions.

In conclusion, SL scholarship is characterized as heterogenous [42], leading to three distinct categories (system-centric, network-centric and individual centric), [46]. Heterogeneity has led to diverse definitions [60], numerous conceptual frameworks [42], and lack of a strong theoretical foundation that has weakened SL theory [41]. The absence of an agreed SL definition, has increased the challenge of spanning multiple boundaries when designing and assessing the SL outcomes [41,45,212]. Policy gaming has been proposed as a boundary spanning artefact to simplify the process of borrowing and testing concepts before they are implemented in the real world.

2.4. Policy Gaming

2.4.1. Policy Gaming: New Innovation in Social Learning Experiments

Studies demonstrate the added value of experimentation in catalysing SL [37], (p. 5). Figure 2.2. represent a timeline analysis of some of these SL experiments. The timeline indicates that most SL experiments focus on WRM, NRM, water and landscape planning. Initial experiments focused on environmental impact assessments. However, there is a growing interest in extending the application of SL in climate change and disaster risk reduction contexts.

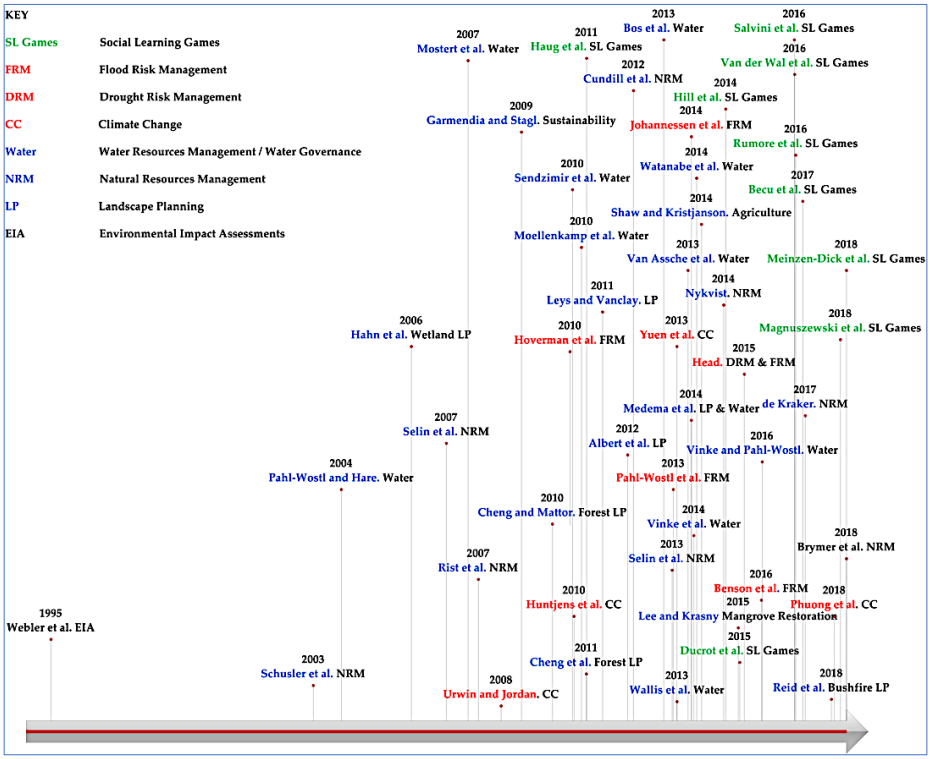


Figure 2.2. Timeline of Social Learning Experiments

Based on the timeline, policy gaming is a new innovation in SL experiments, and its potential is barely tapped. I only include in the timeline game experiments that specifically assess the SL process, outcomes or impact. Most of these studies relate to a particular game that has been designed,

specifically, to enhance social learning [37,51,80,213]. In some of the studies, policy games enhance adaptive capacity amongst policymakers with no history or little history of cooperation [37].

Until recently, policy gaming has not been exploited in SL experiments. The timeline also demonstrates increased SL scholarly contribution to NRM, with limited research on flood and drought risk management. Moreover, studies to assess the contribution of gaming as a transition management method, is under researched. Therefore, it's possible potential is unknown and untapped. In the subsequent sub-section, I discuss why SL policy gaming is gaining traction and review current SL games to identify the research gaps.

2.4.2. Advantages of Using Water Policy Games to Catalyse Social Learning

Water policy games have been used to enhance SL due to a number of benefits. A vital advantage of policy games is the restoration of broken relationships, and trust building [37,214,215]. A policy game may lead to the building of trust through repeated constructive social interactions [37], (pp. 5-7). Meaningful social interactions [37,214,215], challenge players existing mental models that hinder cooperation [14]. In the course of the interactions, players clarify existing values and judgments [97] through "step-wise, round-based interactions" [37], (p. 6). The players communicate deep-seated tacit information that they would never articulate in a formal setting [37], (p. 5). A game setting may reveal what water diplomacy seeks to conceal [99], thus drawing the participants closer. Once the tacit and explicit knowledge is clarified and reframed, policymakers may develop a shared understanding of the issues.

According to Medema [37], (pp. 5-6), games are "appealing" because they enhance players understanding of the socio-political and techno-physical complexities, at the same time. Simultaneous integration of socio-political and techno-physical realities in one game enables players can assess the complexities from different lenses [35]. The gameplay also requires more than the player's technical knowledge; the player is immersed in the game environment and uses their emotional intelligence, tacit knowledge and explicit knowledge, to solve the challenges [214]. This process of integrating socio-technical realities, makes gaming an appealing approach to enhance cognitive SL [37,51,80,213].

Policy games facilitate the process of increasing understanding of other players mindsets, which is an essential element for increased respect for diversity [37], (p. 6). Most water management policy games encourage respect for diversity by engaging multiple state and non-state actors in decision-making processes.

Policy games increase understanding of basin complexity and facilitate knowledge co-creation through inbuilt cooperation and team interdependence game mechanics. Basin management is complex due to: vested interests of the

various governments and their users [6], (p. 495), externalities like scale issues, and deep uncertainty occasioned by climate change [216], (p. 5). Also, many factors are interconnected, complex, and have ripple effects [217]. Knowledge co-creation is one of the vital requirements for effective operation of complex systems [218]. Co-creation enables diverse actors to update and develop new knowledge, jointly. Through co-creation, complexities are better understood, thus bridging the uncertainty gap, and managing scales issues. Co-creation of knowledge is the first step towards updating, diffusing and institutionalizing knowledge [37], (p. 6).

Policy gaming is a proven method for enhancing water cooperation by building rapport, establishing new partnerships, shaping coalitions and facilitating constructive engagements. Games are playful and entertaining. Negative realities like overexploitation of natural resources are framed positively as competitive edge / comparative advantage to facilitate the process of goal convergence. Some games create shared meaning to complex water issues and facilitate the stakeholders to make trade-offs and jointly manage the shared resource [37,219]. Through multiple repeated rounds, stakeholders have the opportunity to frame and re-frame water policy issues. In the process, they discover the core problem and what solution is beneficial for all the different parties [35]. Framing and reframing, facilitates the change of mental models, that is essential for a paradigm shift [214].

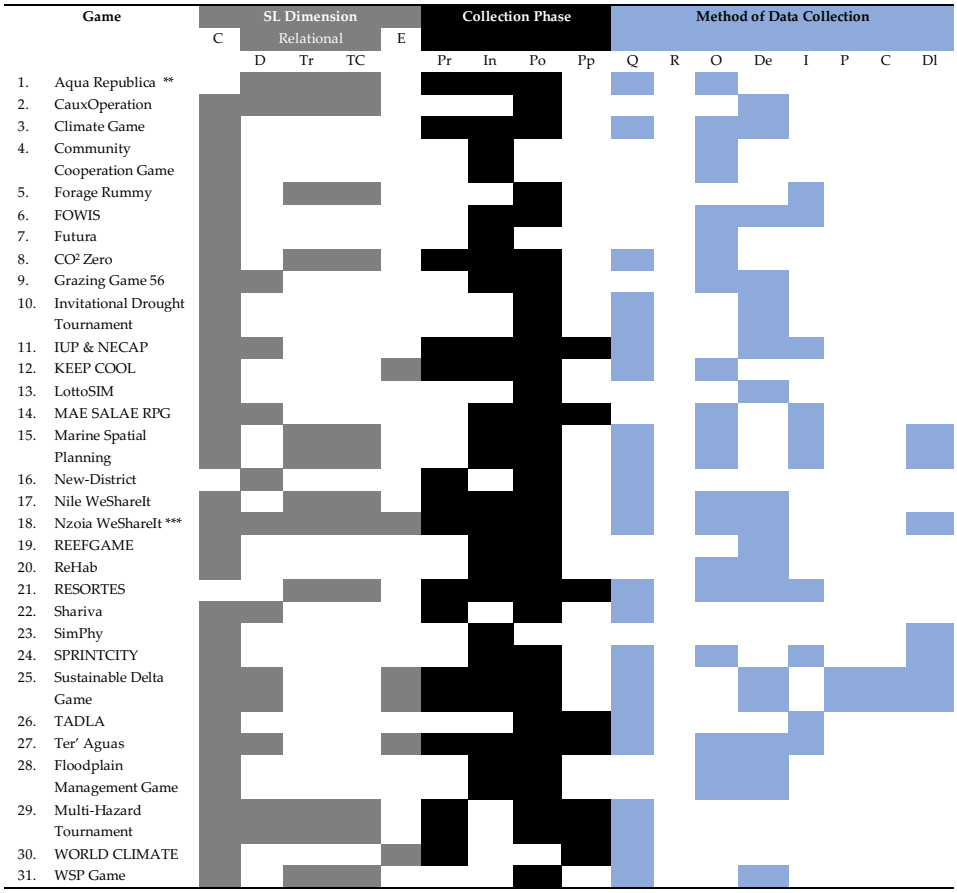
2.4.3. Literature Assessing Outcomes of Social Learning Games

A recent study on SL games, provides valuable insights into the conceptualization of SL, the mode of data collection, select game evaluation methods, evaluation approaches (qualitative or quantitative) and the SL game outcomes [45]. Table 2.1 is a modification of some of the outcomes of den Haan and van der Voort [45] literature review study. The Table contains existing games, that have enhanced SL outcomes, and the used data collection phases and methods. I only extracted the games that had names and had indicated a positive learning outcome. One game was eliminated because there were no observed learning outcomes, and several were eliminated because they had no names. Therefore Table 2.1 does not represent all the SL games identified by the den Haan and van der Voort [45] literature review. It is important to note that relational learning outcomes were extracted and grouped in the three categories (Diversity, Trust and Cooperation) based on how the SL outcome was phrased in den Haan and van der Voort [45].

Table 2.1 demonstrates a heavy dependence on post-game data followed by in-game data, then pre-game data and the least being post-post game data. Pre-game data can be used to collect baseline data. According to the den Haan and van der Voort [45] literature review results, 37, 30 and 22 of the 47 games

collected post-game, in-game and pre-game data, respectively. The study also indicates that games that the most preferred data collection combination was in-post game (25 games), followed by pre-post game (21 games) and the least was pre-in-post game (15 games).

Table 2.1. Outcomes of Social Learning Games
Modified* from: den Haan and van der Voort [45]



	SL Dimension	C Cognitive
		R Relational – Respect for Diversity (D), Trust (Tr), Team Interdependence and Cooperation (TC)
		E Epistemic
Data Collection Phase		Pregame (Pe), Ingame (In), Postgame (Po), and Post-post (Pp)
Data Collection Methods		Questionnaire (Q), Real World Data (R), Observation (O), Debriefing (De), Interviews (I), Perspective Mapping (P), Control Group (C), Data Logging (Dl)
Other Methods of Data collection		** the game also used interaction analysis and social network analysis *** the game also used interaction analysis
Modifications made from den Haan et.al [45]		* Removed games with no SL outcome, and updated Nzoia WeShareIt Game, based on later publications.

Ten out of the 47 games conducted post-post game analyses, to assess SL impacts and epistemic changes. Concerning the Nzoia WeShareIt game, I did not conduct post-post game analyses due to time and resource constraints. den Haan and van der Voort [45] identified two key games that conducted post-post analyses. The Sustainable Delta Game post-post game analysis confirmed that the developed strategy for adaptive pathways that had been tested using the game sessions was adopted in New Zealand [220]. The other game conducted post-post game analyses through follow-up sessions with the players and other community members and provided empirical evidence of knowledge diffusion, knowledge integration and SL impacts of the game in the real world social context [221].

den Haan and van der Voort [45] findings indicate that the most prevalent data collection methods are questionnaires (#25), session observations (#24) and debriefing notes (#18). Moreover, interviews (#14) and data logging (#8) are also common data collection methods. Some of the unique data collection methods that have barely been tapped with the exception of a few games include: real world analyses (#1), perspective maps (#2), concept maps (#1), social network analyses (#1), interaction analyses (#1) and control group (#3). Most of the policy games use a mixed method approach, to triangulate the results. Most of these studies adopt three and five policy gaming approaches.

The findings also indicate that most of the game analyses used qualitative research methods to collect the assessment data. Amongst the 47 games, 21 used qualitative data, and 16 combined both qualitative and quantitative data. Only five games used purely quantitative data to assess SL outcomes.

Normative learning outcomes (epistemic changes) as represented in the den Haan and van der Voort [45] literature review, are of particular interest. Five out of 47 report normative epistemology changes as a result of the SL gaming intervention. However, six of the 47 games assess normative epistemology and one reported no noticeable positive changes [222]. Assessment of normative learning is critical, because several SL studies indicate that this is the most under-studied and under-investigated SL dimension, it is difficult to measure and most of the time it is hard to manifest, within short project durations [50]. Therefore, den Haan and van der Voort [45] findings are useful in informing future game designs that intend to assess normative learning. Three studies [223-225] use the individual-centric approach to learning to assess normative learning, while two use a systems-centric mixed method approach to assess convergence of opinions by the group [220,226]. Another interesting finding the measurement of short (post game subjective rating assessment) and long-term (8 months post-game subjective rating assessment) changes in normative epistemology of individual players [223]. This is an innovative approach to connect the game outcomes to real life SL outcomes.

Relational learning was mainly measured using self-reflective questions. The common methods were interviews, debriefings and questionnaires [45]. There are three games that conducted post-post self-reflective assessments after: 8 months [223]; 4-6 weeks [227] and 3 months [228]. Aqua Republica game used an innovative approach, combining a subjective questionnaire, social network, and interactive analyses [71].

There are a number of observations, that I identified by analysing Table 2.1. First, SL policy games barely study the epistemic dimension. Most games focus on cognitive learning. Amongst the 47 games, only five games, did not report cognitive learning outcomes. A variety of games assess the contribution of the game to relational learning. Second, the study of relational learning barely incorporates the three elements (trust, cooperation and respect for diversity, in one game assessment framework). According to Table 2.1, only four out of 32 games, study the three main aspects of relational learning – diversity, trust and cooperation (including team interdependence). Finally, from Table 2.1, only the Nzoia WeShareIt game was designed to study cognitive, all the three relational dimensions, and epistemic learning.

2.5. Concluding Remarks

In conclusion, this Chapter contains the main theoretical foundations of this dissertation. First, I conducted an institutional analysis of the endogenous and exogenous institutional changes. Based on this analysis, I assessed the strengths, limitations, assumptions and opportunities created by the existing body of knowledge. There are two key findings, first the need to maintain an endogenous institutional change lens that incorporates institutional heterogeneity, and complexity. Second, is the need to combine institutional change theories and SL theories to understand when a suggested change is transformative or merely an incremental change to satisfy the majority while maintaining the status quo. It was evident that the problem of self-enforcing, routinised, stable institutions has not been sufficiently addressed in current institutional change theories, thus leading to calls for SL.

I assessed the SL discourse, mainly focusing on a recent study by Rodela [42]. The SL discourse is heterogenous, with most of the SL scholars relying on policy analysis, system sciences and both individual and group-based adult learning theories. SL scholars are mainly divided into three categories, individual-centric, group / network-centric and systems-centric. However, when applying SL experiments, some SL scholars may span various disciplines, depending on the project or experiment implementation phase (input, process, outcome and impact). A key recommendation drawn from the SL analysis is the need to adopt discipline-related theories and their methodologies, comprehensively. In addition, there is a need to be aware of the challenges of interdisciplinary research and seek support, when conceptual disciplinary distances exist. Another major finding was the inability of discipline related boundary spanning, without a change of the knowledge carrier (from routine to symbols) to address the problem of institution routine.

Finally, I assessed whether water policy gaming holds a promise in SL experiments. The analysis confirms that this promise has barely been tapped, however, recent games indicate that there is a promise. Most SL games reports positive outcomes. In addition, the assessment indicates the possibility to experience changes in all the three dimensions of SL, in one game. The assessment also provides guidance on the different game design approaches and various methods to evaluate SL outcomes. Nzoia WeShareIt game seeks to address two main research gaps. First, to strengthen SL scholarship on design and measurement empirical analyses. Second, to provide design guidance aimed at establishing linkages between the game session, actual social interactions, and real life SL.

3. Nzoia WeShareIt Policy Game

The first part of this is chapter explains the transition from the Nile by 2050 scenarios to Nzoia WeShareIt water policy game. The second part gives a general summary of the application of Nzoia WeShareIt. Then, the third part provides the overall Nzoia WeShareIt conceptual framework. The final part describes the fourteen primary game elements, used to design the water policy game.

3.1. From Nile Basin by 2050 Scenarios to WeShareIt Game

At the start of the research project, I sought to identify the core problem hindering water institutions from reflecting, learning and adapting. The aim of the initial analysis was to identify the strongly held values, beliefs and worldviews that hinder institutional learning and change, and the possible opportunities. To undertake the analysis, I selected the Nile Basin. The problem and opportunity analysis was undertaken through a participatory process of scenario development [90,170,229]. The scenarios are known as Nile Basin by 2050. In February 2014, I convened a meeting with representatives of the eleven Nile Basin countries in Jinja, Uganda (Figure 3.1), to develop the scenarios.

Figure 3.1. Identification of Driving Forces at the Scenario Workshop

The Nile Basin by 2050 scenarios are an illustration of the potential benefits and the potential negative consequences of pursuing a particular trajectory. The scenarios are four in total. Two plausible futures are impacted by climate change, while two are not [90]. The two climate-change scenarios are proactive (Ejo Heza and Kazuri). What triggers the stakeholders to action, in the two scenarios, are climate-change induced disasters. What differentiates the two scenarios is the adopted governance mode, to address the social problem. In one scenario, collective action occurs, at all levels, and is engineered using top down approaches (Ejo Heza), whereas the other governance mode focuses on horizontal networks with limited bottom up and top down interventions (Kazuri). Despite the high climate variability, there were positive outcomes as the societies/countries adapted better to the changing circumstances, than in contexts with low climate variability.

The two reactive scenarios are Miskeen and Umoja. They occur in a system with low climate variability. In Miskeen, the states do not cooperate, because non-cooperation enables them to maximize their national outcomes. The riparian states maximise national outcomes in the short-term and ultimately diminish the natural resources. In Umoja, the 11 riparian states unite into one supra-national institution known as the United Nile Republic, to jointly manage the water resources.

During a stakeholder workshop held in Nairobi, Kenya in October 2014, the stakeholders expressed fear of the Miskeen future. In Miskeen, the Nile Basin water institutions continue to repeat the same unilateral actions. The repeated actions cumulatively damage the natural capital, thus increasing community vulnerability [230]. Noticeable characteristics of Miskeen are continued unilateral actions and construction of large national WRM infrastructural projects. The countries compete for scarce water resources, with no form of cooperation or joint action. Riparian states continue unilateral actions, repeatedly, for 45 years, without checks and balances. None of the riparian states question the underlying assumptions of repeated actions. Moreover, the riparian states assume that the system is resilient and capable of bouncing back to provide enough water for nature, food and energy needs. However, by 2050, all the tributaries to the Nile river are dry and natural capital is damaged, due to massive deforestation, land degradation and enormous water projects along the river. Furthermore, the eleven Nile Basin governments assume that the system is robust and resilient, and do not prepare for the sudden famine and lack of fresh water. As a result, the countries go to war, and the basin is no longer safe and self-sustaining.

Unlike Kazuri and Ejo Heza, there were no unexpected climate change induced events in Miskeen. Consequently, the water institutions in Miskeen do

not learn, they repeat past actions, while the environment is drastically changing. These institutions do not prepare for the Miskeen future.

Therefore, one key lesson from the scenarios is the need to challenge routine, and subsequently catalyse institutional change. This dissertation is a response to the Nile Basin stakeholders call in October 2014, to support policymakers to avoid the Miskeen future [90,229]. I contributed to this call, by assessing the impact of routine on institutional learning, continuity, and change. To address this gap, I designed a water policy game to catalyse institutional learning and change.

3.2. Nzoia WeShareIt

Nzoia WeShareIt was designed, between November 2015 and July 2016, through an iterative process of designing, testing, applying and redesigning. After designing the game, I tested it in Uasin Gishu county government [91]. In July 2016, the game was ready to be applied in the Nzoia river basin. The game was played by 35 policy makers, in seven-game sessions (See Figure 3.2). I then extensively collected data, with the aim of studying whether SL game can catalyse institutional change, in the context of the Nzoia River Basin. [90,99,231].

The Nzoia basin policymakers have three basic policy decision options:

- Maximize food and energy production based on comparative advantages of the various county governments.
- Limit food and energy production to the bare minimum that is required to meet the county government citizen needs.
- Stop focusing on food and energy production based on productivity levels and buy the shortages from other county governments.

Uasin Gishu has a high energy and food productivity factor (8 and three respectively), but their water allocation is too low to produce both food and energy, for the entire basin (they have only six water circles). Therefore, Uasin Gishu has to decide whether to:

- **MAKE** its food and LIMIT its energy production (not BUY anything). This decision enables Uasin Gishu to meet all its local needs within the confines of its geographical boundary with little or no consideration of the basin's needs and interests.
- **STOP** "nature" by cutting down trees to MAKE BOTH food and energy (not BUY anything). This decision helps Uasin Gishu to be self-sufficient and independent, and at the same time address, some of the resident needs, at the expense of its environment.

- **MAXIMISE** food production and STOP energy production (BUY energy). If Uasin Gishu focuses only on food production, it has to rely entirely on other riparian states to provide energy for its residents, at an agreed price.
- **MAXIMISE** energy production and STOP food production (BUY food). If Uasin Gishu focuses only on energy production, it has to rely entirely on other riparian states to provide food for its residents, at an agreed price.

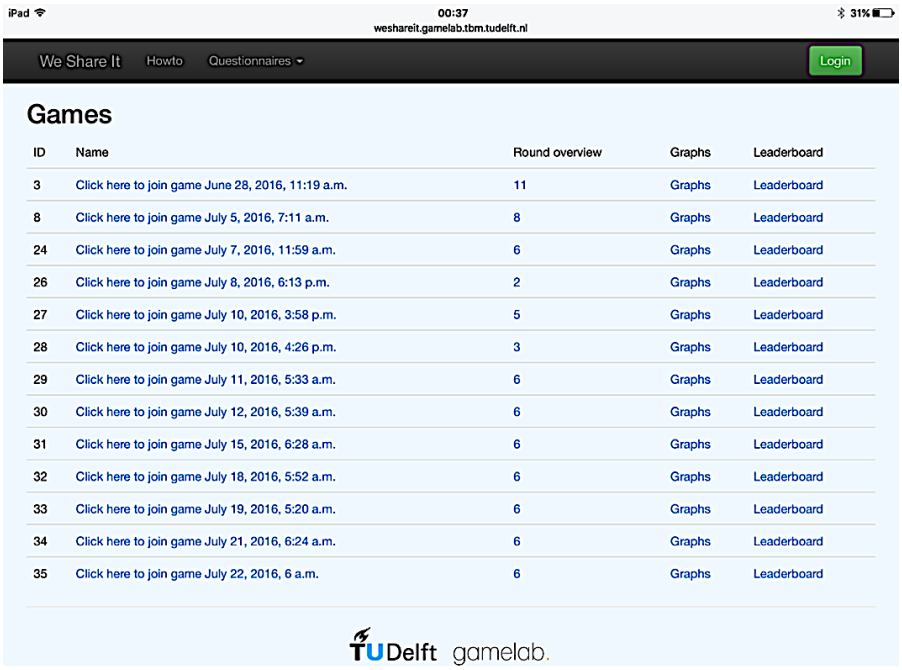


Figure 3.2. Screenshot of Nzoia WeShareIt Online Start Page

Two factors that limit a player's decision to make their food and energy is the scarce water resources and natural disasters. Each player has a limited number of water circles and has to make their decisions within the confines of their water resources. Second, after every three rounds, the player's resources are halved, when a slow onset disaster strikes (drought). The sudden and drastic decline in player resources profoundly and negatively affect their ability to make their food and energy.

3.3. The Conceptual Framework

I designed the Nzoia WeShareIt conceptual framework (Figure 3.3) using three models, namely, (1) the serious game input-process-output model by Garris, Ahlers, and Driskell [232], , (2) Landers (2014) theory of gamified

learning model [233] , and (3) the Recognition-Primed decision (RPD) model by Klein [234]. I used the input-process-output model of serious games to design the recurring Nzoia WeShareIt game cycle which comprises steps and cycles. In each cycle, players learn through their actions, judgments (gained while interacting with other players) and the in-game feedback. In the input-process-output model, the game instructions, characteristics and cycle are vital to the learning process. The instructional content in the game ensures that the players are familiar with climate change risks. The aim of the input-process-output model of serious game design is to influence the learning process, directly.

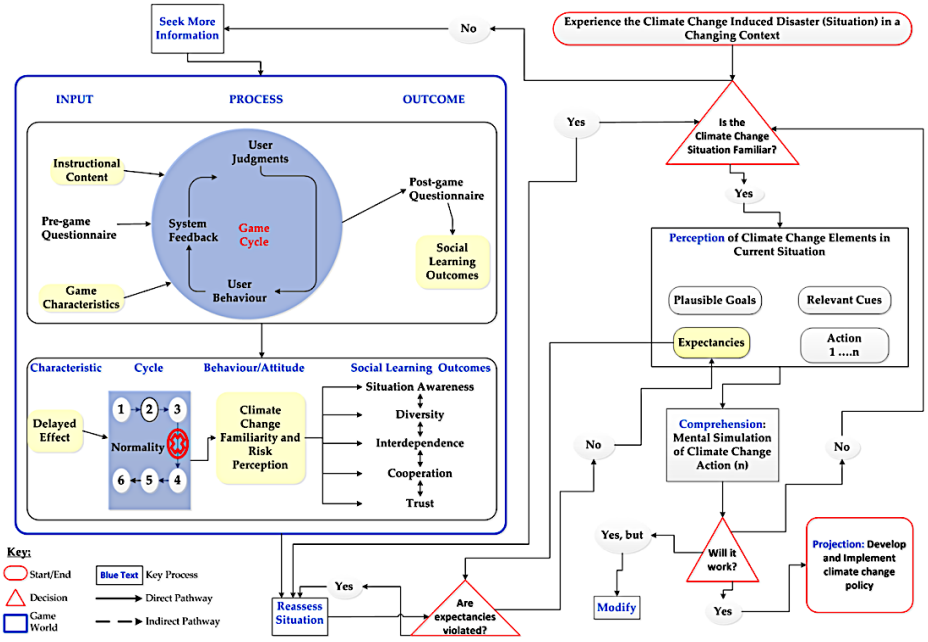


Figure 3.3. Nzoia WeShareIt Conceptual Framework

I incorporated the Landers (2014) theory of the gamified learning in the design approach to indirectly influence players' behaviours and attitudes concerning climate change and the perception of unfamiliar risks. I used the model to facilitate the process of "digging deeper" to answer the complex underlying problems of behaviour and attitudinal change. Climate change is a crucial in promoting cooperative actions. Since climate change disasters are slow-onset, their effects are delayed, and can be catastrophic, if not well planned [86,87,89,90,99,100].

Amongst the naturalistic decision models, I adopted the Klein (1993) Recognition-Primed Decisions (RPD) model as illustrated in Figure 3.3 [234,235]. This model is suitable when the decision maker is an expert (policymaker) and

there is time limitation (caused by the climate change induced disasters). Klein (1993) explains that policymakers barely undergo an organized decision-making process, where alternatives are assessed when there is time pressure. In such instances, policymakers assess the nature of the situation and, based on whether the situation is familiar or not, they discount the decision-making, seek more information or proceed to three phases of decision-making. The first phase is situation recognition, which I rename perception of climate change elements. The second phase is serial option evaluation (comprehension), where the decisionmaker selects policy actions from a cue and elects the most typical response. The final phase involves simulating the actions in the policymaker's mind to assess whether they are satisfactory. RPD has two stages where the policy decision may be discounted. First, at the initial stage, if the situation is not familiar. Second, at the perception level, if the expectancies are violated. Expectancies refer to what the policymaker anticipated would happen in a given situation, based on the established norms. The focus of this research is to increase the uptake and progression of decision-making by influencing the first and second stages of the RPD process, where the decision can be discounted, for being unfamiliar or when the expectancies are violated [235].

The following factors complicate climate change decision-making [236]:

1. Ill-structured problems that contain complex causal effects and links;
2. Uncertainty of climate change and the dynamic environment;
3. Constantly changing, poorly-defined, or competing goals;
4. Action/feedback loops—series of events and strings of climate change actions that are intertwined;
5. Time stress when making decisions during the disaster phase;
6. High stakes—large investments and slow returns coupled with deep future uncertainties of the occurrence of the climate change events;
7. Multiple players at multiple levels of governance and from different sectors;
8. National and local government goals and norms need some consideration before making a climate change decision.

Naturalistic decision-making simplifies complexity through the use of familiarity and cues. Familiarity discounts unknown circumstances. Cues reinforce the use of the past to address somewhat familiar present circumstances. Both approaches bolster routine, and may not support adaptation to new, unfamiliar, and uncertain situations. When a new, unfamiliar, and uncertain circumstance emerges, the game plays a key role in disrupting routine and supporting reflection on new approaches to address the unfamiliar situation.

3.4. Nzoia WeShareIt Primary Game Elements

I designed the game elements using the guide by Peters and van de Westelaken [237], (pp. 27-33). The Nzoia WeShareIt game is made up of fourteen (14) primary elements, namely:

1. The Objective of Nzoia WeShareIt Game;
2. The Participants;
3. The Scenario;
4. Game Contents (physical and virtual game items);
5. The Objective in the Game;
6. Cycles and Steps of Play (macro and micro cycle);
7. The Roles (played, simulated and pseudo);
8. The Unexpected Events (planned, random, ad-hoc);
9. Rules;
10. Decisions;
11. Indicators and Assessment Criteria;
12. Data;
13. Computer Equipment, Accessories and Paraphernalia; and
14. Rules for the Implementation of the Game.

3.4.1. Nzoia WeShareIt Game Objectives

The six-county governments cannot utilize everything they have within the confines of their respective geographical boundaries. They have the option to work unilaterally and compete for the scarce resources or jointly manage and distribute the cost and benefits of water cooperation. In the game, food, energy, and nature are the main sectors that compete for water. Agriculture for food production is the highest consumer of the Nzoia river shared water resources [89-91,99,229,231]. I designed the game to address the challenges that policymakers face while seeking to equitably distribute water resources between various sectors (mainly food, energy and ecosystem services (nature)) and amongst the various county governments. The objective of the game is not to resolve the water allocation challenge but to help the players to realize the struggle for scarce water resources (between sectors and counties) and the effects this struggle might have within their respective county governments [99]. Nzoia WeShareIt game, therefore, focuses more on the process of reaching an equitable decision and not the substantive content of the preferred solution.

3.4.2. The Participants

The gameplay requires at least five policymakers and a facilitator. The facilitator's role is to guide the players through the various steps of the game.

The participants were water policymakers from four local governments within the Nzoia River Basin. The four local authorities are Busia, Kakamega, Bungoma and Trans Nzoia. The participants were 35 in total (12 female and 23 male).

3.4.3. The Scenario Setting / Description Tools

I developed multiple scenario description tools to widen the options for better communicating the game objectives, elements and how to play the game. At the start of the game session, I used a combination of scenarios setting tools, namely:

- The game rules card (mandatory);
- Face to face (one on one) interactions between the facilitators and the players (mandatory);
- A short film prepared using the Nile WeShareIt game session (by the Ministry of Water and Irrigation) [238] (optional);
- A PowerPoint presentation explaining the game elements and how to play the game (optional);
- A how to play film prepared by the Delft University of Technology that explains the game elements and how to play the game in detail (optional); and
- The facilitator's guide and games rulebook (detailed book on the game).

It is sufficient to explain the scenario using a combination of the game rules card and face to face explanations coupled with either a short PowerPoint presentation or a video. At the start of the Nzoia WeShareIt game sessions, I used PowerPoint presentations combined with the rules card and face to face interactions. However, later in the game, I replaced the PowerPoint presentation with the short film on the Nile WeShareIt game played in Nairobi, Kenya by the Ministry of Water and Irrigation.

3.4.4. The Contents of the Game

To maximize the advantages of a hybrid board game, I designed Nzoia WeShareIt with both physical, and virtual game elements. The physical items improve physical play while the virtual items enhance virtual play. The players can simultaneously touch and utilize the game items in the physical realm with direct feedback of the consequences of their actions in the virtual realm. The physical items in the Nzoia WeShareIt game are:

1. Five playing fields for the five county governments in the Nzoia River Basin;
2. Five game rules cards (information sheets) to provide details on the game specifications and rules;
3. Parcels allocated to Food, Hydro-electric power, and Nature; and
4. Solar cars to represent solar power projects.

There are five playing fields or boards in the game. Each board represents a particular county government within the Nzoia river basin. The board contains a map of the county government on the right and water circles on the left. The number of water circles in the playing fields is different for every county government. The upstream counties (Trans Nzoia and Uasin Gishu) have fewer water circles because the water emanates from these counties at high altitudes that a significant amount flows out of the county's geographical boundary through gravitational force. The middle-stream counties have relatively the same amount of water circles (Bungoma and Kakamega). Busia, the only downstream county in the game, has the highest amount of water circles. Busia retains a significant portion of the Nzoia water in the Budalangi and Yala swamps.

The game restricts player's decisions to the amount of water available in their county government. The circles represent the water available for delivering ecosystem services and producing food and energy. The players cannot change their water quantity (number of circles allocated for each playing field), throughout the game.

To play the game, the players make water allocation decisions by placing the parcels on the water circles within the playing fields. There are three types of parcels: food (red); hydro-electric power (blue) and nature (green) [88]. Solar energy is not limited to the number of parcels allocated. Therefore, the players can increase their initial solar power allocation to any amount, depending on the availability of money to purchase the solar power projects.

There are two main electronic elements, money and emoji faces. Money plays a vital role throughout the game and is automatically calculated based on player actions. Emoji faces are also automatically calculated and displayed at the end of every round. Both money and emoji faces are cumulative and carried over to the subsequent round. County governments start the game with a fixed starting income. At the beginning of every round, they receive the same amount of income. In addition to the income, county governments get more money for every conversion of nature parcel to either food or hydro-electric power. Unused income is carried over to the next round.

In the game, there are three kinds of faces: happy, neutral and unhappy. Happy faces are issued electronically when the food, energy and investments in public services surpass the minimum need. Neutral faces are issued when the food, energy and investments in public services equals the minimum need. Unhappy faces are issued when the county government falls below the minimum requirement for energy, food and investments in public.

3.4.5. The Objectives in the Game

The players have one fundamental objective in the game; to gain as many "happy faces" as possible. The policymakers get happy faces when they make their residents happy. The county governments gain "happy faces" through increased food and energy supply and investment of a certain amount, in public services.

Additionally, the players have a shared goal to jointly manage the basin sustainably and equitably, while maximizing the benefits and reducing the costs. Therefore, the policymakers determine to what extent they can make their resident's happy, and maintain a healthy level of competition with other riparian states. Since they share the water resource, their decisions may also be influenced by other factors (like maintaining good relations with their neighbours), beyond their responsibilities to their county residents. The game provides the players with the flexibility to redesign the game.

3.4.6. Cycles and Steps of Play

While playing the game, there are two types of cycles that the players experience. The macro and micro-cycle. The game consists of a series of rounds or macro cycles. The first three rounds or cycles are regular rounds, followed by a drought round. The duration of the game is half a day (typically played in the morning). The players conclude the game after an agreed set of cycles or rounds or at a pre-determined time. If there is no agreed time, the facilitator has the power to stop the game at any time. After concluding the game, there is a debriefing session to reflect on the gameplay, outcomes, lessons learned and recommendations.

There were seven sessions, and each of the sessions had five participants (See Figure 3.4). All the participants were Kenyan, from the county governments, public sector, and water companies. Participants provided informed consent, before completing the questionnaires [88]. There were two game sessions in Busia, Bungoma and Trans Nzoia county governments, and one game session in Kakamega county government [239]. Most of the participants had a bachelor's degree (20). The age range of most of the participants was 25 to 34 (11), 35 to 44 (7) and 45 to 55 (10) [88].

The game is designed for players to play as many rounds as they wish. However, in practice players play between five and eight rounds, within half a day. The game sessions indicated that there was no added value of continuing with the game, in the afternoon, with the same players.

Figure 3.4. Nzoia WeShareIt Game Session 6 in Trans-Nzoia

3.4.7. The Micro Cycle (Five Steps of Play)

The micro-cycle (one round) consists of five steps of play, namely:

1. *HARVEST:* The players get their harvest in the form of food parcels, hydroelectric energy parcels, nature parcels, solar and income.
2. *TRADE:* They trade in food and hydroelectric energy.
3. *PAY PENALTY:* A penalty of 600 Euros is payable for every unit of energy shortage, in the current round.
4. *INVEST:* The county government may invest in public services and/or solar power projects or not take any action. After that, the players assess the results, as displayed on their respective iPads and plan the next strategy, individually or with the group.
5. *RE-ALLOCATE:* Finally, the players may make water re-allocations decisions, also known as conversions.

Harvest refers to a summation of total resources at the start of a particular round, namely income, food, energy (hydro and solar) and nature. During the trading round, the players are allowed (but not obliged) to move around the room with their iPads, looking for buyers of surplus food or hydro-electric power. The players can also look for sellers if they have a food or energy shortage. Some players may not have food or energy shortage but would like to trade to increase their happiness results. Once a trade has been made, the players are expected to record their trades electronically using their iPads.

The penalty is payable immediately after trading with other county governments and before any purchase of solar projects or investments are made. If the county government still has an energy shortage, the game automatically deducts the penalty at the close of the trading round. If the available income is lower than the penalty, the game deducts the penalty from the income in the subsequent round. The players can select to invest in one of the following public services: Education, Agriculture, Energy, Finance, Infrastructure, Security, Health, Transport, ICT and Water (Figure 3.5). This list was determined by the Kenyan stakeholders as the essential public service sectors, during the game design and testing sessions, in Eldoret, Kenya [91]. The choice of a specific public service does not affect the overall result.

Figure 3.5. Investment in public services iPad screenshot

Players may make water allocations decisions in the form of re-allocations or conversions. When the game starts, there is an initial water allocation made for each county government. The players can change their allocation at the end of every round. The players adjust their parcel allocations by either increasing or decreasing their total amount of food, energy, and nature. Once, the players have concluded their water allocation decisions, the gamemaster closes the round and opens the next round. Once the gamemaster closes trading or a particular round, s/he cannot electronically return to that round or trade session.

3.4.8. The Roles

The game consists of three roles types, namely, played, pseudo and simulated. There are five played roles. The five players are policymakers in five county governments (Bungoma, Busia, Kakamega, Trans Nzoia and Uasin Gishu). A policymaker's interpretation of his or her respective roles determines the player's actions. The game design guides the player through allocating different **resources** to each player, providing players with different **responsibilities**, providing space for player **interests** and diverse **options**. The diverse **resources** may lead to the following player interpretations of their functions.

- *Energy producers and suppliers* (Uasin Gishu with the highest energy productivity factor of 8);
- *Food producers and suppliers* (Trans Nzoia and Kakamega with the highest food productivity factor of 4 and 2, respectively). Uasin Gishu may also be considered a food producer, due to their high food productivity levels. However, their energy productivity levels are much higher than food; and
- *Food and energy consumers/money suppliers* (Busia and Bungoma with the income levels of 6,500 and 5,000, respectively).

Apart from the available resources, players may take specific actions based on their perceptions of their role in accomplishing the **individual and shared goals**. The game assigns two goals to all the five players:

- The internal individual county government goal of making their residents happy through the supply of food, energy and investing in public services; and
- The shared goal of jointly managing the shared scarce water resources sustainably while maximizing food and energy production, based on comparative advantages.

Since there is a concurrent operation of both the shared and individual goals, there may be simultaneous roles operating at any given time. The presence of multiple simultaneous roles may lead to tensions and conflicts if the players do not focus on their comparative advantages and the overall goal of managing the basin jointly and sustainably.

The game design incorporates tensions between the individual and **shared goals**, thereby leading to healthy competition between the multiple roles assigned to each player. To ensure that the competition is healthy, I introduced the goal asymmetry and goal synergy game mechanics. **Goal asymmetry** game mechanic ensures that all players have unique individual roles assigned to them that compete with the shared goal in all the rounds. The **goal synergy** game mechanic ensures that the competition is healthy by ensuring that the assigned goals and roles are not fundamentally divergent but complementary. All the

players have an assigned responsibility to work as a team and cooperate. The game mechanics that steer the players towards these responsibilities are:

- The players do not have the full picture of the basin and need to interact and share information to increase their situation awareness levels, and thus make more informed decisions (**complementary knowledge** game mechanic).
- The players do not have a full picture of other player's responsibilities, niches and how they can work together to fulfil the shared goal. To get a better understanding, the game requires players to play more roles in the game, such as communicators, negotiators, and boundary spanners. These additional player roles enable the players to fulfil their assigned responsibilities and the overall shared goal. I used the **role asymmetry** game mechanic to assign different player responsibilities.
- To ensure that there is an added value in team interdependence and cooperation I introduced the **complementary roles** game mechanics. Each player's role complements the other, for instance, food suppliers' role complements the food consumers role. This game mechanic gives purpose to the respective roles and encourages interdependence play.
- In addition to the different resources, individual and shared goals and the assigned responsibilities, players perceive their roles based on **interests** and available **options.** For instance, a player may be interested in maintaining good relations with other players and thus take up the role of being a producer and supplier at reasonable prices to advance this interest.

The player interests vary depending on the game elements and personal perceptions. The player options keep on changing, as the circumstances change. In the drought round, resources are halved leading to a change in roles, based on the limited resources and reduced player options. Therefore, a player's perceived role affects other players roles, based on previous player actions. In this complex game context, players continue to change their roles or maintain the current roles to advance or protect their interests or expand their available options.

Pseudo roles are actively played in the game but not by the policymakers (participants). The game design introduces two pseudo roles: The World Bank and the World Food Programme (WFP). The gamemaster plays the two pseudo roles in the drought round. The gamemaster introduces these roles in a game session where players do not focus on pursuing their shared goal, within the first three rounds; thus, they not prepared for the drought round. When the slow onset disaster strikes and their resources are halved most of the players do not have sufficient food to enable them to continue to the next round (if a player falls below their minimum food they are removed from the game). Therefore, the gamemaster acts as both the World Bank and the World Food Programme

(WFP), in this round. The World Bank allows the players to borrow money to buy food from the World Food Programme (WFP). The World Bank provides money in the form of a loan which the counties pay in subsequent rounds.

Some simulated roles are inbuilt in the game. One example of such a role is the role of the Kenyan Treasury that issues pre-determined income to the county governments at the beginning of every rounds. The Treasury also receives income from the county governments in the form of penalties for not meeting their energy needs. Another simulated role is the National Environmental Management Authority (NEMA) that charges a penalty for cutting down trees and destroying the environment. The simulated roles are incorporated into the game because they are an essential part of the game process. Therefore, it is not necessary for a player to be assigned some of these roles.

3.4.9. The Unexpected Events

Unexpected events were incorporated to introduce new elements and change the course of players thinking, within the game. These events are important because they introduce new game dynamics that disrupt normality and challenge the players to think more in-depth about the core issues, their perceptions, values, arguments, and their subsequent decisions. I also include unexpected events to encourage players to manage the shared water resource jointly and to deter unilateral actions. Moreover, unexpected events increase the Nzoia basin complexities, thereby breaking the monotony and increasing uncertainty within the game.

Nzoia WeShareIt game has three types of unexpected events: planned, random and adhoc. Two planned events occur unexpectedly in the fourth and eighth round of the game: the drought round and the introduction of pseudo roles played by the gamemaster. The drought round occurs unexpectedly in the fourth and eighth round. I introduced drought to assess the effect of slow-onset disasters on the present players repeated actions. As a result of the drought, player resources are significantly reduced. Therefore, players have to find solutions, individually or jointly to address the pressing needs. In this way, the game serves two significant functions. First, it is a practice ring where the players test the viability of various strategies within a safe environment. Second, it is a laboratory, where the researcher and the players can analyse the effect of disasters on the current actions, power dynamics and eventually on the social system.

Apart from the drought, the gamemaster introduces two pseudo roles in the fourth and eighth round, the World Food Programme and the World Bank as players. These roles are introduced to address the sudden gap in food resources that may threaten the ability of the players to continue playing the game. The gamemaster activates the planned event only after establishing that

some players have been severely affected by the drought and cannot proceed to the next round.

The players have the freedom to develop random events during the drought round to address the challenge. In some game sessions, the players seize the opportunity while in others the opportunity is not seized. In the Nile WeShareIt game session, the players convened an inter-governmental basin meeting. In the meeting, they assessed how they arrived at their current position and jointly agreed on joint actions to address their shared problem. In this game session, they devise a short-term and long-term action plan. In the short-term, they sought the help of the World Bank and international food companies to address food insecurity. In the long-term, they agreed to jointly manage the basin and ensure that their plans incorporate disasters such as droughts and other forms of uncertainties.

During the game sessions, the gamemaster can introduce ad hoc events. For instance, the introduction of drastic reductions in the solar power project prices to increase investments in solar and boost energy production. The gamemaster introduced this event after realizing that the players barely purchased solar because of the high prices. One of the facilitators played the pseudo role of a company that produces and sells cheap solar power panels. Later the solar power projects price was changed, in the electronic game, from 2,500 to 1,500, after the ad hoc event proved to be successful. Other ad hoc events that have been devised by the gamemaster are increases in income for specific county governments to increase their purchasing power and the reduction of available resources to increase the complexity of the game.

