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This is the author's manuscript

Original Citation:

Availability:

This version is available <http://hdl.handle.net/2318/1790329> since 2021-06-22T00:27:10Z

Publisher:

University of Helsinki

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COMMUNITY AND INSTITUTIONAL PERSPECTIVES ON WATER MANAGEMENT AND ENVIRONMENTAL CHANGES IN THE TAITA HILLS

FINAL RESEARCH REPORT



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6.5.2014

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Summary

Water is probably the most important natural resource for both human beings and the environment. However, water resources are dependent on multiple environmental and social systems and thus are very sensitive to changes in those systems. With the rising global water demand, and decreasing sources, a dilemma arises for both water users and managers. As part of the TAITAWATER (Integrated land cover-climate-ecosystem process study for water management in East African highlands) project of the University of Helsinki, Finland, we have studied the water resources use and management in the Taita Hills, South-East Kenya. These hills form an important water tower providing water for the ecosystems and people living in the hills and the surrounding semi-dry savannah area. Currently, the water resources of the Taita Hills are declining, causing negative impacts on the livelihoods of the local people. This research has attempted to understand the current status of the water resources from the perspective of the local people and to analyse the driving forces behind the declining water resources. We have also mapped the roles of different stakeholders involved in use and management of water resources and the related ecosystems.

This document reports the methods and results of the field research that was conducted in the Taita Hills in the years 2013-2014. In this study, we used mainly participatory research methods, which we believe form the best way to involve the local communities and decision makers in the research, and to understand the local perceptions and knowledge concerning the natural resources, their use and management. Our study focused on Wundanyi and Mwatate river catchment areas. We gathered data using semi-structured interviews, targeting the local water users, community groups and different institutions involved in managing the water resources or the related ecosystems. We also organized two 'Water and Livelihoods' workshops, one in each catchment. In these workshops, the community groups were asked to draw maps of their home areas and indicate the water sources, water infrastructure, forests and other important landscape features and the problems related to these areas. The groups also drew timelines, which depicted the historical events that have affected the water resources and livelihoods in the areas. The transect walks, participant observation, questionnaires and review of the government documents and other relevant material were also done. Qualitative content analysis supported with some cartographic and statistical methods, were the principal methods for analysing the data. The findings were validated in a concluding workshops organized in February 2014.

The main results of the institutional analysis reveal a complex interaction between the many stakeholders involved in the local water resources governance and management. Government and other institutions are not always able to fulfil the roles assigned to them by law due to local realities and lack of resources. The interaction between the levels of governance is not always adequate. The reforms in the water sector aim to transfer more responsibilities to the locally operating water user and management groups. However, in most cases the local level actors struggle to get financial or technical support from the higher levels. This leads to problems in local level water management and thus contributes to deterioration of the water sources and related ecosystems.

According to the local community, there has been a noticeable reduction in water quantities in the Taita Hills at least over the last 50 years. The water levels in many springs, rivers and streams have gone down and some have even dried up completely. Since the communities depend mainly on local natural sources for their domestic and agricultural water needs, water scarcity has become one of the biggest challenges people currently face. Water scarcity affects agricultural production causing poor crop and livestock yields. It has also reduced horticultural production, which has been a sizeable livelihood source for smallholder farmers in the area. People living in downstream areas suffer more from the deterioration of the water resources, because people in the upstream areas divert the diminishing resources to their fields. Water quality has also deteriorated. Local people believe that this is related to the increased use of agrochemicals and point sources of solid and liquid waste from urban centres.

Many people believe that population growth and the increasing water demand are the main reasons for decreasing water quantities. Many also blame the cutting down of indigenous forests and planting of water

consuming *eucalyptus* trees, in the area. However, we would like to suggest that the main driving forces behind the changes date back to the demarcation of land in the 1960's, which forced people to move to new areas and cut down forests in order to continue their earlier livelihoods. This was also associated with land privatization, which limited communal lands and thus, people's access to water resources. Even nowadays this is causing a lot of problems for the river bank management and spring protection, because people cultivate up to water courses on their land, thinking they belong to them. However, according to law, several meters wide should be left between the river or spring and the field. Moreover, the water belongs to the government and is therefore a common resource that everyone should have a right to use. However, the local institutions do not normally have enough authority to enforce the protective laws, as the power of private land ownership is so strong.

The institutions have responded to the changes in environment in various ways. Monitoring of streams to check for cases of water diversion for irrigation is done to ensure people downstream get water. Tree planting has also been widely adopted and institutions are undertaking massive tree planting campaigns, encouraging local people to establish tree nurseries and plant trees to protect water catchments. Several institutions also carry out interventions related to soil and water conservation including constructing structures that control erosion and maintain soil moisture for longer periods. Other interventions by institutions include education and awareness programs about sustainable farming techniques and alternative livelihoods that demand less land and water.

The local people had many suggestions on what should be done in order to improve the water quantity and quality in the area. They suggested that the *eucalyptus* should be replaced gradually with indigenous species. Also the waste water management should be improved. People should also make more use of the rain water by collecting it to tanks or other catchment structures. The WRUAs should also be empowered to control the various water uses and ensure equity as well as take a more active role in catchment protection and local water conflict resolution. Community capacity building on the water issues is also important in order to change people's attitudes towards the protection of water resources and related ecosystems. However, also the government departments and NGOs should integrate their policies on priority actions to be taken. One big problem is the unclear land ownership, which should be resolved in both policy and practical level. The borders of indigenous forests, wetlands, springs and riverines should be clearly marked and encroachment stopped.

We also suggest that genuine community participation should be part of the management of water and related ecosystems. Participation should not mean transferring all the responsibility to the local communities or using them as a free work force. Instead it should be cooperative and mutually respectful. The higher level institutions should take responsibility to empower the local level groups and provide them enough technical and financial support. The local knowledge of people on the natural resources and their changes should be integrated into scientific and technical knowledge that the trained officers possess in order to adjust that knowledge into local circumstances. We also hope that the participatory methods used in this research, like participatory mapping and timelines, will provide new ideas to water management planning in the Taita Hills. For example, the water problem map could be used as a basis for planning and monitoring protective actions and also infrastructure development to most water scarce areas. Participatory methods could also enhance cooperation between stakeholders and assist in finding shared solutions to problems affecting the commons.

By widely disseminating the findings, this research aims to enhance local capacities to address the environmental changes, and their socio-environmental consequences, especially with regard to water-related ecosystems. In addition, this research hopes to provide opportunities to increase further dialogues among all stakeholders involved in water use or management, as well as in the wider field of natural resource management, both locally and regionally. We believe this report is timely and hope that it will contribute to improved water management in the Taita Hills, as the Taita-Taveta County Government begins working on its development strategies, in line with Kenya's new Constitution, Vision 2030 and other national and international development objectives.

Acknowledgements

We would like to thank all the local people, officers and community groups that shared their valuable information with us during the interviews and workshops. We are also grateful to Mr. Mwadime Mjomba who assisted us in the field work and translated the interviews when it was needed. We would also like to thank Dawson Mwanyumba from TTWF, and Darius Mwambala Kimuzi and Granton Righa from the Taita Research Station who helped us in the workshops. We thank the TAITAWATER project and the Academy of Finland for providing funding for the research. We are also grateful for all the Taita Research Station staff who supported us during our field work.

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List of abbreviations

ASDS	Agricultural Sector Development Strategy	KWS	Kenya Wildlife Service
ATC	Agricultural Training Centre	MCG	Micro-Catchment Group
CAAC	Catchment Area Advisory Committee	MoA	Ministry of Agriculture
CBO	Community Based Organization	MoE	Ministry of Education
CDC	County Development Committee	MoH	Ministry of Health
CDF	Constituency Development Fund	MoLSS	Ministry of Labor, Social Security and Services
CEC	County Environment Committee	MoWI	Ministry of Water and Irrigation
CEO	County Environment Office	NDMA	National Drought Management Authority
CHW	Community Health Workers	NEMA	National Environment Management Authority
ClrP	Community Irrigation Projects	NGO	Non-governmental organization
CWSB	Coast Water Services Board	NLC	National Land Commission
CWP	Community Water Project	NWQMS	National Water Quality Management Strategy
DaBiCo	Dawida Biodiversity Conservation project	NWRMS	National Water Resources Management Strategy
DAC CWSB	District Area Coordinator for Coast Water Services Board	NWSS	National Water Services Strategy
DANIDA	Danish Development Aid	PES	Payment for Ecosystem Services
DAO	District Agricultural Office	PGIS	Participatory Geo-information Systems
DC	District Commissioner	REDD+	Reducing Emissions from Deforestation and Degradation
DDO	District Development Office	SCMP	Sub-Catchment Management Plan
DDC	District Development Committee	SAP	Service Provision Agreement
DEC	District Environment Committee	SSP	Small Service Providers
DFO	District Forest Office	TAVEVO	Taita-Taveta Water and Sewerage company
DFIO	District Fisheries Office	TEI	Taita Environment Initiative
DIO	District Irrigation Office	TTWF	Taita-Taveta Wildlife Forum
DLRO	District Land Reclamation Office	UN	United Nations
DLO	District Livestock Office	VDC	Village Development Committee
DO	District Officer	VEC	Village Environment Committee
DPHO	District Public Health Office	WSRB	Water Services Regulatory Board
DPSIR	Drivers-Pressures-State-Impacts-Responses	WFP	World Food Programme
DSG	District Steering Group	WRMA	Water Resource Management Authority
EIA	Environmental Impact Assessment	WRUA	Water Resources Users Association
EMCA	Environment Management and Coordination Act	WSB	Water Service Board
ES	Ecosystem services	WSP	Water Service Providers
FBO	Faith Based Organization	WSTF	Water Services Trust Fund
GPS	Global Positioning System	WRUA	Water Resources Users Associations
KAPSLM	Kenya Agricultural Productivity and Soil and Land Management Program	WV	World Vision
KCDP	Kenya Coastal Development Project	WW	Wildlife Works
LCB	Land Control Board		
KFS	Kenya Forest Service		

1 Introduction

The Taita Hills have been covered by cloud and rainforests for tens of millions of years (Rogo and Oguge, 2000). The Hills and its forests are a head water area for many springs, streams and rivers, which provide water for agricultural and household use in the hills and surrounding lowlands. However overuse of natural resources and consequent environmental degradation is placing a lot of pressure on water resources. For example, during the last 200 years and especially since the 1960s, the indigenous forest cover has decreased significantly due to population increase, expansion of intensive agriculture, plantation of exotic tree species and building of roads (Pellikka et al., 2009).

Concerned by the rising challenges facing water resources in Taita Hills, the University of Helsinki project TAITAWATER: '*Integrated land cover-climate-ecosystem process study for water management in East African highlands*', proposed a study of the recent changes and interdependences between water resource uses and environmental changes in the catchments of the Taita Hills. The project aimed to create new knowledge on human practices and their impacts on the local hydrology and ecosystems, and on potentials for enhancing adaptive capacities, in order to reduce both human and environmental vulnerabilities and to promote sustainable community-based natural resource management in the target areas.

The study was conducted by an interdisciplinary research team consisting of one PhD and three MSc students from the University of Helsinki, Finland, University of Jyväskylä, Finland and Kenyatta University, Kenya; their supervisor from the University of Helsinki and two research assistants from the Taita Research Station in Wundanyi. The researchers used several methods to investigate the issues facing water resources and their management in the Mwatate and Wundanyi catchment areas. Most importantly, the researchers held many discussions and interviews with both community members and institutions involved in water use or management in the two catchment areas. This research aimed to come up with suggestions based on local knowledge, which can be used to create solutions for the improvement of the management of water resources in the area.