3.4.10. The Rules

There are two primary rules in the game, the trading rules, and the land / water conversion rules. The game rules determine fixed trade prices in the first round. The fixed price is 500 Euros per unit of food or hydro-electric power. The players are allowed to change the prices (lower the prices or increase the prices) in the subsequent rounds. In subsequent rounds, players are also allowed to provide food and energy for free if they deem it necessary. The conversion rules are standard for all the county governments. Players can convert food and energy immediately. To convert nature to food or energy, the player leaves the land idle for one round (referred to as "not in use" in the game). Each nature conversion to food or energy leads to a cash increment of 500 euros, for the sale of the wood fuel collected when cutting down trees. Any conversion back to nature takes two rounds (land remains idle for two rounds). The conversion from arable land to nature takes longer (2 rounds) because it takes a lengthy period for trees to grow and mature.

3.4.11. Decisions

Each county government has different:

- *Incomes levels:* The county governments make income based on the taxes they collect from their residents and the income they derive from their natural resources (game reserves, water, national parks, beaches, the tenancy of land). Therefore, counties that are endowed with natural resources and have productive land and enough water to grow crops and produce energy have higher incomes than resource-poor counties.
- *Food productivity levels:* Some counties have higher food productivity levels due to the fertile soils, (Trans Nzoia county government), compared to others whose productivity is low.
- *Energy productivity levels:* Some counties have higher energy productivity levels due to the presence of large amounts of water flowing from hilly landscapes, and many waterfalls, (Uasin Gishu county government) compared to others whose productivity is low.

The Nzoia basin policymakers have three basic policy decision options

- *Maximise* food and energy production based on comparative advantages of the various county governments.
- *Limit* food and energy production to the bare minimum that is required to meet the county government citizen needs.
- *Stop* focusing on food and energy production based on productivity levels and buy the shortages from other county governments.

Two factors that limit a player's decision to make their food and energy is the scarce water resources and natural disasters. Each player has a limited number of water circles and has to make their decisions within the confines of their water resources. Second, after every three rounds, the player's resources are halved, when a slow onset disaster strikes (drought). The sudden and drastic decline in player resources profoundly and negatively affect their ability to make their food and energy.

3.4.12. Assessment Criteria

At the start of the game, participants complete the pre-game questionnaire that contains demographic questions, trust-related questions, and the consent form. After the conclusion of the game, the participants fill the post-game questionnaire. Finally, I facilitate a short debriefing session.

The questionnaire measures for all the responses were on a 5-point-Likert (1.00 = Very Inaccurate, 2.00 = Moderately Inaccurate, 3.00 = Slightly Inaccurate, 4.00 = Moderately Accurate and 5.00 = Very Accurate). The learning outcomes

were phrased in statements like: – through the game 'I became more aware of the need for joint action.'

I collected data through seven (7) research instruments. These instruments were the: pre-game, in-game and post-game questionnaires an inbuilt data collection mechanism; observations, video recording, and the debriefing session. The facilitators and game-master record their observations throughout the game, and there was a rough-cut video recording of the entire game session. The questionnaires are accessed through a drop-down button at the top left corner of the players' iPads.

I divided the pre-game questionnaire into three main parts. The first part collects data on the participant's background (county they represent, age, gender, organization, their highest level of education and email). The second part collects data on their current perception of the water management situation, in the Nzoia Basin (instability, complexity, variability, arousal, spare mental capacity, concentration, a division of attention, information quantity, information quality and familiarity with the situation). The last part assesses their trust and trustworthiness levels, at the start of the game.

The in-game questionnaire entails one question with 16 parameters. I grouped the 16 factors into four parts (time, place, action and relation). I translated the in-game questionnaire into Kiswahili, to reduce multiple interpretations of the in-game assessment tool by the policymakers. The wording in English was subject multiple interpretations, thus affecting the assessment results. The players were requested to assess their perception of at-least two players on a scale of 1 (for low) and 10 (for high) using sliders. I incorporated the in-game questionnaire within the game and chose to use sliders so that players can quickly input the data by sliding left or right.

I divided the post-game questionnaire into twelve (12) primary parts. First, questions to assess change in players awareness of the Nzoia basin water allocation and climate change situation. Second, an assessment of the game quality. Third, players perceptions on the contribution of the game to problem-solving and skills development. Fourth, players experience the game world, story and identity development. Fifth, players experience in the game with building and modifying the game. Sixth, an assessment of the social interactions in the game. Seventh, players motivation to continue playing the game. Eight, players analysis of the level of cooperation in the game. Ninth, an assessment of the learning component of the game. Tenth, analysis of the level of trust or distrust, during the gameplay. Eleventh, an assessment of the use of computer applications to support the game. Finally, players rating on their satisfaction with the game and any additional feedback.

The inbuilt game is designed to collect numerical data from the trading, purchase of solar, investment and water allocation decisions, for every round.

Also, there is data on the trading partners, the trade price, and the traded goods. The game automatically collates the data and reflects it in inbuilt game graphs. The game visualizes the inbuilt game data through four principal graphs. The first graph indicates the happiness results of the five county governments for every round. The second graph tabulates the investments made by all the five county governments, for every round. The third graph demonstrates the changes in water allocation decisions that increase or decrease food, energy, nature and "not in use" (land left idle while converting to food or energy). The last graph visualizes the amount that county governments allocated for hydro and solar energy, in every round. The facilitator projects these graphs on the screen (throughout the game session) and the information changes real-time on the screen.

During the debriefing session, each county government explains the experiences they faced during the game, lessons learned and proposals to improve the game design and process. The debriefing session is brief and informal. In these sessions, the participants reflect and give general observations and recommendations, and the proposed way forward.

I collected the observations during the gameplay by writing short notes on some predetermined factors. The list of factors includes;

- The gameplay in general;
- The interactions and self-organization of the players;
- The chosen content and policy measures; and
- The problems identified and the strategies undertaken to resolve these problems.

I collected unedited rough-cut video data for all the seven Nzoia WeShareIt game sessions. This data covers the entire half day game session. I gathered this data to assess whether the game increases team interdependence and cooperation, amongst the players.

3.4.13. Computer Equipment, Accessories and Paraphernalia

To play the Nzoia WeShareIt game, I ensured that the select hotel had high-speed Wi-Fi internet access. I also had two laptops, five iPads, two screens for projecting the results, two projectors, a video recorder, sound system and paraphernalia (registration forms, notebooks, pens, one calculator, one stopwatch, and nametags).

3.4.14. Rules for the Implementation of the Game

The gameplay consists of a series of rounds (maximum 8) and each round consists of six steps. First, players receive their resources. Second, they trade in food, wood fuel, and hydroelectric energy. Third, if applicable, players pay

penalties for energy shortages. Fourth, the players invest in public services and get their (un) happy face scores. Fifth, they make water allocation decisions and buy solar panels (optional). Finally, move to the next round [88,239].

During the trading round, the players have an option to cooperate or make unilateral decisions. Unilateral decisions are possible for the resource-rich counties like Trans Nzoia and Uasin Gishu. They may choose to produce food and energy only for their county governments and not engage in any trade activities. In the trade round, players can either negotiate around the table or move around the room with their iPads looking for buyers or sellers, to meet their money, food or energy needs. Once a trade exchange is made, the players record the transaction in their iPads [88].

The five playing fields comprise of water circles where player make water allocation decisions at the end of every round. The players can convert existing parcels into food, hydro-electric power, and nature. The game restricts allocation decisions to the number of water circles in their respective playing fields. The game electronically awards smileys, when a prescribed amount of food, energy, investments in public services is attained [88].

3.5. Concluding Remarks

The game design underwent several iterations. Apart from the testing sessions in Delft, Nairobi and Eldoret, there were seven actual game sessions. Each of the testing and actual game sessions had five participants. All the actual game session participants were Kenyans from the county governments, public sector, and water companies. Two game sessions were played in Busia, Bungoma and Trans Nzoia county governments, and one game session in Kakamega county government [239]. In total, there were 12 females and 23 males. Most of the participants had a bachelor's degree (20). The age range of most of the participants was 25 to 34 (11), 35 to 44 (7) and 45 to 55 (10) [88].

The county government representatives were policymakers in charge of water & irrigation, energy, agriculture, and the environment. The other county government institutions included representatives from Nzoia Water Services Company (NZOWASCO); The National Environmental Management Authority (NEMA); The Water Resources Management Authority; and the Water Resources Users Associations (WRUAs). All the participants provided informed consent before completing the questionnaires [88].

In the subsequent chapters, I delve into the different methods, results and analyses that I undertook after collecting and collating the different sets of the Nzoia WeShareIt game data.

4. Cognitive Learning: Situation Awareness

Title: From Paris Agreement to Action: Enhancing Climate Change Familiarity and Situation Awareness

Authors: Abby Muricho Onencan and Bartel Van de Walle

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Research Context: This empirical study assessed the contribution of the Nzoia WeShareIt to cognitive learning of policymakers in the Nzoia Basin. To be able to integrate the acquired knowledge, we simulated the game to address a particular policy challenge: climate change inaction. The game provided the policymakers with a safe environment to test the policy implications of applying the Paris Climate Change Agreement.

Abstract: The Paris Agreement was a monumental stride towards global climate change governance. It unlocked the climate change gridlock, introducing country-subjective commitments and a five-year review mechanism. To support the implementation of the Paris Agreement, we designed the Nzoia WeShareIt climate change game. Game sessions were conducted in June and July 2015, and 35 respondents completed a pre- and post-game situation awareness (SA) questionnaire and an in-game performance measurement system. The questionnaire uses a 10-dimensional situation awareness rating technique (SART). Subsequently, we conducted a factorial MANOVA (multivariate analysis of variance) to assess the interaction effects between familiarity, team, and gender. Results indicate an increase in situation awareness. However, policymakers' action was not contingent on the increased SA only, there was a significant interaction effect between familiarity and SA, to lead to climate change actions. Therefore, we recommend more emphasis on the role of familiarity in enhancing SA and, subsequently, supporting the implementation to the Paris five-year review country commitments. We also recommend the increased usage of symbols and capacity development of policymakers on connective capacity to enable them to span the climate change boundaries.

Graphical Abstract (Figure 4.1)

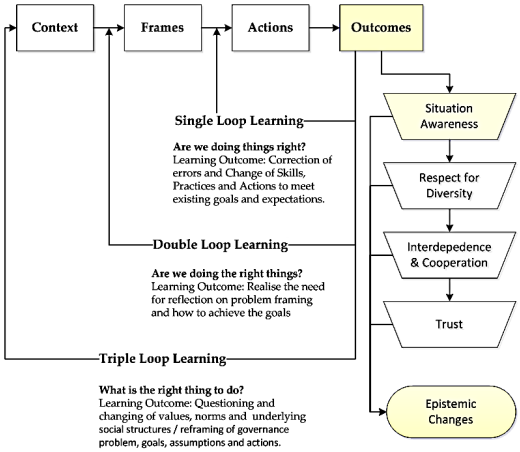


Figure 4.1. Triple-Loop Social Learning Sequence: Situation Awareness

Keywords: climate change disaster risk reduction; symbols; familiarity; policy games; situation awareness; water governance; gender; team cooperation; stories; synecdoche; metaphors

4.1. Introduction

The Paris Climate Change Agreement that was adopted 12 December 2015 by 195 countries marks a "monumental triumph" [240] that unlocked the "global warming gridlock" [241]. The 1992 UN Framework Convention on Climate Change (UNFCCC) was agreed upon by UN member states so as to reduce greenhouse gas (GHG) emissions [242]. Thereafter, the UN member states sought to develop legally binding rules through the 1997 Kyoto Protocol and subsequent supporting instruments like the Clean Development Mechanism [243]. Unfortunately, despite many policy documents aimed at combating GHG, there was a steady rise in GHG emissions [244]. In 2009, the Copenhagen Conference (COP-15), sought to combat the GHG emissions problem, by creating a subsequent treaty to the Kyoto protocol [245]. The Copenhagen Conference's attempt to police nation states and impose mandatory emission reductions failed [245,246]. At this stage, many observers concluded that the climate change negotiations had reached a deadlock [245]. In the midst of the deadlock, the Paris Agreement was successfully adopted [247]. It is a departure from all previous endeavours to manage GHG emissions. Through the Paris Agreement, countries set their own emission reduction targets. The countries make voluntary pledges and, through regular reviews, poorly performing countries are named and shamed [245]. Therefore, emission cuts are not forced upon countries, but they are voluntarily pledged and later reviewed.

Despite an oversaturated climate change policy regime, the problem of rising GHG emissions still persists [248]. The 2015 Paris Agreement "name and shame" strategy against countries that fail to reduce their GHG emission commitments may not be sufficient in stimulating countries to action. Falkner (2016), states that "time and again, major emitters have shown themselves willing to accept a loss in international reputation when domestic economic priorities have been at stake" [245]. Therefore, there is need to adopt another strategy that may lead countries to take action.

Gupta (2015), assessed the global climate change history and concluded that it is difficult to create an international climate change regime with mandatory GHG emission targets. The problem is not a lack of policies and laws to regulate climate change. According to Falkner (2016), there are numerous global, national and regional climate change policy instruments focusing on institutional capacity development, GHG emission reduction, adaptation, climate-smart agriculture, energy efficiency policies, low-carbon technological innovation and forestry management [245]. Nachmany et al., (2014) states that since 1997, the number of climate change-related laws and policies double every five years. Nachmany et al., (2014) explains that the noted increase in climate

change policies applied to both Annex 1 and non-Annex 1 countries. By 2009, there were 426 laws and policies on climate change [249] (p. 20).

Falkner (2016), states that the "past record of climate policies suggests that governments have a tendency to express lofty aspirations but avoid tough decisions" [245]. Giddens (2009), states that the problem lies in the perception of climate change. It is mostly treated as a "back-of-the-mind" [250] problem and future discounted with no present serious action, taken until an actual disaster occurs [89,90,170]. Falkner (2016) explains the difficulty of translating "normative engagement into collective action" through different facets of the problem [245]. The first facet is an investment problem. Climate change requires extremely high investments in a short duration and the impacts are realized in the long-term. Falkner (2016) adds that it is hard for a government to justify to its citizens high investments with limited or no returns within the short term that the government is in office. The second facet is the complexity of the problem, the climate change effects are not uniform, thus leading to some countries benefiting from the changing climate while others face serious threats. Alexandria, Egypt may face extinction if sea levels rise due to climate change [87,100,170]. At the same time, Kenya might benefit from the increased rainfall, if they invest more on rain harvesting and water storage facilities [90,91,99,229]. The third facet is the deep uncertainty as to whether the climate change projections will materialize [87,99]. Falkner (2016) explains that deep uncertainty has led to governments adopting the "wait and see approach" as the rational decision. Even though climate change is catastrophic, it is seen by many as "abstract and elusive" [250]. According to Luhmann (2000), human beings live within the constraints of a familiar world, familiar risks, familiar hazards, familiar dangers. Luhmann (2000), adds that people never leave the familiar world. Thus, there is a danger of making policies to address only the familiar risks. The fourth facet is the trust issue, most countries lack the certainty that other countries will reciprocate. The diligent work of countries to reduce their GHG emissions might be derailed by "free-riders" who continue business as usual or produce more GHG emissions [245]. Roberts and Parks (2006) explain the last facet, concerning the strained North-South climate change relations. Falkner adds that the tension relates to the division of the mitigation burden. The global south maintains that a large share of the burden should be borne by the industrialized nations who historically are responsible for most of the GHG emissions.

Falkner (2016), explains that there is a lack of clarity on whether the Paris Agreement will ensure that climate change commitments translate into action. Before the Paris Agreement, the approach was mainly top-down. For more than two decades countries sought to establish an international climate change regime to impose and enforce mandatory GHG emission reduction targets.

However, the Paris Agreement introduced a new climate change governance model. Keohane and Openheimer (2016) state that the Paris Agreement established a "two-level game" approach, linking the global five-year Paris Agreement review mechanism to national climate change politics. This "two-level" game is designed to rely on the fear of reputational loss and the availability of nation civil society capacity to effectively review and advocate for their respective governments to meet their stated commitments. Unfortunately, the "name and shame" strategy against countries that fail to reduce their GHG emission commitments may not be sufficient in stimulating countries to action. Falkner (2016), states that "time and again, major emitters have shown themselves willing to accept a loss in international reputation when domestic economic priorities have been at stake" [245]. Also, many countries lack the civil society capacity and independence to review and advocate for countries to implement their stated commitments.

Paris Commitments may translate into action if the climate change risks are familiar [83]. However, the perception of climate change as a familiar risk that requires immediate action remains a significant challenge [89,90]. Therefore, there is a need to introduce the unfamiliar world, risks, and opportunities into the familiar world and increase policymakers climate change SA.

The goal of this chapter is to propose policy recommendations to support the implementation of the Paris commitments and contribute to combating GHG emissions and the climate change governance problem. We propose working with policymakers through introducing the unfamiliar world of climate change to enhance their situation awareness (SA) with the aim of changing their perceptions, attitudes, and behaviours, leading to action. We assessed whether increased situation awareness through the introduction of the unfamiliar climate change effects to policymakers may lead to action. We adopted the Endsley (1995) definition of situation awareness as "the perception of the elements in the environment […], the comprehension of their meaning and the projection of their status in the near future" [73]. According to Endsley (1995), there are three levels of SA: level one is perception, level two is comprehension, and the final level is projection. Increased situation awareness depends on the success of level 1 (perception), coupled with comprehension and projection of the change in awareness [73,251,252]. On the other hand, studies also confirm that the level 1 (perception) of SA is influenced by comprehension and projection [252,253]. Thus, there is a strong linkage between the three levels, and the relationship is not simple nor linear. Bartel (2016) explains that team SA is "the degree to which every team member possesses the situation awareness required for her or his responsibilities" [252] (p. 68).

The study area is the Nzoia River Basin in Western, Kenya. The Nzoia river is shared by six county governments, namely Busia, Siaya, Bungoma,

Kakamega, Trans Nzoia and Uasin Gishu [88]. The basin area residents are highly susceptible to climate change risks that have in the past led to climate change disasters that include droughts, floods and the activation of the inactive volcanoes along the Great Rift Valley [89,91].

The research results demonstrate that the future may be positive if water policymakers' awareness of the fragile water system situation is increased, leading to transitions from short-sighted planning towards more long-term and integrated planning that may enable future societies to sustain themselves amidst a changing climate. The results also indicate that familiarity and connective capacity through boundary spanners plays a crucial role in increasing policymakers' situation awareness, with the aim of changing their perceptions, attitudes, and behaviours, leading to action.

The chapter is organized as follows. The theoretical background, research goal and questions, are contained in Section 4.2. Section 4.3 describes the research method which comprises of SA assessment, a subsequent factorial MANOVA (multivariate analysis of variance), and the Nzoia WeShareIt game design. The research findings are presented in Section 4.4 and the discussion in Section 4.5. The discussion addresses the three core recommendations, triangulation of research methods, the need for capacity development in connective capacity and the policy relevance of bridging the familiarity gap with symbols. Finally, Section 4.6 contains the concluding remarks.

4.2. Background

4.2.1. Numerous Climate Change Commitments and Policy Instruments

Kenya actively participates in the climate change international and national arena [254]. On 28 December 2016, Kenya ratified the 2015 Paris Agreement (signed 22 April 2016); which represents a first collaborative virtually unanimous climate change global framework [247]. Prior to that, Kenya signed (12 June 1992) and ratified (30 August 1994), the United Nations Framework Convention on Climate Change (UNFCCC), [242]. Additionally, on 25 February 2005, Kenya ratified the 1997 Kyoto Protocol to the UNFCCC [243]. To implement its international obligations, Kenya developed four main policy documents: the 2016 Climate Change Act that established the National Climate Change Council [255]; the 2010 National Climate Change Response Strategy (NCCRS), [256]; the 2013 to 2017 National Climate Change Action Plan (NCCAP), [257]; and the 2015 to 2030 National Adaptation Plan (NAP) [110]. Kenya has also submitted two reports; the First National Communication (FNC) in 2002 and the Second National Communication (SNC) in 2015 [254] so as to fulfil its obligations under Articles 4 and 12 of the UNFCCC under the guidance of the 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines

[258]. The two national communications (NCs) provide information on greenhouse gas emissions (GHG) in Kenya, including the sources of the emissions and the removals by sinks.

Kenya is not only facing adaptation challenges, increasingly it has to address climate mitigation as well. The second NC indicates that in 2013, Kenya was contributing 0.13 percentage of the GHG emissions global total, which amounts to 60.2 million metric tons of carbon dioxide equivalent (MtCO2e) [121]. This percentage may seem low when compared to the United States (14.75), the 15 European Union countries (9.33), India (6.43), China (5.93) and Russia (4.86). However, it is a high percentage compared to most developing economies. Kenya is at the same level as Ireland, Serbia, Ecuador and Hungary, whose GHG emissions are also 0.13%. Its GHG emissions are higher than some developed nations, for instance: Denmark (0.12), Switzerland (0.11), Sweden (0.11), Norway (0.10), and Luxembourg (0.02) [259].

Kenya's positive policy reforms have not translated into tangible results with a 59% and 77% increase in agriculture and energy GHG emissions from 1990 to 2013, respectively. As a developing country, its land-use change and forestry (LUCF) sector were expected to be a source of sink to counter the destructive actions of developed countries [260]. Unfortunately, the 1995–2010 GHG inventory indicates that the Kenyan LUCF is a source of emissions [121,122]. The inventory indicates that since 1990 to 2010, Kenyan LUCF activities emitted 17.2 MtCO2 annually [122]. Agriculture was the most significant contributor of GHG emissions (62.8%), followed by energy (31.2%). The two leading causes of GHG emissions was enteric fermentation from cows, goats, sheep, camels and other ruminant animals that produce methane (55% of the emissions) and manure that has been left on pasture (55% of the emissions). In the energy sector, there were three main GHG emission contributors: transportation (39%), heat and electricity production (26%), and biomass, stationery and mobile combustion (25%) [121,122,259].

To reduce GHG emissions, Kenya has committed to:

1. increase the production of solar, geothermal and wind energy;
2. improve its energy and resource efficiency;
3. increase tree cover to at least 10% of its land mass;
4. promote the use of clean energy technologies over wood fuels;
5. adopt efficient and low carbon transport modalities;
6. the use of climate-smart agriculture (CSA) to implement the Kenya CSA Framework; and
7. improve the management of waste [121,122].

Most of these commitments can be initiated through individual and joint action [88-91,99,170,229], without being contingent on financial, investment,

technical and human resource support, as stated in the SNC [121,259]. Awareness of the role of government and the community in implementing some of these actions could improve decision-making with limited or no financial support [170]. For instance, increased awareness of the contribution of the following practices to GHG emissions may lead to positive actions: non-electric vehicles, hydroelectric power production, meat consumption from ruminants, poor land and animal husbandry practices, poor waste management practices, cutting of trees and the increased use of wood fuel [89,90]. This increased awareness may also contribute to informed decision making [99].

Two primary policy instruments have been developed to address the largest GHG emitters: agriculture and energy. To address the GHG emissions from agriculture, Kenya has developed a Climate Smart Agriculture Strategy for the period 2017 to 2026 [261]. The strategy aims at enhancing the adaptive capacity and resilience of pastoralists, farmers, and fisher-folk, reduce GHG emissions, improve institutional collaboration and address CSA cross-cutting issues. In the strategy, some critical issues identified were gender mainstreaming, increased collaboration and improved data and information on CSA [261] (p. 37). To cut down on the GHG emissions from vehicles, an electric Bus Rapid Transit Plus (eBRP+) System for the Nairobi Metropolitan Region is being developed for Nairobi with the support of the World Bank. The first eBRT is known as Ndovu (elephant) BRT line. After completion of the single Greater Nairobi route, the system will be replicated in four following routes: Nyati (buffalo), Chui (leopard), Simba (lion), and Kifaru (rhino), between 2020 and 2030 [262]. These two policy instruments are largely top-down; government-initiated; government-led; and donor dependent.

A policy environment that facilitates the bottom-up adoption of climate-smart agriculture, energy and environmental decisions, is of paramount importance [90,170,229]. Unfortunately, Government-led approaches that are loan or donor financed are not sufficient to address the current climate change challenge. The need for all stakeholders from the public and private sector to embrace individual and group responsibility to address climate change, requires more than top-down, government-led, externally financed, climate change processes and programs.

4.2.2. Future Discounting of Actions Contingent on Climate Change Finance

In accordance with the 2015 Paris Agreement, Kenya's Intended Nationally Determined Contribution (INDC) is the reduction of the GHG emissions by 30 percentage (143 MtCO2e), relative to the projected business as usual levels by 2030 [121,122]. This commitment is subject to a pre-condition. Kenya made this commitment contingent to receiving financial, investment, technical and human resource support [121,259]. Kenya's 30% reduction in GHG emissions will only

translate into action if it received external climate change support to realize the commitment.

Slow or lack of action to address climate change, in Kenya, may lead to water resources management disasters that will affect the quantity and frequency of rain and lead to floods and droughts. According to climate change predictions, Kenya will experience a mean annual temperature increase of between 0.8 °C and 1.5 °C by 2030 and a further increase of between 1.6 °C to 2.7 °C by 2060. In addition, there will be an increment in the frequency by 19–45% and 45–75% of hot days and nights, respectively. The increase in hot days and nights will lead to a subsequent decrease in "cold" days and nights [254]. The Government of Kenya (2015), Second National Communication to the United Nations Framework Convention on Climate Change states that: "cold days and nights are expected to become very rare" [254] (p. 4). The government of Kenya (2015), further adds that there will be a change in the amount of rainfall. The percentage of rainfall change is unknown due to disagreements between various climate change models. The projected rainfall change will range between a decrease of 5% to an increase of 17% by 2030. The most significant increase will be in the months of October to December, and by 2060 there will be a 26% increment in rainfall. This information is useful in the management of water resources. With the projected increase in rain and droughts, there is a need to trap and store the water during the rainy seasons and conserve the water for the prolonged drought seasons. This would call for more investments in rainfall trapping and water storage systems. Most of these actions have been put on hold because the climate change outcomes are uncertain or the planned actions are contingent on climate change financing.

The recent crack along the Great Rift valley in Suswa, Kenya illustrates the assertion that some climate change mitigation actions are on hold until a disaster occurs. On 19 March 2018, Kenya was reported to have split at Suswa along the Great Rift Valley (Figure 4.2). Kahongeh and Mwangi (2018), attribute the sudden initial split of four Horn of Africa countries from the rest of Africa (Somalia, Kenya, Tanzania, and Ethiopia) to the increased rainfall that washed the volcanic ash, exposing the ash and activating the inactive volcanic activities. Houses were split into half [263], and families vacated their homes before the crack became catastrophic [264]. The tear was more than 15 m deep and 15 m wide [263]. The crack at Suswa had already been projected in previous studies. Skilling (1993) reported the incremental collapse of the Suswa volcano [265]. Bigg et al. (2009), reported multiple inflation and deflation events in a number of Kenyan volcanoes. Suswa was identified to contain active magmatic systems [266] (p. 981).

Figure 4.2. Aerial view of the extending Great Rift Valley cracks at Suswa, Kenya.

Source: Akwei (2018) [263].

The Government of Kenya (2015) report, affirms that the increase during the short rains (March and April) will primarily affect the western Rift Valley region leading to flooding and other climate change-induced disasters [110,254]. The Suswa Rift Valley crack was instigated by a significant flooding event during the March/April rain season.

Risk perception is a crucial component that is required to translate climate change commitments into action [267-270]. Despite numerous studies on the adverse effects of climate change and the effects of heavy rains on the Suswa volcanoes, there has been inaction in the public and private spheres [265,266]. The actual life-threatening tear of the Earth's surface along the Rift Valley, and the subsequent destruction of roads, houses and other infrastructure, increased stakeholders' perception of the particular risk and led to immediate relocation and government action [263,264]. The complication facing Kenya and many other countries is the lack of familiarity of climate change and SA of the need for individual and joint responsibility to address the risks. This has led to inaction, when so much can and still remains to be done, with or without external support.

4.2.3. Research goal and questions

The goal of this chapter is to propose policy recommendations to support the implementation of the Paris commitments and contribute to combating GHG emissions and the climate change governance problem. Through the research we build the capacity of policymakers by introducing the unfamiliar world of climate change to enhance their situation awareness with the aim of changing their perceptions, attitudes, and behaviours, leading to action.

To arrive at the research goal, we formulated three questions with the use of the research, learning and intervention conceptual framework developed by Mayer, Veeneman (2002) [271] (p. 33).

1. *Learning:* Do the policymakers enhance their situation awareness (SA) of climate change risks?
2. *Research:* Can increased situation awareness move policymakers from Paris commitments to action?
3. *Intervention:* How can familiarity, gender, and team factors contribute to the change in SA of climate change risks in the Nzoia River Basin?

4.3. Methods

In this section, we provide a summary of the methodological steps used to answer the research questions. There are three steps: first, assess whether the policymakers' situation awareness was increased by comparing the pre-game and post-game SART results [272]. Second, if the SA increases, assess whether it led to action, whether immediate or delayed. Finally, if there was action (whether delayed or immediate) assess, which of the select three factors (familiarity, gender, and team SA) or their combined effect contributed to the action. We are interested in the interaction effects of the three factors, familiarity, gender and team of players, on situation awareness.

4.3.1. Situation Awareness (SA)

To assess whether climate change may lead to increased situation awareness, we conducted a quasi-experiment using gaming and simulation. The respondents completed a pre- and post-game situation awareness questionnaire. The questionnaire uses a 10-dimensional subjective pre- and post-trail rating approach developed by Taylor (1990), known as SART. Results indicate an increase in situation awareness on three aspects: (1) demands on attentional resources; (2) supply of attentional resources, and (3) understanding of the situation.

There are several SA measurement techniques, including SART [273]. In the Nzoia WeShareIt game, we used three SA measurement techniques: subjective rating measures (SART) pre-test and post-test questionnaires, performance measures and embedded task measures that were inbuilt in the game [88,100,239]. Endsley (1995) highlights objectivity and less intrusion as critical advantages of performance measures over self-rating subjective techniques. The players did not realize that they were being assessed because the performance matrices were inbuilt in the digital game. Performance measures model a more realistic environment. In addition, performance measures helped in checking the reliability of the subjective SART scores [274]. Another type of performance measurement that was inbuilt in the Nzoia WeShareIt game was external task measures. Sarter and Woods (1991) explain that external task measures entail altering the information and, thereafter, measuring the time taken to react to this change [275]. This measurement technique was introduced in the Nzoia WeShareIt game through a drought round that leads to a significant reduction in resources. Endsley (1995) cautions that the technique may be based on wrong assumptions and is highly intrusive. We incorporated this technique because we strategically intended to intrude and alter ongoing tasks and plans thereby disrupting normality with the aim of increasing situation awareness. Team and cross team SA was not included in the design and measurement of the policy game [274]. The Nzoia WeShareIt game also uses the embedded task measures technique to measure situation awareness. The inbuilt electronic game automatically calculated how much trading is done by each participant and what they buy and sell. Also, there is information on how much each player spends on buying food, hydro-electric power, solar power, investing in public services and the payment of penalties. This information can be used to measure many aspects of preferences, strategies, goals and situation awareness levels. The challenge we faced while using the data collected from this technique was the interconnectedness of many factors, that may lead to misleading results. To address this, we used many research techniques to triangulate and confirm the results.

SART is a subjective rating by a person of their level of SA [252]. The technique involves 10 dimensions, based on three 7-point Likert subscales (1 = Low, 7 = High). These subscales measure the degree to which that person perceives (i) the demand on attentional resources (D), (ii) the supply of attentional resources (A), and (iii) the understanding of the situation that they face at that particular moment (U). The factors that comprise demand (D) are the stability of the current situation, the complexity of the situation or and the variability of the situation. Supply of attentional resources (S) includes factors that measure the person's level of concentration and the degree of their spare mental capacity. The factors that influence understanding (U) are the quality

and quantity of available information and the extent to which the person is familiar with the situation. According to the SART, SA is measured by combining the ratings in each subscale and then calculating the respondent's SA. Composite SART scores are derived using the following formula:

$$SA = U - (D - S).$$

- U refers to summed understanding.
- D refers to summed demand.
- S refers to summed supply.

In this study, we measured the SA of seven Nzoia policymaking teams. In addition, we contrasted this internal perspective with game data derived from the playing of the game by the seven teams, each playing six rounds. The game data collected were the individual scores that each of the SART respondents scored in every round, based on their perception of the game elements in the Nzoia WeShareIt game environment, the comprehension of their meaning in relation to climate change and the projection of their status through long-term planning and joint management of the shared resource. In every game session, we had three facilitators. However, the facilitators did not rate the SA of the policymakers, because of previous research questions about the validity of the rating scores by observers [252,276].

4.3.2. Factorial Multivariate Analysis of Variance (MANOVA)

We used factorial MANOVA to measure the influence of three independent variables (familiarity, gender and seven teams comprising of five persons each for seven-game sessions) on a dependent variable (situation awareness) with three subscales (demand, supply, and understanding). We selected MANOVA as opposed to analysis of variance (ANOVA) because the tested group differences are on four dependent variables (one SART scale variable for situation awareness and three subscales). Another advantage of using MANOVA instead of ANOVA is its ability to test the differences between the groups on two or more dependent variables simultaneously. It considers all the dependent variables and looks at the interaction effect simultaneously. For ANOVA, the analysis is done separately and does not consider the combined effect.

The three independent variables (also called factors) are categorical, while the dependent variable is continuous. Therefore, the total number of groups compared was 28 (2 × 2 × 7). The Fisher test was conducted to assess whether the group means for the dependent variable are equal or different.

We designed the three-way ANOVA to study two types of effects: (1) the main effects, this refers to the separate influence of each factor; and (2) the

interaction effects, this refers to the combined action of the factors. The study comprises three factors: familiarity, with two (2) levels (low, high); gender, with two (2) levels (male, female); and a team of players, with seven (7) levels (pre and post-game teams for Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans-Nzoia*6 and Trans-Nzoia*7). The research study is designed to assess seven effects in three orders: three main effects: familiarity (F), gender (G) and teams (T) (the separate factor effects); three second-order interaction effects: F*G, F*T, and G*T; and one third-order interaction effect: F*G*T. The detailed design specifications for the MANOVA is contained in Appendix A. Details of the various factorial MANOVA interaction effects studies and the questions and hypotheses that were assessed are contained in Appendix C.

4.3.3. Nzoia WeShareIt Game Experimental Design

To bridge the gap between the familiar and the unfamiliar we need a "s'ymbolon". "S'ymbolon" is a Greek word for symbols. A symbol is a phrase, object, identity or token, that takes a different meaning or form from the original item or word [277]. Symbols are used to introduce the unfamiliar world into the familiar. The game utilizes climate change disasters to introduce the unfamiliar world and increase the opportunity for planning or taking actions to address unfamiliar risks. A detailed description of the game design is provided by Onencan et al. (2018) [88].

The quasi-experimental design is as follows:

1. The policymakers subjectively rate their situation awareness level before the game using a pre-game questionnaire (low familiarity).
2. During the game, the delayed effect game mechanic introduces a climate change-induced disaster (drought), thus increasing the exposure of the policymakers to risk.
3. The policymakers subjectively rate their situation awareness level after the game using a post-game questionnaire (high familiarity).

Prior to each session, the participants filled in the SART pre-game questionnaire. Immediately after that they were introduced to the game and played six rounds for half a day. After the conclusion of the sixth round, players completed the post-game questionnaire which also incorporated the SART 10-dimension questions. Throughout the quasi-experiment, SA feedback was provided to the players in the form of their game performance scores that were updated real-time and made available on the whiteboard screen, at the end of every round. The in-game leaderboard that was projected on the screen and updated real-time, and there were regular updates from other participants through the step-wise interactions.

4.3.4. Treatments and Measures

The quasi-experiment had no control group. Therefore, all the teams experienced the same game environment with the same game mechanics and elements. Each team was exposed to the same treatment conditions of familiarity (low versus high) and mixed gender setting (female versus male). Since it was a quasi-experiment, it could not be treated as a typical 2 × 2 experimental design. The variables we used (familiarity, gender, and SA) and the constructs they measure are presented in Table 4.1.

Table 4.1. Variables definition and measurement.

Construct	Variable	Type	Variable Description	Variable Measurement
Familiarity	The extent of risk exposure	Nominal: dichotomous	The extent to which the policymakers are exposed to climate change risks, which was either high or low (normality)	0 = Low 1 = High
Gender	Interaction of risk familiarity and gender	Nominal: dichotomous	The interaction of the different genders to exposure to high or low climate change risks, amongst the 7 teams (game sessions)	1 = Female 2 = Male
Situation awareness (SA)	Demand	Interval: continuous	Demand level on attentional resources	7 Point Likert Scale
	Supply	Interval: continuous	Supply of attentional resources	7 Point Likert Scale
	Understanding	Interval: continuous	Understanding of the Nzoia Basin situation	7 Point Likert Scale
	Situation awareness	Interval: continuous	Situation awareness that has been attained	Understanding—(Demand–Supply)

SART scores were measured by first deriving the summation of demand, supply and understanding scores. Thereafter, SA was calculated by the use of the following SART formula: U − (D − S). U represents understanding, and D represents the demand for attentional resources, and S represents the supply of attentional resources. SART is intended to be measured at the end of the experiment. However, the research approach was designed to measure SART before the start of the game (pre-game) and after the end of the game (post-game). The SART questionnaire was electronically inbuilt in the game and connected to SurveyMonkey so that the results were collected using the SurveyMonkey. In total, seven pre-game and seven post-game teams were assessed. The number of respondents was 70 (35 pre-game and 35 post-game). The observers did not complete the SART questionnaire. The in-game assessment was different for each player, depending on the county government

they were representing. The assessment measured performance based on the amount of food, energy, and investments made, based on five different scales unique for each county government. Based on the policymakers' performance, they collect smileys which accumulate in every round. Onencan et al. (2018) provide a detailed description of the in-game design and assessment framework. The dataset used to conduct the SA, factorial MANOVA and in-game performance measurements are found in the 4TU repository [272].

4.4. Results

In this section, we present the experimental findings on the SA of the different water policymakers in the quasi-experiment. Section 4.4.1, presents the general SA results as well as the underlying dimensions of demand, supply, and understanding. In Section 4.4.2, the overall in-game results on the individual policymaker's performance are visualized and explained. Section 4.4.3 focuses on the factorial MANOVA results that assess the role of the three factors (gender, team, and familiarity) on SA. The results section focuses on answering three research questions:

1. *Learning:* Do the policymakers enhance their situation awareness of climate change risks?
2. *Research:* Can increased situation awareness move policymakers from Paris commitments to action?
3. *Intervention:* How can familiarity, gender, and team factors contribute to the change in SA in climate change risks in the Nzoia River Basin?

4.4.1. Climate Risk Situation Awareness of the Nzoia River Basin Policy Makers

The SA findings are based on subjective SA scores of the Nzoia River Basin policymakers before the start of the Nzoia WeShareIt game (pre-game questionnaire) and at the end of the game (post-game questionnaire). Each team consisted of five policymakers each representing the five selected county governments in the Nzoia River Basin (Bungoma, Busia, Kakamega, Trans Nzoia and Uasin Gishu). Since we had 7 teams, each with 5 members and SA was measured for the pre- and post-game subjective ratings, we had in total 70 measures of SA. Table 4.2 indicates an increase in SA at all levels (demand, supply, and understanding). The standard deviation scores showed a spread out of the scores at the pre-game stage and more convergence towards the mean at the post-game stage. Table 4.2 summarizes the means, standard deviations, and percentiles of the policymakers' situation awareness.

Table 4.2. Descriptive statistics of SA and its dimensions

	N	Mean	Std. Deviation	Min	Max	Percentiles 25th	50th (Median)	75th
Pre-Game Demand	35	8.23	4.14	3.00	18.00	5.00	8.00	10.00
Post-Game Demand	35	16.69	3.22	10.00	21.00	14.00	17.00	20.00
Pre-Game Supply	35	9.94	5.37	4.00	28.00	6.00	9.00	12.00
Post-Game Supply	35	24.17	3.67	13.00	28.00	22.00	25.00	27.00
Pre-Game Understanding	35	8.43	3.88	3.00	20.00	6.00	8.00	11.00
Post-Game Understanding	35	19.37	2.14	14.00	21.00	18.00	20.00	21.00
Pre-Game SA	35	10.14	7.88	−3.00	38.00	4.00	9.00	13.00
Post-Game SA	35	26.86	5.21	17.00	38.00	23.00	27.00	30.00

We checked for significant outliers. According to the boxplot diagram in Figure 4.3 there is only one significant. The Y-Axis represents the total SA score for each of the 35 respondents, whereas the X-Axis visualizes two separate statistics for the two data subsets, the individual SA scores for the pre-game and post-game. The respondent that was identified as an outlier had extremely high pre-game SA scores compared to other players in all the seven teams. Since it was only one outlier, we decided to keep the respondent results in the subsequent analysis.

An ANOVA using Friedman's test and Tukey's test for non-additivity for SA scores was conducted. The ANOVA showed that there is a statistically significant increase in situation awareness at the $p < 0.05$ level, $F(1, 34) = 26.85$, $p = 0.005$. The ANOVA test details are in Table A.1 (Appendix A). The increase is also visualized in the Boxplot (Figure 4.3).

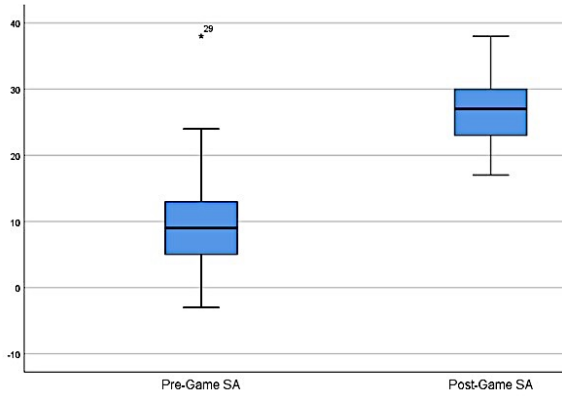
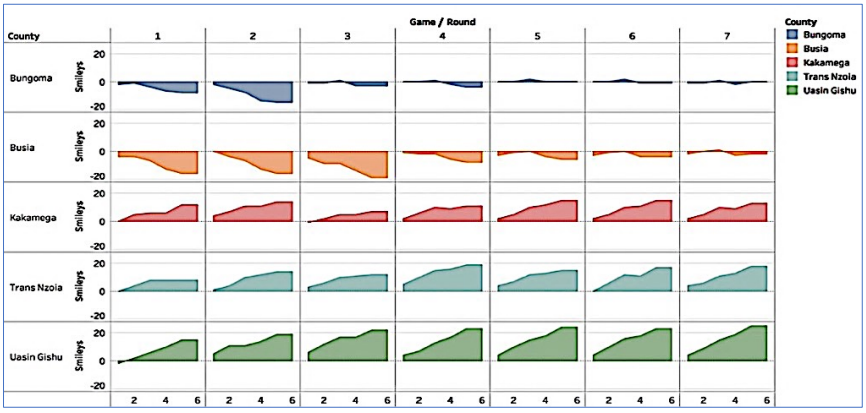


Figure 4.3. Boxplot to identify significant outliers.

4.4.2. The Contribution of Nzoia WeShareIt Policy Game to Enhancing SA

The in-game findings indicated a cumulative improvement in game performance with team 1 and 2 being the least performing teams and team 5, 6 and 7 being the best performing teams (Figure 4.4). Results showed that there was cross learning within and between teams. The within-team learning was demonstrated by the improved results after every successive round. The between-team cross-learning was demonstrated by improved overall performance and the mastering of the game after each successive game session.



F**igure 4.4.** Smileys received by local governments per round

It is important to note that the players did not meet each other before and after the game sessions. Therefore, we concluded that the boundary spanners that connected the different teams so as to enhance the between-team SA, were the three facilitators. There was no quantitative data that was collected to verify this assumption. The assumption on the contribution of the facilitators as boundary spanners to the 7 teams was based on the qualitative data captured in the game observations, the rough-cut game video recordings, and the debriefing session notes.

4.4.3. Factorial MANOVA Results

A 3 × 4 factorial MANOVA was conducted to compare the effect of three independent variables (IDVs), (gender, familiarity, and team) on the overall situation awareness as well as on the three SA dimensions (demand, supply, and understanding). Table A.2 (Appendix A) lists effects, questions, and hypotheses for the three IDVs (gender, team, and familiarity) and their interaction effects. Table A.3 contains the main descriptive statistics. Table A.4 contains details on the between subject factors.

The highest order interaction effect (the third order interaction effect), indicated a significant difference between the levels of familiarity levels (high or low), gender (female or male) and teams (one of the seven teams), when considered jointly on the variables demand, supply, understanding and situation awareness, (Wilk's λ = 2.82 (F 9, 112.10) = 0.78, p = 0.01, partial $\eta 2$ = 0.15).

The results of the MANOVA indicated that there is no significant simple second-order interaction effect (Table A.5). In particular, there was no significant difference between policymakers with different familiarity levels (high or low) and gender (female or male), when considered jointly on the variables demand, supply, understanding and situation awareness (Wilk's λ = 0.95 (F 3, 46) = 0.82, p = 0.49, partial $\eta 2$ = 0.05). The results also indicated no significant difference between policymakers with different familiarity levels (high or low) and teams (one of the seven teams), when considered jointly on the variables demand, supply, understanding and situation awareness (Wilk's λ = 0.61 (F 18, 130.59) = 1.37, p = 0.16, partial $\eta 2$ = 0.15). In addition, there was no significant difference between policymakers with different gender (female or male) and teams (one of the seven teams), when considered jointly on the variables demand, supply, understanding and situation awareness (Wilk's λ = 0.94 (F 9, 112.10) = 0.30, p = 0.97, partial $\eta 2$ = 0.02).

For the 1st main effect, the results of the MANOVA indicated that there was a significant difference between high and low familiarity on the three

subscales and the overall SA, (Wilk's λ = 0.16 (F 3, 46) = 82.74, p = 0.005, partial $\eta 2$ = 0.84). For the 2nd main effect, there was no significant difference between female and male SART scores on the three subscales and the overall SA, (Wilk's λ = 0.95 (F 3, 46) = 0.78, p = 0.51, partial $\eta 2$ = 0.05). For the 3rd main effect, there was no significant difference between seven teams on the three subscales and the overall SA, (Wilk's λ = 0.75 (F 18, 130.59) = 0.76, p = 0.74, partial $\eta 2$ = 0.09).