The specific objectives of the study were:

1. To study the water and environmental changes through the local perspectives that is commonly declared in IWRM (Integrated Water Resource Management) principles but rarely pursued in practice.
2. To identify and map changes related to water resources.
3. To understand how these changes have modified provision of ecosystem services related to water and access to water for all.
4. To understand the historical causes and main normative factors.
5. To understand the roles of different institutions and community groups, their responses to the water conservation and management problems, and the challenges they are facing.
6. To discuss some solutions proposed by the involved stakeholders.
7. To evaluate the way ahead for cooperation at the water catchment scale.

This report presents the final results of this study that was conducted between January 2013 and February 2014 and that involved over 200 local community and institutional stakeholders. This research contributes to the project and other water related research by addressing the social aspects of the water related issues. It is part of the integrated approach of the whole TAITAWATER project and the main channel to let the locals explain their side of the story.

2 Participatory Research Methods

2.1 How did we collect the data?

The research team used several methods for data collection in Wundanyi and Mwatate catchments. Review of scientific literature and technical reports was necessary to gain basic information and to prepare for the participatory work. After studying the background, valuable information about water use practices, declining water resources and management strategies were collected from local community and institutional representatives through interviews, transect walks, and from workshops organised for members of various stakeholder groups involved in use or management of water. An ethnographic approach was used in the study, meaning that the researchers took an interest in the experiences and perceptions of peoples' and institutions' everyday lives, for instance on the effects of decreasing water levels to peoples' livelihoods and institutions' management strategies. When local knowledge and perspectives is the core of the research, participatory methods are required. The use of participatory methods enable the participants to have a voice and sense of engagement about the issues under research, in this way avoiding exploiting people for information only. In this research the participants were involved in producing the data as well as validating it in the form of reports and seminars. The methods used in this study are summarized in Table 1. The following text describes the methods in more detail.

Table 1: Data gathering methods.

Method/tool	Aim	Who participated
Scientific and technical literature review	Gaining understanding of theoretical issues and earlier scientific research done on water resources and their management. Understanding the institutional organization and legislation governing water resource management in Kenya.	Researchers
Semi-structured interviews	Understanding the context of the local people's everyday lives in terms of society, economics and politics. Understanding the roles of different institutions and community groups and the issues influencing management of water resources and water supply in the area.	Local farmers, town-dwellers, hotel staff and small entrepreneurs in Wundanyi and Mwatate catchments. Community groups, local and regional Government Departments, Water Management Institutions, Provincial Administration and NGOs operating within study catchments.
Workshops/focus groups	2013: Gathering different stakeholders in a common discussion about the water issues. 2014: Validating the research findings	2013: Community groups involved in water provisioning, environmental conservation, forestry, agriculture and fish farming. 2014: Community groups and local and regional Government Departments, Water Management Institutions, Provincial Administration and NGOs operating within study catchments.
Participatory mapping	Locating water points, land uses, water infrastructure and water problem areas.	Community groups that were invited to the workshop.
Time line	Getting an insight into local history and perceptions about main drivers of change in water availability and management.	Community groups that were invited to the workshop.
Transect walks	Validating the sketch maps with GPS-points and obtaining further information about the study area and changes.	An expert and people we met along the way.
Participant observation	Getting better understanding of data we were collecting (a continuous method).	Researchers
Questionnaires	Understanding how institutions and community groups perceive and value different water-related ecosystem services	Community groups, local and regional Government Departments, Water Management Institutions, Provincial Administration and NGOs operating within the study catchments.

2.1.1 Scientific and technical literature review

Scientific articles and literature on water resources and water management theory were read before and then continuously throughout the project, in order to gather information and attach the study to the earlier research and overall context. Government and institutional documents, such as the legislative Acts and sector strategy reports that were available in the Internet or were retrieved from the interviewed officers were read in order to gain an understanding of the water and environmental governance structure, the roles of the different actors, and normative or policy responses provided by the institutions. Information from the documents was supplemented with interviewing the relevant institutional representatives.

2.1.2 Semi-structured interviews

Household, hotel staff and small entrepreneur interviews

In total 82 household interviews were conducted in the two catchments in 2013. The respondents were selected randomly from different areas of the catchments. The majority of the interviewees were farmers, who form the largest group of water users in the study area (Table 2). We also interviewed town dwellers renting rooms or apartments in rural centres. The third group was formed by small entrepreneurs such as shop keepers, carpenters and a few pump attendants working at local petrol stations. We also visited hospitals and smaller health centres. Respondents were aged between 18 and around 75 and some of the older respondents were not sure about their age (Table 3). In Wundanyi, half of the respondents were men and half women, while in Mwatate approximately two thirds were women and one third was men (Table 4). The aim was to interview the same number of women and men, but in Mwatate the men were harder to reach since they were mostly working farther away from their home, while in Wundanyi they worked on a farm close to their houses. The lowlands of Mwatate catchment are much dryer, compared to Wundanyi and the fields are rarely next to the house.

The interviews were done in English whenever it was possible, but some of the respondents spoke only Taita language or Kiswahili and in those cases a local interpreter, well trusted by the community and researchers, translated their speech for us. In many interviews, a mix of English and the local language was used. Most people, who were speaking their own mother tongue, were clearly expressing themselves more freely than those who spoke English. While interpretation can always miss some nuances of expressed information, the fact that the interpreter is well trusted gives little room for misinterpretation.

All the interview sessions began with introducing the research topic to the respondents and asking for permission to record the interview. After the background questions, the informants were asked about the water sources they use, the problems and changes they have experienced with water quantity and quality, their livelihoods, their perceptions on the causes of environmental changes and their opinions about the water management in their living area. What often happened in what was supposed to be an individual interview was that other family members or neighbours suddenly joined the conversation. Sometimes the interview felt more like a focus group discussion, which in fact gave more information of the issues.

The household interviews made in 2013 were complemented with shorter interviews conducted in February 2014, during which 20 interviews were carried out in Mwatate catchment and 10 interviews in Wundanyi catchment. These interviews targeted only women. The main aim of these interviews was to find out how large a share of their monthly income families spend on water. In addition, women were asked about their migration history. However the results of that study are not included in this report.

Table 2. Stakeholders interviewed in 2013.

Group	Wundanyi	Mwatate
Farmers	36	21
Town dweller	4	5
Hotel staff	1	2
Entrepreneurs	6	2
Hospital	2	2
Prison	1	0
Total	50	32

Table 3. Age distribution of the household, hotel staff and small entrepreneur interviews in 2013.

Age group	Wundanyi	Mwatate
18-30	7	6
31-40	11	8
41-50	15	6
51-60	6	5
61-70	8	5
71-80	3	2
Total	50	32

Table 4. Gender division of the household interviews in 2013.

Gender	Wundanyi	Mwatate
Female	25	20
Male	25	12
Total	50	32

Institutional / expert interviews and questionnaires

Different institutions and other informants have the mandate to address local environmental issues and regulate the use of natural resources including water. Thus their priorities and strategic views as well as the political context they operate in inevitably affect the management of these resources. Therefore for this component of the study, informants were selected from different local and some regional government departments that work in sectors which directly or indirectly influence management of water and the related Ecosystem Services (ES) in the Taita Hills (Table 5).

The interviews were done in English whenever it was possible, but some of the respondents (like community groups) spoke only Kitaita or Kiswahili and in those cases a local interpreter translated their speech for us. In some interviews, a mix of English and the local language was used. Most people, who were speaking their own mother tongue, were clearly expressing themselves more freely than those who spoke English. On the other hand, translation of the local language by the interpreter may have led to some loss of information. However, this can be considered minor.

All the interview sessions began with introducing the research topic to the respondents and asking for permission to record the interview. After some background questions, the informants were asked about their tasks in general and about their roles regarding the management of water and land, the problems and changes they have observed or experienced with water quantity and quality as well as land resources, their

perceptions on the causes of environmental changes and their opinions about the water management in their area of jurisdiction.

In addition, 45 structured questionnaires that focused on valuation of water related ES relevant to catchment management were filled by representatives of local institutions and community groups (Table 6). In these questionnaires, respondents were asked to state their preference of one ES over the other. Our assumption was that non-monetary valuation can shape management decisions as it shows the resource managers' preferences for the availability and maintenance of their valued ES.

Table 5: In total 72 semi-structured interviews were conducted with the experts / institutions in the two catchments.

Respondent category	Wundanyi	Mwatate	Both Wundanyi and Mwatate	Regional and National
Government departments and agencies	4	7	11	7
Provincial administration	1	1	1	
Village elders	3	4		
Chiefs	3	5		
WRUAs	2	2		
Non-Governmental Organizations (NGOs)	1	1	1	
Water projects	4	5*		
Other Community Based Organizations (CBOs)	1	1	1	
Companies (Public and Private)		3	2	
Other experts				1
Total interviews conducted	72			

*Three interviews were done in 2014

Table 6. Questionnaires filled by respondents in different categories.

Respondent category	Wundanyi	Mwatate
Government departments	10	6
Water projects	5	2
Village elders	5	5
Chiefs	3	2
WRUAs	1*	2**
NGOs/companies/other	1	3

*Questionnaire filled by 1 group with 5 members

**Questionnaire filled by 2 groups with 4 and 8 members

2.1.3 Workshops

The workshops organized in 2013 contained group discussions, timeline drawing and participatory mapping. The aim was to create a platform for discussion among the locals with possibly differing opinions on how the water resources should be managed. Two workshops called “Water and Livelihoods” were organised in Wundanyi and Mwatate catchments. They resulted in maps from each group, audio and video recorded material from the presentations and discussions, and timelines.

Participants for the workshops were invited from various activity groups representing either resource management groups or different uses of water and related ecosystems (see Annex 2 for groups represented in the workshops). In the workshop the participants were then divided into groups of 3 to 9 people, which were formed according to their villages of residence. Formation of groups was done in this way based on the assumption that group members are familiar with their own local areas and would therefore easily identify the important features and issues in their respective areas. This was expected to make discussions easier and less prone to conflicts (e.g., between upstream and downstream water users). Five groups were created in the workshop held in Wundanyi (Fig. 1).