The 2 × 4 MANOVA assessment of the familiarity IDV indicated a significant difference between the group means for the familiarity (F) factor on the overall situation awareness as well as on the three SA dimensions (demand, supply, and understanding) as the dependent variables (Table A.5).

Follow up tests of between-subjects' effects were conducted for gender, team, and familiarity, with each ANOVA conducted at an alpha level of 0.05. The results confirm the MANOVA results. There was no significant gender or team between-subjects effect on the overall SA and its three dimensions (demand, supply, and understanding). The detailed results of the test of between-subjects' effects can be found in Table A6.

The tests of between-subjects effects indicated significant demand effect (F 1, 6) = 92.27, p = 0.005, partial $\eta 2$ = 0.66), with the post-game SART results reporting significantly higher familiarity on demand for attentional resources than the pre-game SART results.

The familiarity between-subjects tests also indicated a significant supply effect (F 1, 6) = 148.81, p = 0.005, partial $\eta 2$ = 0.76)), understanding effect ((F 1, 6) = 180.26, p = 0.005, partial $\eta 2$ = 0.79), and overall SA effect (F 1, 6) = 112.96, p = 0.005, partial $\eta 2$ = 0.70).

The post-game SART results reported significantly higher familiarity effects on all the four dependent variables (overall SA, demand on attentional resources (D), the supply of attentional resources (A), and the understanding of the situation that they face at that particular moment (U)), than the pre-game SART results.

Follow up univariate tests of between-subjects' effects were also conducted for third and second order interaction effects of gender * familiarity * team (third-order effect), familiarity * gender (2nd-order effect), familiarity * team (2nd-order effect), and gender * team (2nd-order effect). The results confirm the MANOVA results. There was no significant second order interaction effect. However, the third order interaction effect indicate mixed results. The mixed results indicate significant combined gender * familiarity * team (third-order effect) interaction effect on demand (F 3, 68) = 5.57, p = 0.005, partial $\eta 2$ = 0.26)) and the overall SA ((F 3, 68) = 4.56, p = 0.01, partial $\eta 2$ = 0.22). The third order interaction effect was not significant on supply (F 3, 68) = 1.53, p = 0.22, partial $\eta 2$ = 0.09) and understanding (F 3, 68) = 0.89, p = 0.89, partial $\eta 2$ = 0.01).

The post-game SART results reported significantly higher familiarity effects on all the four dependent variables (overall SA, demand on attentional resources (D), the supply of attentional resources (A), and the understanding of the situation that they face at that particular moment (U)) than the pre-game SART results. The mean difference between low and high familiarity is 16.71. Table A.5 details the results of the tests of between-subjects' effects for familiarity factor. Table A.6 contains the univariate test results that test the effects of familiarity, based on pairwise comparisons that are linearly independent among the estimated marginal means. Table A.7 is a simple comparison between high and low familiarity, which indicates that that difference between the four dependent variables, is significant.

Overall SA has an important influence on the dependent variable familiarity. Additionally, D and SA have a significant influence on the third-order combined effect of F*G*T. To assess how big is the influence of SA on the dependent variable familiarity we assessed the difference between the groups by consulting the table of pairwise comparisons (Table A.8, Table A.9 and Table A.10 in Appendix A). To demonstrate that SA increases familiarity, we maintained only the positive difference. Therefore, the mean difference between the low familiarity and the high familiarity groups is 16.71; the *p*-value is lower than 0.0005. Thus the difference is statistically significant. In conclusion, SA is effective at high climate change risk familiarity levels.

In summary, we noticed that both familiarity and the third order combined effect of F*G*T effect grow when the SA increases. These findings reveal the importance of familiarity in enhancing SA at all levels. While an increase in familiarity leads to a subsequent increase in demand, supply, understanding, and overall SA, the third-order combined effect of F*G*T only affected demand and the overall SA. For the gender and team factor to have any effect, they need to be combined with familiarity at the third order effect level. Any lower level (lower than the third level of interaction) interaction where familiarity is not incorporated in the factors, led to no significant results. In addition, it is not clear whether the third-level interaction was only significant because of familiarity because the other two factors do not seem to have any effect at the second-order and main effect levels. Therefore, we concluded that familiarity is a critical factor that should be incorporated into the design and implementation of climate change risk situation awareness interventions.

4.5. Discussion: Key Findings and Policy Relevance

4.5.1. Summary of the Key Research Findings

The research results can be summarized in three main findings:

1. There was a significant increase in player SA when comparing the pre-test and post-test SART results. The pre-game individual scores were treated as the baseline data. The movement from commitments to actions is a complex socio-technical system that requires further analysis. We, therefore, propose triangulation of the research measurement method to effectively assess this complexity (see Section 5.2.).
2. We noticed that increased SA did not lead to immediate actions. Actions were only taken by the later teams after hearing stories on previous game sessions from the facilitators. Therefore, there are two key elements to successful policy implementation: a story (see Section 5.4.) and a person with the connective capacity to effectively narrate the story and span the boundaries between two or more geographically dispersed teams (see Section 5.3.).
3. The results indicate that increased SA only leads to action if the policymakers are familiar with climate change actions and there is a combined interaction effect between gender, team (mainly cross-team) and familiarity. To ensure gender balance, we recommend mainstreaming gender in climate change processes and actions. Gender mainstreaming will be addressed in more detail in a subsequent publication. For the team, we recommend more capacity development of policymakers' connective capacity to enable them to span the multiple climate change boundaries. Team-interdependence and social learning will also be addressed in more detail in subsequent publications. For familiarity, we recommend an increase in the quantity and quality of climate change stories, metaphors, and synecdoche's as explained in Section 5.4.

4.5.2. Triangulation of SA Measurement Techniques

The findings in Section 4.5.1, indicate an unexplained variance between the subjective individual SART scores and the game results. The SART results measure individual situation awareness and do not consider team and cross-team SA. These findings are based on the three SA measurement techniques that we used: subjective rating measures (SART) pre-test and post-test questionnaires, performance measures and embedded task measures that were inbuilt in the game. The findings reveal the positive influence of within-team and cross-team SA. There was cross-learning between these geographically dispersed teams, and they did not have any contact during the game sessions.

Based on the in-game findings, there was a cumulative improvement in game performance with team 1 and 2 being the least-performing teams and team 5, 6 and 7 being the best-performing teams. This indicated that there was a form of social learning that kept building up with each successive round and game, despite the weak linkages between the teams, if any.

In similar future research, game designers should triangulate a number of measurement techniques. Apart from the three measurement techniques used in the research, game designers should also consider using observer-ratings to test other factors that influence the final results and the in-game freeze technique. The observer-rating technique was not incorporated in the Nzoia WeShareIt assessment. However, it proved useful from the game results. The game outcomes indicate that the facilitators had a significant influence on the player's SA. This conclusion could only be inferred because the facilitators were not incorporated in the measurement techniques. The observer-rating technique requires an independent, knowledgeable observer to rate the SA of the players and the facilitators. This observer could also assess the role of the facilitators in the team and cross-team cooperation when the teams are dispersed. Endsley (1995) explains that the freeze technique involves random freezing of the system displays and suspending simulations for a short moment to allow the participants to reflect on the perception of the situation [274]. This approach is implemented several times during the simulation. We noticed that half a day was too long before reflection and so many things happen and are forgotten during the game session. The debriefing was not useful in measuring situation awareness, especially just before lunch when the participants are hungry or plan to return back to their respective offices. Therefore, the freezing technique would be ideal for addressing some of these challenges.

Triangulation is the proposed approach to ensure more objective, reliable and valid results that can easily be tested and confirmed with a separate set of results measured on the same respondents during the same climate change gaming simulation. Many techniques can be used to measure the enhancement of climate change situation awareness. Each situation is different. Therefore, one technique might work in one case study and not in another. Policy game designers should understand the contribution, value, and drawbacks of each technique, before finally selecting the suitable set of techniques.

4.5.3. Role of Boundary Spanners in Enhancing Climate Change Governance

The policymakers within the 5 teams increased their SA by actively participating in the policy game. Unfortunately, the in-game data indicated that increased SA was not sufficient to spur policymakers to undertake policy action. The results indicate the need to hear actual stories from someone who had experienced that game in a previous game session in order to act. The first

players did not have this advantage, and thus they were not able to implement what they had learned quickly.

For the climate change discourse to change people and for these changed individuals to act, there is a need for boundary spanners. A boundary spanner enters an unfamiliar world, experiences the unfamiliar world, and comes back, to the familiar world with unfamiliar experiences. As such, the facilitators' stories of previous game sessions were symbols that made climate change risks and opportunities not unfamiliar to the new team of policymakers. Through the stories of experiences in the previous game sessions, the policymakers were ready to take the risk of moving from commitment to action aimed at addressing climate change risks. This change happened, because the risks no longer were unfamiliar.

Future climate change interventions should incorporate boundary spanners, to spur change from within the system through horizontal social networks. Climate change boundary spanners can play the following roles:

1. Unfamiliar climate change information processing and validation through experience;
2. The external representation of the dynamic climate change system that they have experienced to persons who are still unfamiliar with the climate change risks and opportunities;
3. Monitoring climate change-related impacts, projects, and opportunities;
4. Scanning the system for climate change risks and opportunities; and
5. Acting as climate change gatekeepers.

4.5.4. Policy Relevance: Bridging the Familiarity Gap

The research findings indicate that familiarity plays an extremely significant role in instigating policy action to support the implementation of the Paris Commitments. However, there is little guidance on how to introduce the unfamiliar climate change world into the current familiar world. Stone (2002) defines a symbol as "anything that stands for something else" [277] (p. 157). Stone (2002) explains that symbols may seem trivial, but they have the ability to take living form, which is not possible with climate change facts and numbers. Symbols are used to represent an unfamiliar world within the familiar world. Once they take a living form of their own, then the unfamiliar world ceases to be unfamiliar [277].

Policy gaming is a useful tool that can be used to introduce climate change symbols in the form of (1) stories; (2) synecdoche's; and (3) metaphors. Climate change stories are narratives of climate change villains and heroes, risks, and opportunities; problems and solutions; and resolutions and tensions, introduced in a storyline. Climate change synecdoches represent the whole with only a small part. A useful synecdoche are horror stories of climate change-induced

disasters. The cracking of Africa into two along the Kenyan Great Rift in Suswa is a horror story and if used well can be a successful strategy to initiate and maintain climate change actions. Climate change metaphors are used to liken one policy problem to the climate change problem. Some of the common metaphors that can be likened to climate change are climate change-related diseases, climate change and water crisis, climate change wars, climate change refugees and immigrants and climate change natural disasters. Metaphors are useful in bridging the climate change familiarity gap. Although climate change may seem unfamiliar, linking it with current policy problems that are considered "real" gives life and form to the climate change story.

Successful climate change story-making requires a careful balance between the two sides of the narrative. First, the story should contain two sides of the narrative. Second, the two sides should be balanced. Game simulation of two sides of the story and ensuring there is a balance between the two sides are critical competencies that all climate change game designers should have. Stories of power must contain two sides: helplessness and control. If the helplessness aspect is too strong that it clouds the control part, then the story is not balanced and is easily discounted as an illusion. Most of the climate change stories leave the listeners feeling helpless with no sense of control. That is why they are barely considered as real stories that necessitate action. Some climate change stories also take the form of "random", "accidental", "deeply uncertain", "natural", and "a twist of fate" [277] (p. 166). The imbalance in the narrative makes it difficult for the story to lead to action. Story imbalance leaves listeners feeling helpless, leading to minimal or no action.

Policy gaming could play a prominent role in the development and narration of balanced climate change storylines, metaphors, and synecdoches. A critical aspect of the Nzoia WeShareIt game was the introduction of climate change synecdoche's in the form of drought. However, this drought horror must be balanced with the positive opportunities that arise out of the disaster to avoid leaving the players feeling helpless.

Human agency and how individual, societal and state actions can catalyse positive change is a critical element that should always be considered when crafting a storyline. However, caution should be taken not to tip the balance towards human agency. Climate change stories that are heavily skewed towards human agency, take the form of conspiracy theories. These stories create the impression that climate change reforms can only be done by a few influential people. Conspiracy stories leave the listeners powerless, and no action is taken. Alternatively, there are also stories that confine human agency to a select few. One prominent story that has taken centre-stage in the climate change negotiations for more than two decades is the blame-the-victim story. The Western worlds are blamed for destroying the ozone layer, and thus they should

pay reparations to developing countries. Such stories blind the developing countries to the many actions happening within their boundaries that may be contributing to the global climate change crisis. As indicated in this research, Kenya is significantly increasing its GHG emissions but still maintains that its commitments are contingent on external climate change support (human, financial, investment and technological). This story precludes the Kenyan government and citizens who continue to buy GHG-emitting vehicles, destroy forests or keep large herds of cattle that emit methane, from taking immediate steps to reduce the current GHG emissions. Blame the victim stories create an "us versus them" mentality where the Western world denies culpability and the developing world waits upon the Western world to fix the problem. Most important to the climate change discourse are the stories of change. Stories of change consist of two sides: decline and progress. A careful balance between the current climate change decline story and the progress made to address and curb the decline is of critical importance. Future research should focus on progress stories, to tilt the scale away from the decline stories, towards a more balanced narrative.

Future climate change research should assess the contribution of symbols in the climate change policy discourse, specifically in the following research fields:

1. Contribution of climate change stories of progress on increased SA;
2. Creation of alliances around a climate change policy problem with the aim of developing shared meaning;
3. Reducing stories that promote helplessness and supporting societies to gain control and strengthen climate change bottom-up, goal-oriented movements and interest groups;
4. Enhancing climate change policymaking that facilitates bottom-up implementation;
5. Encouraging climate change collective action at the local, national, regional and global level [277] (p. 181).

4.6. Conclusions

The adoption of the Paris Agreement was a great stride in global climate change governance. The agreement changes the traditional mode of international cooperation that is mainly top-down to a hybrid model that incorporate both top-down and bottom-up elements. The core mechanism of the Paris Agreement is the five-year review mechanism. However, studies indicate that this mechanism is bound to fail, if not supported.

The chapter proposes policy recommendations to support the implementation of the Paris commitments and contribute to combating GHG emissions and the climate change governance problem. Through research,

we build the capacity of policymakers by introducing the unfamiliar world of climate change to enhance their situation awareness with the aim of changing their perceptions, attitudes, and behaviours, leading to action. Three research methods were used. SART for the pre-test and post-test subjective ratings of SA. In-game performance measures assessed whether the increased SA led to the implementation of policy actions. Finally, MANOVA assessed the interaction effects of familiarity, gender, and the 5-member teams. To arrive at the research goal, we formulated three questions:

- *Learning:* Do the policymakers enhance their situation awareness (SA) of climate change risks?
- *Research:* Can increased situation awareness move policymakers from Paris commitments to action?
- *Intervention:* How can familiarity, gender, and team factors contribute to the change in SA of climate change risks in the Nzoia River Basin?

The research results can be summarized in three main findings:

1. There was a significant increase in player SA, between the pre-test and post-test SART results. However, the movement from commitment to action in a complex socio-technical system, requires further analysis, and the use of triangulation of various methods.
2. There are two key elements to successful policy implementation: a story and a person with the connective capacity to effectively narrate the story and span the boundaries between two or more geographically dispersed teams.
3. Increased SA only leads to action if the policymakers are familiar with climate change actions and there is a combined interaction effect between gender, team (mainly cross-team) and familiarity.

The overall research findings indicate that familiarity plays a significant role in instigating policy action to support the implementation of the Paris Commitments. However, there is little guidance on how to introduce the unfamiliar climate change world into the current familiar world. We recommend that there should be more focus on the role of symbols in facilitating the change towards implementing the Paris Commitments. Stories are one form of symbol that can be used. However, we recommend that stories should be balanced, have two sides and ensure that human agency is promoted.

Future climate change research should assess the contribution of symbols in the climate change policy discourse. In summary, the climate change discourse can be changed through the use of boundary spanners and symbols to bridge the familiarity divide between what is considered real or merely an illusion.

5. Relational Learning: Respect for Diversity

Title: Influence of Personal Attributes and Demographic Diversity on Nzoia Basin Negotiation Outcomes

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Research Context: One key attribute of SL is the respect for diversity. Previous research shows that negotiators need to understand and respect diversity attributes, to increase the likelihood of a win-win negotiation outcome. However, there is limited scholarship on what aspects of diversity contribute to expected cooperative actions, in a given social context. This empirical study assessed the predictive power of four diversity attributes on water negotiation outcomes (age, gender, education-level and personal attributes), in the Nzoia River Basin.

Abstract: The Kenyan government has made significant advances in water resources management at the local authority (county) level with little or no cooperation at the drainage basin level. Research on critical determinants of cooperation amongst transboundary water negotiation teams is limited. In this chapter, we assess whether personal attribute diversity (PAD) is a stronger factor than demographic diversity (gender, age, and education play) in determining whether the negotiation team will cooperate or make unilateral actions. We used a negotiation game to study decisions taken by water policymakers. After that, we conducted a multiple discriminant analysis (MDA) to assess the influence of PAD, gender, age, and education on water negotiation outcomes. The findings indicate that PAD plays a significant role in determining whether the group will cooperate or compete. Gender, education, and age barely influence the outcome. Only upon removal of the PAD variable do we see an increase in the discriminant power of gender and education. Age has minimal influence on the negotiation outcomes. We applied the research at a lower level of governance (Nzoia River Basin). However, results might be extrapolated to a bigger basin, like the Nile Basin, through future multiple level analysis which takes account of the complex socio-technical systems.

Graphical Abstract (Figure 5.1)

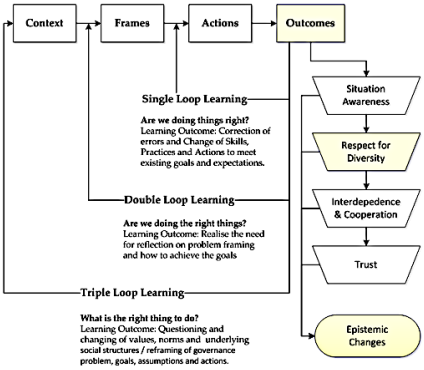

Figure 5.1. Triple-Loop Social Learning Sequence: Respect for Diversity

Keywords: personal attributes diversity (PAD); demographic diversity (DD); negotiation teams; cooperation; unilateral actions; shared superordinate identity (SSI); negotiation game; water resources management; multiple discriminant analysis (MDA); Nzoia River Basin.

5.1. Introduction

Water scarcity is a major global challenge [278-283]. UN-Water defines water scarcity as either physical water shortage or inaccessibility caused by failed water supply systems or inadequate water infrastructures [280]. The problem with this definition is that it combines water deficit and water scarcity in one defintion, which can be misleading or inaccurate in circumstances where there is no water deficit but only water scarcity. Jaeger et al. [284] explain that water scarcity should be distinguished from water deficit. Water scarcity is normative and anthropocentric in nature because it varies based on temporal, spatial and social values (direct and indirect) regarding multiple water uses. We adopted the Kampas and Rozakis [285] (p. 1258) definition of water scarcity as " the opportunity costs of forgone human options that result from a specific water use decision." Jaeger et al. [284] explain that water deficit is purely descriptive. Kampas and Rozakis [285] (p. 1258) define water deficit as "the case where the water is not enough for a specific biophysical process."

Anthropogenic interventions and activities to water, soil and air systems are the main contributors to water scarcity, within a given river basin [282]. Thus there is a need for cooperation within a shared river basin to sustainably manage and control anthropogenic interventions and activities [229,286-289]. In a shared river basin, there will always be in-group and out-group tensions as diverse teams are negotiating to minimise human actions and interventions that threaten current and future water security [86,87,89-91,99,100,170,283]. Therefore, the negotiation team needs to create a willingness amongst the different riparian states to cooperate and sustain the cooperation [288].

Research indicate that the inability of transboundary water negotiation teams to arrive at a win-win solution [167,290] is a major barrier to cooperation [288] for a given river basin [100,286]. According to research, one approach to counter win-lose solutions is introducing a shared superordinate identity (SSI) to surpass in and out-group differences [291]. SSI creates a perception that the riparian governments belong to one group even though they represent different states or local governments [292-294]. It reduces competition, increases cooperation and helps to avoid one-sided outcomes [295-297]. It also spurs innovation leading to knowledge creation, knowledge transfer and improved negotiation outcomes [298-300] According to Gaertner et al. [295], SSI can bridge cultural divides and reduce inter-group conflicts [297]. It also creates an enabling environment for developing both bonding (in-group) and bridging (out-group) social capital [299]. Putnam [301] defines social capital as "social networks and the associated norms of reciprocity and trustworthiness" [301] (p.137). Bonding capital binds people within a given riparian state. Bridging social capital, on the other hand, builds bridges between different riparains

states sharing the drainage basin [301] (p.143). Climate change has been one of the effective tools to create SSI [100]. Through concerted climate-change actions, bridging social capital between riparian states that share a given basin has been strengthened [100,302-304].

SSI is essential for diverse out-groups that have a limited history of collaborative actions [103,305]. We define diversity as the distribution of demographic attributes (e.g., age, nationality, racio-ethinicty, sex, education level) and underlying personal attributes (e.g., values, cognitive, functional, personality, capabilities, knowledge). Studies confirm that diversity has value [301,306]. First, to the network of water negotiators representing the riparian states within a given river basin, it spurs creativity and innovation [301]. Haidt [306] (p.2) states that a diverse environment encourages complex thinking, increases performance, participation, motivation to do more than the bare minimum and interest in the subject matter. Where there is inequity, diversity may support the process of removing barriers to achieving equity and addressing past inequities [87]. Salman [307] explains how a bilateral water agreement between two downstream countries that share water flows within the river forecloses the future use of the water by the upstream countries. In this instance, diversity may facilitate the removal of the foreclosure barrier and address inequities occasioned by the bilateral agreement.

Jackson, Stone and Alvarez [74] classify diversity into two groups, namely, personal and demographic attributes. Demographic attributes are defined as "immutable, … readily detected during a brief interaction with a person, and for which social consensus can be assumed" [74] (p.56). Haidt [306] (p. 4) provides a list of demographic attributes, namely, sex, age, race, and ethnicity. Jackson et al. [74] (p. 56) define personal attributes as "mutable and subjectively construed psychological and interpersonal characteristics." Haidt [306] (p.4) provides a list of personal attributes, namely, status, knowledge, behavioural style and values. Haidt [306] argues that amongst PAD, values (including attitudes) have barely been researched. Kakabadse et al. [308] (p.23) affirm the importance of personal attributes, specifically cognitive abilities, values, background and experiences, in influencing decisions.

Previous research has mainly focused on demographic diversity (DD), with limited studies on underlying personal attributes diversity (PAD) [309]. Jackson [309] (p.805) identifies the most studied attributes in diversity research. Sex (DD) was the highest studied, followed by age (DD), racio-ethnicity (DD), education level (DD), functional background (PAD), tenure in organisation (DD), tenure in job/team (DD), cognition/mental models (PAD), personality (PAD), education content (DD), cultural values (PAD) and finally nationality (DD). Most of the studies focused on performance outcomes with a small percentage focusing on process and affective outcomes.

Haidt [306] argues that different forms of diversity lead to different effects and a general study on diversity that does not disaggregate it into its attributes may not produce useful policy insights. Kakabadse [308] concludes that most of the available research is at the conceptual level, with limited empirical research on the value addition of diversity. Figure 5.2 contains a literature review on DD and PAD studies and their respective added value including the elements that contributed to value-creation [308]. Most of the studies are at the conceptual level with empirical research limited to studies on: values, cognitive, nationality and age diversity.

There is barely any research on the discriminant power of DD and PAD in a given group [308]. We conducted this research to help policymakers reduce the water management costs that arise from heterogeneity, by predicting the possible future group configuration and its strongest diversity attribute. In addition, there is no study that assesses what happens when the heterogeneous groups transform into a demographic homogenous (DH) or a personal attribute homogenous (PAH) group. Do other subdued diversity attributes take prominence and change the group dynamics?

The outcomes may guide water resources management experts to emphasize on the most powerful diversity attribute, so as to enhance its benefits, reduce the costs and focus less on attributes that have limited or no impact on the final outcome. Based on the research outcomes, further diversity studies in water resources management can be conducted on how to introduce and strengthen SSI using the most powerful diversity attribute, so that the heterogeneous group enjoys the benefits of diversity and homogeneity (SSI).

Therefore, we hypothesize that PAD has greater discriminating power than DD (education level, age and gender) in determining water negotiation outcomes (whether a water negotiation groups will develop SSI surpassing in and out-group differences and cooperate or they will act unilaterally), and will diminish in PAH groups leading to a change in group dynamics as DD takes prominence. With the use of a negotiation game known as Nzoia WeShareIt, we examined seven teams of negotiators in western Kenya. By analysing the in-game and post-game data, we assessed which, if any, of these four variables, are useful in predicting whether the composition of certain negotiation teams will cooperate or act unilaterally, leading to unhealthy competition for scarce water resources.

We conducted a discriminant analysis (DA) as a grouping and predictive technique, with the pre-game and post-game questionnaire data. First, we maintained the status quo, the players negotiate within an environment where the four variables are under consideration. Afterward, we conducted a follow-up analysis where we excluded PAD, which is the variable with the highest discriminant power. We then assessed the power of the other three variables in

predicting whether the negotiation groups will cooperate or unilaterally act. The two instances are compared to assess the discriminating power of PAD and DD (gender, age, and education level).

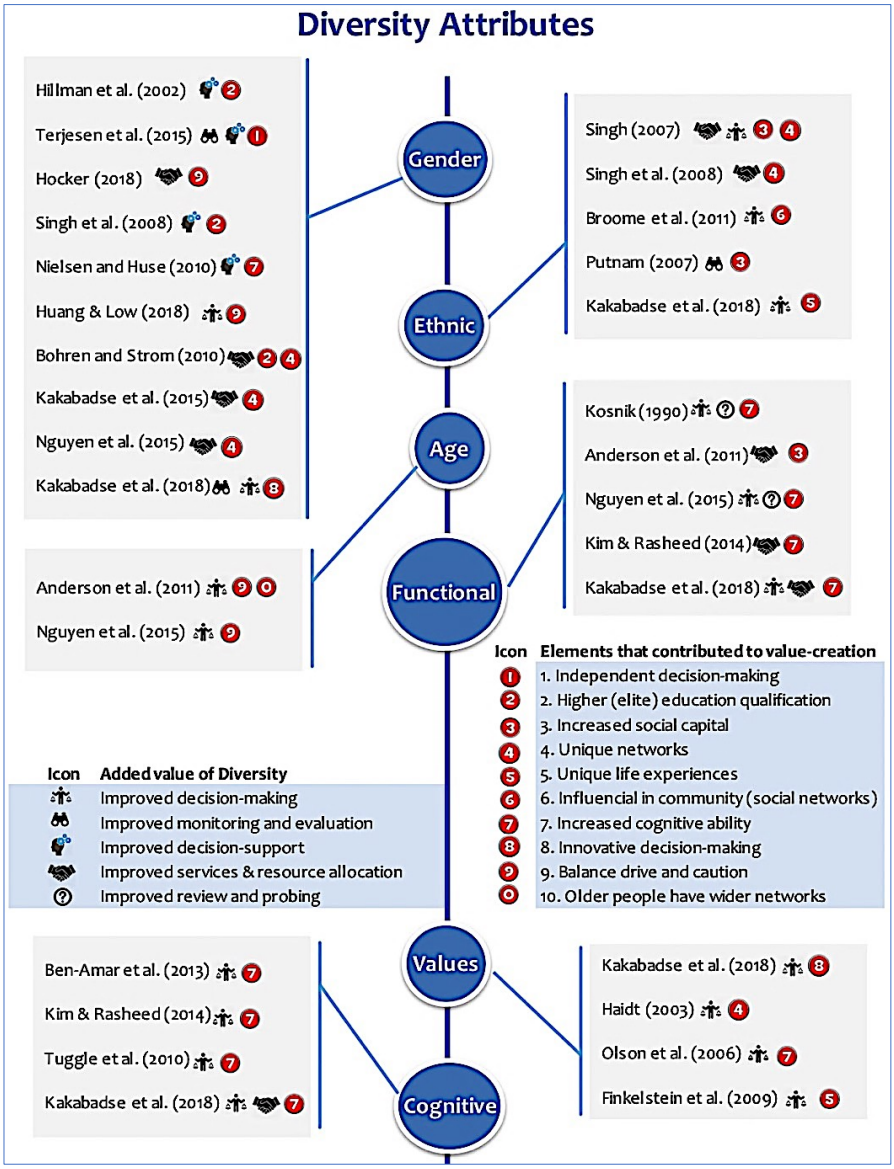

Figure 5.2. Demographic and personal attributes diversity studies

We first provide a detailed description of how we analysed the data. The third section discusses the results of the in-game, and post-game questionnaire data. The final section discusses the emerging issues and makes concluding remarks.

5.2. Data Analysis Procedure

In this section, we will explain the four-pronged data analysis procedure. In step one we selected the methodology. In step two we conducted a crosstabs procedure. Crosstabs procedure is used to create cross tables or contingency tables to disaggregate the data according to gender, age and education. These tables are useful for examining the relationship between two categorical variables. The crosstab contains the number of cases for all the probable combinations of the three variables. The third step in data analysis was assumption testing for the Multiple Discriminant Analysis (MDA) procedure. In the fourth step, we conducted the MDA. Thereafter, we conducted a follow-up MDA analysis where we exclude the variable with the strongest discriminant power.

5.2.1. Step 1: Selection of Methodology

To conduct our analysis, we needed a statistical procedure that is both a grouping method and a predictive technique. Discriminant analysis (DA) met the two requirements because it classified PAD and DD (grouping method) and predicted which variable had a stronger discriminating power. We already knew the groups in advance and did not need to undertake cluster analysis.

We seek to assess whether PAD has more influence than DD on water negotiation outcomes (whether a water negotiation groups will develop SSI surpassing in and out-group differences and cooperate or they will act unilaterally), and will diminish in PAH groups leading to a change in group dynamics as DD takes prominence. Therefore, MDA was found to be the most relevant procedure, after analysing the data and objective of the study. The game data for conducting MDA is available as supplementary information S2.

5.2.2. Step 2: Conducting a Crosstab

We used Crosstabs to create cross tables or contingency tables. These tables are useful for examining the relationship between two categorical variables. The crosstab tables are in Appendix B. We extracted the grouping variables and the three independent variables from the pre and postgame questionnaires. The grouping variables are the 7 game sessions; and (2) four independent variables,

namely age range, gender (male, female), education level and the respondent ID (35 respondents).

Table B.1 (Appendix B) are the results from conducting a cross-tabulation of Gender * Education. The results indicate that the highest number of player's highest attained education was bachelors (8 females and 12 male). The lowest education completed was primary education, by one female. The highest education completed was a Master's degree. Only one woman and two men had completed a Master's degree. There were six male and one female whose highest level of education was a college diploma.

Table B.2 (Appendix B) are the results from conducting a cross-tabulation of Game * Age. The results indicate that the highest number of players were in the 25 to 34 age brackets (#11) and the lowest was the 55 to 64 age brackets (#3). Trans-Nzoia county government policymakers were mainly young persons (25 to 44), and Bungoma county government mainly comprised of elderly persons (45 to 64). Only one game session (Busia_2) had an even distribution of players in all the age sets – 1 player in each age bracket.

Table B.3 (Appendix B) are the results from conducting a cross-tabulation of Game*Gender. The results indicate that three groups purely comprised of male players. The other three game sessions had an acceptable gender balance (3x2). One group had four females and one male. No group had no male represented.

Table B.4 (Appendix B) are the results from conducting a cross-tabulation of Game*Education. The results are similar to Table B.1 results. However, Table B.4 is not disaggregated by gender. All the game sessions had players with a bachelor's degree. The players with the highest education were from Trans Nzoia county government. The player with the lowest education was from Busia county government. Trans Nzoia is the upstream county government, and Busia is the downstream county government.

5.2.3. Step 3: Assumption Testing

Before conducting the MDA procedure, we first checked some assumptions. The three assumptions that were tested and met are: (1) the dependent variable is categorical, with disjoint groups; (2) the independent variables are continuous (or at least ordinal); and (3) there is no critical multicollinearity (the independent variables are not strongly correlated with each other). The detailed results of the assumptions testing are in Appendix B.

The last assumption we tested was that the data does not present significant outliers. The outliers or extreme values may represent a danger for our proposed analysis because they affect the mean and standard deviation. We conducted a graphical test, using boxplot chart histograms to identify outliers (Figure B.1 and B.2). Based on the graphical representation of all the assessment

results of the 20 dependent variables distributed according to gender (Figure B.1) and the seven game sessions (Figure B.2), we identified multiple outliers. Some outliers appear to be extreme because of their distance from the mean. We proceeded to conduct the MDA, after testing model robustness. It was found to be robust enough - not affected by the significant outliers.

5.2.4. Step 4: Conducting an MDA Procedure

To conduct the MDA procedure, we used SPSS discriminant analysis function. For the MDA classification, we treated all groups as equal and used the within-groups covariance matrix. The MDA functions assigned each case to one group by computing the probability of belonging to one group based on the scores of the IDVs. From the MDA we were able to differentiate the groups of the response variables. The MDA procedure aims to use the results to identify what differentiates various negotiators (female, male, young, elderly, and their education level).

5.3. Results

5.3.1. In-Game Data Results

There were two datasets of the in-game data that we found relevant for this particular analysis. The first dataset is the changes in the resources (Food, Energy in the form of Hydroelectric Power and Money) in the seven game sessions for the five county governments. The second dataset is the grand totals of smileys earned in the seven game sessions for the five county governments. We analysed the dataset using the one vital element of cooperation, SSI [77,310]. Figure 5.3 visualizes the changes in the food, energy and money resources, based on the negotiations between the five policymakers in each of the seven game sessions.

Based on the results, there is more evidence of SSI in the game sessions 4 and 6 where the critical producers of food (Trans Nzoia and Kakamega), increase their production to be able to sell the surplus to the other local authorities. In the game session 4, Trans Nzoia also increases food production, thus pursuing SSI based on its comparative advantage, but Kakamega does not increase its production in the game session 4. Uasin Gishu county government pursues SSI in 4, 5 and 6, with better results in game 6, followed by 4 and finally 5. Busia and Bungoma also pursue SSI with the highest changes in the money resource in the game session 6, followed by game session 4 and then 5.

Therefore, from the results, game session 6 negotiation outcomes lead to cooperation, evidenced by the five county governments pursuing SSI in an environment where there are goal asymmetries.

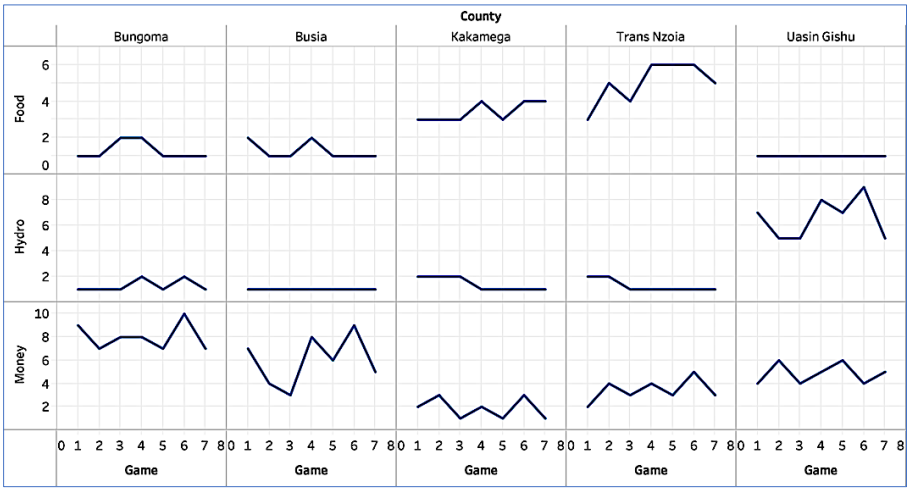

Figure 5.3. The changes in the resources (Food, Energy and Money)

Figure 5.4 visualizes the total of smileys earned based on the negotiations between the five policymakers in each of the seven game sessions. Participants earned smileys when the county government met its resident's food, energy, and investments in public service needs. Based on the results, there is more evidence of SSI in the game sessions 4 to 6 because inequities reduce. Game session 7 has the least negative results whereas game session 2 has the highest negative results.

Using the outcomes visualized in Figure 5.3 and 5.4, we grouped the seven teams as follows:

1. Group 1: **Unilateral actions** (Game session 1, 2 and 3 comprising of 15 policy makers in 3 water negotiation teams); and
2. Group 2: **Cooperation** (Game session 4, 5, 6 and 7 comprising of 20 policy makers in 4 water negotiation teams).

Based on the varied outcomes (cooperation and unilateral actions), it was not clear what diversity attribute was the strongest predictor of the water negotiation outcomes. To gain more insights, we proceeded to conduct a Multiple Discriminant Analysis (MDA) Procedure, as explained in the subsequent parts of this section.

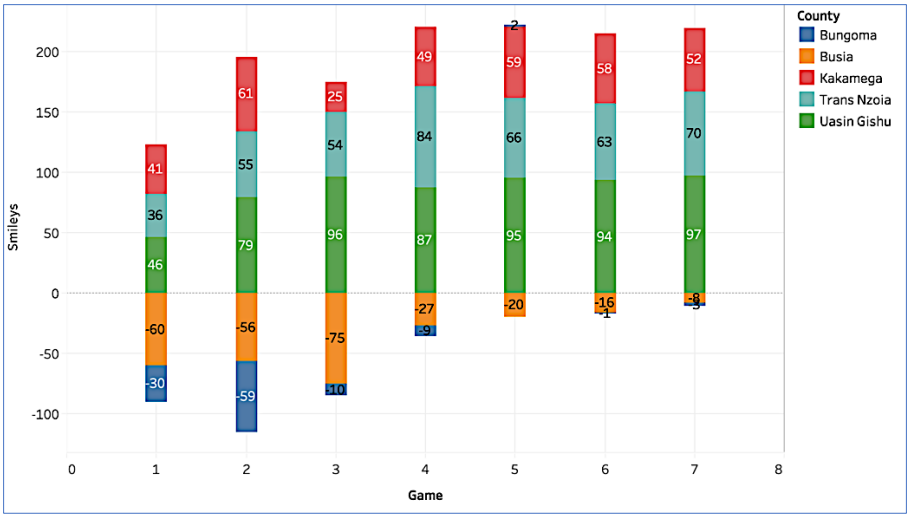

Figure 5.4. Grand totals of smileys

5.3.2. Strength of the Multiple Discriminant Analysis (MDA) Procedure

The program computed four discriminant functions based on four independent variables, education, gender, age, and respondent ID. Every function derives a meaning depending on the variables that it is correlated. Also, with the help of the discriminant function, the program computed the probability of k belonging to one category or another and assigned each k to a category.

The Eigenvalues of each function are found in Appendix B (Table B.5). These values show the importance of each function. The first function has an Eigenvalue was equal to 56.94 and explains 97.1 % of the total modal variance. By contrast, the second function is less critical, its Eigenvalue is only 1.38, and explains only 2.3% of the total modal variance. The third function has an Eigenvalue of .28 and explains .5 % of the total modal variance. The final function has an Eigenvalue of .03 and does not explain any percentage of the modal variance. In the last column of Table 5.1 are canonical correlation coefficients. These squares show the percentage of the variation in the response variables, which is an explanation of the variation by each function. The canonical correlation associated with the first eigenvalue was equal to 0.99, followed by 0.76. The first function explains the highest variation whereas function 4 explains the lowest.

Table 5.1. The table of the Eigenvalues of each function.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	56.935[a]	97.1	97.1	0.991
2	1.376[a]	2.3	99.5	0.761
3	.282[a]	0.5	100.0	0.469
4	.029[a]	0.0	100.0	0.167

[a.] First 4 canonical discriminant functions were used in the analysis.

The table of Wilks' Lambda (Table B.5 in Appendix B) indicated how strong is the discriminating power of the PAD and DD variables. The lower the Wilks' Lambda, the stronger the discriminating power of the independent variables. The first line represents the Wilks' Lambda for all the four functions, which was found to be statistically significant (Wilks λ = .006, F (24, 148.248), p = .0005). Additionally, the Wilks' Lambda for function 2 through 4 was found to be statistically significant (Wilks λ = .319, F (15, 32.557), p = .005). Since the Chi-square test p-value for functions 1 through 4 and 2 through 4 is lower than 0.005, it indicated that the MDA model is robust.

By contrast, the 3 through 4 and function 4, were not found to be statistically significant (Wilks λ = .758, F (8, 7.887), p = .445) and (Wilks λ = .972, F (3, 0.810), p = .847). Moreover, the p-value in the two tables indicates that the distances between the group centroid are significant. Table B.6 (Appendix **B**) contain the functions of group centroids for functions 1 through 4, evaluated at group means. For each function, we have at least seven centroids. Since the p values are lower than 5%, then the distances between the centroid are large enough to be considered significant for functions 1 through 4. Therefore, there are good chances that the discriminant functions classify the cases correctly.

5.3.3. Equality of Group Means Test

Table 5.2 presents the results of the test of "equality of group means". Respondent ID has the lowest Wilks' Lambda, thus the highest discriminating power, which is statistically significant. All the test results except age, are statistically significant.

Table 5.2. Equality group means tests

Variable	Wilks' Lambda	F	df1	df2	Sig.
Gender	0.558	3.697	6	28	0.008
Education	0.560	3.667	6	28	0.008
id	0.020	233.333	6	28	0.000
Age	0.845	0.854	6	28	0.540

The MDA computed the structure matrix for function 1 to 4, from Table B.7 correlation results. Based on the discriminant functions, the SPSS program computed, for each case, the probabilities of belonging to each of the seven original groups. Busia_1, Busia_2, Kakamega and Trans Nzoia_2 were correctly classified. However, Bungoma_1, Bungoma_2, and Trans Nzoia_1 were incorrectly classified. Trans Nzoia_1 is the only group where the females largely outnumbered the males (4 females, 1 male). Bungoma_1 and Bungoma_2, comprised of purely male teams. Therefore, the incorrectly classified groups were the extremes. Overall, an outstanding percentage of 94.3% were correctly classified, proving the power of the discriminant function in our model.

5.3.4. MDA Procedure 1: Four Function Structure Matrix

Table 5.3 on the structure matrix, describes the correlation between each discriminant function and the independent variables. The first function is positively correlated with respondent ID, education and age and negatively correlated with gender. We could assume that this function is associated with a negotiation team selected based on PAD, education, and age, with little consideration of education and no consideration of gender. In function 1, the highest (0.937) positive discriminating factor is PAD and the only negative discriminating factor is gender (- 0.023).

Table 5.3. Structure Matrix for Functions 1 through 4.

Variable	Function			
	1	2	3	4
id	0.937*	0.013	0.295	-0.187
Education	0.069	-0.475	0.850*	0.218
Gender	-0.023	0.668	0.726*	0.164
Age	0.017	0.319	0.026	0.947*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within the function.
*. Largest absolute correlation between each variable and any discriminant function

Function 2 is positively correlated with ID, age and gender. Function 2 is negatively correlated with education. We could assume that this function is associated with a negotiation team selected based on PAD, age, and gender with

little consideration of education. In function 2, the highest (0.668) positive discriminating factor is gender, followed by age and then PAD/skills (ID). Function 2, as explained earlier, explains only 2.3% of the total modal variance. Function 3 and 4, will not be considered, because they are statistically insignificant, based on the previous analyses.

When gender, age and education are combined with respondent ID, the discriminating power of PAD (respondent ID) is overwhelming that the effect of gender, age and education is negligible, as evident in function one results of the structure matrix (Table 5.3). The first canonical discriminant function is crucial because it explains 97.1% of the variance (Table B.5). Additionally, the Wilk's Lambda for a test of functions 1 through 4 is only 0.006, and its p-value is 0.0005, thus confirming function 1's high discriminating power (Table B.5). Function one is heavily controlled by PAD. The influencing power of education, age, and gender is negligible.

5.3.5. MDA Procedure 2: Three Function Structure Matrix less PAD

Due to the high discriminating power of PAD, in the next MDA model, we removed the respondent ID from the structure matrix, in favour of looking for generic gender effects. Thus, when we left the model with only three functions, the structure matrix changed (see Table 5.4). Gender and education gained more prominence.

Table 5.4. Structure Matrix for Functions 1 through 3.

	Function		
Variable	1	2	3
Education	0.574	.818*	-0.037
Gender	-0.578	.815*	0.044
Age	-0.203	0.280	0.938*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within the function.
*. Largest absolute correlation between each variable and any discriminant function

Function 1 was found to be statistically significant (Wilks λ = .252, F (18, 39.969), p = .002). Function 2 is positively correlated to all the three independent variables, which was found not to be statistically significant (Wilks λ = .685, F (10, 10.967), p = .36). While the new model is not as strong as the previous model (42.9% classified correctly), it provided insights into the probable structural composition of the functions when we did not consider PAD. Gender and Education have a high discriminating power while the predicting power of age is negligible.

5.4. Discussion and Conclusions

Results corroborate the hypothesis that PAD is a better predictor than DD (age, education level, and the results confirm the hypothesis that PAD is a better predictor than DD (age, education level, and gender) of negotiation outcomes (whether a water negotiation groups will develop SSI surpassing in and out-group differences and cooperate or they will act unilaterally). The MDA procedure indicate that the strongest predictor of water negotiation outcomes in the Nzoia WeShareIt game is PAD. When assessing the impact on negotiation outcomes in the MDA, a four-structure matrix, PAD is the dominant predictor with little or no influence from gender, age and education.

The results also support previous studies indicating that PAD is a stronger predictor of improved decision-making than DD. Based on the reviewed literature, we attribute PAD being the strongest predictor of the water negotiation outcomes to four main factors: increased cognitive ability [308,311-314], innovative decision-making [308], unique networks [306], and unique life experiences [315].

Moreover, when we eliminated PAD from the model, gender and education gained more prominence and competed almost equally. Thus, when PAD is negligible, for instance, a water negotiation team comprising of only lawyers (functional), with similar knowledge, cognitive skills, capabilities and values, then gender and education diversity will take prominence. Since age and gender are negatively correlated, they jointly have a stronger discriminating power than education. The discriminating power of gender is the highest because its correlation coefficient is the highest, followed closely by education. However, when gender and age are combined, they possess more discriminating power than education.

These second result clearly presents a challenge and possibly an opportunity. Based on previous research, it is important to focus more on PAD rather than DD [306]. The results in this chapter indicate that when PAH negotiation team is constituted, there is a high likelihood that decisions will be influenced not by PAD (because it no longer exists) but by gender and education level. Moreover, as earlier discussed, the literature on DD is not conclusive. It provides numerous outcomes that could not be easily substantiated since most of the studies on DD were conceptual in nature with no empirical backing. Moreover, DD research indicate that in the short term, DD does not build trust [316], social cohesion [301,306,316], nor does it lead automatically to improved decision-making [317]. Research also indicated that DD is useful for monitoring, evaluation, service delivery, broadening the network, tapping into unique networks and fostering equity [308,318].

Therefore, if the aim of the basin management institution is to improve decision making and enhance cooperation, PAH may be a threat to this aim, thereby presenting a challenge. Nevertheless, in such instances, there are two policy options that water policymakers may decide upon, which may open more opportunities for integrated river basin management. First, diversify their PAH negotiation teams by introducing new members who possess divergent values, skills, capabilities, functional, cognitive abilities and knowledge. Second, introduce SSI to develop bonding and bridging social capital that enables the demographic heterogeneous PAH group to surpass their differences, perceive themselves as one team, and be willing to cooperate.

This empirical study, conducted in Kenya, supports the argument that diversity discussions should move away from whether diversity is good or bad towards understanding how the different diversity attributes contribute to cooperative decision-making, their respective elements and their unique value addition. If the policy aim is improved decision-making in water management, then more focus should be on PAD than on DD. However, if the aim is improved supervision, monitoring, evaluation and service delivery, then DD should be the focus when deciding on group composition. Furthermore, the results indicate a need for more clarity, there is a need for further investigations on the contribution of different diversity attributes to negotiation outcomes in a given river basin.

The research approach faced a few limitations. First, the broad assertion that water resource negotiation teams can be ideally formed with attention to the diversity characteristics presented in this chapter may be considered is an assumption. Sometimes, the formation of the team is based on the national laws and regulations or other considerations. Moreover, we acknowledge the limitation that the research is based on the outcomes of a simulation game and not an actual negotiation. Therefore, we advise caution and further analyses and actual pilot programme before considering scaling up. Nevertheless, gaming simulation has an effective role to play in research and knowledge diffusion. Gaming simulation can be attributed to real life situations by ensuring a diffusion of knowledge on real world situations. The Nzoia WeShareIt game was entrenched to the ongoing water policy reforms in Kenya to test the efficacy of proposed diversity related water policies in a game environment before actual application in a real-life setting. Another limitation is that the Nzoia WeShareIt game constructed solely intra-county basin management, whereas most of the water negotiations are conducted at the international basin level. The Nzoia WeShareIt game is inspired by the Nile WeShareIt game, which we developed for the Nile basin. Considering the complexity and challenges in this sub-basin; and it being the largest tributary to the Lake Victoria basin in Kenya and second largest at the international level after Kagera basin, and also

considering the upstream–downstream tensions within this sub-basin, it seems justifiable to use the term basin. We also note that the conclusions and the use of the games as a learning tool for negotiators would have been made much stronger with a meta-game session involving several or all of the county teams. We hope to implement this in future studies to ensure that the results are validated at the basin level by all county governments.

Clearly, there is a need for further studies to understand these complexities and provide more guidance to decision-makers on what mix of diversity attributes to focus on, so as to get the intended outcome. Our findings are valid only for this particular situation, but the implications might be wider. The findings put to discussion the idea that DD rather than PAD characteristics are the best predictor of successful negotiations. Evidently, this is not always the case and we are not the first to make this claim explicit. Therefore, at the river basin level, determining the predictors of negotiation outcomes can guide the water policymakers to focus on strengthening the high predictors to get the best outcome out of a planned water negotiation. This information would support or expedite the process of developing cooperative framework agreements aimed at increasing water access and reducing water scarcity.

6. Relational Learning: Interdependence and Cooperation

Title: Sustainability Indicators: Monitoring Cross-County Water Cooperation in the Nzoia River Basin, Kenya

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Research Context: This empirical study assessed the contribution of the Nzoia WeShareIt to team interdependence and cooperation (relational learning) of policymakers in the Nzoia Basin. We simulated the game to address a particular policy challenge: weak indicators to measure cross-county cooperation. The game tested the effect of WeShareIt transboundary indicators on cross-county government cooperation.

Abstract: Kenya Water Services Regulatory Board (WASREB) Impact Report indicates a stagnation in water coverage at 55 percent, for the last three years, contrary to the 2015 target of 80 percent. One main reason for the stagnation is weak cross-county cooperation between hydrologically interdependent governments. WASREB has little guidance on what indicators to use to enhance cross-county water cooperation. Through literature review, we evaluate whether the UN-Water methodology for assessing Sustainable Development Goals (SDG) 6.5.2 would provide useful guidelines. Based on the literature review outcomes, we designed a water policy game known as Nzoia WeShareIt. After that, we played seven-game sessions in four county governments (Busia, Bungoma, Kakamega, and Trans Nzoia), on 11–22 July 2016. We used the in-game and post-game questionnaire data to measure learning outcomes on interdependence and cooperation. The findings indicate that Nzoia WeShareIt policy game as a form of experiential learning increased understanding on the value of cross-county cooperation. The study constitutes a practical guideline to WASREB and a quick reference tool to be explored when designing indicators to monitor cross-county cooperation. We also propose a mixed method approach that incorporates team interdependence indicators as distinct and separate indicators from cooperation. Moreover, we recommend strengthening the SDG 6.5.2 indicator to measure transboundary water cooperation inputs, processes, and outcomes.

Graphical Abstract (Figure 6.1)

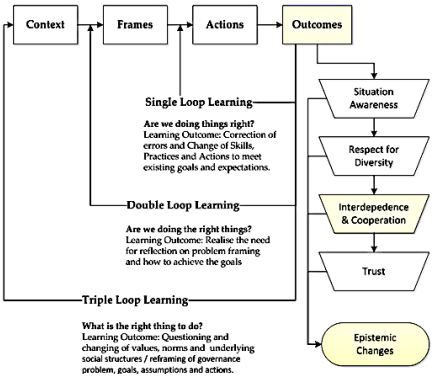

Figure 6.1. Triple-Loop Social Learning Sequence: Interdependence and Cooperation

Keywords: Sustainable Development Goals (SDG); SDG Indicator 6.5.2.; transboundary water cooperation; team interdependence; water policy games; Nzoia river basin; sustainability; equity; benefit sharing

6.1. Introduction

The Kenyan National Water Service Strategy (NWSS) 2015 target was 80 percent access to safe water in urban centres and 75 percent in rural centres [319] (p. 7). The Water Services Regulatory Board (WASREB) 2018 Impact Report, documents that water coverage stagnated at 53 percent for three years (2011–2014) and later at 55 percent for another three years (2014–2017) [320] (p. 19). The 2009 population census reports 28 percent access to piped water and 37 percent to non-piped water (springs, wells, and boreholes) [120] (p. 22).

Kenya water resources are sufficient to meet the 2030 projected demand, thus the current water scarcity is owing to governance failure [14,321]. Global Water Partnership (GWP) defines water governance as "the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and deliver water services, at different levels of society" [322]. According to the 2018 Water Resources Authority (WRA) Situation Report, the 2030 projected demand is 21,468 Million Cubic Meters (MCM)/year, against available water resources of 26,634 MCM/year.

The WRA situation report identifies three main governance challenges that need to be addressed to resolve water scarcity in Kenya. First, there is a significant water demand variance from various geographical regions (county governments). Second, the geographical distribution of available water varies considerably [323]. Thirdly, there is a considerable strain on stored water resources, especially during the dry spells, due to low water storage capacity, population pressure, rapid urbanization, anthropogenic activities, and climate change. In the last eight years, the population has significantly increased from 39,799,151 to 51,571,283 (population on 28th of December 2018) [324]. Addressing the three core governance problems will advance Sustainable Development Goal (SDG) 6 on ensuring "availability and sustainable management of water and sanitation for all" Kenyans [325] (p. 9).

WASREB is charged with the responsibility of monitoring the implementation of SDG 6 [325]. WASREB was re-constituted under the 2016 Water Act [117], and its mandate enhanced from water regulation to monitoring and issuing water licenses [120,320]. Figure 6.2 represents the Kenya institutional framework after the enactment Water Act 2016.

County governments are responsible for ensuring that Kenyan residents within their county have access to safe water and sanitation. They exercise their responsibility through establishing public limited liability companies, known as Water Service Providers (WSPs) [120] (p. 17). WSPs can either be within a county or be cross-county. We define cooperation as the voluntary act by two or more riparian governments to jointly engage in an exchange which benefits all parties through the sharing of river basin water resources, and the creation of

new resources or both [79]. Cross-county cooperative arrangements are managed by the eight national Water Service Boards (Boards).

The study focus is the Nzoia River Basin, in western Kenya. It is a sub-basin of Lake Victoria Basin. Nzoia river transverses through six county governments. Two downstream counties (Busia and Siaya), two middle stream counties (Bungoma and Kakamega) and two upstream counties (Uasin Gishu and Trans Nzoia). The Lake Victoria North WSB management of the Nzoia River Basin is piecemeal. Siaya, a downstream riparian government is not part of the WSB. Moreover, the WSB manages county governments outside Nzoia Basin (Keiyo Marakwet, Nandi, and Vihiga) [120].

Nzoia River Basin county governments have no agreement or formal arrangement for the joint management of the basin. However, through the Nzoia Water Services Company Limited (NZOWASCO) and the Lake Victoria Basin Commission (LVBC), there is evidence of cooperation between Bungoma, and Trans Nzoia. NZOWASCO delivers water services within its framework of cluster towns. The cluster towns approach only applies to the urban centers in the local government, thus leaving a large area of the local government, which is mainly rural. LVBC covers all the Lake Victoria Basin countries and county governments [83,326,327]. Therefore, its scope is much broader and not customized for the Nzoia River Basin.

WASREB is the only institution that monitors county government performance through WSPs. County governments are the sole institution constitutionally responsible for the provision of water and sanitation services. Particularly, they are absent in the 2016 Water Act institutional framework (Figure 6.2), [120]. Therefore, it is difficult to hold them accountable for responsibilities beyond the scope of WSPs. WASREB plays a critical role of monitoring county government actions and documenting the outcomes in the Annual Impact Reports, to increase transparency and accountability [320].

The 2016/2017 WASREB Impact Report raises some critical water governance issues that need to be addressed [120] (pp. 29–37). Some of these critical issues are:

1. Devolution as provided in the 2010 constitution [152] and subsequently in the 2016 Water Act [117] has led to conflicts between the central government and the county governments leading to vexatious litigations, stalling of planned water projects and subsequently a decline in water service provision [120] (p. 31);
2. The commercial sector is encroaching catchment areas, risking water resources [120] (p. 30);
3. Citizens are polluting the river water with waste and straining service provision [120] (p. 30);
4. Lack of adequate sewerage infrastructure has led to more river pollution,

thus increasing water treatment costs [120] (p. 31);

5. Climate change is not aligned with current efforts to conserve water, thus threatening the sustainability of water towers [120] (p. 31); and
6. Poor land practices have led to degradation and siltation of the dams [120] (p. 31).

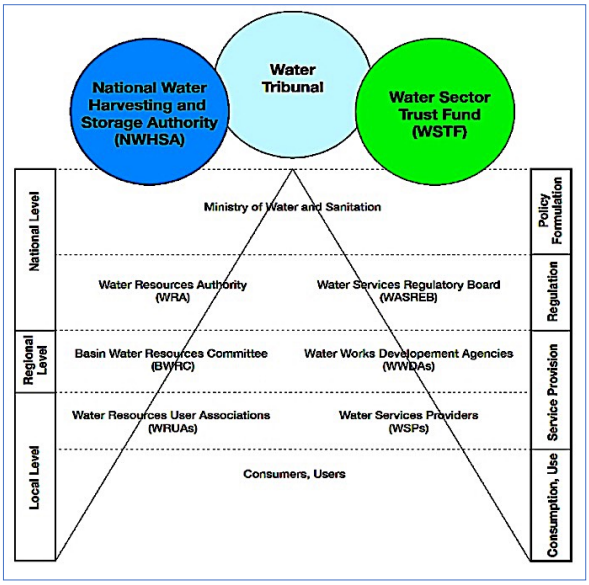

Figure 6.2. Water Institutions, Act 2016. Source: WASREB [320] (p. 12).

To address some of these governance challenges, WASREB monitors WSPs using ten Key Performance Indicators (KPIs), namely: (1) Water Coverage; (2) Drinking Water Quality; (3) Hours of Supply; (4) Non-Revenue Water; (5) Metering Ratio; (6) Staff Productivity Measured by Staff per 1000 Connections; (7) Personnel Expenditure; (8) Revenue Collection Efficiency; (9) Operation and Maintenance Cost Coverage; and (10) Sewerage. None of the indicators measures cross-county cooperation nor addresses the key governance challenges facing the water sector, in Kenya [320].

Consequently, WASREB faces two significant challenges. First, monitoring using the KPIs will not resolve the core governance problems as outlined in their environmental scan [120,320]. The governance challenges need to be resolved to create an enabling environment for the WSPs to operate [86,87,89,90,99,100,103,170,239,305]. Second, there is a mismatch between the WASREB KPIs and the SDG 6 goal. KPIs enhance competition, unilateral WSP actions, and ultimately inequitable water allocation [103]. Competition and

unilateral actions do not promote national access and sustainable water use [87,90,229]. The top ten WSPs are from water-rich counties (Nyeri, Meru, Thika, Nakuru, Ngagaka, Nanyuki, Ngandori Nginda, Malindi, and Kakamega). The bottom ten utilities are mainly from water-scarce arid and semi-arid zones (Lodwar, Tililbei, Kwale, Kitui, Bomet, Wajir, Garissa, Eldama Ravine, and Olkejuado) [320] (p. 21). Migori though not in the arid and semi-arid zone is in the bottom ten WSPs because the resident's taps were dry for five months due to failure by the WSP to pay electricity expenses worth five million Kenya Shillings (Kshs). These energy expenses were incurred when extracting water from the river and distributing the water to residents [328].

The WASREB KPIs are not comparable across the WSPs due to inequitable water distribution, water demand and topography. First, the performance of water-rich counties cannot be compared with the performance of water scarce counties, with no water to distribute during the dry seasons. Second, the performance of cities with dense population, few water sources and residents who rely 100 percent on piped water is not comparable with rural areas. Third, the performance of highland counties using gravity method to distribute water cannot be compared with lowland counties that have colossal energy expenses due to extracting the water from the river and later distribute it to the residents. Moreover, if the playing field is not leveled to ensure equity, the water resource-rich counties will continue amassing capital and constructing water storage facilities to perform better. Whereas the water-scarce regions will not receive any revenue from their residents due to their inability to deliver services. Therefore, the gap between the top performers and the bottom performers will continue to widen. This may lead to either continued stagnation or declined national performance of SDG 6.

We undertook this study to support WASREB in monitoring SDG 6. The specific target that we will focus on is 6.5 "By 2030, implement integrated water resources management at all levels, including through transboundary cooperation." Transboundary waters refer to ground and surface waters that "mark, cross, or are located on international political boundaries between two or more States [329]." The Indicator we intend to improve is 6.5.2, on the "proportion of transboundary basin area with an operational arrangement for water cooperation" [330]. Nzoia Basin does not cross international boundaries. Therefore, it is not a transboundary basin under indicator 6.5.2. However, being a sub-basin of Lake Victoria, and Lake Victoria being a sub-basin of the Nile Basin, the results of the studies can be applied to the two larger basins and locally [120].

We first conducted a literature review to identify gaps in implementing the SDG 6.5.2 indicator. After that, we designed a water policy game to enhance learning on water cooperation [331]. Gaming is an experiential learning method

that has proven to be effective in enhancing cooperation through facilitated interactions and shared player experience [332]. Water policy games have the potential to bridge collaboration gaps and ultimately increase the interdependence of groups that are geographically dispersed [77,333]. Research on the effect of gaming on team interdependence and cooperation in river basin management remains unexplored [99,100]. Thus, there is little guidance to WASREB on innovations to enhance learning on water cooperation. Also, at the policy level, there is little guidance on what indicators WASREB should use to measure cross-county water cooperation [77]. With a primary focus on interdependence and cooperation, we designed a game known as Nzoia WeShareIt. After that, we played seven sessions with Nzoia basin water policy makers [91]. We collected in-game and post-game data. We adopted the main recommendations from the Depping and Mandry [77], namely; we incorporated competition as a positive element that enhances collaborative play and assessed cooperation and interdependence as two distinct mechanics.

To address identified science, policy and practice gaps, we seek to answer these questions:

1. Contribution to Science: What are the identified gaps/challenges WASREB may face when implementing the "step-by-step monitoring methodology for Indicator 6.5.2"?
2. Contribution to Practice: Did the WeShareIt game increase learning on team interdependence and cooperation in the Nzoia River Basin?
3. Contribution to Policy: What are the policy recommendations to the Kenyan Water Services Regulatory Board (WASREB) on improving the monitoring of cross-county water cooperation?

The chapter is organized as follows. The next section identifies gaps/challenges WASREB may face when implementing the "step-by-step monitoring methodology for Indicator 6.5.2" (Section 6.2). The third section introduces the subscales, measures, procedure, and data analyses. The fourth section presents the results obtained from the post-game data. The data were analysed using two methods: Chi-Square test for goodness-of-fit and one-way Analysis of Variance (ANOVA). Then we analysed the results and provide recommendations to improve the identified science, practice, and policy gaps (Section 6.5), and provide concluding remarks in section 6.6.

6.2. Local and Global Gaps to Monitoring Water Cooperation

6.2.1. Applicability of SDG Indicator 6.5.2 in the Nzoia River Basin in Kenya

UN-Water developed a "step-by-step monitoring methodology for Indicator 6.5.2" [330,334,335]. The methodology defines water cooperation arrangement as treaties (bi/multilateral), agreements, conventions or other formal arrangements (for instance a Memorandum of Understanding between the riparian states) [330]. The definition limits the scope of water cooperation to state actors. It is only State actors that are qualified to enter into such agreements or arrangements, either as individual riparian states, interstates, inter-ministerial, regional agencies/authorities, and inter-governmental bodies [330,336]. The methodology, further provides that the "arrangement for water cooperation" must meet the following set of criteria to be considered "operational":

1. "There is a joint body, joint mechanism, or commission (e.g., a river basin organization) for transboundary cooperation;
2. There are regular (at least once per year) formal communications between riparian countries in form of meetings (either at the political or technical level);
3. There is a joint or coordinated water management plan(s), or joint objectives have been set;
4. There is a regular exchange (at least once per year) of data and information" [330] (p. 3).

Based on the SDG 6.5.2 requirements, Nzoia basin is at 0 percent cooperation. It does not possess:

- A joint basin management institution for cross-county cooperation;
- A basin management plan to jointly and sustainably manage the shared resource [287] (p. 12).
- A data sharing protocol [170], thus water managers hardly possess information on the current water use and quality within the drainage basin [287] (p. 13).
- An information management system [287] (p. 13) on the basin's current, planned and potential future water uses [229], the effects of the rapid population and economic growth [287] (p. 13); and
- A history of strong cooperation [287] (p. 12). There is no institutional framework at the basin level to convene and facilitate basin meetings. Water management is an internal WSP matter.

The Water Resources Authority (WRA) National Water Master Plan 2030 [118] (p. 46) indicate plans to construct several dams along the Nzoia river for irrigation and stop flooding. Flooding will be controlled by setting an environmental flow rate and environmental monitoring. Conversely, SDG Indicator 6.5.2 does not measure steps towards establishing cooperation. Some researchers indicate that the proposed methodology fails to capture and monitor the true state of implementation of Transboundary Water Cooperation (TWC) [336,337]. In the next sub-section, we will assess the identified gaps when implementing Indicator *SDG 6.5.2*, in other river basins.

6.2.2. Proposed Methodologies to Monitor Water Cooperation

Studies propose three methodologies to measure cooperation (Figure 6.3). The first assesses formal agreements, and is supported by most Inter-Governmental Organizations. This approach, partially measures cooperation outcomes and fails to measure process and input elements. SDG indicator 6.5.2 takes the first approach [336,337]. To strengthen SDG 6.5.2, various researchers propose either a cooperation continuum [338] or qualitative analyses, including hydropolitical assessments and discourse analyses [286,336,339-351]. Based on the relevant literature review, we identified ten Indicator 6.5.2 gaps, as discussed in this sub-section.

6.2.3. Gap 1: Team Interdependence is not Measured

SDG 6.5.2 measures the outcomes of cooperation with negligible attempts to measure the process and no provision to measure input elements. Team interdependence is an input element, which if lacking, the process and outcomes may not materialise. Research indicates that interdependence is the most critical element for team formation [331] (p. 201). A team is a group of persons that interact adaptively and interdependently, to achieve their "specified, shared and valued" objective(s) [352] (p. 3). Studies confirm that hydrological interdependence does not automatically translate into team formation and cooperation [86-90,99,100,170,229,283]. River basin groups lack the basic elements of team formation, namely, a common purpose and individuals who "interact adaptively and independently to achieve specified, shared and valued objectives" [352] (p. 3). The water sector is lagging in developing strong river basin teams that work interdependently to achieve a shared goal [287,353].

Lack of team interdependence negatively affects the quality of cooperation [77,305]. Hall (2014), argues that without interdependence, many groups proceed with their planned unilateral actions, without any form of cooperation and never mature into a team [331] (p. 201). If the river basin group does not mature into a team, then they cannot cooperate [287]. To facilitate cooperation,

there is a need for capacity development of WSPs in team interdependence [77,333].

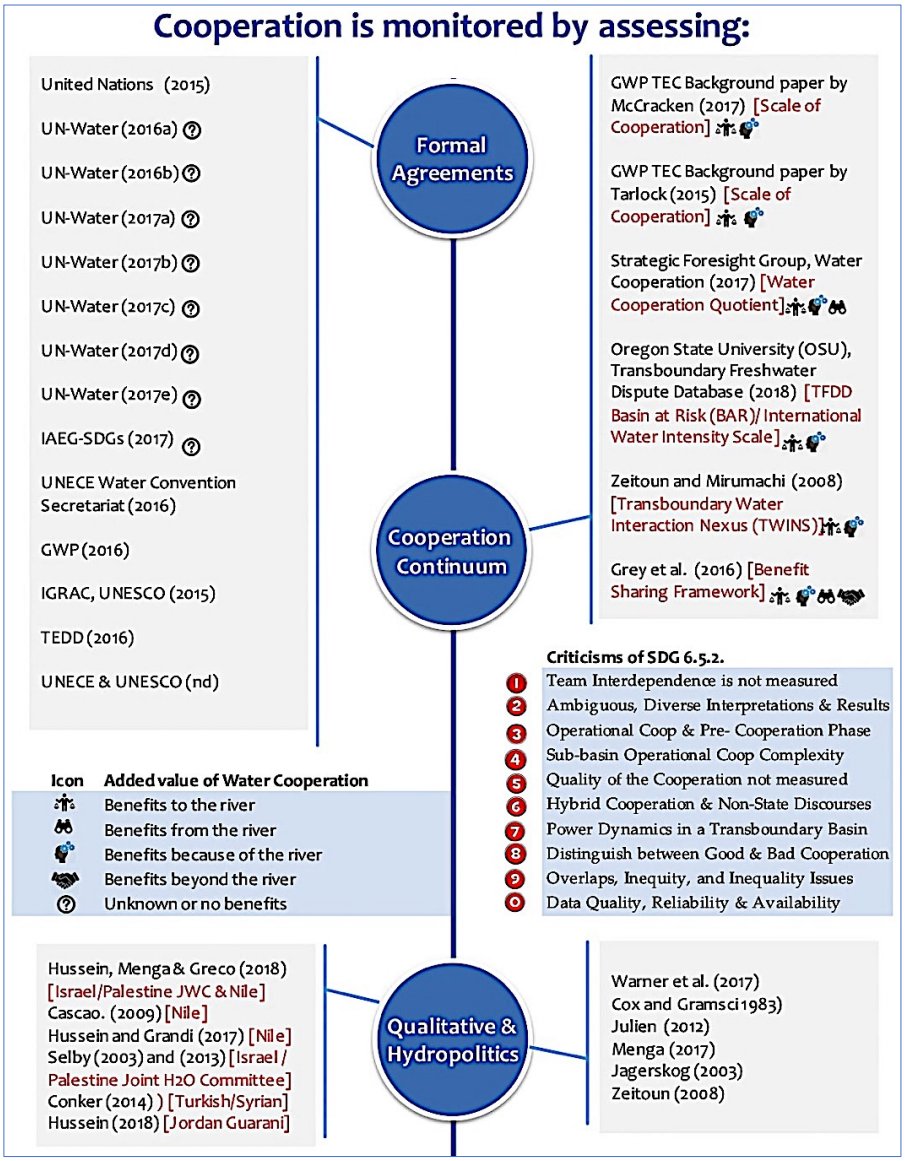

Figure 6.3. Review of Current and Proposed SDG 6.5.2 Monitoring Instruments

6.2.4. Gap 2: SDG 6.5.2. Is Ambiguous, Leads to Diverse Interpretations

SDG 6.5.2 criteria to measure operationality of cooperation is ambiguous [336,354]. It is comprised of four components, namely: (1) joint river basin management plans; (2) joint river basin institution/organization; (3) meetings; and (4) data exchange [355]. According to a study by McCracken and Meyer [337] (p. 9), most continents got zero percent, at the transboundary aquifer level (zero percent for America, Asia, and the Middle East and 0.1 percent for Europe). At the river basin level, America and Africa were leading (90.8% and 67.1%, respectively), while Europe (31.7%), Asia and the Middle East (11.7%) were still lagging. Different countries and continents defined the attributes differently leading to results that cannot be compared. Meetings and the joint river basin management were construed widely or extremely narrowly, leading to diverse results [337].

6.2.5. Gap 3: Operational Indicator Masks Pre-Cooperation Phase [337] (p. 9)

SDG 6.5.2. fails to measure the pre-cooperation phase[336]. McCracken and Meyer [337] (p. 9) explain that the SDG 6.5.2 operational cooperation fails to capture the stage at which a riparian state is in the cooperation continuum. It is limited to official/formal cooperation thus leaving out the pre-cooperation phase and stepwise cooperative processes. de Chaisemartin [354] (p. 20) state that "the fact that an arrangement 'operates' as per indicator 6.5.2 does not indicate the quality of the operationality." SDG 6.5.2, fails to capture hybrid forms of cooperation, such as water policy networks, that have become more attractive to state actors in the recent past compared to formal cooperation [86,87,89,100,229,283]. To address this gap, Hussein et al. [336] recommend the revision of Indicator 6.5.2 to incorporate formal, informal and technical state deliberations (preoperational phase).

McCracken and Meyer [337] (p. 9) further explain that the binary nature of operational cooperation requires that a riparian state meets all the four criteria, to qualify. Therefore, if a state meets only three of the four criteria, they receive a zero percent rating. The binary nature of the indicator fails to take account of the process and the steps towards cooperation and ranks riparians on two sides of the spectrum. To illustrate this challenge McCracken and Meyer [337] (p. 9) provide an example of the Ganges-Brahmaputra-Meghna basin where the riparian states met three criteria and failed to fulfill the joint basin management criteria. As a consequence, the achieved step-wise cooperative efforts and evolving collaborative actions were not included in the final assessment. It is not clear how to address cooperative actions and arrangements that do not meet the four criteria of operational cooperation.

6.2.6. Gap 4: Sub-Basin Operational Cooperation Complexity (Scale Issues)

The UN-Water 2017 Step-by-Step Methodology for Indicator 6.5.2 [334] was updated (from the April 2016 draft [335]) to incorporate sub-basin scale operational cooperation [337]. Thus, cooperating sub-basins can measure evolving cooperation actions separate from the umbrella basin. Swain [356] explain the difficulty of cooperation for large basins, and recommends that joint cooperative actions should take place at the sub-basin level.

McCracken and Meyer [337] (p. 10) state that the UN-Water 2017 revision to the Step-by-Step Methodology for Indicator 6.5.2, is a positive move towards addressing scale issues, but still leaves two gaps unaddressed. First, there are cooperation actions and arrangements that do not cover the entire basin area or sub-basin. The 1959 agreement between Egypt and Sudan that allocates the Nile river flows between two countries is a cooperative agreement that covers only a part of the Eastern Nile sub-basin and only two out of the 11 countries [87]. This unique instance is not anticipated nor provision made under SDG 6.5.2 [337] (p. 10). Second, the sub-basin results of SDG 6.5.2 are not comparable. The indicator fails to assess the substantive issues, which make an amalgamation of the results at different governance levels inaccurate and unreliable.

6.2.7. Gap 5: Quality of the Cooperation Not Measured

The indicator measures only the outcome indicators, thus excluding process and input indicators [239], and thereby failing to measure the quality of cooperation [336]. McCracken and Meyer [337] explain the deception behind the term "cooperation" and the ongoing hydro-politics that cannot be measured by an agreement. Research indicate that power plays a critical role in the allocation of water resources, which is barely captured through counting the number of agreements a country has signed and ratified [286,339,347]. Hussein et al. [336] recommend the revision of Indicator 6.5.2 to qualitative indicators to assess the quality of cooperation. de Chaisemartin [354], recommend the use of indices to measure the quality of cooperation.

6.2.8. Gap 6: Non-recognition of Hybrid Cooperation and NSA Discourses

Another criticism of indicator 6.5.2 is its inability to incorporate hybrid forms of cooperation. These networks lie between the formal kind of cooperation where the countries have to sign an agreement and establish a joint body and ad-hoc/fluid types of cooperation. These informal arrangements cannot be measured under indicator 6.5.2 [336]. Moreover, the indicator does not measure the numerous actions by Non-State Actors (NSA), including, politicians (political statements), media (print, radio, television, social media), non-profit organizations (NGOs), civil societies, and development partners including the

World Bank. There is no analysis of the ongoing discourse between different state and non-state actors with competing interests and diverse objectives. Hussein et al. [336] recommend the revision of Indicator 6.5.2 to include qualitative indicators to assess state and non-state discourses and hybrid forms of cooperation where different stakeholders are involved.

6.2.9. Gap 7: Fails to Account for Power Dynamics in a Transboundary Basin

SDG 6.5.2 fails to take account of the power dynamics that exist in some river basins. To explain the importance of power dynamics Hussein et al. [336] provides an example of the 1995 Israel—Palestine Liberation Organization Oslo II Agreement. The Oslo treaty "codified and cemented asymmetric power relations and a non-equitable share of water resources between the two parties" [336] (p. 4). Within the so-called cooperation, all Palestinian water development requests were not approved by Israel between 1995 and 2008. Palestinians approved Israeli's requests to construct water supply facilities in the West Bank. Zeitoun (2008) cautions against agreements that seem to portray cooperation, and in reality, they foster domination [357]. Hussein et al. [336] recommend developing indicators that pierce through the formalities and diplomatic subtleties of formal agreements and unveil concealed power asymmetries and domination.

6.2.10. Gap 8: Does Not Distinguish between Good and Bad Cooperation

Indicator 6.5.2 does not make a distinction between good and bad cooperation. Hussein et al. [336] provide instances where transboundary river basins with agreements or formal arrangements experience weak or no cooperation, whereas others have no agreement and enjoy quality cooperation. Indicator 6.5.2 assumes that the presence of an arrangement for cooperation is equivalent to good cooperation. The cooperation between 1959 Egypt and Sudan agreement led to the allocation of the Nile water flows amongst two countries to the exclusion of the upper riparians. Onencan [87] explains the inequity in the 1959 agreement's water allocation. Moreover, Egypt got the largest share of the Nile water flows while Sudan paid considerable to implement the agreement provisions [87].

6.2.11. Gap 9: Overlaps, Inequity, and Inequality Issues

There are many overlaps at the basin and sub-basin level leading to double reporting and distortion of the overall picture. For instance, the Democratic Republic of Congo is a Nile River Basin riparian states, and at the same time a riparian state in Congo Basin and Tanganyika Lake sub-basin. The freshwater from Lake Tanganyika flows into River Congo and finally into the Atlantic

Ocean. McCracken and Meyer [337], explain that under SDG 6.5.2, a transboundary basin can only be accounted for once. Therefore there is an overlap between the Congo Basin and Tanganyika Lake sub-basin. It is not clear whether the cooperative actions and arrangements of the Democratic Republic of Congo should be attributed to Congo Basin or Tanganyika Lake sub-basin.

Moreover, transboundary aquifers do not lie within specific river basins leading to further overlaps. The overlaps deepen the complexity of monitoring transboundary water cooperation. A single jacket approach to address existing complexities has led to inequitable outcomes [87].

The area as a unit of analysis obscures the real basin situation. To address the complexities that arise from using basin area as a unit of analysis, de Chaisemartin [354], recommend the use of other units of measurement like the area of the riparian state in the basin and the volume of water. McCracken and Meyer [337] (p. 10) propose a shift from the area as the unit of analysis towards "volume of water, number of people dependent on the resource or number of agreements." Area as a unit of analysis provide false impressions that larger basins are more important. In the case of the Nile River, it is the longest river in the world and transverses 11 countries. The basin area is massive, but the volume of the Nile river flows does not correlate with the vast basin area. Also, the river flow is seasonal, most of the water is lost through evaporation in Lake Victoria and the Sudd swamp. Furthermore, 86 percent of the main Nile water is from one country, Ethiopia [49].

6.2.12. Gap 10: Data Quality, Reliability, and Availability Issues

The binary (yes or no) nature of the SDG 6.5.2 indicator makes it difficult to grasp the actual situation from the aggregated data. The pressure to have a yes as opposed to a no may lead to unreliable data, thus affecting the quality. Moreover, there is no mechanism to check the quality of the data which affects the reliability of the data. Some of the indicators are ambiguous and depend on one's interpretation, leading to multiple interpretations and collection of data that is not comparable nor interoperable. Lack of disaggregation of the data makes it difficult to assess the actual situation [337] (p. 9).

6.3. Materials and Methods

6.3.1. Nzoia WeShareIt Compared with SDG 6.5.2 Indicator

To address the identified indicator 6.5.2 gaps, we designed the Nzoia WeShareit conceptual framework for the Water Policy Game. Table 6.1 provides how we addressed all the gaps within the Nzoia WeShareIt conceptual framework.

Table 6.1. Nzoia Game Innovations to Address the SDG 6.5.2 Policy Gaps

SDG Indicator 6.5.2 Gap	The Contribution of Nzoia WeShareIt Water Policy Game
1. Team Interdependence	• Two sub-scales were developed to measure cooperation and team interdependence separately with separate game mechanics
2. Ambiguous, Diverse Interpretations and Results	• In-game assessment indicators were clear, precise and disaggregated. • The game outcomes were Real-time and displayed on the Whiteboard. • In-game questionnaire in Kiswahili and discussed before it was applied
3. Operational Cooperation and Pre-Cooperation Phase	• The game measured pre-game, in-game and post-game cooperation outcomes, including operational cooperation. • Water policy networks at the same level as a formal agreement.
4. Sub-basin Operational Coop Complexity	• Each player had different indicators based on the county's circumstances. • Cooperation arrangements that do not cover the basin area were monitored. • Substantive issues related to cooperative arrangements measured.
5. Cooperation Quality is not measured	• Nzoia WeShareIt was designed to assess the input, process, and outcome in the entire policy process. • Mixed methods were employed to collect and analyse the data. • The in-game, post-game and pre-game data formed the quantitative data. • The post-game questionnaire, debriefing sessions with the policymakers and the rough-cut videos for the game sessions constituted the qualitative data.
6. Hybrid Cooperation & Non-State Discourses	• Non-state policymakers were also invited to play the game. • The discourse between the various actors was captured through mixed method data collection methods and an in-game peer review mechanism. • Hybrid policy networks and measured using in-game trading data [86,103]
7. Power Dynamics in a Transboundary Basin	• The game rules were flexible for the stronger county governments to exercise hydro-hegemony and this was measured through the in-game data & video.
8. Distinguish between Good & Bad Cooperation	• In-game peer review questionnaire filled at the end of every round. • Anonymous results displayed Realtime on a leaderboard. • Discussion of the results from the Real-time feedback and provide an opportunity to improve cooperation.
9. Overlaps, Inequity, and Inequality Issues	• The area is not the unit of analysis. The unit was available water volumes and productivity levels for food and energy production.
10. Data Quality, Reliability & Availability	• Complementary knowledge game mechanic encouraged data sharing. • Shared information was vetted through the in-game peer review mechanism. • Negative reviews for poor quality, unreliable information or for not sharing.

6.3.2. Scale Statistics and Reliability Analyses

At the start of the analysis, we had 12 items for team interdependence and 11 items for cooperation. However, during the final Principal Component Analysis (PCA), three items were eliminated because they failed to load more than 0.4 in one of the components. We eliminated the three items from the overall 23 items scale, based on the PCA results. However, we retained the original component structure. Appendix C explains the PCA procedure and results. We assessed internal consistency for the three scales, using Cronbach's alpha (see Table C.1). After that, we assessed the descriptive statistics of the team interdependence and cooperation scales. The results of the Shapiro-Wilk test and the supporting descriptive statistics are provided in Tables 6.2 and 6.3.

Table 6.2. Descriptive Statistics for Cooperation

	Mean	**Std. Dev**
I worked with others to achieve a common interest	4.71	0.79
We managed the Nzoia water resources jointly	4.66	0.87
I enjoyed pursuing the shared goal with other counties	4.80	0.72
I am more aware of the benefits of working together	4.77	0.77
I worked with other players to be successful	4.69	0.76
I preferred to trade with our neighbours to reach our game goals	4.69	0.80
I respected other players	4.71	0.79
I got along with most of the other player	4.60	0.77
I am more aware of the need for joint action	4.69	0.76
My collaboration skills were enhanced	4.77	0.73

The means for cooperation is high confirming that the data is negatively skewed. Two hundred eighty-four of the responses perceive the contribution of the game in increasing their understanding of cooperation as "very accurate." Fifty-one preferred the "moderately accurate" category, whereas five preferred "slightly inaccurate" category. One respondent consistently rated chose the "very inaccurate" category (ten ratings in this category in total, each for the ten dependent variables).

Table 6.3. Descriptive Statistics for Team Interdependence

	Mean	Std. Dev
My knowledge on balancing food, energy, and environment increased	4.80	0.72
I felt responsible to the group for the regional strategy	4.51	0.82
I became a valuable member in the game	4.63	0.77
I established a role that increased interactions with others.	4.80	0.76
We made water allocation decisions together	4.51	0.89
We gave feedback on each other's contribution	4.46	0.85
I learned the importance of sharing information	4.77	0.73
I interacted with others to achieve game goals.	4.60	0.91
I respected other players	4.60	0.88
I developed social connections	4.54	0.85

The means for team interdependence is lower than cooperation. The team interdependence dataset is also negatively skewed. Two hundred sixty-three of the responses perceive the contribution of the game in increasing their understanding of team interdependence as "very accurate." Sixty-three preferred the "moderately accurate" category, whereas 13 and 1, preferred "slightly inaccurate" "moderately inaccurate" categories, respectively. The same respondent consistently chose "very inaccurate" category for cooperation, provided similar results for team interdependence.

After assessing the descriptive statistics, we conducted a graphical test, using boxplot chart histograms to identify significant outliers (Figure 6.4).

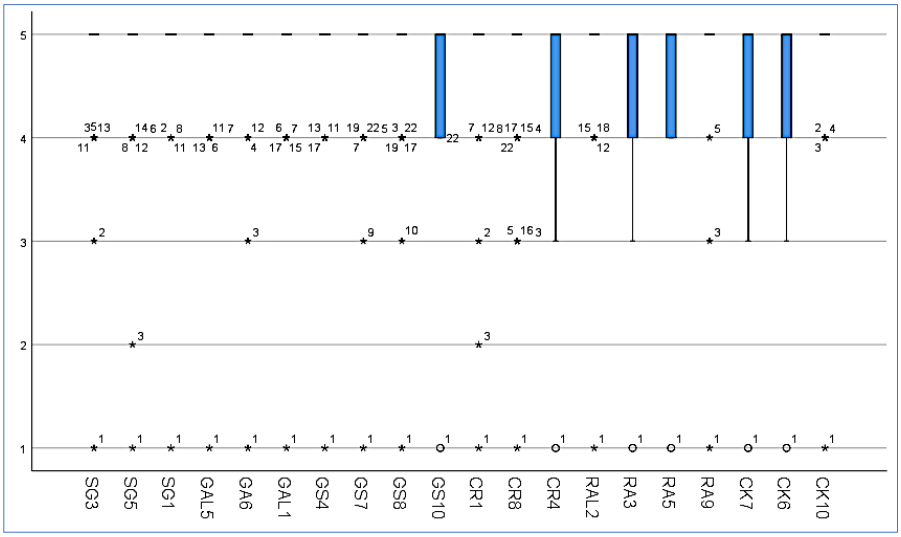

Figure 6.4. Boxplot representation of extreme outliers

The presence or absence of outliers informed the choice of method for the statistical analyses. We identified multiple outliers. A number of these outliers appear to be extreme because of their distance from the mean. Appendix C provides the details concerning the assumption testing and the analyses we made regarding the significant outliers.

6.3.3. Data Analyses

We performed data analyses using the Statistical Package for the Social Sciences (SPSS) version 25 and XLSTAT version 19.7. Overall, a few questions were left blank by some participants. However, we did not find any non-compliant participants. The final dataset contained 35 participants. Having decided to maintain the outliers, we still had a problem; these extreme values may inflate the within-group variability when we conducted parametric results, thus affecting the significance assessment. Also, the data series is negatively skewed with most of the respondent ratings between 3 and 5 and few ratings in the 1 and two range. Since we decided to keep the outliers, we selected the Chi-Square test for goodness-of-fit, which is useful for Likert scale data. The test is useful in comparing the observed distribution (sample distribution) with a theoretical distribution. Also, we conducted a separate one-way between-subjects ANOVA with Friedman's nonparametric test on the same data.

PCA data were performed using XLSTAT. We used PCA to visualize correlations amongst our original variables and between these variables and the components, to improve the questions asked in the cooperation and team interdependence sub-scale, to inform future research.

6.4. Results

This section focuses on the results of the Chi-Square test for goodness-of-fit and the one-way between-subjects ANOVA with Friedman's nonparametric tests. The Chi-Square test for goodness-of-fit null hypothesis is: there is no significant difference between the observed distribution for the cooperation and team interdependence dependent variables and the theoretical distribution (H0). The alternative hypothesis for the Chi-Square test for goodness-of-fit is: there is a significant difference between the observed distribution for the cooperation and team interdependence dependent variables and the theoretical distribution (H1). The theoretical distribution corresponds to a situation of indifference where the responses are at mid-point (3) in the 5-point Likert Scale. We reject the null hypothesis if Sig. < .05. The p-value for all the ten variables is lower than 5% (Sig. < .05).

6.4.1. Chi-Square test for goodness-of-fit

We reject the null hypothesis for the cooperation results. There are significant differences between the observed frequencies and the expected frequencies (Table 6.4).

Table 6.4. Chi-Square Test for Goodness-of-Fit Results for Cooperation

	SG3	**SG5**	**SG1**	**GS4**	**GS7**	**GS8**	**GS10**	**GAL5**	**GAL1**	**GA6**
Chi-Square	63.17[a]	57.69[a]	48.23[b]	31.77[b]	57.69[a]	63.17[a]	23.03[b]	31.77[b]	43.60[b]	75.51[a]
df	3.00	3.00	2.00	2.00	3.00	3.00	2.00	2.00	2.00	3.00
Asymp. Sig.	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.8.

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.7.

The p-value for all the ten team interdependence variables is lower than 5% (Sig. < .05). Therefore, we reject the null hypothesis. There are significant differences between the observed frequencies and the expected frequencies (Table 6.5).

Table 6.5. Chi-Square Test for Goodness-of-Fit Results for Team Interdependence

	RAL2	**RA3**	**RA5**	**RA9**	**CK7**	**CK6**	**CK10**	**CR1**	**CR8**	**CR4**
Chi-Square	48.23[a]	34.37[b]	25.60[a]	82.27[b]	37.57[b]	29.80[b]	43.60[a]	73.14[c]	51.29[b]	38.71[b]
df	2.00	3.00	2.00	3.00	3.00	3.00	2.00	4.00	3.00	3.00
Asymp. Sig.	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.7.

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.8.

c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.0.

6.4.2. One-way between-subjects ANOVA with Friedman's nonparametric test

We employed a one-way between-subjects ANOVA with Friedman's nonparametric test on the independent ratings on the effect of team interdependence mechanics, independent ratings on the effect of the cooperation mechanics and the combined ratings of all the game effects. This revealed a significant increase in understanding of team interdependence: X^2 (34, N=12) = 32.26, p=.001. It also revealed a significant increase in understanding of cooperation: X^2 (34, N=11) = 23.42, p=.009.

6.5. Discussions

In the discussion section, first, we analyse the findings of recent articles on the SDG 6.5.2 indicator. Then, we explain the contribution and new results of the current study. Finally, we make policy recommendations to WASREB based on the literature review and the findings of the present study.

6.5.1. The Contribution of Recent Studies on SDG 6.5.2 Indicator

By reducing complexity, UN-Water chose the path of selecting targets that are quantifiable [336,337]. The approach is a timely and cost-effective measurement of performance [330]. Unfortunately, quantifiable targets alone cannot measure the complexity facing most shared river basins [336,358]. Hussein state that "quantitative methodologies are generally not able to capture nuances and different shades, forcing towards fixed and set categorizations" [336] (p. 5). Before any written agreement, most countries implement hybrid forms of cooperation, over extended periods [359,360]. Therefore, legal agreements is a narrow definition of cooperation [360]. SDG 6.5.2 considers agreements and arrangements as a precondition to cooperation [330], thus narrowing the scope of transboundary water cooperation and affecting the sustainability of joint basin actions [336]. Table 6.6 summarizes the identified policy gaps of SDG indicator 6.5.2, the proposed action(s) and the authors who contributed to the studies.