1. Wasinyi / Kitukunyi
2. Wesu / Yale
3. Shate / Mbirwa
4. Mogho / Sungululu
5. Sangenyi

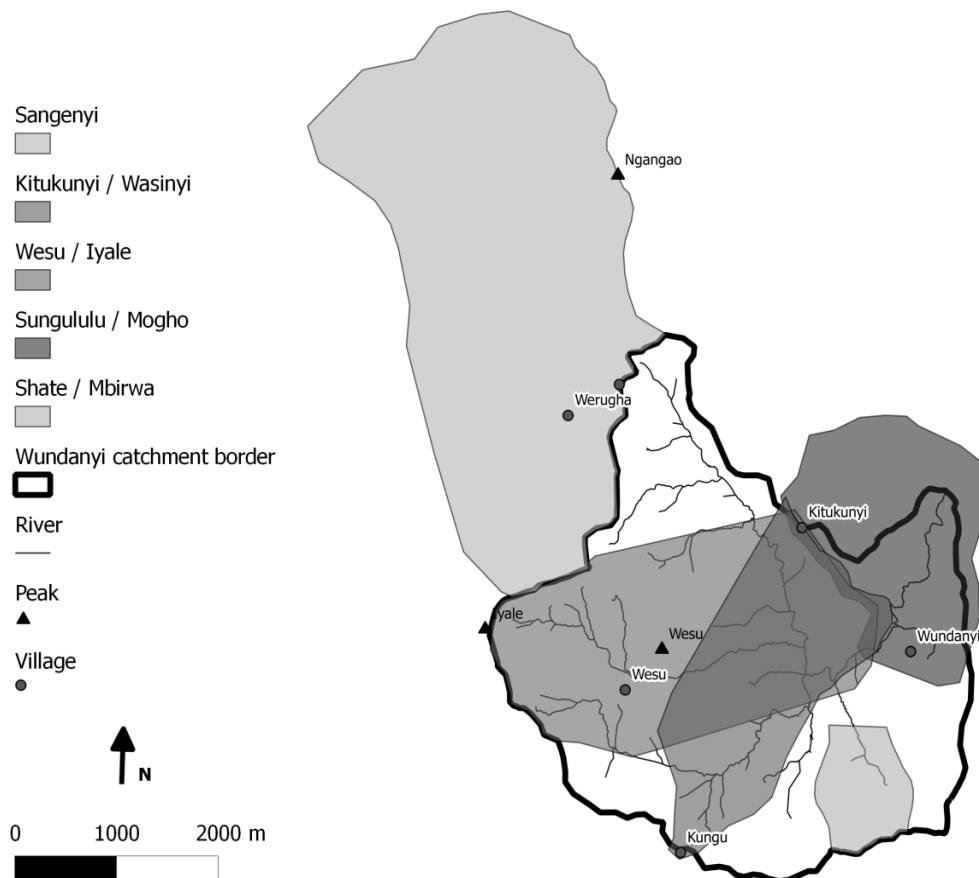


Figure 1. Wundanyi workshop group areas.

Four working groups were created in the Mwatate workshop (Fig. 2).

1. Mwatate/Mwachabo
2. Kidaya/Ngerenyi
3. Chawia/Wusi
4. Kishamba/Modambogho

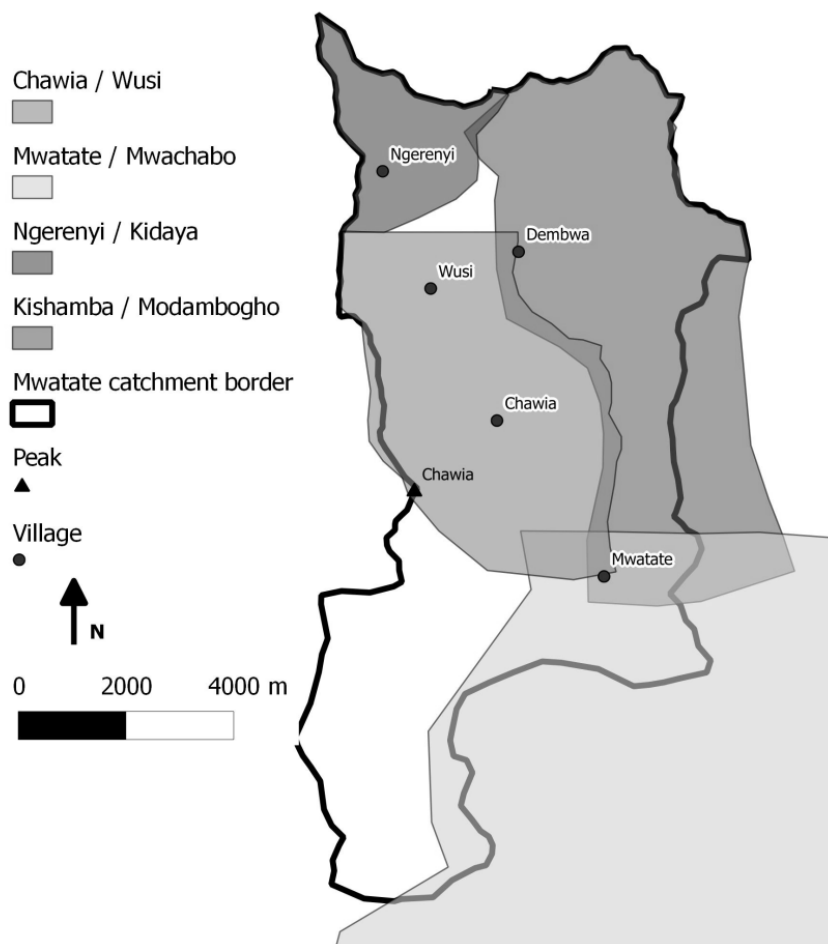


Figure 2. Mwatate workshop group areas.

The groups consisted of people from the same or neighbouring villages but did not necessarily represent the same activity group. The idea was to bring together people from various activities in order to understand the issues affecting the water resources in both river catchments and to establish how solutions for the problems could be designed in a manner that would be beneficial for everyone concerned. Each group had a facilitator (a researcher) and an interpreter to guide the exercises. A chairman and a secretary were also elected to represent each group. The groups finalized two exercises, which are described briefly below.

Exercise 1. Participatory mapping

In the first activity, participants from each group created a map together of their home area, with emphasis on water points, rivers and forests. Each group had a blank sheet of paper and markers in different colours. The secretary in each group drew the map according to what the other group members discussed. The groups began by drawing the roads, rivers, and main buildings. After that, indigenous and exotic forests, springs, dams, cultivated areas, fish ponds, water tanks and pipes were marked. When the map was completed with different land uses, problematic issues were written on post-its, which were attached to the map on the places where those particular issues occurred.

Exercise 2. Timeline

The second activity involved drawing a timeline outlining the most important events that have had impact on the water resources or on livelihoods of people in the Taita Hills within a time span from 1900 to the present. Also, positive and negative impacts of these events were indicated. The aim of this activity was to understand local peoples' perceptions on the changes that have occurred in land use and water resources.

People remember things differently and this exercise was a way of creating the big picture of the events that might have led to certain issues.

Group presentations and end discussion

After the exercises, one person from each group presented the map and the timeline they had created together, to all participants in the workshop. Through these presentations it was expected that discussions would be stimulated and participants would learn from each other. Some of the presentations were given in Kitaita, some in Kiswahili and some in English. All presentations were recorded in audio and video and when necessary, translated into English for the foreign researchers.

At the end of the workshop, the first two activities were summarised in a final debate. The participants lively discussed the possible solutions to the issues affecting water resources in the area. It was important for the participants to share what they had learned from the workshop activities and also to get to know more about the people who live in the neighbouring villages and understand their interests. Therefore the workshop created a platform for the water users to understand each other's needs and their required roles and actions.