Based on Table 6.6, there is a consensus regarding the identified gaps to monitoring water cooperation using SDG Indicator 6.5.2. The difference is on the proposed solution for gap number five (how to measure the quality of cooperation). Most of the studies recommend measuring cooperation with indices [337,354,361-363], while one research suggest qualitative data [336].

Examples of proposed indices / scales are:

1. A scale of Cooperation presented in the GWP TEC Background paper by McCracken [361];
2. A scale of Cooperation presented in the GWP TEC Background paper by Tarlock [363];
3. Water Cooperation Quotient by the Strategic Foresight Group, in Water Cooperation [364];
4. Transboundary Freshwater Dispute Database (TFDD) Basin at Risk (BAR)/International Water Intensity Scale presented by the Oregon State University (OSU), in the Transboundary Freshwater Dispute Database [365]; and
5. Transboundary Water Interaction Nexus (TWINS)] by Zeitoun and Mirumachi [286].

Table 6.6. Literature on SDG 6.5.2 Policy Gaps.

Indicator 6.5.2 Gap	Policy Gap	Proposed Action (s)	Relevant Article
1. Team Interdependence	• Interdependence of states that share a basin and team interdependence of transboundary groups not measured	• Measure team interdependence separate from cooperation	Depping and Mandryk [77]
2. Ambiguous, Diverse Interpretations & Results	• Criteria to measure operationality of cooperation is ambiguous and confusing	• Revise ambiguous indicators. • Develop standard and harmonized indicators and improve monitoring to increase comparability of data	Hussein, Menga and Greco [336] de Chaisemartin [354],
	• Different countries interpret meetings and the joint river basin management differently leading to non-comparable results.		McCracken and Meyer [337], (p. 9) Ortigara, Kay and Uhlenbrook [362], (p. 8)
3. Operational Cooperation & Pre-Cooperation Phase	• Limited to official / formal cooperation thus leaving out the pre-cooperation phase. • Operational cooperation requires that a riparian state meets all the four criteria, to qualify. • The binary indicator fails to take account of progress and stepwise cooperative processes	• Incorporate formal, informal and technical state deliberations (preoperational phase) • Develop indicators that are not binary and take account of stepwise cooperative processes.	Hussein, Menga and Greco [336] McCracken and Meyer [337], (pp. 9-10) de Chaisemartin [354], (p. 20) McCracken [361] Tarlock [363]
4. Sub-basin Operational Coop Complexity	• Exclusion of cooperation actions and arrangements that do not cover the entire basin. • Sub-basin results of SDG 6.5.2 are not comparable. • Failure to assess substantive issues, which make data amalgamation inaccurate and unreliable.	• Include a provision to address cooperative arrangements not covering the whole basin. • Develop indicators that measure substantive elements of cooperation.	McCracken and Meyer [337], (p. 10). Hussein, Menga and Greco [336]
5. Cooperation Quality is not measured	• Exclusion of process and input indicators, thus not measuring the quality of cooperation. • Formal agreements cannot measure ongoing hydropolitics. • Outcome indicators fail to capture the progressive improvements made.	• Use of indices analysed and suggested [337,354] • A scale of Cooperation proposed [361,363] • Qualitative analyses including hydro-political assessments and discourse analyses proposed [336].	Hussein, Menga and Greco [336] McCracken and Meyer [337] de Chaisemartin [354] Ortigara, Kay and Uhlenbrook [362] McCracken [361] Tarlock [363]

Indicator 6.5.2 Gap	Policy Gap	Proposed Action (s)	Relevant Article
6. Hybrid Cooperation & Non-State Discourses	• Informal cooperative arrangements cannot be measured under indicator 6.5.2 [336]. • Cooperative actions by politicians (political statements), media, NGOs, civil societies, and development partners, excluded.	• Include qualitative indicators to assess state and non-state discourses and hybrid cooperation.	Hussein, Menga and Greco [336]
7. Power Dynamics in a Transboundary Basin	• Fails to take account of the power dynamics that exist in some river basins.	• Develop indicators that unveil concealed power asymmetries and domination.	Hussein, Menga and Greco [336]
8. Distinguish between Good & Bad Cooperation	• Indicator 6.5.2 does not make a distinction between good and bad cooperation.	• Distinguish good from bad cooperation and measure the quality of cooperation.	Hussein, Menga and Greco [336]
9. Overlaps, Inequity, and Inequality Issues	• Area as the unit of analysis distorts the overall picture due to many overlaps (basin & sub-basin levels, surface water & transboundary aquifers) • A single jacket approach to address existing complexities has led to inequitable outcomes	• A shift from the area as the unit of analysis towards use of other units of measurement • Water volume/# of water users/# of agreements proposed [337], (p. 10) • Area of the riparian state in the basin/volume of water proposed [354]	McCracken and Meyer [337] de Chaisemartin [354]
10. Data Quality, Reliability & Availability	• Binary (yes or no) nature of the indicator makes it difficult to grasp the actual cooperation situation. • There is no robust mechanism to check the quality of the data which affects the reliability of the data. • Ambiguous indicators lead to multiple interpretations and data that is not comparable nor interoperable. • Lack of disaggregation of the data makes it difficult to assess the actual situation • Basins and aquifers reported spatial data collection problems.	• Revise the binary indicators, address the ambiguous issues and disaggregate the data [337]. • Develop standard and harmonized indicators and improve monitoring to increase the comparability of data [362], (p. 8) • Address data availability and financial related data collection challenges [362].	McCracken and Meyer [337], (p. 9). Ortigara, Kay and Uhlenbrook [362], (p. 10) McCracken [361]

We compared these scales and the Benefit Sharing Model [288,338,366], and concluded that most of the scales are robust in assessing benefits to the river and because of the river. Only the water cooperation scale addresses the benefits from the river, and none of the scales is adequate to evaluate benefits beyond the river.

According to Sadoff and Grey [366], (pp. 393–395), benefits to the river creates opportunities for improved river flow, water quality, conservation of soil, protection of biodiversity, and ensuring sustainability. Increased benefits to the river also reduce pollution, land degradation, loss of biodiversity, drying of wetlands and unmanaged watersheds. Benefits from the river, lead to increased food production, hydropower production, and sharing the energy through interconnection lines, increased river navigation, increased recreation and tourism, and improved flood-drought management [366], (pp. 395–397). Improved cooperation may facilitate the process of reducing costs because of the river [366], (pp. 398–399). Most of the river basins barely engage in cooperation until a conflict arises [1,23,67]. Therefore, benefits because the river helps the riparian states to agree on a governance framework that shifts unilateral actions towards joint management and development [68]. Benefits because the river also reduce the food and energy production costs, through an agreement on joint cost and benefit sharing [49,69]. Finally, the process of developing a governance framework to support the regional integration of the riparian nation-states increases the benefits derived beyond the river [366], (pp. 399–400).

Hussein, Menga, and Greco [336] propose qualitative analyses that incorporate discourse analyses and hydro-political studies. The advantage of qualitative analyses and indices is the ability to track progress, explicitly. McCracken [361], (p. 66) explain that indices and qualitative data are beneficial because they provide more flexibility in cooperative actions, assess political will, establish the socio-economic context within which cooperation occurs, support step-wise cooperative processes, and acknowledge the cooperative actions of non-state actors. However, McCracken [361], (p. 65) highlight that qualitative data "does not present a single value for each country, which does not meet the needs for global SDG monitoring." To address this gap, we propose a collection of both qualitative and quantitative data. In addition, a stronger SDG monitoring mechanism should be established. Therefore, qualitative data will be used to substantiate and justify the quantitative data.

6.5.2. Contribution of the Nzoia WeShareIt Water Policy Game

The Nzoia WeShareIt game results indicate that a water policy game is a useful experiential learning tool on team interdependence and cooperation. Both the Chi-Square test for goodness-of-fit and the one-way between-subjects ANOVA with Friedman's nonparametric tests confirm that the game positively contributed to the planned learning outcomes on team interdependence and cooperation. The two sub-scales indicators are a subjective assessment of respondents' game learning outcomes. These game-specific questions need not to be adopted by WASREB in its normal operations. The water policy game's contribution is testing and suggesting an innovative WSP capacity development on team interdependence and cross-county cooperation. WASREB could use the results to develop similar social innovations and assess learning outcomes.

Of primary importance are the cooperation and the team interdependence game mechanics that we used to design the game. These mechanics may form the foundation for the design of Kenyan specific indicators to measure cooperation and team interdependence. For cooperation, we propose the introduction of shared goal, goal asymmetry, and goal synergy indicators. For team interdependence, we propose the introduction of complementary knowledge, role asymmetry, and complementary roles indicators. The practical application of the six mechanics may entail:

1. Shared Goal indicator(s) for measuring cross-county cooperation. An indicator to measure whether county governments within a given basin have a shared goal to sustainably manage the water resources for the benefit of all the basin residents.
2. Goal asymmetry indicator(s) for measuring cross-county cooperation. Each county government has different water availability levels and demand. Therefore, the current KPI indicators should be revised to avoid inequitable outcomes. WASREB should integrate the volume of water, water demand and supply indicators into the current KPIs. Besides, WASREB should encourage, support, finance and measure cross-county water partnerships.
3. Goal synergy indicator(s) for measuring cross-county cooperation: WASREB should measure the interactions between WSPs that promote interdependence and cooperation. In Nzoia Basin, there is one cross-county WSP, NZOWASCO [320] (p. 74). WASREB should develop cross-county collaborations indicators directly linked to SDG 6.5.2 monitoring financing advanced to WSPs.
4. Complementary knowledge indicator(s) for measuring cross-county team interdependence: To enhance team interdependence WASREB may develop joint reporting mechanisms where WSPs need information from other county governments to comply with the KPIs. For instance, indicators that

measure the impact of WSP actions on other riparian county governments. This indicator will require the various WSPs within the shared drainage basin to agree on the information submitted to WASREB to avoid conflicting information. Through their interactions and reporting, cross-county team interdependence will be enhanced.

5. Role asymmetry indicator(s) for measuring cross-county team interdependence: WASREB should develop indicators that take account of the different roles that county governments from various geographical zones have to undertake. The county governments in urban centers where residents solely rely on WSP for water and sanitation services have different roles from rural-based county governments. Therefore they may not require the same number of staff. Some WSP have no water distribution role during prolonged dry seasons because they have no water to distribute. All these complexities should be included in the revised WASREB indicators.
6. Complementary roles indicator(s) for measuring cross-county team interdependence: Different county governments have different comparative advantages. Therefore, WASREB KPIs should acknowledge the complexity and revise their current KPIs to reflect this. For instance, the cross-county collaboration between Bungoma and Trans Nzoia that led to the formation of NZOWASCO, creates complementary roles. Trans Nzoia is an upstream riparian government. Therefore their role is to extract water resources from Mt. Elgon and Cherangany Hills, treat and distribute downstream. The role of the Bungoma county government is to store the water resources and distribute it to its residents. These complementary roles need to be acknowledged and assessed differently in the revised WASREB KPIs.

6.5.3. From Policy to Practice: Recommendations to WASREB

WASREB monitors the implementation of SDG 6 at the WSP level. However, to foster cross-county cooperation, we recommend monitoring SDG 6 at the basin level. WASREB should encourage and support cross-county cooperation and continuosly monitor cross-county cooperative actions. Furthermore, if WASREB decides to use the UN-Water SDG 6.5.2 indicator's methodology to assess cross-county cooperation, there is a need for the following adjustments:

1. Disaggregate the SDG 6.5.2 indicators and have a clear definition of terms.
2. Develop qualitative and process-based indicators for operational cooperation.
3. Develop clear indicators to measure team interdependence and cooperation as two distinct indicators.

4. Develop indicators that take account of the basin complexities and peculiarities.
5. Use a mixed methods approach to measure cooperation, that incorporates substantive elements of the formal agreements to support the current quantitative form of data collection. An SDG 6.5.2 index should be developed that complies with the cooperation continuum as described in Sadoff and Grey [288,366]
6. Develop indicators to measure hybrid forms of cooperation, and expand the measurement of Indicator 6.5.2 to non-state actors. WASREB should use discourse analysis methods to measure the emerging discourses and how they impact on transboundary water cooperation
7. Use mixed methods to assess power dynamics within a given basin. Since the power dynamics change, the results should be regularly updated.
8. Institute a peer-review mechanism to distinguish good from bad cooperation. Also, the qualitative data and the study of power dynamics would provide valuable information on whether the finalized agreement is masking bad cooperation or cooperation is good.
9. The unit of analysis should be carefully selected to ensure that it does not propagate inequities and deepen complexity. Area as a unit of analysis is misleading and should be replaced.
10. Institute mechanisms to promote data sharing, check on the reliability of the data being provided. Also, the non-availability of data needs to be urgently addressed. Disaggregate data to identify whether WSPs are extracting water from surface water bodies or aquifers.
11. Before licensing WSPs, WASREB should require that they conduct detailed analyses of surface and groundwater resources. Thereafter, WASREB should use the data to develop an integrated information system, jointly managed by all WSPs. To encourage data sharing WASREB should develop indicators to measure the quality of data shared and contributions of a WSP to the overall information management system.

6.6. Concluding Remarks

In this chapter, we conducted a detailed literature review of SDG indicator 6.5.2 that measures transboundary water cooperation. The focus of the chapter is to support local monitoring of water cooperation, especially at the cross-county governance level. The target institution is the Water Services Regulatory Board (WASREB), which monitors the implementation of SDG 6 at the local level. Based on the analyses of previous studies and the results of the Nzoia WeShareIt

game, the chapter makes some recommendations that WASREB may incorporate into their current KPIs, to enhance cross-county cooperation.

To improve indicator 6.5.2, this chapter introduces a mixed method approach and a set of indicators that focus on the quality of cooperation. The process and content are given more weight than formal documents that may or may not be produced to cement the relationship. The proposed methodology moves away from the overall assessment of outputs towards a subjective assessment of the quality of cooperation, by both state and non-state actors. The mixed method approach lacks a single value of measurement, thus not meeting the requirements of a global indicator. However, it is important that the mixed method approach is adopted and the single value indicators can be later extracted for the global monitoring of SDG 6.5.2. This approach ensures that the data submitted for global monitoring of SDG 6.5.2 is substantiated by high-quality data that is both quantitative and qualitative.

Also, we introduced a critical aspect of cooperation—team interdependence—to enrich cooperative relations and check power asymmetries. Team interdependence indicators measure the extent of connectivity between the different riparian local governments. Team interdependence is enhanced when there is a valued shared goal and the cross-county communications and actions are targeted towards achieving the shared goal.

Another contribution of the study is an assessment of the value addition of a water policy game in enhancing cross-county cooperation. Nzoia WeShareIt game results indicate that gaming is a promising method for encouraging cross-county cooperation in a region prone to unilateral actions by the local authorities. The game created a learning space where the policymakers could test various water cooperation options and identify the configurations that would create benefits for all the riparian county governments.

This study was the first application of SDG 6.5.2 in the Kenyan county government level. There is a need for further assessments aimed at deepening understanding on existing global and local indicators and their impact on sustainability and equity. Since the application was confined to a water policy game, there is a need for actual real-life application of the recommendations to assess whether the gaming environment was an accurate reflection of the reality in Nzoia river basin. Future studies should also focus on how the findings can be replicated to larger basins, including Lake Victoria and the Nile Basin.

7. Relational Learning: Trust, Trustworthiness and Distrust

Title: A Study of Trust and Cooperation in the Nzoia River Basin Using a Water Policy Game

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Research Context: Studies indicate that trust is a key attribute of social learning (SL). However, there is limited guidance on how to design a SL experiment aimed at trust formation and sustenance. Moreover, the relationship between trust, trustworthiness and distrust is still not clear, especially in the context of water resources management (WRM). WRM societal contexts are normally complex and highly uncertain and there is limited evidence to explain what happens to trust and distrust levels, when the complexity and uncertainty conditions change. This empirical research addressed some of these research gaps, in the context of Nzoia River Basin.

Abstract: Nzoia river basin county governments barely cooperate in water resources management to jointly increase the basin's food and energy productivity levels, due to limited trust. In this chapter, we propose a game-based approach that can be replicated in any river basin, to assess trust and collaboration processes. In particular, we used the pre-game, in-game, and post-game assessment results to assess the relationship between Cooperation and Competition; Trust and Trustworthiness; Trust and Distrust; and (Dis) trust, Complexity, and Uncertainty. The initial assessment of respondents' propensity to trust (PTS) was divided into two variables (trust and trustworthiness) while adopting the unidimensional view of trust and distrust. We later examined whether we could separate the two constructs using a multidimensional scaling (MDS) technique known as the ALSCAL procedure. There are potentially significant results. Namely, that: trustworthiness and trust are not complementary; both cooperation and competition coexisted and increased throughout the game; more profound complexity and uncertainty led to an increment in trust, and reduced complexity and uncertainty led to a decrease in distrust. Based on the results and discussions, we provide recommendations for further research on trust, trustworthiness, and distrust in the river basin management context.

Graphical Abstract (Figure 7.1)

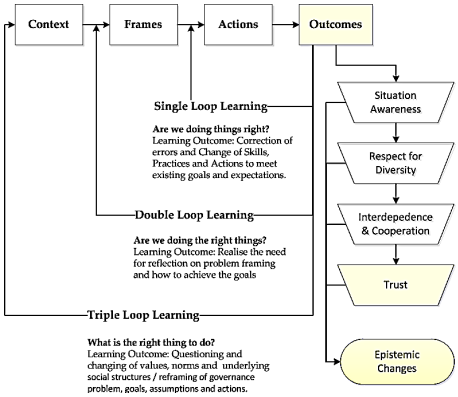

Figure 7.1. Triple-Loop Social Learning Sequence: Trust, Trustworthy and Distrust

Keywords: trust; trustworthiness; distrust; water cooperation; competition; complexity; deep uncertainty; risk perception; Nzoia river basin; water policy gaming

7.1. Introduction

Studies show an increasing difficulty for countries to make all their food and energy, within national geographical boundaries, due to scarce water resources [86,89,99,100,229,239,283,367-369]. Therefore, basin states are faced with a difficult decision: whether to maximize food and energy production or limit and /or stop production and buy the shortfall from other riparian states [88]. Rational decision-making supports cooperation aimed at maximizing production while minimizing costs, regardless of where the food or energy is produced within the basin [99]. Based on previous research, trust is a critical element needed when making the bold decision to stop or limit production and buy the shortfall from other riparian states [86,87,100]. The willingness by the parties to cooperate is sufficient to emit signals that get reciprocated and based on repeated reciprocation of signals that foster cooperation; trust can be cultivated [370], (225). Some riparian states are not willing to cooperate, due to low levels of trust [86,87,89,90,100,371]. Therefore, many basin states are locked in an impasse: they need to cooperate to build trust, and they cannot cooperate because they lack the 'willingness to cooperate,' which is a core element that initiates cooperation [370], (225).

We define a trusting relationship as one where the trustor (A) has definite feelings of assurance and hope that the trustee (B) will act in the trustor's favour "to do X" [75]," and not take advantage of the relationship to the detriment of the trustor [75,269,372]. According to Hardin [372], the relationship is divided into three parts "A trusts B concerning matters X." In the case of basin states, A can trust B with food production for A's residents, but not energy production. In other instances, A can trust B with money and not personal secrets. Therefore, X is a critical component of the trust relationship, and A can trust B on some issues and not others [75].

One critical advantage of trust is the reduction of complexity [373,374]. In this dissertation, we define complexity as decision makers inability to assess future effects of planned actions due to unknown interactions between many variables [375]. The past is used to reduce the complexity of the familiar present, through repeated actions reinforced when they lead to the same outcome [305]. However, when the present and future is uncertain, trust is one possible mechanism for reducing complexity. We define uncertainty as the absence of knowledge [376], (p. 16), or when the available knowledge is not certain (impacts of climate change, unknown adaptation & mitigation costs, unknown effects of policy options, and unpredictable social and political environment) [377], (p. 160). According to Luhmann [378], (p. 23), the act of trust reduces deep uncertainties and complexity of the future world. Even though there are many

plausible future possibilities, trust reduces the possibility to one possible outcome, the act X by the trustee (B).

Since the fulfillment of X is dependent on B considering the interests of A, then B's trustworthiness encapsulates A's interest. Ben-Ner [379], (p. 65) defines trustworthiness as "the willingness of a person B to act favourably towards person A when A has placed an implicit or explicit demand or expectation for action on B." For instance, in a river basin, A (downstream riparian government) entrusts B (upstream riparian government) to maintain good water quality upstream (X). In this instance, it is in the interest of A for B to cooperate and not pollute the river (X). Conversely, it is B's interest to act in a trustworthy manner, and thus maintain good diplomatic relations with A. Therefore, B's trustworthiness encapsulates A's interest.

According to Mayer et al. (1995), trustworthiness consists of three factors: benevolence, ability, and integrity [269]. Evans and Revelle (2008), defines benevolence as "the general desire to do good" [380], (p. 1586). Benevolence is the willingness to support others, notwithstanding the costs [380]. Ability refers to a set of competencies, skills, and characteristics that facilitate the effective operation in a certain discipline or domain. Evans and Revelle (2008), defines integrity, as "the desire to uphold rules and social norms" [380], (p. 1586). Both benevolent and persons of high integrity reciprocate in a trust relationship [269]. However, the driving force for reciprocity differs. According to Evans and Revelle (2008), the benevolent reciprocate because they are concerned and have a desire to help and perform good actions. Contrary, integrity driven individuals reciprocate out of the conviction that "it is the right thing to do" [380], (p. 1586). If B cannot maintain good water quality (maybe B cannot monitor and stop water polluters), then B will not be considered trustworthy, even if B demonstrates integrity and /or benevolence. Research indicates that evidence of being trusted by the trustor increase the likelihood of the trustee reciprocating [380].

B may choose not to reciprocate and thus take advantage of the trust relationship and act to the detriment of A. The perception by a trustor (A) that the trustee (B) will reciprocate or not, introduces the third element of our study, distrust. According to Gambetta (1988) "it is important to trust, but it may be equally important to be trusted" [370], (p. 221). In trust, the trustor is willing to take the risk of being vulnerable to the trustee, whereas distrust feelings are risk-averse. The distruster is not willing to be vulnerable to the distrusted and take any risks that arise from cooperative actions. Distrust feelings create fear, avoidance, and discomfort. Distrust helps to defend the distruster from the distrusted [381]. In a high trusting relationship, there can also coexist high distrust levels [381-383]. Lee (2018) explains that distrust has for a long time been perceived as "the opposite of trust." Recent studies have discounted the

unidimensional view of trust and distrust and adopted a bi-dimensional view [381,384,385]. Lee (2018) states that "high trust is not the same as low distrust" and argues that distrust is distinct from trust and should be treated as a separate construct [381,384,385]. Thus, low levels of trust are not similar to high distrust levels, and an increase in trust does not automatically lead to decreased distrust [381,385,386].

Most studies focus on understanding trust [372,378,379,387-391], with insufficient research on trustworthiness and the relationship between trust, trustworthiness, and distrust [387]. Reiersen [387], (p. 1) states that it "is somewhat surprising given that trustworthiness is fundamental to trust." Hardin [75] explains that most of the trust literature barely mention the term trustworthiness, "though implicitly much of it is primarily about trustworthiness." Reiersen [387], (p. 1) adds that "It makes no sense to trust others if others are untrustworthy." Also, it is detrimental to the trustee to trust an untrustworthy person. According to Reiersen [387], (p. 1) trust is based on the belief that the trustor can be entrusted not to abuse the trust shown. Furthermore, some models theorize that the trust-trustworthiness relationship is complementary and cyclical [380,392]. Moreover, there is limited research on the relationship between trust and distrust, especially in the context of water cooperation [99]. Also, due to the weak conception of trust, many studies do not incorporate the three elements of trust in their research instruments: trustee, trustor and the trustee's behaviour (X). Countless researches focus on A and B with no reference to X [393], (p. 19). Hardin [75] explains that A and B without X is an incomplete understanding of trust. Bauer [393], (p. 19) further states that the inclusion of X has diffused slowly within the trust scholars. Bauer [393], (p. 20) recommends that trust scholars should conceptualize trust and formulate questions that demonstrate the three dimensions of trust.

To increase trust amongst riparian governments that share a river basin, it is essential to understand trust elements and how they relate to one another [387], (p. 3). We seek to study trust and collaboration processes using a game environment. We chose policy gaming method because of the low risks associated with gaming, which provide a safe learning and policy practice environment. Through the game, we simulated the river basin context and facilitated the process of interaction, joint problem solving and learning [51,80,394,395]. We used the pre-game, in-game and post-game assessment results to assess the relationship between:

1. *Cooperation and Competition:* Are cooperation and competition alternatives, or can they coexist [370], (p. 215), in the context of river basin management?

2. *Trust and Trustworthiness*: Is the trust - trustworthiness relationship complementary [380,387,392], within the context of the Nzoia WeShareIt game?
3. *Trust and Distrust*: Is the trust - distrust relationship bi-dimensional [381,384,385], within the context of the Nzoia WeShareIt game?
4. *(Dis) Trust, Complexity, and Uncertainty*: Increased trust leads to the reduction of complexity and uncertainty [378,396]. What is the effect of reduced complexity and uncertainty on distrust [397], within the context of the Nzoia WeShareIt game?

In this research, we undertook a subjective assessment of respondents' propensity to trust (PTS) which we divided into two variables (trust and trustworthiness). We adopted the unidimensional view of trust and distrust at the start of the experiment and later assess whether we can separate the two constructs using multidimensional scaling (MDS) technique known as ALSCAL procedure [381,386]. The ALSCAL procedure facilitates detailed analysis of the underlying dimensions and clusters using the multidimensional scaling technique. Based on the MDS results, we provide recommendations for further research on trust, trustworthiness, and distrust in the river basin management context.

The chapter is structured as follows. Section 7.2 introduces explains the research methods and materials which includes the materials used in the quasi-experiment, the process of data collection and the methods used to analyse the data. Section 7.3 contains the findings based on the in-game data, the initial descriptive statistic results, the Chi-square goodness of fit test results and the MDS ALSCAL procedure. The subsequent section discusses the findings and explains the limitations of the study. The final section provides concluding remarks and proposes future research.

7.2. Materials and Methods

We used three methods to analyse the pre-game and post-game assessment results. First, the Principal Component Analysis (PCA), followed by the Chi-Square test for goodness of fit and finally the multidimensional scaling using the ALSCAL procedure. For the **in-**game data**,** we extracted the results of all the trading rounds and assessed them using Tableau professional edition version 10.2.3. Supplementary Material S1, contains the detailed description of the Nzoia WeShareIt game.

7.2.1. Materials

The assessment contained 18 questions from the Propensity to Trust (PTS) scale. The PTS scale is situated; it measures the underlying behaviour of a person based on the simulated state [269,380,398]. Ten of the questions assess trust and eight assess trustworthiness. For each question, the respondent assessed the accuracy of the statement, according to their perception. The scores were from 1 to 5, one meaning "very inaccurate" and five meaning "very accurate."

The original PTS scale has 21 questions. We adopted the PTS scale from Evans and Revelle (2008), with a few modifications. Appendix D encompasses a description of the modifications made and Table D.1 in Appendix D lists all the questions asked in the pre-game and post-game questionnaire. Supplementary Material S2, contains the raw data we used to extract the results.

7.2.2. Method 1: Principal Component Analyses (PCA)

Using the respondent's responses, we first conducted a PCA of the two sub-scales to assess the underlying structure of the two PTS sub-scales psychometrically. The purpose was to check whether the two sub-scales had sufficient loadings before undertaking further analyses **[380]**. A detailed explanation of the PCA results is in Appendix D.

The trustworthy factor loadings were stable and significantly higher than the trust factor loadings in both the pre-game and post-game stages. Therefore, we concluded that the trustworthy sub-scale measures one construct.

The trust sub-scale was unstable and seemed to be measuring more than one construct. Though the trust sub-scale passed the goodness of fit test at the post-game level, its loadings are not high, and the underlying structure was not straightforward. Thus the need for further analyses, as explained in the subsequent sub-sections. The loadings per item for the two subscales are in Appendix D (Table D.1).

7.2.3. Method 2: Chi-Square test for goodness-of-fit for PTS

The chi-square goodness-of-fit test was used to compare an observed distribution with a theoretical distribution. The Chi-Square test for goodness-of-fit null hypothesis is: there is no significant difference between the post-game results for the PT sub-scales (trust and trustworthiness), and the pre-game results (H0). The Chi-Square goodness-of-fit test alternative hypothesis is: there is a significant difference between the post-game results for the PT sub-scales (trust and trustworthiness), and the pre-game results (H1). We reject the null hypothesis if Sig. < .05.

7.2.4. Method 3: The multidimensional scaling (MDS) ALSCAL procedure

The multidimensional scaling (MDS) is a technique used to visualize the level of similarity of the individual objects in a dataset [399]. It places these objects in an n-dimensional space, the coordinates of which are formed by a series of hidden or underlying attributes [400]. The purpose of the MDS is to identify those attributes, compute the coordinates of each object and represent the objects in space [399]. The primary purpose of conducting the MDS was to compute the distances between objects and group them in clusters, based on their similarities [399]. Afterward, we labeled each dimension according to the characteristics of the object in each class. The MDS procedure starts from a single object attribute to discover the underlying dimensions behind that attribute [400].

7.3. Results

In this section, we present the findings on the WeShareIt Game trade exchanges (Figure 7.2), and the PT sub-scales responses findings based on the Chi-Square goodness-of-fit test and the MDS. Appendix D explains the results of the pre-game and post-game descriptive statistics. The standard deviations and means for each PTS sub-scale item, **are** contained in Table D.2.

7.3.1. Cooperation Outcomes: Nzoia WeShareIt Game Results

Using Tableau, we visualized all the trades conducted by the five county governments (Figure 7.2). The exchanged resources are food, energy (hydroelectric power) and money *[88]*. In-game trade data was extracted to visualize the exchanges between County Governments starting with hydro-electric energy then food and finally money. There were numerous trade transactions; some can be grouped as 'short-term opportunistic' transactions, that did not develop long-term engagement while others were grouped under strong long-term oriented relationships *[360]*, (p. 338).

However, the short-term opportunistic transactions were minimal compared to the long-term oriented and repeated transactions. Due to the repeated transactions, a network of buyers and sellers seemed to be emerging based on comparative advantages. Uasin Gishu was the sole provider of hydro-electricity energy for the basin. Trans Nzoia and Kakamega were the food providers. However, Trans Nzoia provided more food than Kakamega. The primary consumers that ensured that the excess food and energy was utilized were Bungoma and Busia.

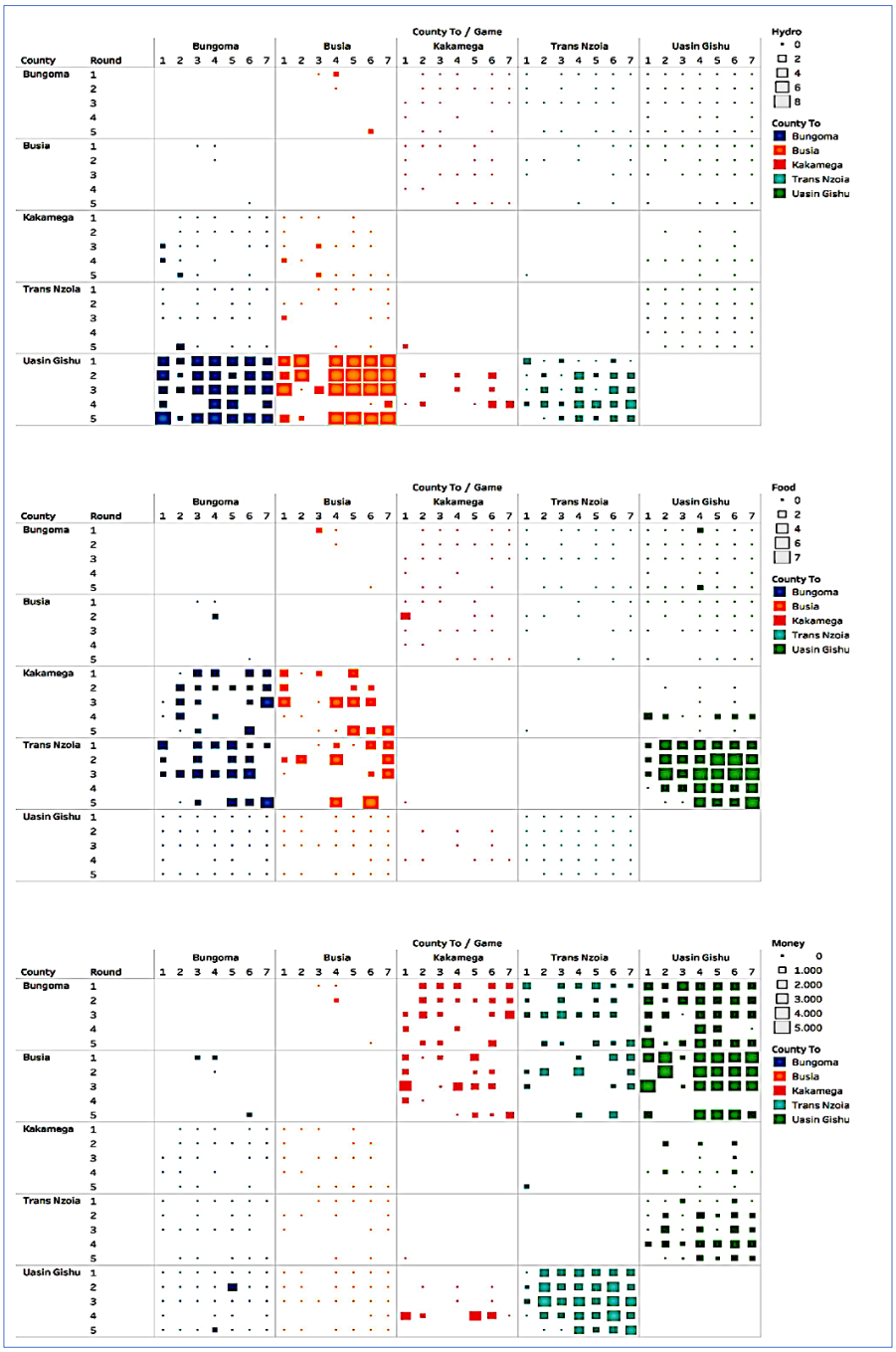

Figure 7.2. Trade Exchanges between County Governments

7.3.2. Chi-Square test for goodness-of-fit for PTS

The goodness-of-fit results indicate statistical differences in the trustworthy sub-scale for all the eight variables. Based upon the observed frequencies it appears that there was a significant increase or decrease in trustworthiness between the pre-game and post-game results. The p-value for all the eight variables is lower than 5% (Sig. < .05). Hence, we reject the null hypothesis: there is no significant difference between the post-game results for the trustworthiness sub-scale, and the pre-game results (H0). Hence, there is an enormous variance between the post-game results for the trustworthiness sub-scale, and the pre-game results (H1).

The results for trust sub-scale are varied. Based upon the observed frequencies, it appears that there was a significant increase or decrease in trust between the pre-game and post-game results in six variables (T1, T2, T3, T4, T7, and T10). The p-value for all the six variables is lower than 5% (Sig. < .05). Consequently, we reject the null hypothesis: there is no significant difference between the post-game results for the trust sub-scale, and the pre-game results (H0). As a result, there is a significant difference between the post-game results for the trust sub-scale, and the pre-game results (H1).

Additionally, there was no significant increase or decrease in trust between the pre-game and post-game results in four variables (T5, T6, T8, and T9). The p-value for all the four variables is higher than 5% (Sig. < .05). Therefore, we maintain the null hypothesis: there is no significant difference between the post-game results for the trust sub-scale, and the pre-game results (H0). The results of the trustworthy sub-scale Chi-Square test for Goodness-of-fit are in Table D.3 and for the trust sub-scale in Table D.4 (Appendix D).

7.3.3. Multi-dimensional scaling (MDS) using ALSCAL procedure

To be able to assess the multiple dimensions of the PTS, we performed a multidimensional scaling (MDS) using the ALSCAL procedure. Appendix D describes the ALSCAL procedure. Model stability is visualized in the scatterplot of linear fit (Figure 7.3). Since the points in the chart tend to gather around the chart diagonal (straight line), then the model's consistency is confirmed.

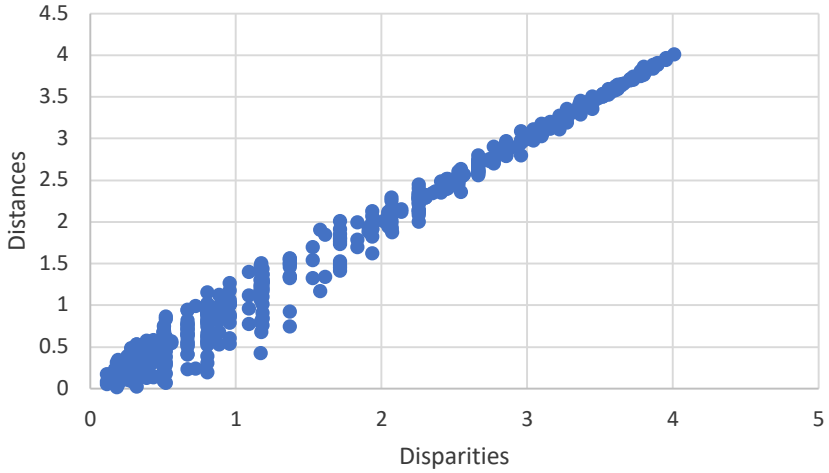

Figure 7.3. Scatterplot of Linear Fit from the Euclidean, distance model.

Based on the scatterplot of linear fit that was derived from the Euclidean distance model, there was more extensive space for disparities than distances. The disparities ranged from slightly above 0 and 4. However, the distances were narrower than the disparities because the responses seemed to gather around the chart diagonal. As the disparities increased, the distances decreased. There were more considerable distances on the lower side of the Y-axis where the disparities were less compared to the upper side of the Y-axis. Figure 7.4 visualizes the distances and disparities separately based on the 36 observations/stimuli.

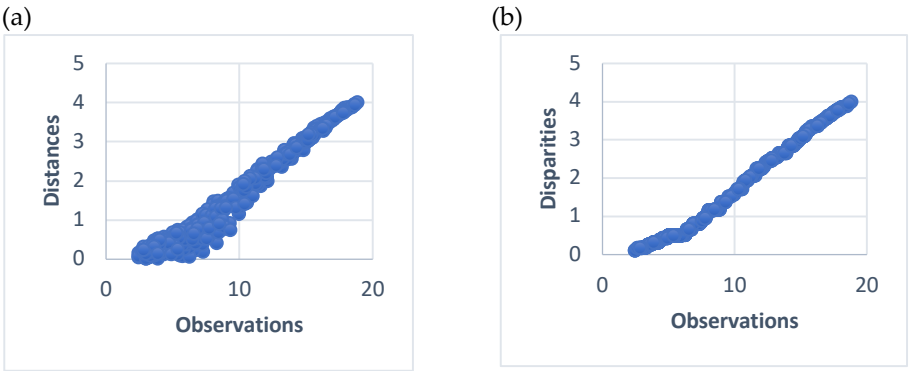

Figure 7.4. Scatterplots (a) Nonlinear Fit Scatterplot (b) Transformation Scatterplot

After that, we assessed the stimulus coordinates, configured in a two-dimensional space. There were 36 observations or stimuli (18 results from the pre-game questionnaire on trust and 18 results from the post-game questionnaire on trust). For each of the 36 observations, the model computed two coordinates (dimension 1 and 2) and grouped the 36 observations into clusters. Figure 7.5 plots the two-dimensional solution obtained for the pre-game and post-game individual dissimilarity scores for the trust and trustworthiness sub-scales, grouped in two dimensions.

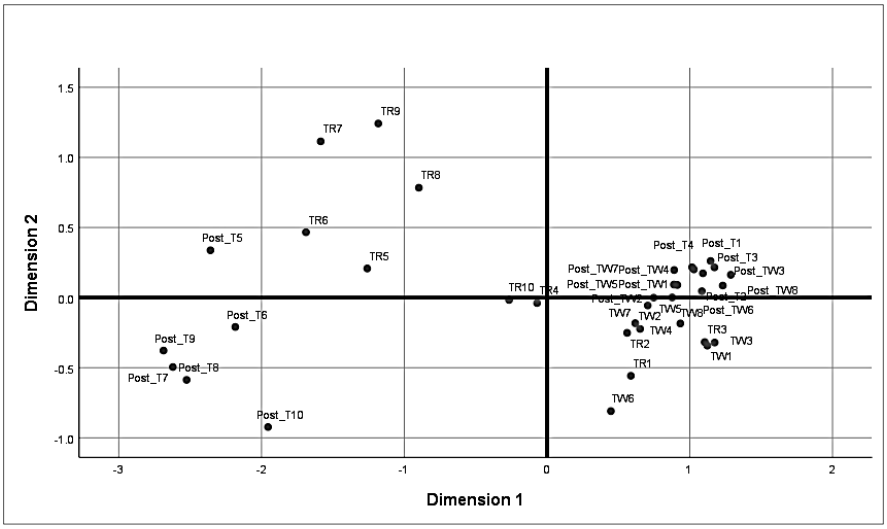

Figure 7.5. Conceptual Map of the Derived Stimulus Configuration.

We clustered the conceptual map results into four groups. Figure 7.6 and Table D.5 (Appendix D) contains the clustering of the 36 trust and trustworthy observations based on the derived stimulus configuration from the Euclidean distance model into four clusters, under two dimensions. To understand the components of the four clusters, we first assessed the features of each of the 18 variables within the PTS. All the 12 variables in the first cluster assessed the respondent's positive perceptions, beliefs, and actions (trust). The four clusters mainly contain the results of the 12 positive, trustworthy PTS sub-scale in one cluster and the results of the six negative trust sub-scale in another. Based on the respondent's score, high scores indicated a high disposition to trust. Low scores indicated a low disposition to trust. The last six variables were grouped in the second cluster that assessed the respondent's negative perceptions, beliefs, and actions (distrust). Based on the respondent's score, high scores indicated profound distrust and low scores indicated low distrust. The other two clusters

differentiate the pre-game results from the post-game results. Particularly, two variables did not fit into the four clusters: T10 and T4.

After that, we interpreted the two dimensions and gave suggestive labels for each dimension: (1) dimension 1 represents uncertainty, and (2) dimension 2 represents complexity (Figure 7.6). Dimension 1 represents the impact of high and low uncertainty on the levels of trust and distrust, with the positive impacts on the right side and negative impacts on the left side. Uncertainty had a mixed marginal impact on trust and a distinct negative impact on distrust. Dimension 2 represents the impact of high and low complexity on the levels of trust and distrust, with trust increasing and distrust decreasing.

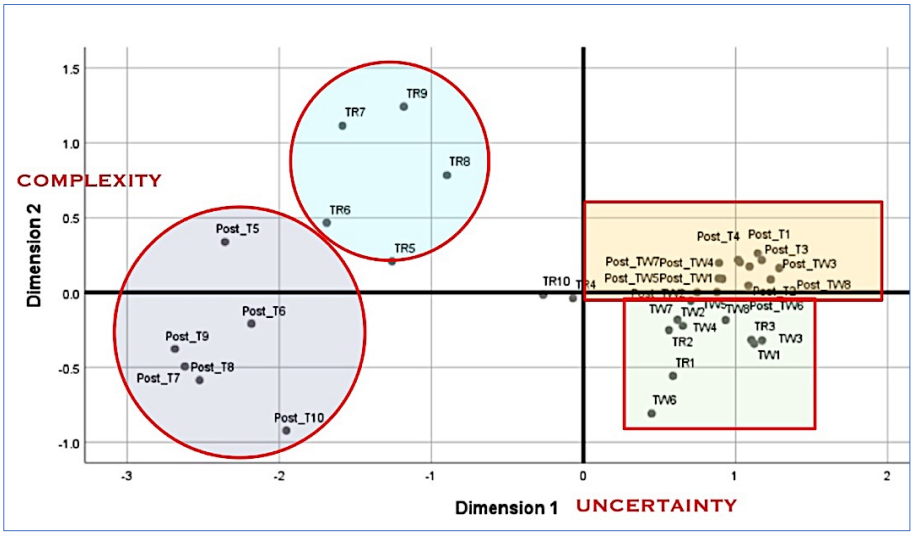

Figure 7.6. Clustering of the Conceptual Map.

The first dimension refers to the level of uncertainty with two values – low and high and the second dimension denotes to the level of complexity with two values – low and high. We were guided by the elements of trust as highlighted by Gambetta [370], (p. 218) when determining the labels for the two dimensions. The first element relates to trust being a "threshold point, located in a probabilistic distribution." In this threshold, the values range from 0 to 1, with 0 representing complete distrust and 1 representing complete trust. At the midpoint of these values (0.50) is uncertainty. From the graph, the midpoint of trust and distrust is located along dimension 1, justifying our interpretation that dimension 1 represents uncertainty. Secondly, trust is principally relevant when there is deep uncertainty and high complexity. Luhmann [124] explains that a

critical element of trust is the reduction of complexity. Thus, dimension 2 represents complexity.

7.4. Discussion

The first four parts of the discussion are centred on the four research questions, as highlighted in the Introduction section. The fifth part discusses the limitations of this particular study.

7.4.1. Cooperation and Competition

Cooperation and competition increased throughout the game. The results support the findings by Gambetta [370], (p. 215) that competition and cooperation should not be perceived as alternatives because they coexist throughout the game sessions. Water cooperation was evident in the game, and at the same time, the participants chose not to stop unproductive food and energy production, as a safety net. None of the county governments decided to make 100% of their food and energy and not engage in any trade relations with the neighboring counties. Based on the debriefing sessions, the respondents stated that it was not wise to completely trust the neighboring counties to produce their food or energy. Therefore the small production, though under unproductive conditions, was a safety net, intended to protect them from the 'increased vulnerability' that emerges from a trust relationship [360], (*p.* 338). Competition and cooperation coexisted due to decisions not to stop unproductive food and energy production. The primary challenge in the game was finding a healthy balance between cooperation and competition [370], (p. 214).

7.4.2. Trust and Trustworthiness

Apart from the eight trustworthy variables, there were 12 trust variables. Within the 12 trust variables, 4 assessed the respondent and six assessed other players in the game. Therefore, there were three groups of constructs being measured: trustworthiness (8 variables TW 1- TW8), cooperative nature of the respondent (4 variables – T1- T4) trust (6 variables T5 – T 10). All these 18 variables comprise the PTS / DTS.