Concluding workshops 2014

In February 2014, concluding workshops were organized both in Mwatate and Wundanyi catchments. The aim of the workshops was to validate the analyses that were done after the field work period of 2013. The aim was also to bring the community members and different institutional representatives to the same place to discuss the issues related to water resource management in the Taita Hills. Before the workshops, drafts of this final report were distributed to selected commentators who were asked to share their thoughts regarding the report and the research in the workshops. The research findings were also presented by the researchers at the workshops and after the presentations everybody in the audience had a chance to take part in the general discussion, ask questions and suggest changes. The participants were also able to write their suggestions and thoughts on separate discussion and feedback forms that were given to them in the beginning of the workshops and collected afterwards. The outcomes of those workshops are included into this report.

2.1.4 Transect walks

After the workshops of 2013, transect walks were done, whereby the research team went by foot to the most important water points mentioned in the workshop to be able to locate them on the map by using a GPS device. Transect walks involved walking through the study area with a local guide, observing, photographing, asking questions and listening. In this case the transect walks took us through the catchments, focusing on water points and other important points that had been marked during the participatory mapping sessions.

Transect walks serve as a complementary method in order to validate the maps created by the locals in the participatory mapping sessions at the workshops. We were able to get the coordinates of the places mentioned in the workshops by carrying a GPS-device on the tour. The saved GPS-points allow participatory maps to be digitized. Also, additional data of the points was gained through short informal interviews with people we met on the way as well as through observation. There was always at least one local person with us who knew the area well, and who was able to contribute by telling his story of why and how the water resources have been declining during his/her lifetime.

2.2 How did we organize the data?

After the interviews and workshop the recorded data were transcribed into text form by the researchers. This material was then used for further analyzing the water resources and their management in the study areas. The analysis methods are described in Table 7.

Table 5: Methods for analysing the data

Method/tool	Aim
Content analysis	To categorise the textual material from transcribed interviews.
Institutional mapping and interpretation of the legal structure	To map or outline the institutions involved in water management and understanding the relevant regulations.
SPSS	To obtain statistics on the water users.
Historical review	To historically identify the major social and environmental changes, using timelines.
PGIS	To digitalise and visualise the locals perception on a map.
Ecosystem service (ES) analysis	Statistical analysis of the ES value survey data using Microsoft Excel.

2.2.1 Content analysis

Content analysis is used for analysing textual data and to pick out the most relevant theme. Content analysis allows for a more in-depth and qualitative understanding of the various viewpoints and experiences of the interviewees. In this research, all the transcribed interviews were coded by highlighting key words in the interviews. After that, the found themes were organised in an Excel-sheet that helped us in finding the most and least common replies in the interviews. For instance, the explanations for environmental changes in the area could easily be compared through this method. The content analysis was the primary method for analysing the interviews.

Regarding the household interviews, differences between the two catchments, Wundanyi and Mwatate, were compared. In the case of expert interviews, the different views were collected into themes and then compared and synthesized into a coherent explanation.

2.2.2 Institutional mapping

Institutional mapping is a data-organizing exercise that aims to analyze or “map” the social space i.e., the institutional environment in which natural resource management practices take place. The mapping exercise first included a stakeholder analysis to identify the specific organizations and individuals (see Annex 1 for the full list of participants) that are involved in the management of water in the study area. This was done based on the document review as well as based on the interviews carried out with local institutions. During the mapping process the roles of formal institutions and organizations related directly to water governance and management, such as the legal frameworks, government departments, the public administration as well as Non-Governmental Organizations (NGOs), Community Based Organizations (CBOs) and representatives of private sector were outlined. The institutional mapping was done similarly to content analysis by collecting recounts of relevant institutions and their roles in water management from transcribed interviews and then after verifying with relevant documents, they were arranged into a coherent visual and textual form.

2.2.3 SPSS

Statistics of some of the answers in the interviews were calculated using IBM SPSS Statistics software. Average household size and access to water (how many have a tap in their household) are examples of what was calculated. The resulting percentages were used to supplement the qualitative content analysis of the interview data. In this report, the percentages are attached to the part 3.3, which describes the local perspectives on water problems.

2.2.4 Historical review

The timelines contain information on important events from the beginning of 1900 up until present. The information from these timelines was analyzed to summarize the key events and this way produce a historical review. The timelines produced in the Mwatate workshop also contained positive and negative impacts on the community. The historical review provides another method for the locals' perception on the water availability and accessibility to be presented clearly. Also, the explanations for the environmental changes became visible here. There were some minor contradictions when comparing the timelines but the general process of the events, as well as how the processes move from one area to another, could clearly be understood.

2.2.5 Participatory geo-information systems (PGIS)

In Wundanyi and Mwatate workshops, community members created sketch maps of their living areas. Each map had a unique composition regarding the choice of colours, symbols, scale and orientation. Even though the workshops were focusing on water, groups also presented some familiar landmarks, such as churches and schools, on their maps. Some of the group members were clearly familiar with Western convention of map making from before and thus the orientation of some of the maps followed the style of cartographic practice of locating South to the lower part of the map and North to the upper part. However, some groups oriented their maps either facing downhill or uphill regardless of the compass points, which is a more natural way of orienting oneself in a mountainous landscape.

In Figure 3, an example of a sketch map drawn by Iyale/Wesu group in Wundanyi workshop is shown. Each map contained a lot of information about the water sources, water structures, land uses, routes and place names. All these objects could be digitised using different map symbols. Figure 4 shows a digitised version of the Iyale/Wesu sketch map.

The GPS points collected on transect walks were combined with the data from the sketch maps. Some locations were also checked from the topographical maps (1:50 000) and aerial photographs taken in January 2012 and those available in Google Earth. The aerial photographs were useful for example for locating the fish ponds (Fig. 5). The catchment borders were drawn based on the contour lines of the topographical maps. Finally, all the spatially corrected and digitised data were combined to single catchment maps in Quantum GIS software. In Wundanyi workshop, a group from the neighbouring Sangenyi area was also present and therefore this area was added to the map. The background land cover data was produced by generalising data from an earlier research made in the study area by Clark and Pellikka (2009). It shows the distribution of the remaining forests in the catchments. The river channels were not part of the previous land cover data, but were added to the maps based on the participatory mapping, transect walks and interpretation of aerial photography. The river channels are relatively narrow (tens of centimetres to 2-3m) in reality and the thickness of them is not in right scale on the maps. It must be noted that the maps are not comprehensive and that there are probably other water sources, tanks, taps and other objects in the catchments that we were not able to reach and thus are not presented on the maps.