The game had a significant positive impact on individual perceptions of their trustworthiness. The players exhibited high trustworthiness, and high

ability to cooperate. All the respondents had positive perceptions of their trustworthiness and this perception increased significantly after the game sessions.

The players assessments indicated a low perception of the trustworthiness of other players. Trust levels declined consistently after the game sessions. The trustee (B) was reciprocating (based on the in-game results) with clear evidence of distrust by the trustor (A).

The trust results were not complementary to trustworthy because the ratings of B by A worsened after playing the game (except the self-assessment PTS ratings, namely T1 – T4). In the case of the Nzoia WeShareIt game, the trust-trustworthiness relationship was not complimentary. The initial Chi-Square test for goodness-of-fit test results indicates contrary findings to previous research regarding the complementarity of the relationship between trustworthiness and trust [380,387,392].

According to Reiersen [387], (p. 4) the trust problem is the lack of knowledge by the trustor that the trustee is trustworthy and B is the solution. To overcome the trust problem, B has to convince A, that B is trustworthy. The 35 B's, in the case of the Nzoia WeShareIt game, did not manage to convince the 35 As, that they are trustworthy. The consistent poor rating of other players indicated that the interactions between the players led to conflicts over the shared water resources, that could not be retracted, leading to low B trustworthiness ratings [381,401]. Increased competition, exclusive dealing, price fixing, refusal to trade with others, and absorption of a competitor led to unfair trading practices. Though cooperation improved, there was also augmented competition, at the expense of B's trustworthiness.

There are various explanations to this contrary finding. First, in the initial game rounds, cooperation was not based on trust, leading to conflicting results. Disposition to trust was consistently built throughout the game because there were repeated actions that proved that cooperation works. Reiersen [387], explains that cooperation based on repeated interaction "is just pure calculation and maximization of long-term self-interest." Therefore, the initial cooperative actions were not grounded on trust and this may be one of the reasons for the contradictory results [387], Trust is one of the elements that enable cooperation, and we could not assume that because there were cooperative actions, trust was established at the initial stages of the game.

Second, Ben-Ner and Halldorsson [379] explain that trustworthiness is embedded in norms. Reiersen (2018) adds that "trustors trust because they are aware that trustworthiness is rooted in norms." Hardin [372], (pp. 25-29) explains some difficulties experienced when seeking to measure trustworthiness in various societies. The first difficulty is framing of the question: different societies frame the same question differently leading to varied responses. The

different frames are mainly due to different institutional structures or variation in time. Another difficulty are individuals with a background of untrustworthy relations. It is harder for such individuals to undertake the risk of perceiving someone else as trustworthy and thus they cannot easily develop a trusting relationship.

Third, changes in the game led to instances of incentive incompatibility that reduced B's level of trustworthiness. If B is a producer of food or energy, X refers to four things:

1. B will make the relevant water allocation to produce excess energy and / or food on behalf of A;
2. B will sell the excess production to A before considering other competing buyers;
3. B will not insist on high fixed prices, even when there is high demand; and
4. B will strive to keep the promise made to A, even under unforeseen circumstances (droughts).

Based on the game design, there is a high likelihood that B will not fulfill all the Xs in every round. In the drought round, B loses half of their resources, and even though they fulfilled the first X, they cannot fulfil the last X because the game rules require B first to ensure that its residents have sufficient food and energy before selling to others. Therefore, though B's actions are perceived untrustworthy, it was challenging for B to convince A that they are trustworthy when achieving specific game rules is competing with an act of trustworthiness. The drought round indicates that there are times when B's interest does not encapsulate A's [75,372]; thus, B had no interest in being trustworthy. Consequently, the post-game questionnaire assesses a summation of all the interactions and does not take account of the moments, when B's interest did not encapsulate A. In this instances, trust and trustworthiness were not complimentary. Incentive incompatibility and competition led to consistent low ratings for B's trustworthiness. Thus confirming the statement by Hardin [372] that trust is "heavily limited and conditional." X is a critical component of trust and B's interest must encapsulate A, before a complementary and cyclical relationship is established.

7.4.3. Trust and Distrust

The trust - distrust relationship bi-dimensional [381,384,385], within the context of the Nzoia WeShareIt game. The results imply that a single dimension analysis of trust of the overall level of PTS may be potentially misleading because the respondents were measuring other constructs, not envisaged when developing the assessment tool. The distances between the variables indicate

that the respondents measured multiple constructs. Disposition to trust variables all clustered into one big group, while another group clustered on the left side of the graph. The vast distances between these two groups confirm that the multidimensional scale separated the two constructs. Though the trustworthy sub-scale was not affected, the trust sub-scale measured different constructs leading to insignificant and conflicting results.

The results confirm that trust and distrust are distinct concepts. Some constructs were being measured, namely, trust in others, distrust of others, a sense of trustworthiness of others, and a self-assessment of trustworthiness. There were high scores for self-assessment of trustworthiness and distrust of others. The respondents were facing a difficult time being trusted by other players. Each player considered themselves highly trustworthy, but that perception was not mutual neither was it a collective perception. The general perception was that none of the players could be trusted. Based upon the vast distances between all the distrust results on the conceptual map, there was no significant change in distrust levels at the start and the end of the game for all the six variables.

7.4.4. Trust, Distrust, Complexity, and Uncertainty

Increased complexity and uncertainty led to increased trust. Based on Figure 7.6, trust is located in the area in the graph representing deep uncertainty and high complexity. The research results indicate that trust levels augmented as uncertainty and complexity increased.

Moreover, trust is excluded in circumstances where a trust relationship will not affect the decision made. In the graph, trust is excluded from the left side of the graph, where there is low uncertainty and low complexity because in this case trust is not needed to decide [270,370,378]. It is also excluded from the upper left of the graph where there is low uncertainty and high complexity, where efforts to understand and address the complexity are needed, instead of trust. Klinke and Renn [376], (p. 1086) support this finding by stating that "it does not make sense to incorporate … perceptions, or any other social aspects into the function of resolving (cognitive) complexity. Charnley [402] adds that when there is deep complexity, social solutions can be used if the specific community has certain knowledge that is critical for reducing complexity. Therefore, community knowledge replaces trust in reducing complexity, where the situation is certain and unambiguous. Klinke and Renn [376] proposes technical solutions in the form of cost-effective methods to address deeply complex problems that are unambiguous and certain.

Reduced complexity and uncertainty led to a decrease in distrust. The conceptual map indicates a decrease in distrust between the pre-game and post-

game findings, though the decrease was not significant. The decrease occurred when complexity was reduced, and uncertainty was also reduced. Therefore, under familiar conditions (when the players were more familiar with the risk and the other respondents), complexity and uncertainty are reduced leading to a decrease in distrust.

7.4.5. Study Limitations and Future Research

The research faced three main limitations. First, It was not possible to include the X in the pre-game questionnaires, which led to the assessment of generalized or social trust, at the start of the game. Hardin defines general trust as "trust in random others or social institutions without grounding in specific prior or subsequent relationships with others [372], (p. 23)." However, based on the nature of the questions (apart from T5 – T10 that needed reverse coding), the response, whether in the real world or a game environment, would not make a huge difference since this was one's subjective assessment of their level of trust and trustworthiness. Therefore, the comparison we made between the pre-game and post-game questionnaires is justified because the questions were a subjective assessment of the trustor (A), save the six questions that focused on the trustee (B). However, the effects of this limitation were not considered immense, since there was no significant difference between the distrust scores before and after the game.

Second, the post-game questionnaire was designed to assess a summation of all the interactions. Though this is a convenient and less cumbersome approach, it did not take account of the moments, when B's interest did not encapsulate A.

Third, we adopted both the 'belief-based [403]' and the 'behavioural-based [404,405]' approaches to trust without integrating the two in one assessment tool. Bauer [393], (pp. 21) points out that one of the biggest challenges of measuring trustworthiness is the inability to yield credible answers. To address this, we used in-game data to measure trustworthiness actions and asked indirect behavioural questions using the pre and post-game questionnaires to measure attributes that influence trustworthiness. It was not clear from the in-game data whether the cooperative actions were grounded purely on trust or there was another factor that contributed to the cooperative actions.

7.5. Conclusion

Trust is a critical element that enhances water cooperation within a shared river basin. Trust establishes a healthy balance between cooperation and competition with the aim of increasing the benefits that riparian governments can derive from the shared water resource. To be able to tap into the positive aspects of trust, it is imperative that trust concepts and collaborative processes that relate to water resources management are better understood.

Little is known of the relationship between trust and trustworthiness. There is limited literature on trustworthiness and how it relates and contributes to a trusting relationship. Moreover, the belief that distrust and trust are unidimensional has led to limited research on the relationship between trust and distrust. Additionally, there is established literature that affirms that trust reduces complexity by limiting the number of possible future options to one: action X by B. However, little is known regarding the impact of changing levels of uncertainty and complexity on the levels of trust and distrust.

In this chapter, we offer *a* game-based approach that can be replicated in any river basin, to assess trust and collaboration processes. The model is supported by pre-game, in-game and post-game data that measure both the 'belief-based' and the 'behavioural-based' approaches to trust. After that, the chapter discusses some interesting and potentially important results, namely, that:

1. Cooperation and competition coexisted and increased throughout the game;
2. In the Nzoia WeShareIt Game context, trustworthiness and trust were not complementary;
3. Trust and distrust are bi-dimensional and operated simultaneously in the game due to the multiple and mixed conditions, leading to varied complexities and uncertainties; and
4. Increased complexity and uncertainty led to increased trust whereas decreased complexity and uncertainty led to a decrease in distrust.

We recommend that future researches focus on deepening understanding of the relationship between trust, trustworthiness, and distrust in the context of river basin management. Also, there is a need to improve existing measurements of trust so that trustworthiness and distrust are correctly measured. These studies should aim at increasing water cooperation within a shared basin and contribute to complexity and deep uncertainty studies. Finally, there is a need for more research on how to establish a healthy balance between cooperation and competition, once the attributes of (dis) trust are better understood.

8. Synthesis of the PhD Research

This dissertation presents climate change policy gaming as a new approach to catalyse Institutional Change through Social Learning (SL). Institutions are "the rules of the game in a society, or more formally, the human devised constraints that shape human interaction [4]." SL "is a change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks [41]." SL comprises of three dimensions – cognitive (obtaining new knowledge or restructuring existing knowledge), relational and epistemic [50]. The relational dimension entails an increased understanding of other actors' mind-sets (respect for diversity), trust, and cooperation [47]. I mainly assessed normative epistemology which includes a change in norms, values, paradigms and idea convergence.

In traditional epistemology, symbols are the knowledge carriers, represented by theories, concepts, models, and facts. Symbols are particularly useful in introducing the unfamiliar world (climate-change), into the familiar world, thus facilitating innovation and change [270,378]. Conversely, in organizational behavioural theories, knowledge is transferred through competencies. Therefore, routine (an established way of action), is the knowledge carrier of competencies. Through routine, the institution is programmed to repeat actions, based on cues, with little or no room for reflection, learning, innovation and change. As a result, many water institutions are trapped in the single-loop phase where they repeat actions and do not reflect on the fundamental assumptions, while their repeated actions continue to damage the natural capital, thus increasing community vulnerability [230]. To address this problem, SL experts propose institutional 'unlearning' of established values, norms, beliefs and worldviews [406]. However, institutional routine resists learning, because established ways of action are designed to reinforce stability, foster continuity and reduce change.

In this dissertation, I introduce the concept of epistemic artefacts to challenge routine, thus catalysing the emergence of new institutions. An epistemic artefact is different from technical artefacts because it is open-ended, thus creating room for unexpected events [56]. Unexpected events challenge routine, leading to questioning of underlying assumptions, and subsequently

change. I designed the epistemic artefact in the form of a climate change water policy game, known as the Nzoia WeShareIt. Policy game is defined by Mayer [51] (p. 825) as "experimental rule-based, interactive environments, where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game." I modelled the current state of institutional policymaking routine within the Nzoia River basin. Therefore, Nzoia policymakers experience the same real-world institutional routine within the "Game world".

The game is designed to take decision makers through several rounds, a session comprises of a maximum of eight rounds. The rules remained the same for the first three rounds to establish and reinforce routine. However, after the third round, routine was interrupted when an unexpected event was introduced – a slow-onset climate change induced disaster. This unexpected event was introduced to catalyse reflection. Interruption of routine enabled decisionmakers to question, nullify and overcome "stable and difficult-to-change" institutions and supported the process of change, which entailed giving more value to natural capital and jointly managing the shared water resource [1].

Based on the Nzoia River Basin game results and subsequent discussions, this dissertation contributes to SL scholarship in water resources management (WRM), by assessing whether SL has the potential to catalyse institutional learning, and change. The main focus is on SL outcomes. Moreover, I recommend strategies within which water managers can influence the real-world SL project inputs, processes and outcomes, using the game-based insights. As such, this dissertation bridges the gap between SL pilot projects and actual reality.

In the following sections, I start with a brief explanation of the key research results and then delve into detailed explanations of each SL outcome (cognitive, relational and epistemic). More emphasis is placed on the observed or identified epistemic changes, because I did not dedicate a specific chapter to this dimension and I treated epistemic changes as cross-dimensional (Chapter 4 – 7). I then revisit the three main research questions (8.2) and later the research objective (8.3). Subsequently, I reflect on the research approach (8.4), and conclude with proposed future research (8.5).

8.1. Synthesis of Results: Contribution to Social Learning

The synthesis of the results is divided into five parts. First, I provide an overview of the research methods and measures (8.1.1). Thereafter, I summarize the results (8.1.2). After that, I discuss observed changes, in the three SL dimensions: cognitive (8.1.3), relational (8.1.4), and epistemic (8.1.5).

8.1.1. Overview of the Research Methods and Measures

I utilized mixed data collection approaches, and triangulated the results. I measured the cognitive dimension using the Situation Awareness Rating Technique (SART) that contains 10 standard questions. First, I assessed whether there were positive cognitive changes. Thereafter, I conducted a 3x4 factorial MANOVA to assess which of the independent variables largely contributed to the observed Situation Awareness (SA) results. Thus, I measured the contribution of each of the water negotiation teams (Seven five-member teams), familiarity (climate change risks and the extent of complexity and variability the socio-technical water system), and gender (demographic diversity), on the observed SA changes. Table 8.1. provides a typology of the SL variables, methods and measures that I employed.

I measured the relational dimension using three separate SL outcomes: respect for diversity, trust (including trustworthiness and distrust), and cooperation (including team interdependence). To assess diversity, I conducted a Multiple Discriminant Analysis (MDA), to check whether the participants levels of trust increased, using the Propensity to Trust Scale (PTS) sub-scales (pre-game and post-game) and in-game trading data. With the trading data, I assessed the relationship between cooperation and trust. Finally, I conducted a Multi-dimensional scaling (MDS) using ALSCAL procedure. I used Team Interdependence (TI) and Cooperation to measure the TI and Cooperation sub-scale data. I measured increases in TI and Cooperation with the Chi-square test for goodness of fit, One-way between subject's ANOVA and an analysis of the in-game data.

I assessed epistemic changes concurrently, with the cognitive (SA) and relational dimensions (diversity, trust, team interdependence and cooperation). I also triangulated the debriefing, observations, session video and in-game data to analyse any changes in epistemic cognition and normative epistemology. I evaluated norm changes, paradigm changes, values change and convergence of opinions. Generally, I also observed changes in players epistemic cognition, through their statements. I used the data to detect changes in the rationalization of actions or inactions, and noted changes in respondents ways of knowing (empirical, ethical, personal, aesthetic and emancipatory) [407].

Table 8.1. Typology of SL variables, methods and measures

	SL Outcomes	SL Variables	Method(s)	Measures
Cognitive	Situation Awareness	• Knowledge of values, beliefs, practices and facts. • Understanding of the core problems' driving factors • Knowledge of alternate solutions	• Situation Awareness Rating Technique (SART) questions. • ANOVA using Friedman's test. • 3 × 4 factorial MANOVA	• Demand [a] • Supply [b] • Understanding [c] • Situation Awareness (SA) • Pre-game and post-game measures
Relational	Diversity	• Perception of other actors • Deeper understanding of other actors' mindsets • Better understanding of the added value of diversity	• Multiple Discriminant Analysis • Tableau analysis	• DD (age, gender and education level) • PAD • Game session • In-game data
	Trust	• Expression of trust • Trust formation • Enhanced trust • Trust sustenance	• Propensity to trust Scale (PTS) questionnaire for pre-game and post-game results. • Multi-dimensional scaling (MDS) using ALSCAL procedure • Tableau analysis	• Trustworthiness • Trust • Distrust • In-game trade exchanges data
	Interdependence	• Identification of prospects for joint actions • Niche development • Establishment of relationships	• Chi-square test for goodness of fit. • One-way between subject's ANOVA. • Tableau analysis	• Team Interdependence sub-scale (post-game) • In-game cooperation data
	Cooperation	• Shared Goal • Collaborative relationships • Enhanced cooperation • Changes in social network structure	• Chi-square test for goodness of fit. • One-way between subject's ANOVA. • Tableau analysis • Review of session videos and notes.	• Cooperation sub-scale (post-game) • In-game cooperation data • Analysis of the debriefing notes and session videos.
Epistemic	Overall change in epistemic cognition	• Ways of knowing • Changes in rationalization of knowledge and validity	• Triangulation of methods to assess any changes in epistemics and normative epistemology as evidenced in data.	• Debriefing • Observations • Session videos • In-game data
	Changes in Normative Epistemology	• Norms change • Paradigm change • Values change • Converging of opinions		

[a] the demand on attentional resources (D)
[b] the supply of attentional resources (A)
[c] the understanding of the situation that they face at that particular moment (U))

8.1.2. Summary of the Results

Table 8.2. provides a typology of the SL results and learning changes. The data indicates positive changes in cognitive learning. All the policymakers, with the exception of one participant, exhibited high increases in SA ($F(1, 34) = 26.85$, $p = 0.005$). Respondents' familiarity of basin's socio-technical complexities, highly influenced the positive SA results. Changes in respect for diversity were not measured. What I measured was the contribution of diversity to the final outcomes. Results indicated that Personal Attributes Diversity (PAD) was a stronger predictor of the SL outcomes than Demographic Diversity (DD). The DD attributes that I measured are gender, education and age. A distinct increase in cooperation and team interdependence was experienced. I triangulated the cooperation results from the subjective post-game assessments, and the in-game data on trade, resource allocation and smileys. All the sets of data indicated that cooperation ($X2$ (34, N=11) = 23.42, p=.009) and team interdependence ($X2$ (34, N=12) = 32.26, p=.001), increased. In addition, the debriefing, observations and session videos contained evidence of increases in cooperation and team interdependence.

There was a quantifiable increase in respondent's trustworthiness and their willingness to cooperate with other players. Conversely, the trust sub-scale produced varied results that required further investigations. As explained in Chapter 7 (Section 7.1), most studies focus on understanding trust [372,378,379,387-391], with insufficient research on trustworthiness and the relationship between trust, trustworthiness, and distrust [387]. Hardin [75] explains that most of the trust literature barely mention the term trustworthiness, "though implicitly much of it is primarily about trustworthiness." Reiersen [387], (p. 1) adds that "It makes no sense to trust others if others are untrustworthy." Also, it is detrimental to the trustee to trust an untrustworthy person. According to Reiersen [387], (p. 1) trust is based on the belief that the trustor can be entrusted not to abuse the trust shown. Furthermore, some models theorize that the trust-trustworthiness relationship is complementary and cyclical [380,392]. Moreover, there is limited research on the relationship between trust and distrust, especially in the context of complex socio-technical water systems [99].

I thereafter conducted a multi-dimensional scaling (MDS) using ALSCAL procedure to comprehend the association between trustworthiness, trust and distrust. The MDS results indicate an increase in trust and a decrease in distrust, thus, explaining the varied results. Trust and distrust were measured as one construct, yet they were treated by the respondents as two separate constructs. Moreover, the results indicated that the association between trustworthiness and trust was not complementary. There are many extraneous factors that may influence trust and trustworthiness including complexity and uncertainty.

Table 8.2. Typology of SL results and social learning changes

	SL Outcomes	Results	Social Learning Changes
Cognitive	Situation Awareness	Statistically significant ($p \leq 0.05$) increase in SA: • Mean and median scores for demand, supply, understanding and SA; • SA ($F(1, 34) = 26.85$, $p = 0.005$). • Statistically significant high order effects of Familiarity levels (high or low), Gender and Teams), differ when considered jointly on the variables (Wilk's $\lambda = 2.82$ ($F\ 9, 112.10$) $= 0.78$, $p = 0.01$, partial $\eta 2 = 0.15$).	• Policymaker's knowledge of Nzoia river basin institutional values, beliefs, practices and facts, increased. • Increased understanding of core Nzoia Basin water problems' and the driving factors • Increase in knowledge of alternate solutions
Relational	Diversity	• Discriminating power of PAD is the highest (0.937) and negates the effect of gender, age, and education, with gender possessing a negative discriminating function (- 0.023). • After removing PAD, in the 3-structure matrix, gender has the strongest discriminating power (-0.578) negatively correlated with education (0.574) and age having the least discriminating power (-0.203).	• SL occurs when there is an increased perception of other actors PAD and deeper understanding of other actors' mindsets/ values and norms. • Increased appreciation of diversity and need for more focus on PAD rather than DD.
	Trust	• Increased respondent's trustworthiness and willingness to cooperate. • Low perception of others trustworthiness leading to the consistent decline of trust, after each round. • Trust increase with high levels of complexity and uncertainty. • Trust excluded in circumstances where there is low complexity and uncertainty. • Distrust decrease with reduced complexity and uncertainty.	• High levels of trustworthiness and the willingness to cooperate • Mixed trust formation results require further analyses. • MDS indicates enhanced trust and reduced distrust • Trust sustenance involve a healthy cooperation and competition balance in uncertain, complex systems.
	Interdependence	• Statistically significant ($p \leq 0.05$) increase in changes in understanding on team interdependence: $X2\ (34, N=12) = 32.26$, $p=.001$.	• Results indicate the formation of water policy networks and niche development • Longer-term relationships
	Cooperation	• Statistically significant ($p \leq 0.05$) in changes in understanding on cooperation: $X2\ (34, N=11) = 23.42$, $p=.009$.	• Results indicate the pursuance of a Shared Goal, the formation of collaborative relationships, and enhanced cooperation.
Epistemic	Overall change in epistemic cognition	• The debriefing notes, observations, session videos and in-game data indicate changes in the overall epistemic cognition.	• Results indicate a change in ways of knowing and how the policymakers rationalize knowledge and validity
	Changes in Normative Epistemology	• The in-game data showed evidence of norms change, paradigm change, values change, and a convergence of opinions, especially in the last four game sessions.	• In-game data indicates a change in routine and convergence of opinions on basin management. • Increased value of water and man-made resources.

It was evident that trustworthiness, distrust and trust are separate constructs and their relationships were neither linear, complimentary nor simple. In addition, trust increased when complexity deepened and uncertainty increased. Distrust decreased with reduced complexity and uncertainty.

Epistemic changes required deeper analysis, and possibly post-post game analyses. However, based on the different sets of data, I identified changes in the overall epistemic cognition and normative epistemology. The main challenge was determining whether these changes would eventually diffuse to the wider social unit. I discuss this challenge later in this chapter (Section 8.4.4 and 8.4.5).

8.1.3. Cognitive Changes

SART is a subjective rating of a person's level of SA [252]. The technique involves 10 dimensions, based on three 7-point Likert subscales (1 = Low, 7 = High). These subscales measure: (i) the demand on attentional resources (D), (ii) the supply of attentional resources (S), and (iii) the understanding of the situation that they face at that particular moment (U). The factors that comprise demand (D) are the stability of the current situation, the complexity of the situation or and the variability of the situation. Supply of attentional resources (S) includes factors that measure the person's level of concentration and the degree of their spare mental capacity. The factors that influence understanding (U) are the quality and quantity of available information and the extent to which the person is familiar with the situation. According to the SART, SA is measured by combining the ratings in each subscale and then calculating the respondent's SA. Composite SART scores are derived using the following formula:

$$SA = U - (D - S).$$

- U refers to understanding.
- D refers to demand.
- S refers to supply.

The results showed a significant increase in SA (supply, demand and understanding). Table 8.3. summarizes the minimum and maximum scores, the mean, median and standard deviations of the pre-game and post-game SART results.

I conducted a subsequent ANOVA using Friedman's test. The results showed a statistically significant increase in SA at the $p < 0.05$ level, $F(1, 34) = 26.85$, $p = 0.005$. The ANOVA test details are contained in Table A.1 (Appendix A).

Table 8.3. SA results (demand, supply, and understanding) for pre and post-game

	Min score	Max score	Descriptive statistics		
			Mean	Median	Standard Dev
pregame Demand	3	18	8.2	8	4.1
postgame Demand	10	21	16.7	17	3.2
pregame Supply	4	28	9.9	9	5.4
postgame Supply	13	28	24.2	25	3.7
pregame Understanding	3	20	8.4	8	3.9
postgame Understanding	14	21	19.4	20	2.1
pregame SA	−3	38	10.1	9	7.9
postgame SA	17	38	26.9	27	5.2

The SA results for cognitive learning are also visualized in Figure 8.1. The boxplot compares the pre-game and the post-game SA results. Generally, improvements in cognitive learning is evident for all the respondents, with the exception of respondent ID number 29, the only significant outlier. The outlier may be explained as: possible high SA at the start of the game by one policymaker, or the respondent might have erroneously filled in the values.

After the initial SA analyses, I conducted a 3x4 MANOVA, consisting of three factors:

1. familiarity, with two (2) levels (low, high);
2. gender, with two (2) levels (male, female);
3. a team of players, with seven (7) levels (pre and post-game teams for Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans-Nzoia*6 and Trans-Nzoia*7).

I designed the three-way MANOVA to study main and interaction effects. The main effects refer to the separate influence of each factor when the other factors remain constant. Interaction effects refer to the combined action of the factors. I started the analysis by studying the highest order interaction effect (the third order interaction effect). If the highest order interaction effect was statistically significant, then I proceeded to study the second-order interaction effects (the interaction effects of two factors at each level of the third factor). If some of the second-order interaction effects were significant, I examined the simple main effects. If at least one simple main effect was significant, I then computed and interpreted the simple comparisons between various factor levels. On the contrary, if the third-order interaction effect was not significant, I inspected the second-order interaction effects. If none of the second-order interaction effects was significant, I either finished the analysis or examined the main effects (if they hold any interest).

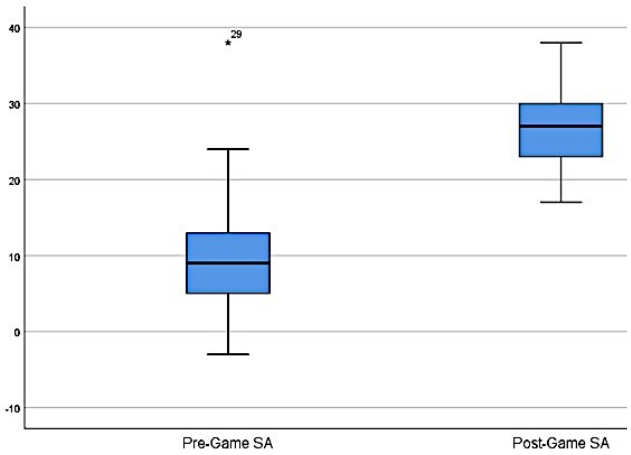

Figure 8.1. Boxplot of Pre-game and post-game SA results

Therefore, the MANOVA assessed seven effects, in three orders, namely:

1. three main effects: familiarity (F), gender(G) and teams (T) (the separate factor effects);
2. three second-order interaction effects: F*G, F*T, and G*T;
3. one third-order interaction effect: F*G*T.

The 3 x 4 factorial MANOVA presented interesting results (Table 8.4) that can be triangulated with the results on the influence of diversity on negotiation outcomes. In summary, the results indicated that both familiarity and the third order combined effect of F*G*T effect augmented with increased SA levels. These findings revealed the importance of the water system and climate-change familiarity in enhancing SA.

While an increase in familiarity led to a subsequent increase in demand, supply, understanding, and overall SA, the third-order combined effect of F*G*T only affected demand and the overall SA. Gender and team factors had no individual influence, except when combined with familiarity at the third order effect level. Any lower interaction level (lower than the third level of interaction) where familiarity was not incorporated in the factors, led to insignificant results. In addition, the other two factors (gender and team) did not seem to have any effect at the second-order and main effect levels. The finding on team and gender was corroborated by the diversity MDA results, where DD (gender, age and education level) had no influence on the final outcomes, when PAD was high. Therefore, I concluded that familiarity is a critical factor that should be

incorporated into the design and implementation of climate change risk SA interventions.

Table 8.4. Results of the factorial MANOVA and between-subjects' effects

	Compared Effects		**Significant Difference**	**Results**
Interaction Effect	**IDVs**	**DVs**		
Highest / 3rd order interaction effects	gender, familiarity & team	D, S, U	Yes	Wilk's λ = 2.82 (F 9, 112.10) = 0.78, p = 0.01, partial η2 = 0.15
2nd order interaction effects	Familiarity* Gender	D, S, U	No	Wilk's λ = 0.95 (F 3, 46) = 0.82, *p* = 0.49, partial η2 = 0.05
	Familiarity* Team	D, S, U	No	Wilk's λ = 0.61 (F 18, 130.59) = 1.37, *p* = 0.16, partial η2 = 0.15
	Gender*Team	D, S, U	No	Wilk's λ = 0.94 (F 9, 112.10) = 0.30, *p* = 0.97, partial η2 = 0.02
1st main interaction effects	Familiarity	D, S, U	No	Wilk's λ = 0.16 (F 3, 46) = 82.74, *p* = 0.005, partial η2 = 0.84
2nd main interaction effects	Gender	D, S, U	No	Wilk's λ = 0.95 (F 3, 46) = 0.78, *p* = 0.51, partial η2 = 0.05
3rd main interaction effects	Team	D, S, U	No	Wilk's λ = 0.75 (F 18, 130.59) = 0.76, *p* = 0.74, partial η2 = 0.09
Between-subjects' effects	Familiarity	D	Yes	(F 1, 6) = 92.27, p = 0.005, partial η2 = 0.66
	Familiarity	S	No	(F 1, 6) = 148.81, p = 0.005, partial η2 = 0.76
	Familiarity	U	No	(F 1, 6) = 180.26, p = 0.005, partial η2 = 0.79
	Familiarity	SA	Yes	(F 1, 6) = 112.96, p = 0.005, partial η2 = 0.70
3rd Order Effects	gender * familiarity * team	D	Yes	(F 3, 68) = 5.57, p = 0.005, partial η2 = 0.26
		S	No	(F 3, 68) = 1.53, p = 0.22, partial η2 = 0.09
		U	No	(F 3, 68) = 0.89, p = 0.89, partial η2 = 0.01
		SA	Yes	(F 3, 68) = 4.56, p = 0.01, partial η2 = 0.22

In the SART questionnaire, demand for attentional resources (D) is assessed by three aspects. First, how unstable the situation is – is it likely to change suddenly or it will stay constant. Second, how variable the situation is – what are the number of variables that require the policymaker's attention. Third, the degree of complexity – what is the degree of complexity in the Nzoia River Basin. Attentional demand (D) refers to the policymaker's understanding of the complex environment when making decisions, whereas attentional supply (S) refers to the policymaker's readiness to make informed decisions. The last component of the SART questionnaire is on understanding (U) the information.

It mainly assesses the information quantity, information quality and familiarity of the situation.

The 3 × 4 factorial MANOVA indicated the value of demand for attentional resources in enhancing SA in the Nzoia River Basin. Follow up analysis of the third order interaction effect indicated a significant increase in the combined gender * familiarity * team (third-order effect) interaction effect on demand (F 3, 68) = 5.57, p = 0.005, partial $\eta 2 = 0.26$)) and the overall SA ((F 3, 68) = 4.56, p = 0.01, partial $\eta 2 = 0.22$). The third order interaction effect was not significant on supply (F 3, 68) = 1.53, p = 0.22, partial $\eta 2 = 0.09$) and understanding (F 3, 68) = 0.89, p = 0.89, partial $\eta 2 = 0.01$). Based on the results, I concluded that future SA work should emphasize more on increasing policymakers understanding of the complex socio-technical systems and their familiarity with the system and less on their individual readiness (attention, concentration, readiness, mental ability), information quantity and information quality.

8.1.4. Relational Changes

In this subsection, I discuss the three SL relational dimension results. The three components are: respect for diversity (discussed in Section 8.1.4.1), cooperation (Section 8.1.4.2), and trust (Section 8.1.4.3). I measured cooperation using two sub-scales: the level of interdependence of the water negotiation teams and the extent of collective action (cooperation). I also measured the Propensity to Trust (PTS) using two sub-scales, i.e., trustworthiness and trust (Section 8.1.4.3).

8.1.4.1. Respect for Diversity

I extracted the main results for respect for diversity from the discriminant analysis of PAD and DD (age, gender and education level). Table 8.5 provides the correlation between each discriminant function and the independent variables. I combined the structure matrix results for the four diversity variables (PAD, education, gender and age), and three functions (education, gender and age). Function 1^a positively correlates with PAD, education and age. Function 1^a negatively correlates with gender. I concluded that this function is associated with a PAD, education, and age dominated negotiation team, with little consideration of age and education and no consideration of gender. In function 1^a, the highest (0.937) positive discriminating factor is PAD and the only negative discriminating factor is gender (- 0.023). I concluded that when gender, age, and education were combined with PAD, the discriminating power of PAD was overwhelming and the effect of gender, age and education was negligible.

Thereafter, I conducted further analyses where PAD was eliminated, and assessed the discriminant power of the DD attributes, in the subsequent MDA model (3 structure matrix).

Table 8.5. Structure Matrix for Functions 1 – 4, Compared with Functions 1 - 3

Variable	Function						
	1 [a]	1 [b]	2 [a]	2 [b]	3 [a]	3 [b]	4 [a]
PAD	0.937*	-	0.013	-	0.295	-	-0.187
Education	0.069	0.574	-0.475	0.818*	0.850*	-0.037	0.218
Gender	-0.023	-0.578	0.668	0.815*	0.726*	0.044	0.164
Age	0.017	-0.203	0.319	0.280	0.026	0.938*	0.947*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within the function.

[a] Structure Matrix for Functions 1 through 4

[b] Structure Matrix for Functions 1 through 3

*Largest absolute correlation between each variable and any discriminant function

The subsequent MDA model contains three functions, thus the structure matrix changed (Table 8.5). Gender and education gained prominence. Function 1^b positively correlated with education and negatively correlated with gender and age, and was statistically significant (Wilks $\lambda = .252$, F (18, 39.969), $p = .002$). Function 2^b positively correlates to all three independent variables, and was statistically insignificant (Wilks $\lambda = .685$, F (10, 10.967), $p = .36$).

While the new model was not as strong as the previous model, it provided insight into the probable structural composition of the functions when PAD was eliminated. The first function positively correlated with education and negatively correlated with gender and age. Function 1 was statistically significant (Wilks $\lambda = .252$, F (18, 39.969), $p = .002$). Gender and Education had a high discriminating power while the power of age was negligible. However, when Gender was combined with Age (since they are both negatively correlated in Function 1), Education had less discriminating power. Therefore, in a team with minimal PAD, negotiation outcomes were largely determined by gender and age group, than diversity in the level of education.

8.1.4.2. Team Interdependence and Cooperation

To assess the contribution of the water policy game to team interdependence and cooperation, I conducted a Chi-Square test for goodness-of-fit and a one-way between-subjects ANOVA, with Friedman's nonparametric test. The p-value for all ten cooperation and ten team interdependence variables were lower than 5% (Sig. < .05). Therefore, the null hypothesis can be rejected because there are significant differences between the observed frequencies and the expected frequencies (Table 8.6).

Table 8.6. Chi-Square Test for Goodness-of-Fit Results

Cooperation Sub-scale results										
	1	2	3	4	5	6	7	8	9	10
Chi-Square	63.2[a]	57.7[a]	48.2[b]	31.8[b]	57.7[a]	63.2[a]	23.0[b]	31.8[b]	43.6[b]	75.5[a]
df	3	3	2	2	3	3	2	2	2	3
Asymp. Sig.	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Team Interdependence results										
Chi-Square	48.23[b]	34.37[a]	25.60[b]	82.27[a]	37.57[a]	29.80[a]	43.60[b]	73.14[c]	51.29[a]	38.71[a]
df	2	3	2	3	3	3	2	4	3	3
Asymp. Sig.	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.8.

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.7.

c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.0.

To verify the positive changes in cooperation and team interdependence, I employed a one-way between-subjects ANOVA with Friedman's nonparametric test on the team interdependence and cooperation sub-scales. Results revealed a significant increase in understanding of team interdependence: X^2 (34, N=12) = 32.26, p=.001, and cooperation: X^2 (34, N=11) = 23.42, p=.009. The positive change in cooperation and team interdependence was further corroborated by in-game data results, the debriefing notes, observation notes and the rough-cut videos sessions. Details of these results are discussed in sub-section 8.1.5.

8.1.4.3. Trust, Trustworthiness and Distrust

Changes in trust were assessed using the Chi-Square test for goodness-of-fit and a subsequent Multi-dimensional scaling (MDS) using ALSCAL procedure. There was a significant increase in trustworthiness between the pre-game and post-game results (Table 8.7), for all the eight variables (Sig. < 0.05). Hence, there

was a large variance between the post-game results for the trustworthiness sub-scale, and the pre-game results (H1).

Table 8.7. Pre-Game and Post-Game Trustworthy Chi-Square Test Statistics

		TW1	TW2	TW3	TW4	TW5	TW6	TW7	TW8
PRE	**Chi-Square**	11,765[a]	25,000[b]	12,600[c]	13,086[d]	29,800[b]	21,114[b]	12,057[d]	17,200[d]
	df	1	3	1	2	3	3	2	2
	Asymp. Sig.	0,001	0,000	0,000	0,001	0,000	0,000	0,002	0,000
POST	**Chi-Square**	16.171[a]	24.314[b]	63.171[b]	14.629[a]	24.588[c]	43.971[b]	15.314[a]	31.771[a]
	df	2	3	3	2	3	3	2	2
	Asymp. Sig.	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
PRE	a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 17,0.								
	b. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 8,8.								
	c. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 17,5.								
	d. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 11,7.								
POST	a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.7.								
	b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.8.								
	c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.5.								

The results for trust sub-scale were varied (Table 8.8). The observed frequencies indicated a significant increase or decrease in trust between the pre-game and post-game results in six variables (T1, T2, T3, T4, T7, and T10). Additionally, there was no significant increase or decrease in trust between the pre and post-game results in four variables (T5, T6, T8, and T9) [Sig. < 0.05].

Table 8.8. Pre-Game and Post-Game Trust Chi-Square Test Statistics

		T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**
PRE	Chi-Square	32,000[a]	25,143[a]	12,600[b]	27,714[a]	6,571[a]	5,714[a]	11,588[c]	3,714[a]	7,143[a]	17,059[d]
	df	4	4	1	4	4	4	4	4	4	3
	Asymp. Sig.	0,000	0,000	0,000	0,000	0,160	0,222	0,021	0,446	0,129	0,001
POST	Chi-Square	23.029[a]	20.800[a]	57.686[b]	16.294[c]	18.647[d]	16.000[e]	36.857[e]	29.879[f]	23.647[g]	10.571[e]
	df	2	2	3	2	4	4	4	4	3	4
	Asymp. Sig.	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.000	0.000	0.032
PRE	a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 7,0.										
	b. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 17,5.										
	c. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 6,8.										
	d. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 8,5.										
POST	a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.7.										
	b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.8.										
	c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.3.										
	d. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.8.										
	e. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.0.										
	f. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.6.										
	g. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.5.										

After that, I conducted the Multi-dimensional scaling (MDS) using ALSCAL procedure and assessed the stimulus coordinates, configured in a two-dimensional space. There were 36 observations or stimuli (18 results from the pre-game questionnaire on trust and 18 results from the post-game questionnaire on trust). For each of the 36 observations, the model computed two coordinates (dimension 1 and 2) and grouped the 36 observations into clusters. Figure 8.2 plots the two-dimensional solution obtained for the pre-game and post-game individual dissimilarity scores for trust and trustworthiness sub-scales, and grouped in two dimensions.

I clustered the conceptual map results into four groups. Figure 8.2. illustrates the clustering of the 36 observations into four clusters, under two dimensions. The detailed discussion on determining the different dimensions and clusters is contained in Chapter 7 (Section 7.3.3). Distrust is represented by the circular clusters and trust by the rectangular clusters.

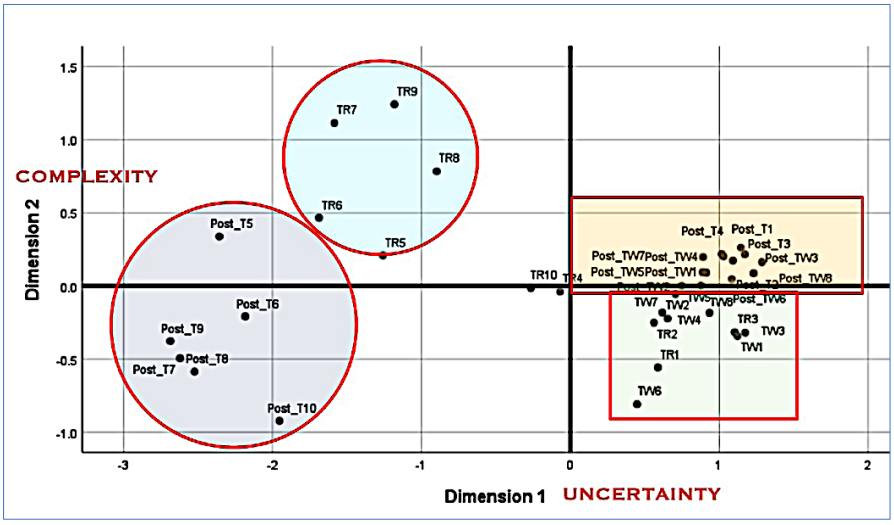

Figure 8.2. Clustering of the Conceptual Map.

To understand the components of the four clusters, I first assessed the features of each of the 18 variables within the PTS. All the 12 variables in the rectangular clusters (right) assessed the respondent's positive perceptions, beliefs, and actions (trust). High scores indicate a high disposition to trust, whereas low scores indicate a low disposition to trust. I clustered six variables in the circular clusters that assess the respondent's negative perceptions, beliefs, and actions (distrust). Based on the respondent's score, high scores indicate profound distrust and low scores indicate low distrust. I differentiated the two similar clusters (whether rectangular or circular) by the pre-game results from

the post-game results. The post-game results contain the words 'post' before the variable identifier (TR for trust sub-scale and TW for trustworthiness sub-scale)

After an analysis of the results, I concluded that, trust increased and distrust decreased. Moreover, trust increased as complexity and uncertainty increased and was absent in low complexity and certain situations. On the other hand, distrust reduced when complexity and uncertainty declined. These results corroborated the SA results; as SA increased, the policymakers were more aware of the complexity and uncertainty, and this reduced the distrust levels and increased trust. Based on the triangulated results, I concluded, at the time the game was coming to an end, there was still deep complexity, however, uncertainty reduced. Therefore, distrust levels reduced due to low uncertainty and increased SA of the complexity. Trust also increased as SA was enhanced.

8.1.5. Epistemic Changes

I assessed two classes of epistemic changes: (1) the overall changes in epistemic cognition and (2) changes in normative epistemology. Assessment of overall changes in epistemic cognition focus on the "ways of knowing' and any observed changes in how the policymakers rationalized knowledge and validity. To assess normative epistemology, I identified norm changes, paradigm changes, values change and any convergence in opinion / mindsets.

At this stage of the assessment, policymakers spoken words and actions were more important than their subjective assessments. I did not use the questionnaire to assess changes in epistemic cognition. I used other indirect means (for instance assessing the in-game data results instead of directly asking the respondents questions) to assess any observed or data logged changes.

I assessed epistemic changes using the in-game data, video sessions for all the seven games, the debriefing sessions notes and the observation notes. I used the in-game data to analyse epistemic changes, as follows:

1. Smileys policymakers received in every round for food, energy and investments in public services;
2. Resource changes made at the end of each round, in the form of food, energy and nature; and
3. Food and energy trade exchanges (exchanged with an agreed amount of money).

The first observed change in values and norms was a shift from unilateral to joint WRM. The change was identified by the number of smileys that each policymaker gained in each successive round. Smileys were issued electronically, in the game, and either were happy (+), neutral, or sad (-) faces, in the following circumstances:

1. Food supply surpasses (+), is equal to, or is below (-) the county government residents' food needs.

2. Energy surpasses (+), is equal to, or is below (-) the county government residents' energy needs.
3. Amount invested in public services surpasses (+), is equal to, or is below (-) the county government residents' investment needs.

In an ideal situation, where the county governments are managing the basin jointly, the disparities between the resource rich and poor county governments, should be minimal or non-existent. The shift in normative epistemology from unilateral actions towards joint basin management enabled a paradigm change from county government WRM to joint river basin management. Thus, they managed it collectively, without regard to the geographical distribution of the water resources. Consequently, the county governments diverted their attention from meeting the needs of their respective county residents – towards meeting the needs of basin residents. Moreover, unsustainable unilateral actions were replaced by sustainable water, food and energy production, to meet the needs of all the basin residents. Furthermore, the production of food and energy was limited to basin areas with high productivity levels, regardless of where they are situated in the basin. Thus, increasing water, food and energy access for basin residents.

The large differences between the cumulative smileys earned by the resource rich counties (Uasin Gishu, Trans Nzoia and Kakamega) and the resource poor counties (Bungoma and Busia) indicated unilateral actions and their negative impact (y-axis of Figure 8.3 represents the cumulative smileys per county government and the x-axis the different game sessions). When disparities between the smileys earned by the resource poor and resource rich counties were minimized, the counties jointly managed the river basin and reduced the negative impacts of unilateral actions. As shown in Figure 8.3, in the first three game sessions policymakers focused on unilateral actions. However, in game session 4, the disparities between the group outcomes reduced and continued to decline until the last game session. In the last four game sessions, I observed a change in values from unilateral actions, towards cooperation.

The difference between Figure 8.3 and 8.4 is the inclusion of game rounds in Figure 8.4, while Figure 8.3 visualizes the cumulative game session results. Figure 8.4 visualizes changes in epistemic cognition in every game session and round. Importantly, Figure 8.4 demonstrates evidence of cross-learning. In the beginning of the sessions, Nzoia policymakers were individual-centric, and later became systems-centric. Interestingly, as they became more system-centric, each of the players (whether from a resource rich county government or a resource poor county government) benefited from the positive change in epistemic cognition. The results improved in subsequent games, even though the players did not meet nor share any information. I attributed the evidence of cross-

learning in Figure 8.4 to the facilitators who acted as epistemic boundary spanners between the different groups of policymakers.

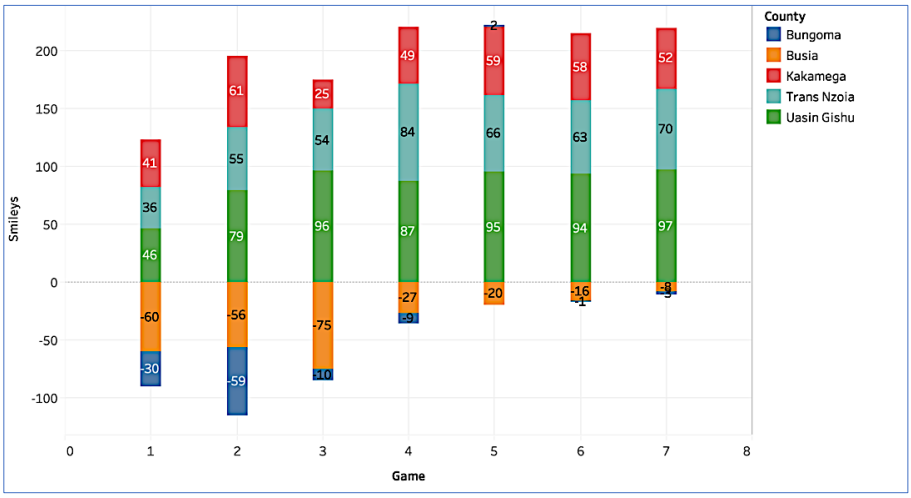

Figure 8.3. Grand totals of smileys

A triangulation of in-game data, the rough-cut video clips, debriefing notes and observation notes indicated epistemic changes, at the individual, group and system level. I extracted the qualitative data from the rough-cut video clips, debriefing notes and observation notes.

I observed a number of individual epistemic changes, especially in game session 4, 5, 6, and 7. The first change was in mental models from individual-centric / unilateral management of WRM towards joint cooperative management of the shared resource. The evidence of this change was obtained from the cumulative smileys quantitative data, visualized by Figure 8.3 and 8.4.

The second epistemic change was a value change. The players initially valued the natural resources (food and energy) and did not value man-made resources (money). Water was not recognized as a resource. However, as the game progresses, the players with excess food and energy realized they needed other county governments with purchasing power and less resources, to purchase their excess products. In addition, the players started to recognize the value of water (without sufficient water they could not increase their food and energy production). At the end of the game, the policymakers recognized water as a resource and structuring element. Before any changes were made, each of the county governments assessed how much water they had and whether available water resources supported their planned actions. Climate change

played a big role in the transformation of values. When the basin faced droughts, the water reduced to half leading to a reduction in available resources. After that, the policymakers realized that the amount of available water was a major constraint that required serious consideration, before making policies.

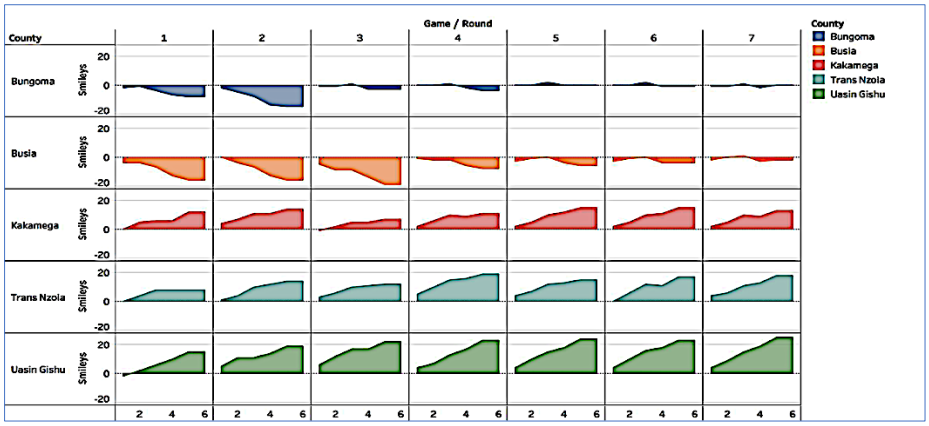

Figure 8.4. Smileys received by local governments per round

The third noted individual change was in the language, In the beginning of the sessions, Nzoia policymakers mainly referred to themselves as 'I' and 'my county government,' and their language later changed to 'we' and 'our river basin.' I used the qualitative data from observations during the sessions, and an analysis of the rough-cut videos of all the game-sessions to arrive at the outcome. I mainly witnessed the change in language, after the drought round, when the players realized that to effectively buffer their citizens from the consequences of climate-change induced disasters, they needed to plan as a team, and thus adopted a systems approach that replaced unilateral thinking.

Figure 8.5 illustrates changes from individualistic / unilateral thinking towards group and systems thinking. Uasin Gishu and Busia stopped production of food and hydro, respectively, due to identified competitive advantages (niche market). Uasin Gishu focused on hydro-power production while Busia focused on increasing its income to purchase the deficit (food and/or energy). Kakamega and Trans Nzoia, at the start of the game, produced both food and hydro-power, and later in the game realized that it is more advantageous for the entire system, if they focused on food production and leave Uasin Gishu to provide surplus hydro-electric energy, to other county governments. Therefore, they stopped further production of hydro-electric energy and solely produced food. In the initial game sessions, the change in strategy mainly occurred during the drought round, when the food producing

county governments were unable to meet the food needs to the basin, and all their food resources were halved. At that point, Trans Nzoia and Kakamega realized their unique role, and how their allocation decisions, put the entire basin in jeopardy. Before coming to this realization, they had adopted self-sufficiency strategies by producing both hydro-electric energy and food.

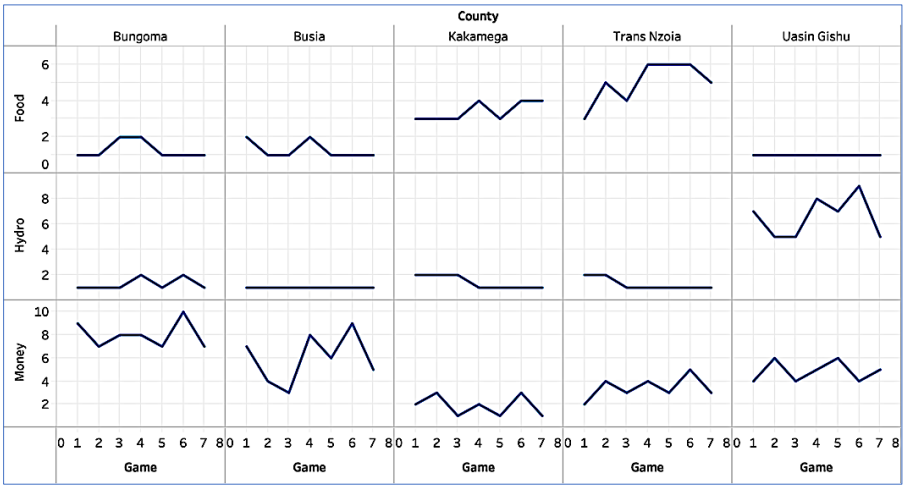

Figure 8.5. The changes in the resources (Food, Hydro Energy and Money)

Besides the individual changes, there were some observed group dynamic changes. In the beginning of the sessions, Nzoia policymakers confined themselves to their respective tables and boards. Even though I informed them that they could walk around to see what kind of resources other county governments had, they did not make any attempts to learn from others. In the last two game sessions, the players barely sat on their chairs. They moved around to quickly identify any changes in resources by other players, so that they could adjust their group and individual strategies. Moreover, they formed an informal network that regularly met to assess the available resources and made joint allocation and trade decisions (Figure 8.6). These regular informal meetings led to collaborative learning, informal networking, and teamwork. Consequently, the later groups performed better than the initial groups.

At the organizational learning level, I identified changes from short-term opportunistic engagements towards more longer-term systems oriented thinking and planning [360], (p. 338). The longer-term oriented interactions between the county governments were repeated over time establishing a trading

routine and niche development, within the basin. Niche development was mainly driven by water availability and productivity levels. The counties that had high productivity levels for food (Trans Nzoia and Kakamega) and energy (Uasin Gishu), had limited water resources. However, counties with low food and energy productivity levels were endowed with water resources. Therefore, as the game progressed, the low productivity counties stopped production and focused on trade for food and energy.

Figure 8.6. The policymakers make joint allocation and trade decisions (Game Session 6)

With the use of Tableau, I developed heat maps to visualize trade exchanges between the five county governments. Figure 8.7 is a visualization of trade exchanges between the five county governments, contained in three tiers. The first tier represents hydro-electric energy trade exchanges, the second tier represents food trade exchanges, and the final tier represents money exchanges.

The size of a particular square, represents the volume of trade / exchanges. The legend first breaks down the tiers of hydro, food and money, from the minimum to the maximum number for hydro and food, and amount of money. I also colour coded the squares based on the county government (second legend).

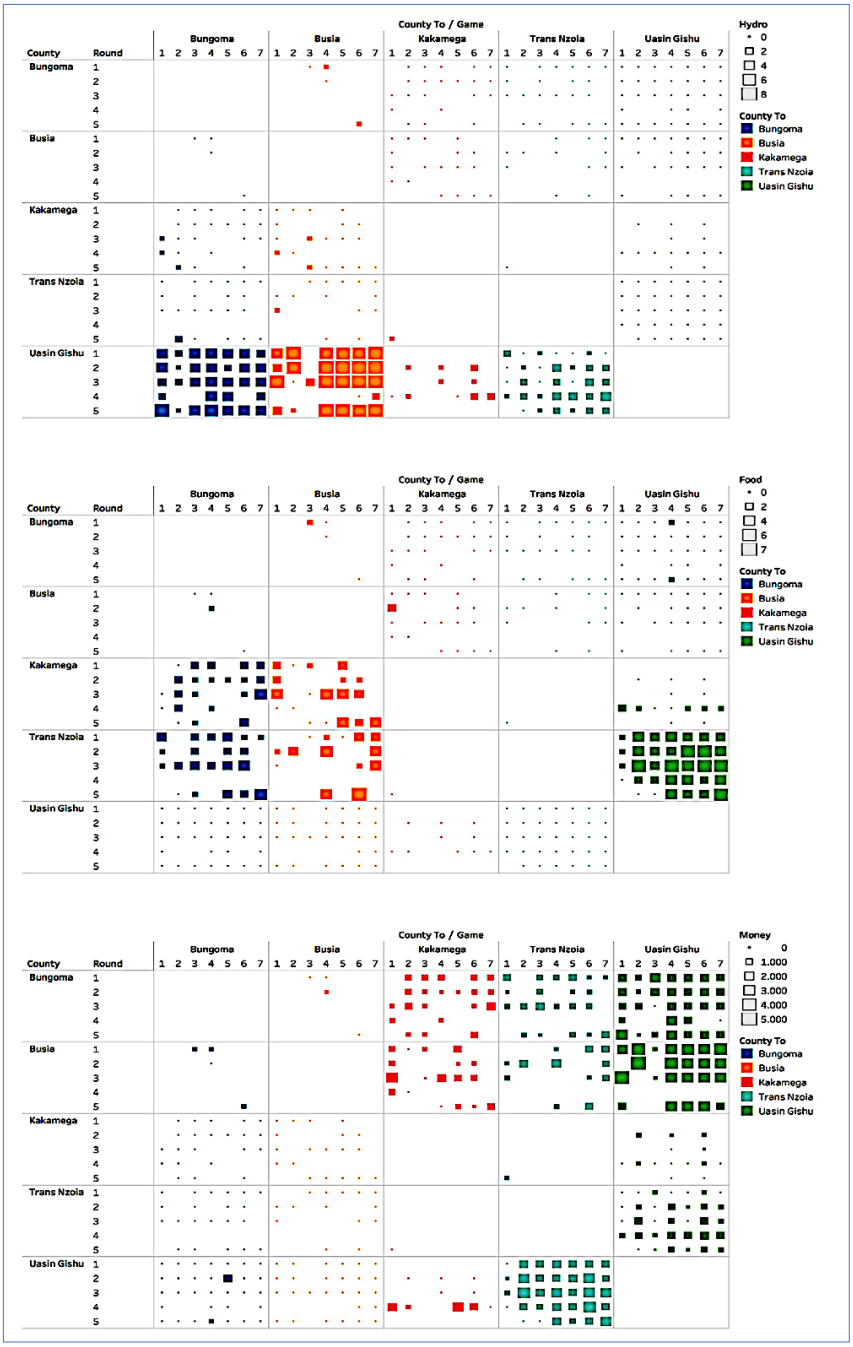

Figure 8.7. Heat map of trade Exchanges between County Governments

In the heatmap, the small squares represent short-term opportunistic trading, while the big squares represent repeated long-term trading relationships. In the first tier, Uasin Gishu had comparatively larger squares than all the other counties. This indicated that Uasin Gishu was the main energy provider for the basin, in the form of hydro-electric power. The second tier indicated that Trans Nzoia and Kakamega were the main food producers, for the basin. The third tier indicated that Busia and Bungoma had the largest demand for the excess food and energy.

The heatmaps indicate that short-term opportunistic transactions co-existed, throughout the game session, with long-term oriented and repeated transactions (see Figure 8.7). Due to repeated transactions, a network of buyers and sellers emerged, based on comparative advantages. Uasin Gishu was the sole provider of hydro-electricity energy for the basin. Trans Nzoia and Kakamega were the food providers. However, Trans Nzoia provided more food than Kakamega. The primary consumers were Bungoma and Busia.

Even though there was a shift towards long-term systems oriented thinking, the county goverments maintained healthy competition. One key paradigm shift was the acceptance by the policymakers that cooperation and competition can healthily coexisted in cross-county partnerships and should not be perceived as alternatives [370], (p. 215). Figure 8.7 indicates that while cooperation is evident throughout the game sessions, the respective county goverments also maintained unproductive food and energy practices. The same is evidenced in Figure 8.5.

During the debriefing sessions, I asked the policymakers why they maintained unproductive / uneconomical food and energy practices. They explained that they could not trust other county goverments to provide 100 percent of their food and energy needs. Thus, they maintained minimal food and energy production as a safety net, in case the other county governments did not reciprocate. There was no intention to completely stop food and energy production. In fact, some county governments started to regularly purchase solar energy for energy and food self-sufficiency (dedicate water resources to food). This strategy is one of the routine actions that was interrupted during the drought round, leading to a reassessment of underlying self-sufficiency assumptions. The self-sufficiency strategy was adopted to reduce vulnerability created by a trusting relationship [360], (*p.* 338). Self-sufficiency is a key driving force, that maintained competition. The main challenge was to sustain a healthy balance between the drive for self-sufficiency and the need to jointly and sustainably manage the shared water resources [370], (p. 214).

8.2. Research Questions Revisited

To assess the SL outcomes, I adopted a multidisciplinary, complex socio-technical systems approach to SL. The research sub-questions are:

1. What is the contribution of WeShareIt game to cognitive learning of policymakers in Nzoia Basin?
2. What is the contribution of WeShareIt game to relational learning of policymakers in Nzoia Basin?
3. What is the contribution of WeShareIt game to the generation of epistemic institutional changes?

In this sub-section, I summarize the results for each of the three research questions.

8.2.1. Contribution of WeShareIt game to cognitive learning in Nzoia Basin

There was a significant increase in player SA when comparing the pre-test and post-test SART results ($F(1, 34) = 26.85$, $p = 0.005$). Increases in SA however did not lead to immediate actions. Actions were taken, after hearing stories regarding previous game sessions, from the facilitators. Therefore, there were two key elements to successful policy implementation: a story and a person with the connective capacity to effectively narrate the story and span the boundaries between two or more geographically dispersed teams. Furthermore, the results indicated that increased SA, only led to action, if the policymakers were familiar with climate change actions and there was a combined interaction effect between gender, team (mainly cross-team) and familiarity.

The results also indicated significant combined gender * familiarity * team (third-order effect) interaction effect on demand ($F\ 3, 68) = 5.57$, $p = 0.005$, partial $\eta 2 = 0.26$)) and the overall SA (($F\ 3, 68) = 4.56$, $p = 0.01$, partial $\eta 2 = 0.22$). The third order interaction effect was not significant on supply ($F\ 3, 68) = 1.53$, $p = 0.22$, partial $\eta 2 = 0.09$) and understanding ($F\ 3, 68) = 0.89$, $p = 0.89$, partial $\eta 2 = 0.01$). Based on the factorial MANOVA results, demand (D) had more influence on the SA outcomes than supply (S) and understanding (U). Therefore, efforts to foster SA should put more emphasis on increasing understanding on system dynamics, complexity and uncertainties (external factors), over the specific individual related SA factors and information quality and quantity.

I concluded that the epistemic object increases cognitive learning of the policymakers, and also identified the key SA factors that should receive more attention in future SL interventions.

8.2.2. Contribution of WeShareIt game to relational learning in Nzoia Basin

8.2.2.1. Respect for Diversity

The MDA procedure indicated that PAD was a better predictor than DD (age, education level, and gender) of negotiation outcomes (whether a water negotiation group may surpass in-group and out-group differences and cooperate, or they will act unilaterally). Moreover, when PAD was eliminated from the model, gender and education gained more prominence, and competed almost equally. Thus, when PAD is negligible, for instance, a water negotiation team comprising of only lawyers (functional), with similar knowledge, cognitive skills, capabilities and values, then gender and education diversity will take prominence. The discriminating power of gender was the strongest, bearing the highest correlation coefficient, followed closely by education. However, when gender and age were combined, they possessed more discriminating power than education.

This empirical study, supports the argument that diversity discussions should move away from whether diversity is good or bad towards understanding how the different diversity attributes contribute to cooperative decision-making, their respective elements and their unique value addition. If the policy aim is to improve decision-making in water management, then more focus should be on PAD than on DD. However, if the aim is to improve supervision, monitoring, evaluation and service delivery, then DD should be the focus when deciding the group composition. Furthermore, when selecting strong DD teams, the selection mechanism should emphasize the combined effect of gender and age diversity, as opposed to diversity in education level.

8.2.2.2. Team Interdependence and Cooperation

The Nzoia WeShareIt game results indicate that a water policy game is a useful experiential learning tool on team interdependence and cooperation. Both the Chi-Square test for goodness-of-fit and the one-way between-subjects ANOVA tests confirmed that the game positively contributed to the planned SL outcomes, on team interdependence and cooperation.

Of primary importance were the cooperation and the TI game mechanics that I used to design the game. For cooperation, I included shared goal, goal asymmetry, and goal synergy game mechanics. For TI, I included complementary knowledge, role asymmetry, and complementary roles game mechanics. These mechanics could inform the design of Kenyan specific indicators to measure cooperation and TI.

The uptake of the recommended cooperation and TI mechanics requires an epistemic change from county government WRM, to basin or cross-county WRM. Thus, the uptake is largely dependent on whether the observed SL in the

Gameworld, diffuses into the real-world, leading to epistemic changes. Currently, the approach Kenya uses to measure water service providers (WSP)'s performance is based on Key Performance Indicators (KPI). KPI's are county government centric and do not promote cross-county or basin cooperation. KPIs are also designed to improve service delivery through competition. However, I argue that KPIs are not the correct basis for increasing water access, when water availability is inequitably distributed. More detailed analysis of the shortcoming of using the current KPIs is contained in Chapter Six (Section 6.1).

8.2.2.3. Trust

The players exhibited high trustworthiness, and high ability to cooperate. All the respondents had positive perceptions of their own trustworthiness. This perception increased significantly after the game sessions. As such, the game had a positive effect on individual perceptions of their own trustworthiness. The assessments also indicated a low perception of the trustworthiness of other players. Trust levels (of the other players) declined consistently after the game sessions. The trustee reciprocated (based on the in-game results) with clear evidence of distrust, by the trustor.

The results also imply that a single dimension analysis of trust using the PTS may potentially be misleading because the respondents were measuring other constructs not envisaged when developing the assessment tool. The distances between the variables indicated that the respondents measured multiple constructs. Disposition to trust variables all clustered into one big group, while distrust clustered on the left side of the graph (Figure 8.2). The vast distances between these two groups confirmed that the MDS separated the two constructs. Though trustworthy subscale was not affected, the trust sub-scale measured different constructs, trust and distrust, leading to insignificant and conflicting results.

Increased complexity and uncertainty led to increased trust. Moreover, trust was excluded in circumstances where a trust relationship will not affect the decision made. Reduced complexity and uncertainty led to a decrease in distrust. The conceptual map (Figure 8.2) indicates a decrease in distrust between the pre-game and post-game findings, though the decrease was not significant. The decrease occurred when complexity reduced, and uncertainty also reduced.

In summary, trust, and trustworthiness were increased after the game sessions. Distrust was reduced when the situation became less complex and uncertain. Therefore, the game has a potential to enhance trust formation.

8.2.3. Contribution of the WeShareIt game to epistemic insitutional changes

There are noticeable epistemic changes, namely, a shift from routine incremental actions aimed at securing food and energy needs (are we doing things right?), to the questioning of underlying assumptions (are we doing the right things?), and even further towards profound structural changes (identifying what is the right thing to do). At the start of the game, the players focused on making incremental changes to ensure that the county government residents had sufficient food and energy. However, it became evident that the water resources are scarce and therefore the players needed to cooperate to 'do the right thing.' Furthermore, after the drought round, it became more evident that 'doing the right thing' may not be right, because the underlying assumptions may be wrong. So the players started to question 'what was the right thing to do?' In some of the game sessions, the players stopped playing after the drought round and held a joint meeting to discuss and reflect on what they were doing. It became evident that what they were doing was not right - the right thing to do was to completely change their artefacts, values and underlying assumptions (as discussed in subsection 8.3).

8.3. Revisiting the Research Objective

This dissertation studies whether SL can catalyse institutional change. Nzoia WeShareIt game is designed as an epistemic artefact aimed at resolving the social problem of hard to change, routinized water institutions [16,56,57]. I used the epistemic artefact to predict what are the right things to do. Therefore the game is a research tool to test various policy options and identify the most feasible SL changes that have the capacity to diffuse to the wider social unit and lead to the transformation of Nzoia River Basin insititutions. The debriefing sessions, observation notes, and rough-cut video sessions indicated the need for the following profound structural changes:

1. *Artefacts:* The structures and processes that manage water resources should be guided by the river. A river is no respector of geographical boundaries. Therefore, attempts to confine water to geographical boundaries may not be not sustainable. The policymakers expressed the need to dismantle geographical WRM structures and processes and replace them with configurations that respect the river, and support the sustainable management of the drainage basin, as a whole.
2. *Values:* Current policies, strategies, goals and practices give higher value to land over water. Water is not the structuring element, within the Nzoia River Basin. Spatial planning is given more impetus, while water is barely taken into consideration, when making any development plan. Water is

also an afterthought in agricultural and energy production plans. However, agriculture consumes the most water, in the Nzoia River basin, and energy is emerging as one of the highest water users. As a consequence, the development of many spatial plans, agricultural plans and energy production plans, does not consider the availability of water. Therefore, the right thing to do is to value water more than spatial, agricultural and energy-production plans, and make water the structuring element, within the Nzoia River Basin. This means that any plan that intends to unsustainably utilise the scarce water resources, should not be supported.

3. *Underlying Assumptions:* Based on the game sessions it emerged that the policymakers held unconscious beliefs and perceptions that the water system was stable and will continue as it is, without any disruptions. The drought round and the reduction of the water resources was not only a shock to the system, it shook the policymakers engrained beliefs and perceptions. Therefore, the policymakers begun to question their subsequent routines and habits. One prevalent routine, that I noted in the game, is the quick reaction to address water governance problems with a water management solution. When the policymakers were requested to feed their basin citizens, they did not question the prevailing water governance systems, they immediately proceeded, under the prevailing water governance systems (water management at the county governance level), with no cooperative framework, at the basin level. The drought round made the policymakers to question two underlying assumptions. First, that the water system is stable and can withstand any future shocks and unexpected events. Second, that the prevailing water governance institutional framework can adapt to sudden unexpected shocks. The questionning of these assumptions was critical in steering the policymakers toward positive cognitive, relational and epistemic changes.

8.4. Reflection on the Approach and its Limitations

8.4.1. Epistemic Objects and Boundary Spanners

At the start of the research, the policymakers had information on the complexity, and vulnerability of the water system. However, the possession of information did not translate into joint action. Past actions dominated future decision-making [123], (pp. 94-105). Policymakers used the past to reduce complexity leading to repeated actions, based on ascertained previous outcomes. Use of history to reduce complexity solved the social dimension dilemma of discounting unknown plausible futures with time (the familiar past) [124] (p. 23). However, the practice of replacing the current social complexities

with the past circumvented the social process of constructing meaning of present and future uncertainties, like Climate Change. Repeated actions relied on the familiar world (the past) and assumed that the already established familiarity endures into the future, unchanged [123], (pp. 94-105).

The familiar past is not prepared to solve future challenges. Climate Change is drastically changing assumed future outcomes and there is deepened complexity and uncertainty about what might happen in the near future. Therefore, the system is rapidly changing and becoming deeply complex and uncertain, but the institutions fail to learn, and adapt to the changing environment. These institutions continue to repeat past actions, that may no longer be relevant or sustainable.

An epistemic artefact was introduced to study and challenge current ways of doing things (institutionalized routine) and introduce adaptive capacity as a new way of acting. Policymakers comprising of 5 teams increased their SA by actively participating in the policy game. The in-game data indicates that increased SA of unfamiliar policy issues is insufficient to catalyse action. They needed to hear actual stories from someone who has experienced the unfamiliar world and brought their experiences into the familiar world, in order to act. The first players did not have this advantage, and thus they were not prepared to implement, what they had learned.

The epistemic artefact cannot catalyse SL on its own. It requires transformed mindsets to act as boundary spanners to ensure that the learning within the small group gets situated within a wider social network. A boundary spanner enters an unfamiliar world, experiences the unfamiliar world, and comes back to the familiar world with experiences of the unfamiliar world. As such, the facilitators' stories of previous game sessions were symbols that made climate change risks and opportunities not unfamiliar to the new team of policymakers. Through the stories and experiences in the previous game sessions, the policymakers were ready to accept the risk and move from commitment to action. This change happened because the risks were no longer unfamiliar, based on the stories from the boundary spanners.

Future epistemic artefacts should incorporate boundary spanners, to spur change from within the system, by strengthening horizontal social networks. Climate change boundary spanners can play the following roles:

1. Unfamiliar information processing and validation through experience;
2. External representation of the dynamic complex socio-technical system that they have experienced to persons who are still unfamiliar with the complexity of the problem and available opportunities; and
3. Monitoring the Nzoia River Basin water system impacts, projects, and opportunities.

8.4.2. Systems-Centric Approach and Multidisciplinary Studies

I faced one major limitation in the application of the system-centric approach to SL while using the established disciplinary theories for respective SL outcomes. Most of the SL outcomes are measured using individual or group centric approaches with strong foundation in psychology and social sciences, that emphasise on the individual or group, but not the system. Therefore, I confined the assessment to individual and group centric learning methodologies, which do not automatically lead to system changes. In SA, I used individual-centric approaches because it is the current way of knowing for the Nzoia Basin policymakers, which I modelled in the water policy game. For trust, I assessed generalized trust at the beginning of the game and faced hurdles because trust is situated, context specific and changes depending on any change in the variables "A entrusting B in matter X." For the post-game data, I assessed individual-centric trust. I could not identify existing bodies of literature that assess system-centric trust. Diversity analyses were also individual-centric. Cooperation and team-interdependence theories were group / network centric, with limited focus on the system. Therefore, the main challenge was consolidating the findings and assessing the contribution of the individual and group-centric SL outcomes on the water system.

8.4.3. Trust as a Social Learning Impact

Analysis of trust as a SL outcome faced some limitations, as discussed in Chapter 7 (Section 7.4.5). According to Gambetta [370], trust formation should not be a SL goal. The goal should be to facilitate cooperation, so that trust can be nurtured. Trust is formed after cooperation and cannot be measured as an independent construct from cooperation. Moreover, trust should be assessed with power. Therefore, the measurement of trust as a separate and independent construct from cooperation, was a limitation in the current study, that needs further investigation, in future studies.

In addition, an analysis of whether cooperation is based on trust or power is particularly useful in providing more insights into the relational dimension of SL. Time is also a vital factor in the assessment of trust, half a day may lead to trust formation, but it is not sufficient to nurture and sustain trust.

Therefore, I recommend that future studies should treat trust as a SL impact at the same level as normative epistemology, because both constructs need more time and an enabling social context before observing tangible and sustainable results.

8.4.4. Policy Game Design Guidance

Despite the current progress in enhancing SL games, researchers have identified two main research gaps [37,51,214]. First, limited design principles for SL games, including the measurement of the learning outcomes. Second, weak linkages between the game outcomes, and real-life application.

To address the first challenge, I used the SL design principles, within the specific bodies of knowledge that theorize and conceptualize SA, trust, cooperation and team interdependence. This ensured embeddedness of SL outcomes within the discipline that is better equipped to assess the SL outcome. Based on recommendations by Rodela [42], I used the established body of knowledge to understand, assess and discuss the specific SL outcomes. This approach ensured the assessment was embedded within an already established theory in the relevant discipline.

The design of a policy game that addresses the second challenge (weak linkages between the game outcomes, and real-life application) required a comprehensive approach to ensure knowledge transferability, into real life. To address this sustainability challenge, Medema [37] propose that policy games provide actors with precise mechanisms to be incorporated in ongoing processes. SL scholars further recommend embedding policy games in an already ongoing process whose outcomes are critical for the players, to facilitate knowledge diffusion, transfer, and integration [37,214,215]. I designed the Nzoia WeShareIt game based on an ongoing policy reform of water governance systems in Kenya [319,323,326]. The ongoing processes (e.g. Paris Climate-Change Agreement) that I embedded the game in, are the current legislative reviews aimed at developing new laws and regulations, aligned to the 2016 Water Act [117]. The Nzoia WeShareIt game environment was safe for testing various policy options and finding the most feasible set of options [51,80,394,395].

Moreover, Nzoia WeShareIt game was designed to influence real world outcomes, through knowledge diffusion. When players continuously communicated their shared understanding, it led to diffusion of knowledge [37], (p. 6). During the debriefing session, the players discussed the lessons learned and how they planned to apply it in real life settings (knowledge integration) [37], (p. 7). Knowledge integration also occurred because Nzoia WeShareIt game simulated a real-life policy challenge and provided the players with the opportunity to test viable options before applying them to real life circumstances [51], (pp. 825 – 826).

Additionally, research findings recommend that knowledge integration [37], (p. 7) should be one of the goals of a game designed for SL [37,222]. Therefore, I incorporated three game mechanics for cooperation to ensure knowledge integration. First, a common goal to facilitate joint basin

management. Second, players have their own individual goals of making their county government residents happy. Third, the game design ensures healthy competition between the shared goal and the individual goals that leads to the development of complementary roles and niches within the basin [86-90,99,100,103].

8.4.5. Scope and Study Limitations

There are two recurring limitations that various stakeholders identified. It was not clear to the various stakeholders, including the WRM and sustainability studies research communities, how an epistemic artefact can eventually diffuse into the society and (1) lead to widespread learning, and/or (2) adjusted WRM institutional behaviour. Experts within the mainstream water sector struggled with the idea that a water policy game would have any societal influence. Interestingly, this perspective was constantly expressed by the water community outside Kenya during the scientific publication process. However, when I engaged the Kenyan Ministry of Water and Irrigation (MWI), five county governments and all the various water institutions in Kenya, they were optimistic about the value of water policy game and its direct influence to learning.

Moreover, within the research duration, a literature review on games that catalyse SL was conducted by gaming and SL experts - den Haan and van der Voort [45]. den Haan and van der Voort [45] identified publications on the Nile WeShareIt [99] and the Nzoia WeShareIt [86], and included the two games in their review. The quality of information on the data and game design is rated highly in this publication. This publication brings to fore the importance of SL games and demonstrates that many researchers are currently focusing on gaming as a tool to catalyse social change. With more SL game publications, the research community that is not yet open to the value of gaming in societal transformation may begin to change their mindsets on the societal contribution of SL games.

However, it is important to consider the impact of policy gaming on real-life institutional changes. Gaming research should continue to demonstrate how identified changes, within the individual policymakers and the group, ultimately lead to adjusted institutional behaviour, in the real world, and diffuse to the relevant social units locally, nationally and internationally (Lake Victoria Basin and the Nile Basin). The research demonstrated SL within groups, but did not focus on diffusion of game outcomes, leading to widespread SL. This was not within the research scope. To maximize widespread SL, the research may require a further phase and focus on developing a game platform that engages a wider social network. Thus, future research should assess how to catalyse small

groups to interact and deliberate with the wider social network, and spur social transformation.

Despite the noted epistemic changes within the water policy game, the thesis did not go further to examine whether the identified changes led to adjusted institutional behaviour within the Nzoia River Basin. Such a study would involve looking at the actual adjustments in institutional behaviour in terms of routine, norms, paradigms, values, ways of knowing and how they rationalize their actions. This further analysis would require more time and resources, which was not within the scope of the research. However, because knowledge diffusion occurred in the Game world, the thesis may inform transition management experts on how to (1) catalyse social learning to challenge routine; (2) create an enabling environment for institutional change; (3) and apply the identified new routines or conceptual models, that worked in the game in reality, to achieve wide-spread social change and an adjustment in institutional behaviour.

8.5. Research Contribution

This dissertation contributes to institutional development studies, on policy related issues, within the WRM sector. The literature review in Chapter 2 indicates that SL research may benefit from an investigation on: whether SL outcomes in the context of WRM can catalyse institutional change. Therefore, the thesis contributes to science, policy and practice, on SL, policy gaming and insitutional change, with a special focus on the Nzoia River Basin.

Scientifically, I provide guidance and lessons learnt in the design and application of SL water policy game, including the frameworks and methodologies for the subsequent measurement of the SL outcomes.

Additionally, I contribute to the theoretical discussions on SA, Trust, Diversity, Team Interdepedence and Cooperation, in respective scientific disciplines, where the theoretical concepts are embedded.

Based on Table 2.1 (Chapter 2), on outcomes of SL games, Nzoia WeShareIt is the only game that measured all the three dimensions of SL comprehensively (it assesses all the three compenents of relational dimension). Therefore, the details on the input, process and outcome of Nzoia WeShareIt is important in initiating a discussion with SL scholar, whether the approach is beneficial and can be customized and replicated, in other river basins.

In policy and practice, I applied the epistemic artefact in current policy discourses, and formulated specific policy advice to key policymakers in Kenya, as outlined below in Table 8.9.

Moreover, the research provides methodologies that SL and policy gaming experts can use to assess SL outcomes (cognitive, relational and epistemic). The

scientific papers describe the design, application, and measurement SL outcomes, in detail, to enable researchers to replicate the study or customize it for another river basin.

In addition, all the datasets for SA, trust, team interdependence, cooperation, and the in-game data are open and easily accessible through the 4TU repository. This provides researchers with the opportunity to test the SL outcomes or use the datasets for further analyses.

Table 8.9. Summary of research contribution to policy and practice

	SL Outcomes	Summary of Policy Application	Key Policymakers
Cognitive	Situation Awareness (Chapter 4)	• Application of SART using Nzoia River Basin pre-game and post-game SA results and making recommendations to support the implementation of the Paris Climate Change Agreement [1] in Kenya.	• Nzoia county governments • Ministry of Water & Irrigation • Climate change experts • Water resources managers • Capacity development experts • Situation Awareness experts
Relational	Diversity (Chapter 5)	• Application of MDA to assess the influence of PAD and DD (age, gender and education level) in Nzoia River Basin negotiation outcomes and recommendations on the added value of diversity.	• Nzoia county governments • Ministry of Water & Irrigation • Diversity experts • Water resources managers • Capacity development experts
	Trust (Chapter 6)	• Application of PTS and MDS on the Nzoia River Basin pre-game and post-game results to assess the relationship between: a) Cooperation and Competition b) Trust and Trustworthiness c) Trust and Distrust d) (Dis) Trust, Complexity, and Uncertainty	• Nzoia county governments • Ministry of Water & Irrigation • Trust experts • Water resources managers • Capacity development experts • Complexity sciences • Policy analysts • Water governance experts
	Interdependence and Cooperation (Chapter 7)	• Review of the SDG 6.5.2. Indicator and comparing the indicator with the indicators in the Nzoia WeShareIt epistemic artefact. Furthermore, assessing the contribution of the policy game to cooperation and team interdependence.	• Nzoia county governments • WASREB • Ministry of Water & Irrigation • UN Water • UNECE
Epistemic	Overall change in epistemic cognition and Normative Epistemology changes	• Since the assessment of epistemic changes is not easy and has been lacking in most of the SL empirical analyses, the research contributes to SL measurement of the epistemic dimension through debriefing, observations, session videos and in-game data.	• Nzoia county governments • Ministry of Water & Irrigation • Education & Learning experts • Water resources managers • Capacity development experts • Policy gaming experts

8.6. Future Research

SL within the context of WRM and policy gaming, is a huge endeavour. Though there are numerous studies that assess SL outcomes in WRM, to which I make this contribution, there are many issues that need further investigation. Based on the insights that I gained when conducting the research, I highlight areas that I found to be important for future research.

Boundary spanning and facilitating the emergence of SL communities of practice (CoP). The challenge of undertaking SL research aimed at catalysing system-wide institutional changes is enormous. SL, WRM and policy gaming are multidisciplinary areas of research. Thus, spanning the boundaries to assess all the SL outcomes, and whether SL was experienced, is a daunting task. The conventional water institutions are managed by technical staff, and SL experts have to use numerous disciplines both technology-oriented and social-oriented, to catalyse change of water institutions. This requires increased collaboration between the technical and social science disciplines, to improve current SL interventions. The borrowing of concepts and theories from other disciplines has its limitations and shortcomings. Future research work should bring all these disciplines together under one CoP, to make SL a reality in the water sector. Future research should also assess how SL experts can realistically span boundaries and use relevant theories from various disciplines effectively, while taking consideration of the underlying assumptions. This is an enormous task that may require the emergence of multi-disciplinary SL CoPs, where joint research can be envisaged, designed, resources mobilized and implemented.

Comparative empirical analyses on social contexts that support SL. SL is dependent on the social context, thus the need for more experiments that investigate the influence of varied contexts, on SL, and its outcomes. I conducted an experiment to assess the influence of the Nzoia WeShareIt SL game on the Nzoia River Basin institutions. I assessed whether SL occurs under normality, during a climate-change induced disaster, and after the disaster. I also evaluated the influence of different governance contexts on SL. First, the players were under the conventional institutional configurations. Later policy networks were formed. As the game progressed, cross-county water institutions emerged. I also considered which context supported cognitive learning, relational learning and epistemic learning. Under relational learning, I further assessed whether PAD or DD produced a better context for learning. I also considered under what conditions, trust, trustworthiness and distrust, increase or decrease. For cooperation, I specifically looked at how to enhance cross-county water cooperation within the context of WASREB KPI, SDG 6.5.2 and the

Nzoia River Basin. The research involved spanning many disciplines and boundaries, understanding their arguments, core discourses and using the key theoretical underpinnings to support the research. The findings are context specific, which calls for further research to identify other contexts that do support SL and how these positive environments can be nurtured.

Design of a policy gaming platform that can diffuse SL from a case study to the wider society. Current WRM policy games focus on individual, group and network centric forms of learning. I designed the Nzoia WeShareIt game to assess whether learning can diffuse to the entire system, beyond the individual, group or network. My interest was in institutional learning. This dissertation identifies notable institutional changes in the Game world, for the Nzoia River Basin. However, it is still not clear how this learning can diffuse to the wider society within the Nzoia river basin. Future policy gaming research should focus on using the power of social media platforms and game platforms to diffuse, confirmed positive SL inputs, processes, outcomes and impacts, from a case study, or a small group, to the wider society or community of practice.

Gamification of Policy Meetings leading to actual, real-time institutional change. Research indicates that there are few policy games that lead to actual institutional adjustment of behaviour [45]. In the Nzoia WeShareIt game, there were distinct changes in institutional routine through norm, values, paradigm, and rationalization changes, leading to a convergence of opinions. However, this adjusted behaviour was limited to the Game world. Future studies should assess how gamification can be incorporated in ongoing institutional routine, leading to internal and real-time changes. As the policymakers deliberate and make actual policy decisions, they could use the positive aspects of gamification to increase reflection, learning and change. This may entail gamifying the actual policymaking Board Meetings, leading to actual, realtime, tangible and sustainable policy outcomes.

I summarise the proposed future studies within three major focus areas, through the use of three concluding remarks:

1. *Supporting intangible water governance studies* – The critical change required to sustainably manage water resources, is not tangible nor technical, it is intangible and institutional.
2. *Catalysing institutional change* – Endogenous institutional change will be too slow to address global water challenges. There is need for further studies to identify societal contexts that support SL and how these positive environments can be nurtured through catalysing institutional change.
3. *Supporting interdisciplinary SL research* – The future of Social Learning (SL) lies in valuing and financially supporting interdisciplinary research, especially when conceptual disciplinary distance exists.

Appendices

9.1. Appendix A (Chapter 4)

Table A.1. Situation Awareness ANOVA Tests

Situation awareness ANOVA with Friedman's Test and Tukey's Test for Nonadditivity							
			Sum of Squares	**df**	**Mean Square**	**Friedman's Chi-Square**	**Sig**
Between People			1549.00	34	45.56		
Within People	Between Items		4888.93 [a]	1	4888.93	26.85	0.00
	Residual	Nonadditivity	227.78 [b]	1	227.78	5.99	0.02
		Balance	1255.79	33	38.05		
		Total	1483.57	34	43.63		
	Total		6372.50	35	182.07		
Total			**7921.50**	**69**	**114.80**		
Grand Mean = 18.5000							

[a] Kendall's coefficient of concordance W = 0.617. [b] Tukey's estimate of power to which observations must be raised to achieve additivity = 1.849.

We designed the three-way ANOVA to study two types of effects: (1) the main effects, this refers to the separate influence of each factor; and (2) the interaction effects, this refers to the combined action of the factors.

The study comprises three factors:

1. familiarity, with two (2) levels (low, high);
2. gender, with two (2) levels (male, female);
3. a team of players, with seven (7) levels (pre and post-game teams for Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans-Nzoia*6 and Trans-Nzoia*7).

The research study is designed to assess seven effects in three orders:

1. three main effects: familiarity (F), gender(G) and teams (T) (the separate factor effects);
2. three second-order interaction effects: F*G, F*T, and G*T;
3. one third-order interaction effect: F*G*T.

The simple main effects of any factor represent the influences of that factor when the levels of the other factors remain unchanged. To illustrate this, the number of groups in the simple main effects model for the factor familiarity (low or high) is 28 (2 × 2 × 7), as listed below:

1. Seven groups measuring the effect of low familiarity on male policymakers for each of the seven teams (Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans-Nzoia*6, and Trans-Nzoia*7);

2. Seven groups measuring the effect of low familiarity on female policymakers for each of the seven teams (Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans-Nzoia*6, and Trans-Nzoia*7);
3. Seven groups measuring the effect of high familiarity on male policymakers for each of the seven teams (Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans-Nzoia*6, and Trans-Nzoia*7); and
4. Seven groups are measuring the effect of high familiarity on female policymakers for each of the seven teams (Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans-Nzoia*6 and Trans-Nzoia*).

The simple second-order interaction effects represent the interaction effects of two factors for each level of the third factor. The simple third-order interaction effects represent the sum of all the interaction effects between the three factors.

The following assumptions form the basis of the analysis:

1. The three independent variables are categorical, each having at least two categories.
2. The dependent variable is continuous.
3. Observations are independent; there is no relationship between the subjects in our groups.
4. The dependent variable is normally distributed in all groups.
5. The dependent variable does not present significant outliers in any group.
6. The dependent variable has equal variances in all groups (variances are homogeneous).

We tested all the assumptions, and the results were positive except the Box's test of equality of variance. This test seeks to check whether the covariance matrices of the dependent variables are equal across groups. Box's test of equality of covariance matrices was not computed because there are fewer than two non-singular cell covariance matrices. Since the SART scale is an already established scale and it has been tested and verified in many studies, we decided to proceed with the analysis without any results from the Box's Test of Equality of Covariance.

Table A.2. illustrates: (1) the MANOVA effects by familiarity (0,1) team (1,7) gender (1,2), (2) the questions to be answered and (3) the tested hypotheses. All dependent variables are related to the SART subjective rating technique for demand, supply, understanding and situation awareness.

Table A.2. MANOVA effects by familiarity (0,1) team (1,7) gender (1,2)

Effects Tested	**Question to be Answered**	**Hypotheses (the mean difference is significant at the 0.05 level), [*N = 70 cases*]**
1st main effect	Does high and low familiarity differ on the three subscales and the overall scale of SA?	1. H1a: the group means for the familiarity (F) factor are equal in the total population. 2. H1b: the group means for the familiarity (F) factor are different in the total population.
2nd main effect	Do male and female policymakers differ on the three subscales and the overall scale of SA?	3. H2a: the group means for the gender (G) factor are equal in the total population. 4. H2b: the group means for the gender (G) factor are different in the total population.
3rd main effect	Is there a difference between the seven (7) teams on the three subscales and the overall scale of SA?	5. H3a: the group means for the teams (T) factor are equal in the total population. 6. H3b: the group means for the teams (T) factor are different in the total population.
1st second-order effect	Do policymakers with different familiarity levels (high or low), and gender (female or male) differ when considered jointly on the variables demand, supply, understanding and situation awareness?	7. H4a: the sum of all the interaction effects between factors F and G, is equal to zero. 8. H4b: the sum of all the interaction effects between factors F and G, is different from zero.
2nd second-order effect	Do policymakers with different familiarity levels (high or low), and teams (one of the seven teams) differ when considered jointly on the variables demand, supply, understanding and situation awareness?	9. H5a: the sum of all the interaction effects between factors F and T, is equal to zero. 10. H5b: the sum of all the interaction effects between factors F and T, is different from zero.
3rd second-order effect	Do policymakers with different gender (female or male) and teams (one of the seven teams), differ when considered jointly on the variables demand, supply, understanding and situation awareness?	11. H6a: the sum of all the interaction effects between factors G and T, is equal to zero. 12. H6b: the sum of all the interaction effects between factors F and T, is different from zero.
Third-order interaction effect	Do policymakers with different familiarity levels (high or low), gender (female or male) and teams (one of the seven teams), differ when considered jointly on the variables demand, supply, understanding and situation awareness?	13. H7a: the sum of all the interaction effects between factors F, G and T is equal to zero. 14. H7b: the sum of all the interaction effects between factors F, G and T is different from zero.