The participatory GIS was tested as a possible tool for transferring local knowledge to the decision-makers in water management planning. Otherwise, the value of the sketch maps created by the community groups

might be dismissed by other scientist and government officials. The purpose of the PGIS is for the maps to work as a matching point for technocrats and the community members.

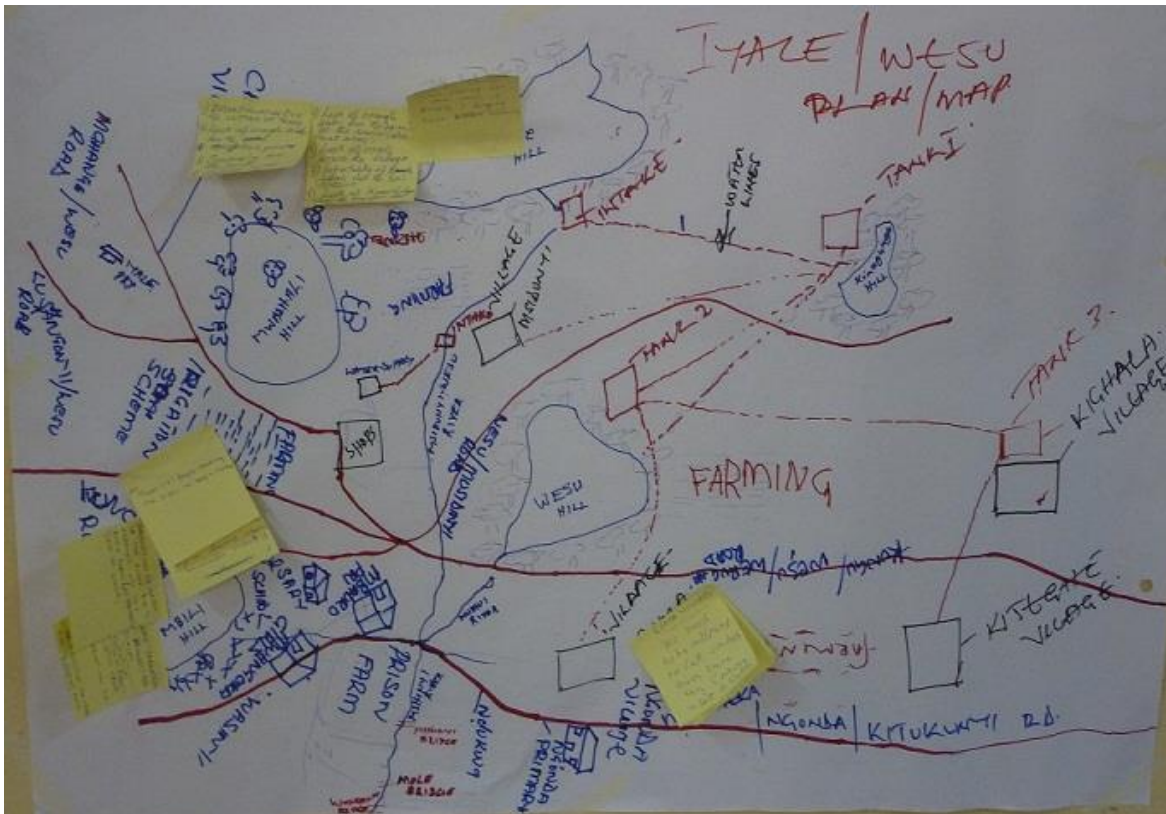


Figure 3. Sketch map of the Iyale/Wesu area made in Wundanyi workshop.