The analysis starts with the study of the highest order interaction effect (the third order interaction effect) (H7). If the highest order interaction effect is statistically significant, we study the simple second-order interaction effects (the interaction effects of two factors at each level of the third factor, i.e., H4–H6)). If some of the simple second-order interaction effects are significant, we examine the simple main effects (H1–H3). If at least one simple main effect is significant, we compute and interpret the simple comparisons between various factor levels.

If the third-order interaction effect is not significant, we inspect the second-order interaction effects. If some of them are significant, we compute the simple main effects. If none of the second-order interaction effects is significant, we can either finish the analysis or examine the main effects (if they hold interest).

An ANOVA using Friedman's test and Tukey's test for non-additivity for SA scores was conducted. The ANOVA showed that there is a statistically significant increase in situation awareness at the $p < 0.05$ level, $F(1, 34) = 26.85$, $p = 0.005$. The ANOVA test details are in Table A.1.

Each of the seven Nzoia WeShareIt teams consists of five water policymakers, each representing the five basin county governments (Bungoma, Busia, Kakamega, Trans Nzoia and Uasin Gishu). Since each team has five members, and that SA (and similarly D, A, and U) is measured twice (pre-game and post-game), during the quasi-experiment, we have in total 70 measures of SA. Table A.2 lists effects, questions, and hypotheses for the three IDVs (gender, team, and familiarity) and their interaction effects. Table A.3 contains the main descriptive statistics.

Table A.3. Descriptive statistics for the familiarity factor.

	Dependent Variable:		
Familiarity	**Mean**	**Std. Deviation**	**N**
Low	10.1429	7.87828	35
High	26.8571	5.20827	35
Total	18.5000	10.71468	70

Subsequently, 3 × 4 factorial MANOVA was conducted to compare the effect of three IDVs (gender, familiarity, and team) on the overall situation awareness as well as on the three SA dimensions (demand, supply, and understanding). The between-subject factors can be found in Table A4.

Table A.4. Between subject factors.

IDV	Value	Value Label	N
Gender	1	Female	24
	2	Male	46
Familiarity	0	Low	35
	1	High	35
Team	1	Busia*1	10
	2	Busia*2	10
	3	Kakamega*3	10
	4	Bungoma*4	10
	5	Bungoma*5	10
	6	Trans-Nzoia*6	10
	7	Trans-Nzoia*7	10

The factorial analysis started with the study of the highest order interaction effect (the third-order interaction effect), followed by the simple second-order interaction effects (the interaction effects of two factors at each level of the third factor). Table A.5 contains the detailed results of the multivariate tests for the SA dimensions (demand, supply, and understanding) and the overall SA. The results are reported using the Wilks' lambda and Pillai's trace tests. Since we could not conduct the Box test of equality of variance, we were not sure whether the assumption of equality of covariances is met. As a consequence, we decided to maintain both the Pillai's trace test (for when the assumption is not met) and the Wilks lambda (when the assumption is met). Otherwise, the Wilks lambda is preferred when the assumption of equality of covariances is met. Both results were relatively similar and the significance levels reported using both tests were the same.

The third order interaction effect assesses whether policymakers with different familiarity levels (high or low), gender (female or male) and teams (one of the seven teams), differ when considered jointly on the variables demand, supply, understanding and situation awareness. There was a significant difference between the levels of familiarity levels (high or low), gender (female or male) and teams (one of the seven teams), differ when considered jointly on the variables demand, supply, understanding and situation awareness, (Wilk's $\lambda = 2.82$ (F 9, 112.10) = 0.78, $p = 0.01$, partial $\eta 2 = 0.15$).

Since the highest order interaction effect is statistically significant, we proceeded to study the simple second-order interaction effects (the interaction effects of two factors at each level of the third factor). Table A.5 contains the detailed results of the multivariate tests for the simple second-order interaction effects. The studied three second-order interaction effects, as follows:

1. H4—Familiarity*Gender—1st second-order interaction effect (Do policymakers with different familiarity levels (high or low) and gender

(female or male) differ when considered jointly on the variables demand, supply, understanding and situation awareness?)

2. H5—Familiarity*Team—2nd second-order interaction effect (Do policymakers with different familiarity levels (high or low), and teams (one of the seven teams) differ when considered jointly on the variables demand, supply, understanding and situation awareness?)
3. H6—Gender*Team—3rd second-order interaction effect (Do policymakers with different gender (female or male) and teams (one of the seven teams), differ when considered jointly on the variables demand, supply, understanding and situation awareness?).

Table A.5. Between subject factors multivariate tests results

Effect	Test	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Gender	Pillai's Trace	0.05	0.78	3.00	46.00	0.51	0.05
	Wilks' Lambda	0.95	0.78	3.00	46.00	0.51	0.05
Familiarity	Pillai's Trace	0.84	82.74	3.00	46.00	0.00	0.84
	Wilks' Lambda	0.16	82.74	3.00	46.00	0.00	0.84
Team	Pillai's Trace	0.27	0.78	18.00	144.00	0.72	0.09
	Wilks' Lambda	0.75	0.76	18.00	130.59	0.74	0.09
Gender * Familiarity	Pillai's Trace	0.05	0.82	3.00	46.00	0.49	0.05
	Wilks' Lambda	0.95	0.82	3.00	46.00	0.49	0.05
Gender * Team	Pillai's Trace	0.06	0.31	9.00	144.00	0.97	0.02
	Wilks' Lambda	0.94	0.30	9.00	112.10	0.97	0.02
Familiarity * Team	Pillai's Trace	0.44	1.38	18.00	144.00	0.15	0.15
	Wilks' Lambda	0.61	1.37	18.00	130.59	0.16	0.15
Gender * Familiarity * Team	Pillai's Trace	0.41	2.50	9.00	144.00	0.01	0.14
	Wilks' Lambda	0.61	2.82	9.00	112.10	0.01	0.15

As such, we confirm that the null hypotheses H4a, H5a, and H6a are supported:

1. H4a the sum of all the interaction effects between factors F and G is equal to zero;
2. H5a: the sum of all the interaction effects between factors F and T, is equal to zero; and
3. H6a: the sum of all the interaction effects between factors G and T, is equal to zero.

Therefore H4b, H5b, and H6b are not supported:

1. H4b: the sum of all the interaction effects between factors F and G, is different from zero;
2. H5b: the sum of all the interaction effects between factors F and T, is different from zero; and

3. H6b: the sum of all the interaction effects between factors G and T, is different from zero.

Since the highest order interaction effect is significant, but all the three second-order interaction effects are not significant, we proceeded to compute and examine the simple main effects. The main effects analysis contained three main effects:

1. H1—Familiarity—1st main effect (Does high and low familiarity differ on the three subscales and the overall SA scale?)
2. H2—Gender—2nd main effect (Do male and female policymakers differ on the three subscales and the overall SA scale?
3. H3—Team—3rd main effect (Is there a difference between the seven (7) teams on the three subscales and the overall SA scale?)

For the 1st main effect, a 2 × 4 MANOVA was conducted with familiarity (low or high) as the independent variable and the overall situation awareness as well as on the three SA dimensions (demand, supply, and understanding) as the dependent variables (Table A.5). The results of the MANOVA indicated that there was a significant difference between high and low familiarity on the three subscales and the overall SA, (Wilk's $\lambda = 0.16$ (F 3, 46) = 82.74, $p = 0.005$, partial $\eta 2 = 0.84$).

For the 2nd main effect, a 2 × 4 MANOVA was conducted with gender (female or male) as the independent variable and the overall situation awareness as well as on the three SA dimensions (demand, supply, and understanding) as the dependent variables (Table A.5). The results of the MANOVA indicated that there was no significant difference between female and male SART scores on the three subscales and the overall SA, (Wilk's $\lambda = 0.95$ (F 3, 46) = 0.78, $p = 0.51$, partial $\eta 2 = 0.05$).

For the 3rd main effect, a 7 × 4 MANOVA was conducted with team (Busia*1, Busia*2, Kakamega*3, Bungoma*4, Bungoma*5, Trans Nzoia*6 and Trans Nzoia*7) as the independent variable and the overall situation awareness as well as on the three SA dimensions (demand, supply and understanding) as the dependent variables (Table A.5). The results of the MANOVA indicated that there was no significant difference between high and low familiarity on the three subscales and the overall SA, (Wilk's $\lambda = 0.75$ (F 18, 130.59) = 0.76, $p = 0.74$, partial $\eta 2 = 0.09$).

As such, we confirm that H2a (the group means for the gender (G) factor are equal in the total population); and H3a (the group means for the team (T) factor are equal in the total population), are supported. Therefore, we did not reject these two null hypotheses. Thus, their alternative hypothesis H2b (the

group means for the gender (G) factor are different in the total population); and H3b (the group means for the team (T) factor are different in the total population), are not supported. Therefore, we did not reject null hypotheses H2a and H3a.

The 2 × 4 MANOVA assessment of the familiarity IDV indicates that H1a is not supported. There is a significant difference between the group means for the familiarity (F) factor the overall situation awareness as well as on the three SA dimensions (demand, supply, and understanding) as the dependent variables (Table A.5). Therefore, we rejected H1a because the alternative hypothesis H1b is supported (the group means for the familiarity (F) factor are different in the total population). As such, we concluded that the null H2a and H3a are supported, and null H1a is not supported. Alternatively, H1b is supported, and H2b and H3b are not supported.

The tests of Between-Subjects effects provide more insights into the effects of familiarity and the third order interaction effects on SA and its three dimensions (demand, supply, and understanding). For the familiarity factor, when considered alone, there was significant demand effect (F 1, 6) = 92.27, p = 0.005, partial $\eta 2 = 0.66$), with the post-game SART results reporting significantly higher familiarity on demand for attentional resources than the pre-game SART results.

In summary, the post-game SART results reported significantly higher familiarity effects on all the four dependent variables [overall SA, demand on attentional resources (D), supply of attentional resources (A), and the understanding of the situation that they face at that particular moment (U)], than the pre-game SART results.

Follow up univariate tests of Between-Subjects effects were also conducted for third and second order interaction effects of Gender * Familiarity * Team (third-order effect), Familiarity * Gender (2nd order effect), Familiarity * Team (2nd order effect), and Gender * Team (2nd order effect). The results confirm the MANOVA results. There was no significant second order interaction effect. However, the third order interaction effect indicates mixed results (Table A.6).

The post-game SART results reported significantly higher familiarity effects on all the four dependent variables [overall SA, demand on attentional resources (D), the supply of attentional resources (A), and the understanding of the situation that they face at that particular moment (U)] than the pre-game SART results. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Table A.6. Tests of between-subjects' effects.

Effect	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Gender	Demand	6.848	1	6.85	0.59	0.44	0.01
	Supply	0.675	1	0.68	0.03	0.86	0.00
	Understanding	18.148	1	18.15	1.75	0.19	0.04
	SA	6.075	1	6.08	0.15	0.70	0.00
Familiarity	Demand	1063.939	1	1063.94	92.27	0.00	0.66
	Supply	3256.546	1	3256.55	148.81	0.00	0.76
	Understanding	1865.295	1	1865.29	180.26	0.00	0.79
	SA	4574.782	1	4574.78	112.96	0.00	0.70
Team	Demand	26.487	6	4.41	0.38	0.89	0.05
	Supply	101.919	6	16.99	0.78	0.59	0.09
	Understanding	63.419	6	10.57	1.02	0.42	0.11
	SA	294.892	6	49.15	1.21	0.32	0.13
Gender * Familiarity	Demand	9.259	1	9.26	0.80	0.37	0.02
	Supply	3.675	1	3.68	0.17	0.68	0.00
	Understanding	6.848	1	6.85	0.66	0.42	0.01
	SA	5.490	1	5.49	0.14	0.71	0.00
Gender * Team	Demand	18.467	3	6.16	0.53	0.66	0.03
	Supply	27.811	3	9.27	0.42	0.74	0.03
	Understanding	2.148	3	0.72	0.07	0.98	0.00
	SA	35.817	3	11.94	0.29	0.83	0.02
Familiarity * Team	Demand	146.689	6	24.45	2.12	0.07	0.21
	Supply	147.395	6	24.57	1.12	0.36	0.12
	Understanding	87.540	6	14.59	1.41	0.23	0.15
	SA	177.321	6	29.55	0.73	0.63	0.08
Gender * Familiarity * Team	Demand	192.748	3	64.25	5.57	0.00	0.26
	Supply	100.745	3	33.58	1.53	0.22	0.09
	Understanding	6.370	3	2.12	0.21	0.89	0.01
	SA	554.557	3	184.85	4.56	0.01	0.22

Since one simple main effect is significant, familiarity, we computed a final *simple comparisons* step between low and high familiarity. Since the *p*-value is lower than 5%, the difference between the factor groups is significant for all the 4 dependent variables in the case of familiarity and significant on only demand and the overall SA on the combined F*G*T third order effect. In other words, familiarity has an essential influence on both demand, supply, understanding and the overall SA. However, the combined effect of F*G*T has an important influence on only demand and the overall SA.

Table A.7. Between Subject Factors.

Dependent Variable:						
(I) Familiarity		**Mean Difference (I–J)**	**Std. Error**	**Sig. [b]**	**95% Confidence Interval for Difference [b]**	
					Lower Bound	**Upper Bound**
Low	High	−16.71 *	1.60	0.000	−19.900	−13.53
High	Low	16.71 *	1.60	0.000	13.529	19.90

Based on estimated marginal means. * The mean difference is significant at the 0.05 level. [b] Adjustment for multiple comparisons: Bonferroni.

Table A.8. Tests of between-subjects' effects for the familiarity factor.

Dependent Variable:					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Familiarity	1251.66	1	1251.66	91.16	0.000	0.57
Error	933.71	68	13.73			
Total	13,048.00	70				
Corrected Total	2185.37	69				

Table A.9. Pairwise comparisons.

Dependent Variable:						
(I) Familiarity		**Mean Difference (I–J)**	**Std. Error**	**Sig. [b]**	**95% Confidence Interval for Difference [b]**	
					Lower Bound	**Upper Bound**
Low	High	−16.71 *	1.60	0.000	−19.900	−13.53
High	Low	16.71 *	1.60	0.000	13.529	19.90

Based on estimated marginal means. * The mean difference is significant at the 0.05 level. [b]. Adjustment for multiple comparisons: Bonferroni.

Table A.10. Univariate tests for the familiarity factor.

Dependent Variable:						
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Contrast	1251.66	1	1251.66	91.16	0.000	0.57
Error	933.71	68	13.73			

The F tests the effect of Familiarity. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

9.2. Appendix B (Chapter 5)

Table B.1. Gender * Education Crosstabulation.

		Education					
		primary education	secondary education	College Diploma	Bachelor's Degree	Master's Degree	Total
Gender	Female	1	1	1	8	1	12
	Male	0	3	6	12	2	23
Total		**1**	**4**	**7**	**20**	**3**	**35**

Table B.2. Game * Age Crosstabulation.

		Age					**Total**
		18 to 24	**25 to 34**	**35 to 44**	**45 to 54**	**55 to 64**	
	Busia_1	1	3	0	1	0	5
	Busia_2	1	1	1	1	1	5
	Kakamega	1	1	1	2	0	5
Game	Bungoma_1	1	0	1	2	1	5
	Bungoma_2	0	1	1	2	1	5
	TransNzoia_1	0	3	2	0	0	5
	TransNzoia_7	0	2	1	2	0	5
Total		**4**	**11**	**7**	**10**	**3**	**35**

Table B.3. Game*Gender Crosstabulation.

		Gender		**Total**
		Female	**Male**	
	Busia_1	3	2	5
	Busia_2	2	3	5
	Kakamega	0	5	5
Game	Bungoma_1	0	5	5
	Bungoma_2	0	5	5
	TransNzoia_1	4	1	5
	TransNzoia_2	3	2	5
Total		**12**	**23**	**35**

Table B.4. Game*Education Crosstabulation.

		Education					
		Primary education	Secondary education	College Diploma	Bachelor's Degree	Master's Degree	Total
Game	Busia_1	0	0	1	4	0	5
	Busia_2	1	2	1	1	0	5
	Kakamega	0	1	1	3	0	5
	Bungoma_1	0	1	2	2	0	5
	Bungoma_2	0	0	1	4	0	5
	TransNzoia_1	0	0	0	3	2	5
	TransNzoia_2	0	0	1	3	1	5
	Total	**1**	**4**	**7**	**20**	**3**	**35**

The results indicated strong correlations between the dependent variables meaning they were mainly testing one variable – the contribution of the game in enhancing cooperation through player negotiations. Additionally, the Box's M test results of 40.776 (associated with a p-value of 0.478), is non-significant (i.e., $p < .05$). Thus, we assumed equal covariance matrices between the groups, for purposes of conducting the MDA procedure.

These outliers are not due to data entry errors or data collection errors. Data entry was electronic through the SurveyMonkey (https://www.surveymonkey.com). Therefore, the chances of data entry errors due to lack of attention, negligence, and tiredness were eliminated. Data collection was also done electronically through the participants filing the online questionnaires. Thus, eliminating errors due to human mistakes or equipment malfunction. Also, data transfer from SurveyMonkey to SPSS was not manual. Thus, eliminating any form of data transfer errors. Therefore, the outliers we were dealing with are genuine non-typical and unusual values in the population.

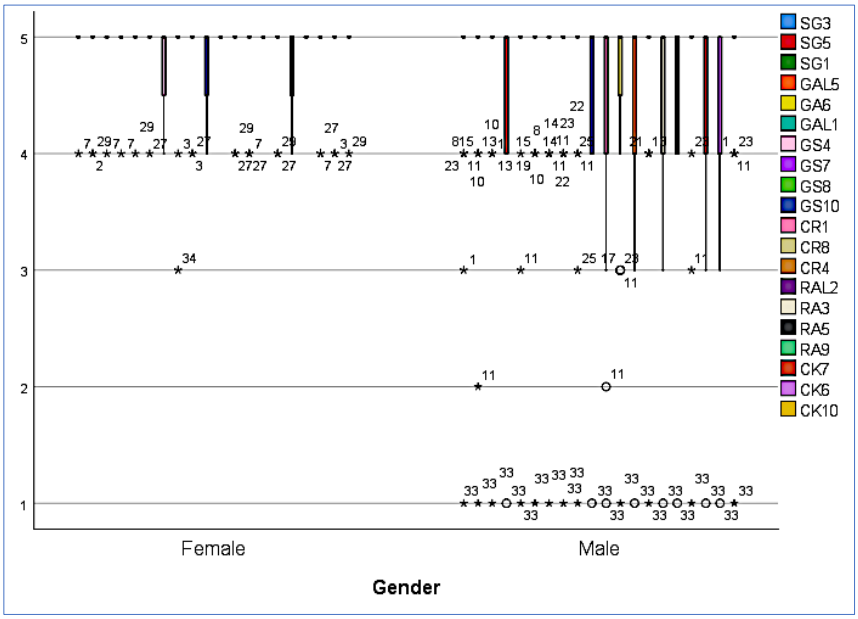

Figure B.1. Gender Disaggregated Boxplot Chart Histograms.

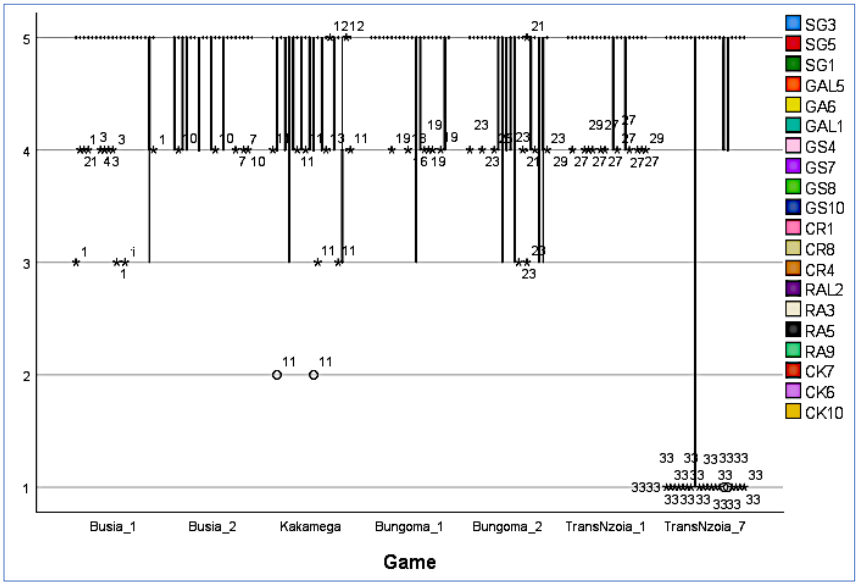

Figure B.2. Game Sessions Disaggregated Boxplot Chart Histograms.

We had two solutions to deal with genuine outliers. The first option was to remove the outlier from the data series. The second option was to keep the outliers in the data series. Based on the graphical representation of all the assessment results of the 20 dependent variables distributed according to the seven game sessions, we realized that removing the outliers would remove all the assessment results of respondent ID number 33 and 27. It would also impact on the results of some respondents, for instance, respondent ID number 1, 11 and 23. Therefore, we decided to keep the outliers.

Table B.5. Wilk's Lambda for Test of Functions 1 through 4.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 4	0.006	148.248	24	0.000
2 through 4	0.319	32.557	15	0.005
3 through 4	0.758	7.887	8	0.445
4	0.972	0.810	3	0.847

Table B.6. Functions of Group Centroids.

Game	Function			
	1	2	3	4
Busia_1	-10.163	-1.615	0.251	0.101
Busia_2	-6.452	0.609	-0.964	0.015
Kakamega	-3.597	0.707	0.493	-0.285
Bungoma_1	-0.040	1.194	0.088	0.019
Bungoma_2	3.261	0.818	0.485	0.248
TransNzoia_1	6.764	-1.435	-0.038	-0.088
TransNzoia_7	10.227	-0.279	-0.315	-0.011
Unstandardized canonical discriminant functions evaluated at group means				

Table B.7. Canonical Discriminant Function Coefficients.

Variable	Function			
	1	2	3	4
Gender	-0.673	2.282	1.535	-0.797
Education	-0.201	-1.061	0.894	0.336
id	0.675	0.051	-0.019	-0.029
Age	0.240	0.036	-0.219	0.860
(Constant)	-10.810	0.051	-5.648	-2.200
Unstandardized coefficients				

9.3. Appendix C (Chapter 6)

Table C.1. Component Loadings based on PCA with Varimax rotation

Item		Sub-Indicators for Cooperation, Interdependence and General Learning	D1	D2	Communality
Cooperation	C_1	Shared Goal: I enjoyed pursuing the shared goal with other counties	.75	.54	.84
	C_3	Shared Goal: I worked with others to achieve a common interest	.88	.40	.77
	C_4	Goal Synergy: I worked with others to be successful	.60	.69	.83
	C_5	Shared Goal: I managed the Nzoia water resources jointly	.73	.44	.69
	C_6	Goal Asymmetry: I am more aware of the benefits of working together	.75	.53	.82
	C_7	Goal Synergy: I valued cooperation over competition	.53	.66	.71
	C_8	Goal Synergy: I respected others	.58	.66	.76
	C_10	Goal Synergy: I got along with most of the others	.85	.43	.78
	L1C	Goal Asymmetry: I am more aware of the need for joint action	.40	.88	.77
	L5C	Goal Asymmetry: My collaboration skills were enhanced	.41	.86	.84
Interdependence	1_1	Complementary Role: I interacted with others to achieve basin goals.	.41	.84	.76
	1_3	Role Asymmetry: I felt responsible to the group for the regional strategy	.76	.50	.80
	I_4	Complementary Role: I developed social connections	.49	.78	.78
	I_5	Role Asymmetry: I became a valuable member in the basin	.80	.42	.77
	I_6	Complementary Knowledge: I gave feedback on each other's contribution	.44	.84	.79
	I_7	Complementary Knowledge: I shared information and encouraged joint action	.64	.58	.74
	I_8	Complementary Role: I discussed progress with others after every meeting	.72	.48	.73
	I_9	Role Asymmetry: I established a role that increased interactions with others	.75	.57	.88
	I_10	Complementary Knowledge: I learnt the importance of sharing information	.71	.61	.87
	L2I	Role Asymmetry: I increased their knowledge of balancing food, energy, and environment.	.83	.34	.71
Learning, Cooperation, and Team Interdependence	L_1	I am more aware of the need for joint action	.72	.52	.79
	L_2	I increased my knowledge on balancing between food, energy, and environment	.77	.44	.79
	L_3	My trust of others has increased	.72	.46	.73
	L_4	I enhanced my decision-making skills	.60	.75	.92
	L_5	I enhanced my collaboration skills	.58	.73	.86
	L_6	I enhanced my conflict-management skills	.28	.83	.76
	L_7	I am more aware of the impact of climate-change induced disasters	.61	.49	.62
	L_8	I am more aware of the need for trust-building	.82	.39	.82
	C_1	Shared Goal: I enjoyed pursuing the shared goal with other counties	.79	.45	.83
	C_4	Goal Synergy: I worked with others to be successful	.84	.37	.85
	C_5	Shared Goal: I managed the Nzoia water resources jointly	.65	.51	.68
	C_6	Goal Asymmetry: the I more aware of the benefits of working together	.72	.55	.82
	C_7	Goal Synergy: I valued cooperation over competition	.59	.59	.70
	C_8	Goal Synergy: I respected another s	.82	.38	.81
	C_10	Goal Synergy: I got along with most of the other	.80	.39	.80
	I_1	Complementary Knowledge: I interacted with others to achieve basin goals.	.43	.78	.80
	I_3	Role Asymmetry: I felt responsible to the group for the regional strategy	.53	.70	.77
	I_4	Complementary Role: I developed social connections	.38	.84	.85
	I_5	Role Asymmetry: I became a valuable member in the game	.69	.53	.77
	I_6	Complementary Knowledge: I gave feedback on each other's contribution	.43	.79	.80
	I_7	Complementary Knowledge: I shared information and encouraged joint action	.57	.64	.74
	I_8	Complementary Role: I discussed progress with others after e round	.48	.68	.69
	I_9	Role Asymmetry: I established a role that increased interactions with others	.66	.67	.89
	I_10	Complementary Knowledge: I learnt the importance of sharing information	.65	.68	.88

9.4. Appendix D (Chapter 7)

Table D.1. PTS items for the pre-game and post-game questionnaires.

Questions/sub-scale/factor loading of PTS items	Sub-scale	Pre-Game		Post-Game	
N=35		TW 37%	Trust 27%	TW 72%	Trust 46%
1. Listen(ed) to my conscience (TW1)	Trustworthy	0.63		0.89	
2. Anticipate(d) the needs of others (TW2)	Trustworthy	0.42		0.72	
3. Respect(ed) others (TW3)	Trustworthy	0.44		0.84	
4. Gets (got) along with most people (T1)	Trust		0.14		-0.73
5. Always been (Was) completely fair to others (TW4)	Trustworthy	0.60		0.86	
6. Believe that laws (game rules) should be strictly enforced (TW5)	Trustworthy	0.63		0.82	
7. Have (had) a good word for everyone (T2)	Trust		-		-0.67
8. Value(d) cooperation over competition (T3)	Trust		-0.28		-0.60
9. Would never cheat on my taxes (never cheated) (TW6)	Trustworthy	0.41		0.84	
10. Follow(ed) through with my plans (TW7)	Trustworthy	0.84		0.89	
11. Believe(d) that people (players) are (were) basically moral (T4)	Trust		0.34		-0.62
12. Finish(ed) what I start (ed) (TW8)	Trustworthy	0.74		0.91	
13. Filled with doubts about things (was filled with doubt) (T5)	Trust		0.78		0.49
14. Feel short-changed in life (Felt short-changed) (T6)	Trust		0.75		0.56
15. Avoid contact with other(s) (players) (T7)	Trust		0.71		0.83
16. Believe that most people (players) would lie to get ahead (T8)	Trust		0.58		0.77
17. Find it hard to forgive others (players) (T9)	Trust		0.61		0.82
18. Believe that people (other players) seldom tell you the whole story (T10)	Trust		0.32		0.64
Valid N (listwise)	32				

Based on the findings, three items were identified not to have the sufficient loadings (higher than 0.30), at the pre-game stage, namely:

1. Gets (got) along with most people (T1), factor loading of 0.14
2. Have (had) a good word for everyone (T2)
3. Value(d) cooperation over the competition (T3), factor loading of -0.28

We did not discard these three items because they had high factor loadings (above 0.60), at the post-game stage. However, these factor loadings were negative leading to the weakening of the VSS. We did not discard any item because the scale and its sub-scales had already been tested and approved by Evans and Revelle (2008), as the goodness of fit for the VSS. However, we noted that Items T1, T2, T3 and T4 might not contribute high loadings for the trust sub-scale.

Table D.2. Pre-Game and Post-Game Descriptive Statistics

	Pre-Game and Post-Game Descriptive Statistics	Pre-Game		Post-Game	
		Mean	Std. Deviation	Mean	Std. Deviation
TRUSTWORTHY SUB-SCALE	1. Listen(ed) to my conscience	4,8	0,4	4.5	0.8
	2. Anticipate(d) the needs of others	4,4	0,8	4.4	0.7
	3. Respect(ed) others	4,8	0,4	4.7	0.8
	4. Have always been (Was) completely fair to others (players)	4,3	0,6	4.4	0.8
	5. Believe that laws (game rules) should be strictly enforced	4,5	0,9	4.4	0.9
	6. Would never cheat on my taxes (never cheated)	4,2	1,1	4.6	0.9
	7. Follow(ed) through with my plans	4,4	0,6	4.5	0.8
	8. Finish(ed) what I start (ed)	4,6	0,6	4.7	0.8
TRUST SUB-SCALE	9. Get (Got) along with most people (players)	4.3	0.95	4.6	0.8
	10. Have a good word for everyone	4.1	1.0	4.6	0.8
	11. Value cooperation over competition	4.8	0.4	4.7	0.8
	12. Believe that people are moral	3.7	0.97	4.5	0.8
	13. Filled with doubts about things (Was filled with doubt)	2.9	1.2	2.1	1.3
	14. Feel short-changed in life (Felt short-changed)	2.6	1.3	2.3	1.5
	15. Avoid contact with others (other players)	2.3	1.3	1.9	1.4
	16. Believe that most people would lie to get ahead 17. Post-game - Believed that most players lied to get ahead	3.1	1.3	2.1	1.5
	18. Find it hard to forgive others (found, other players)	2.5	1.4	1.9	1.4
	19. Believe that people (Players) seldom tell you the whole story	3.5	0.8	2.5	1.5

For each of the PTS sub-scales, we computed a two-way contingency table, that cross-classifies the PTS subjective rating before the game and after the game session. The pre-game variables were assigned two different labels: T for trust and TW for trustworthiness. Subsequently, we numbered each variable. For trust, the variables ranged from T1 to T10, and for trustworthiness, the variables ranged from TW1 to TW8. We assigned the numbers based on the numbering in the online questionnaire. For the post-game labels, we used the same labels, and added the word post, to differentiate the findings from the pre-game findings.

From each of the contingency table, we computed the mean and standard deviation scores to assess the difference between the pre-game scores and the post-game scores, for each variable (dissimilarity matrix). The difference between the mean scores indicated whether there positive change (increase in the mean score), a negative change (decrease in the mean score) or no change at all.

Based on the findings, there was an increase in the PT in 4 variables within the trustworthiness subscale (TW4, TW6, TW7, TW8). The increase in TW4, TW7, and TW8 was marginal (0.1). TW6 was reported to have the highest increase (0.4). There was no change in PT in TW2. However, there was a slight decline in the standard deviation for TW2 (0.1). There was also a decline in PT for three variables (TW1, TW3, and TW5). The decline was marginal for TW3 and YW5 (0.1). The decline in PT for TW1 was the highest (0.3).

According to the initial findings, there was an increase in the PT in 3 variables within the trust subscale (T1, T2, and T4). None of the increases were marginal (0.3, 0.5 and 0.8). T4 was reported to have the highest increase (0.8). The standard deviations for the trust subscale were much higher than the trustworthiness subscale. The highest standard deviation for trust was 1.5, and for the trust, it was 1.1. There was a decline in PT for seven variables (T3, T5-T10). The decline was marginal for T3 only. The decline in PT for T8 and T10 were the highest (1.0).

The use of raw cell frequency to assess whether there was trust formation or not, can be misleading. From the raw cell frequencies (expressed as mean and standard deviation), T8 had the highest mean difference between the pre-game and post-game results (1.0) and standard deviation (1.5). In the non-parametric Chi-Square test for goodness-of-fit for the trust sub-scale, the results for T8 were not significant. Additionally, the trustworthy mean differences between the pre-game and post-game results were marginal compared to the trust sub-scale with much lower standard deviations. On the contrary, all the trustworthy Chi-Square test for goodness-of-fit results were significant.

Table D.3. Pre-Game and Post-Game Trustworthy Chi-Square Test Statistics

		TW1	TW2	TW3	TW4	TW5	TW6	TW7	TW8
PRE	Chi-Square	11,765[a]	25,000[b]	12,600[c]	13,086[d]	29,800[b]	21,114[b]	12,057[d]	17,200[d]
	df	1	3	1	2	3	3	2	2
	Asymp. Sig.	0,001	0,000	0,000	0,001	0,000	0,000	0,002	0,000
POST	Chi-Square	16.171[a]	24.314[b]	63.171[b]	14.629[a]	24.588[c]	43.971[b]	15.314[a]	31.771[a]
	df	2	3	3	2	3	3	2	2
	Asymp. Sig.	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
PRE-	a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 17,0.								
	b. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 8,8.								
	c. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 17,5.								
	d. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 11,7.								
POST	a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.7.								
	b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.8.								
	c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.5.								

Table D.4. Pre-Game and Post-Game Trust Chi-Square Test Statistics

		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
PRE	Chi-Square	32,000[a]	25,143[a]	12,600[b]	27,714[a]	6,571[a]	5,714[a]	11,588[c]	3,714[a]	7,143[a]	17,059[d]
	df	4	4	1	4	4	4	4	4	4	3
	Asymp. Sig.	0,000	0,000	0,000	0,000	0,160	0,222	0,021	0,446	0,129	0,001
POST	Chi-Square	23.029[a]	20.800[a]	57.686[b]	16.294[c]	18.647[d]	16.000[e]	36.857[e]	29.879[f]	23.647[g]	10.571[e]
	df	2	2	3	2	4	4	4	4	3	4
	Asymp. Sig.	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.000	0.000	0.032
PRE-GAME	a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 7,0.										
	b. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 17,5.										
	c. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 6,8.										
	d. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 8,5.										
POST-GAME	a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.7.										
	b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.8.										
	c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 11.3.										
	d. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.8.										
	e. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.0.										
	f. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.6.										
	g. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.5.										

From the raw cell frequencies (expressed as mean and standard deviation), T8 had the highest mean difference between the pre-game and post-game results (1.0) and standard deviation (1.5). In the non-parametric Chi-Square test for goodness-of-fit for the trust sub-scale, the results for T8 were not significant. Additionally, the trustworthy mean differences between the pre-game and post-game results were marginal compared to the trust sub-scale with much lower standard deviations. On the contrary, all the trustworthy Chi-Square test for goodness-of-fit results were significant. It appears that there are hidden attributes in the data that cannot be visualized with the use of raw cell frequencies, which emphasizes the need for further investigation. Also, based on the high standard deviations in the trust sub-scale, the respondents seem to measure more than one variable, that may not be known to the researchers. Therefore, we conducted an MDS to shed more light on whether there was trust formation.

The ALSCAL performed resulted in a dissimilarity matrix, and the chosen model was Euclidean distances with the minimum dimensionality of two, and the maximum dimensionality of two. The SPSS program computed the Euclidean distances between the scores. We chose a two-dimensional model to get one model with two dimensions for ease in the visualization of the conceptual map and interpretation. The maximum model iterations were 30.

The first pieces of information we analysed were the: (1) model stress; and the (2) stress and squared correlation (RSQ) in distances. They are both indicators of model efficiency. The model stress also called the 'phi' statistics, is the most important. The lower the stress, the better the model. The critical values to assess model quality are:

1. Stress (phi) *lower than* ***0.10***, it means that the model quality is *excellent*;
2. Stress (phi) *between than* ***0.10 and 0.20***, it means that the model quality is *good*; and
3. Stress (phi) *greater than* ***0.20***, it means that the model quality is *poor*.

SPSS computed two values, one proposed by Young (Young's S-stress formula 1) and the other proposed by Kruskal (Kruskal's stress formula 1). Young's S-stress value for the model is 0.0495, and it stopped at the 4th iteration because the S-stress improvement was less than 0.001. Because the value is lower than 0.10, our model is excellent. As for Kruskal's stress, the values were 0.068. Therefore, since both stress values are low and below 0.10, our model is of excellent quality.

After that, I assessed the RSQ value. The RSQ value for the model is 0.98748. Since the RSQ is above 0.95 and close to 1, it confirms that the model is of excellent quality. Table D.5. represents the clustering of the 36 trust and trustworthy observations based on the derived stimulus configuration from the Euclidean distance model into four clusters, under two dimensions.

Table D.5. Clustering of the 36 trust and trustworthy observations

Obs. Label	Question /Stimulus Coordinates	Pre-Game Component		Post-Game Component	
		1	2	1	2
TW1	1. Listen(ed) to my conscience	1.12	-0.34	0.89	0.09
TW2	2. Anticipate(d) the needs of others	0.71	-0.06	0.75	0.00
TW3	3. Respect(ed) others	1.17	-0.32	1.29	0.16
T1	4. Gets (got) along with most people	0.59	-0.56	1.15	0.26
TW4	5. Have always been (Was) completely fair to others	0.65	-0.22	0.89	0.20
TW5	6. Believe that laws (game rules) should be strictly enforced	0.88	0.00	0.91	0.09
T2	7. Have (had) a good word for everyone	0.56	-0.25	1.09	0.17
T3	8. Value(d) cooperation over competition	1.10	-0.32	1.17	0.22
TW6	9. Would never cheat on my taxes (never cheated)	0.45	-0.81	1.08	0.05
TW7	10. Follow(ed) through with my plans	0.62	-0.18	1.03	0.20
T4	11. Believe(d) that people (players) are (were) basically moral	-0.07	-0.04	1.02	0.22
TW8	12. Finish(ed) what I start (ed)	0.93	-0.18	1.23	0.09
T5	13. Filled with doubts about things (was filled with doubt)	-1.26	0.21	-2.36	0.34
T6	14. Feel short-changed in life (Felt short-changed)	-1.69	0.47	-2.18	-0.21
T7	15. Avoid contact with other(s) (players)	-1.59	1.11	-2.62	-0.50
T8	16. Believe that most people (players) would lie to get ahead	-0.90	0.78	-2.52	-0.59
T9	17. Find it hard to forgive others (players)	-1.18	1.24	-2.69	-0.38
T10	18. Believe that people (other players) seldom tell the whole story	-0.27	-0.02	-1.95	-0.92

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About the Author

Abby Muricho Onencan was born in Nairobi, Kenya, where she lived for a large part of her childhood. She later moved to Eldoret at the Moi University to study Bachelors of Law. After being admitted as an advocate of the High Court of Kenya in 2001. In October 2002 to October 2003, she undertook a Masters of Arts in Governance and Development. The MA thesis focused on Amartya Sen's and Martha Nussbaum's collaborative work on the capability approach and consequently won the 2003 Government of Belgium Development Price. In 2007, Abby received a Commonwealth Scholarship from the British Government, that enabled her to pursue a Master's of Science in Education for Sustainability. She completed her MSc degree at the London South Bank University (mainly distance learning), in 2010.

Abby Muricho Onencan began her career in 2001 as an Eligibility Officer of the United Nations High Commissioner for Refugees (UNHCR) and shortly after as a Program Manager and Legal Officer with the United Nations Development Programme (UNDP) seconded to the National Council of NGOs as a United Nations Volunteer (UNV). She was responsible for the overall management of the Regulatory Committee, a tribunal constituted under the laws of Kenya to resolve disputes within the Non-Governmental organizations and promote self-regulation. While at the National Council of NGOs, she formulated the 1995 NGO Code of Conduct and reduced the Regulatory Committee case backlog.

In May 2005, she joined The CRADLE, a child rights organization where she trained East African judges and law enforcement officers on trafficking in humans and provided technical assistance in child law reforms in Kenya. Later she got a UNDP consultancy, seconded at the Office of the President as a Transformative Leadership Capacity Development Programme Manager. She spearheaded the process of developing the Public Service Performance and Results Bill, 2007, its training curriculum and a prospectus for the "Results for Kenyans" programme. She also trained Public Service Officers on Performance Contracting regulations 2007 (these regulations won the 2007 United Nations

Public Service award).

At the end of 2007, she was engaged in a 16 million euros European Union poverty reduction project for the local government in Kenya. She was responsible for project technical and financial reporting for the Eastern Kenya region (11 Local Governments). Her main tasks were capacity development, monitoring and reporting. She mainly monitored water infrastructure projects within 11 local authorities in the central province, to ensure that they are well managed and sustainable. The project was successfully completed in 2010.

In October 2010, Abby became the Regional Manager of the Nile Basin Discourse (NBD). She managed a $4.5 million multi-country DFID project and a subsequent $1.5 million World Bank project (under the Cooperation in International Waters in Africa Programme), and reported to the donor and the NBD Board. She successfully coordinated the project activities of the NBD secretariat, two advocacy offices in Rwanda and Addis Ababa, Ethiopia and Eleven (11) National Chapters in the 11 Nile Basin Countries. She also successfully coordinated the implementation, monitoring and evaluation of the DFID project, until its final closure in 2013.

In April 2014, Abby was officially registered as a PhD candidate at Delft University of Technology. While conducting her PhD, she successfully completed the 3TU University Teacher Qualification in December 2015 and Certificate in International Water Law and the Law of Trans-boundary Aquifers in December 2016. She also supervised Master students from the Faculty of Civil Engineering and taught two courses (EPA 2933: Preparation for Master Thesis Course and EPA 7030: Interviewing Techniques). Her research position in the University has sharpened her analytical and research skills, enabled her to publish many scientific articles and enhanced her leadership and negotiation skills. She also learnt how to maintain creativity and initiative, in a fast-paced world.

Propositions

accompanying the dissertation

Institutional Change through Social Learning: Climate Change Policy Gaming in Kenya

by

Abby Muricho ONENCAN

1. The future of Social Learning lies in valuing and financially supporting interdisciplinary research, especially when conceptual disciplinary distance exists.
2. The critical change required to sustainably manage Nzoia and Nile Basin water resources, is not tangible nor technical, it is intangible and institutional.
3. Cooperation based on power is easier to achieve than cooperation based on trust, but is not sustainable (this dissertation).
4. Situation Awareness alone will not lead to action, actual stories of someone who experienced an unfamiliar situation will (this dissertation).
5. The watercourse should guide spatial planning and act as a structuring element for the revision of current land-use practices (this dissertation).
6. Endogenous institutional change will be too slow to address global water challenges.
7. The current PhD system is blind to diversity issues, leading to an unequal playing field for people from a different educational background.
8. The strongest predictor of PhD success is GRIT (long-term oriented perseverance) which is contrary to most PhD terms of reference (TORs) that focus on IQ.
9. Many Universities are full of research groups and few research teams.
10. Replacing the language of nationality with locality shifts focus to where real-life experiences occur.

These propositions are considered opposable and defendable and as such have been approved by the promotor Prof. Bartel Van de Walle.

ABOUT THIS RESEARCH

Research indicates that complex and uncertain societal problems cannot be addressed by technical solutions that rely solely on predictions. Institutions that exclusively rely on predictions, repeat the same actions, habits or practices (also known as routine), with little reflection on the impact of these technological solutions upon the socio-technical system. Although routine is beneficial for stability and continuity of any institution, it may stifle reflection and thus reduce any opportunity for change. Consequently, when an institution does not change, it cannot innovate nor adapt to changing circumstances.

Social learning (SL) has been proposed to catalyse institutional change. SL is a change in societal understanding, achieved through social interactions, which eventually gets situated within broader social units. In principle, SL holds a promise in addressing the problem of routinized, non-adaptive institutions. Nevertheless, there is limited evidence on whether SL does indeed lead to institutional change.

This PhD research uses policy gaming to assess whether SL can lead to institutional change in the Nzoia River Basin. The results indicate that SL has the potential to change routine-based institutions and generate adaptive capacity. The outcomes also show the need for the following profound institutional changes in Nzoia River Basin:

1. **Artefacts:** Replace current WRM structures with configurations that respect the river, and support the sustainable management of the drainage basin, as a whole.
2. **Values:** Value water more than spatial, agricultural and energy-production plans and make water the structuring element within the Nzoia River Basin. This means that any proposed laws, regulations, practices and norms that intend to utilize the scarce water resources unsustainably should not be supported.
3. **Underlying Assumptions:** Question underlying assumptions, and make transformations to existing laws, regulations, values, norms and actor-networks to build adaptive capacity.

ABOUT ME

Abby Muricho Onencan was born in Nairobi, Kenya and studied law at the Moi University, Eldoret and later undertook a Masters of Arts in Governance and Development. The MA thesis focused on Amartya Sen's and Martha Nussbaum's collaborative work on the capability approach and consequently won the Government of Belgium Development Price. She later received a Commonwealth Scholarship from the British Government, that enabled her to pursue a Master's of Science in Education for Sustainability. at the London South Bank University.

She began her career at UNHCR and shortly after at UNDP. At the end of 2007, she was engaged in a European Union poverty reduction project for the local government in Kenya. . In October 2010, Abby became the Regional Manager of the Nile Basin Discourse (NBD). She managed a $4.5 million multi-country DFID project and a subsequent $1.5 million World Bank project (under the Cooperation in International Waters in Africa Programme).

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