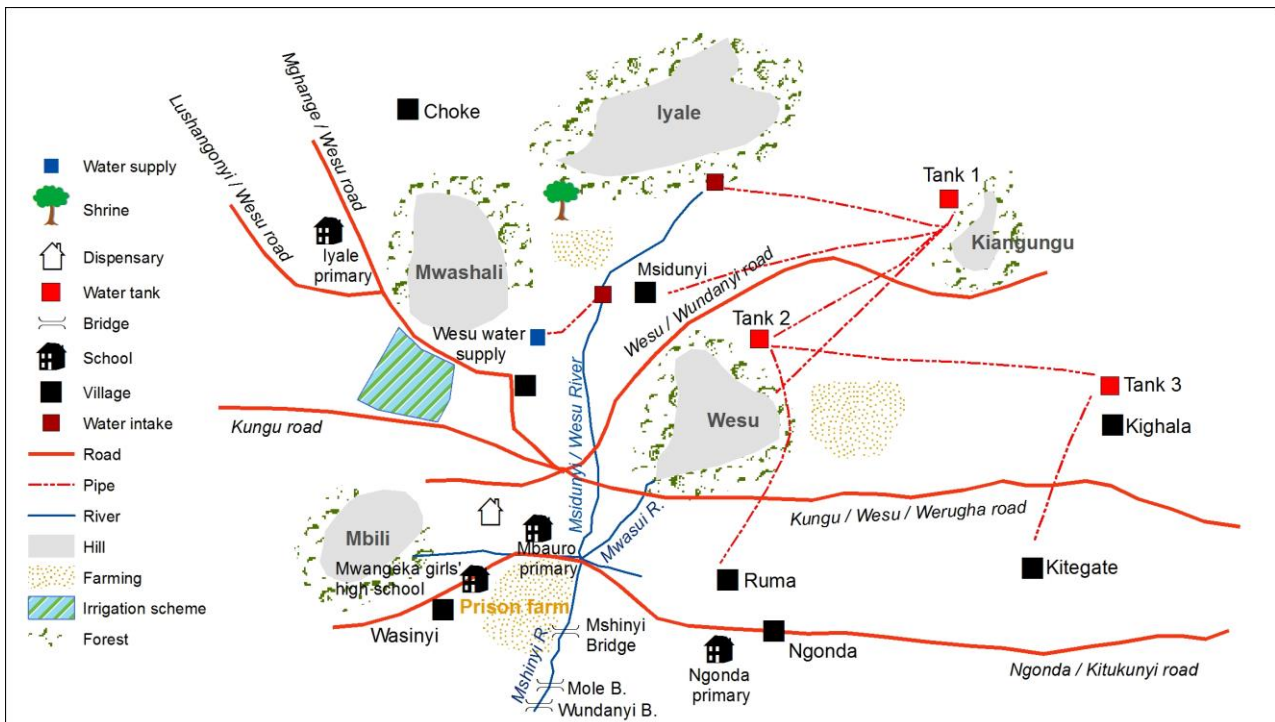


Figure 4. Digitized version of the Iyale/Wesu map.



Figure 5. Fish ponds in Mbirwa valley in Wundanyi catchment

3 What did we get as results?

In this section, we describe the results of our study. We start by defining the water governance structure and different stakeholders that are involved in the water resources management. Then we move on to look at water as an ecosystem service and see how different institutions and community groups value water-related ecosystem services. Next we present the current state of the water resources followed by the analysis of the causes of the environmental and water resource degradation. We also discuss how the different institutions have responded to the water problems, what actions they have taken and what challenges they face in environmental management. Finally, we present some solutions that local people have suggested for the improvement of the water resources management and add some ideas that we have got from this research.

3.1 Governance and management of water and related ecosystems in the study area

In order to understand the local situation of water related changes and management practices, it is vital to outline the institutional set-up in which these changes take place. A part of the research therefore included institutional mapping of the governance structures of water and related ecosystems in the study area, taking into consideration the various levels of governance from village up to national and even international level. The results are described in this section beginning with presenting the institutional map of the involved institutions, the relevant legal frameworks and finally the roles of locally relevant governance and management institutions. However, these descriptions should not be understood as exhaustive, due to the limitations of the research in terms of time and space, as well as the fact that *all institutional arrangements are dynamic in nature*.

3.1.1 Institutional map of governance and management institutions in the study area

The institutions governing and managing water and related ecosystems in the study area are mapped according to their governance levels¹ in Figure 6. The institutions in the figure have been identified through interviews with the various organizations, but not all of the ones visible in the figure have been interviewed

¹However, for some of the institutions like parastatals (WRMA, KFS, KWS) the areas of jurisdiction do not limit to administrative units, but they cover natural areas e.g. river catchment areas, forested areas and national parks, respectively.

(see list of interviewees in Annex 1). The vertical arrows represent the hierarchies of various sectors among their own structures. In the case when the other governance levels are not relevant for this case, the arrow indicates a direct link to the local level, meaning that the organization/institution operates in the study area but is connected to wider arenas of governance in terms of policies etc. However, it should be noted that these are also simplified and do not visualize the actual power relations or roles between the institutions. Due to lack of space, the horizontal relations between the various stakeholders have not been indicated; however, some of the connections are presented when describing their roles. The abbreviations are explained inside the text and in the beginning of the report under the “List of Abbreviations”. The roles of each institution regarding the governance and management of water and related ecosystems are further explained in the next section.

It is visible from the institutional map that the institutional set-up of water governance and management of the study area is quite complex, having various actors from up to international level operating in the local setting. In addition, the old and new governance structures are mingled together in yet quite incomprehensive ways. As the study took place before any formal changes had taken place in the formation of the county government, the figure does not include the county government institutions. Furthermore, the names of the administrative organs still reflect the old system. The figure does also not include all stakeholders, e.g. the individual water users, because the focus is more on the formal organizations that take part in the governance or management of water and related ecosystems in the study area. However, the large scale water users are presented at the end of this chapter. The legal framework, also a part of the institutional set up of governance and management of water and related ecosystems, is presented in Box 1.

Box 1. Legal Framework for Governance of Water and Water-Related Ecosystems

The Kenyan water sector has been under an institutional reform for the past decade launched first by the 1999 Water Policy and later officially by the Water Act 2002. The Water Act, a mother legal framework for other sectoral policies and rules, such as the National Water Resources Management Strategy (NWRMS), the National Water Services Strategy (NWSS) and the National Water Resource Management Rules, continued a process of decentralizing the responsibility of management of water resources and service provision to the community level. It also separated water resource management and water service provisioning from each other by forming new institutional structures. The Act also introduced the involvement of non-government entities in the management of water resources and in the provision of water services. The reform is based on the UN's concept of “Human Right to Water”, and therefore the reforms express that “*the right to water entitles every person to have access to sufficient, affordable water and sanitation of acceptable quality for personal and domestic use.*” In order to reach this goal the before mentioned strategies (NWRMS and NWSS) and pro-poor implementation plans (PPIP) have been published to guide the actions (MoWI 2007). The process of institutional reform is still ongoing and currently the Act is being realigned with the new Constitution of 2010, and a new Draft Water Bill 2012 has been published (MoWI 2013). Hence the legal framework is in a dynamic condition, and therefore is not fully put into operation.

Another legal framework directly involving water resources is the Environment Management and Coordination Act (EMCA) of 1999. The main implementing agent for this law is the National Environment Management Authority (NEMA). EMCA is the overall supervising legal act for all activities involving the environment and it aims to integrate environmental issues into governmental policies, plans and programs. As regards the water sector in particular, NEMA has a role in formulating water quality regulations (Water Quality Regulations 2009). However, despite the reforms, water quality management was not given due emphasis in the mandates and roles of the water sector institutions. Currently co-ordination between the multi-sector institutions is weak. The Ministry of Environment has developed a policy on water catchment areas and protection of resources such as the water towers, but under the MoWI similar catchment management issues are also addressed through the CAACs, WRUAs, and other relevant institutions. NEMA has also developed its own rules on waste water management which are in conflict with WRMA's rules (NWQMS 2012 -2016).

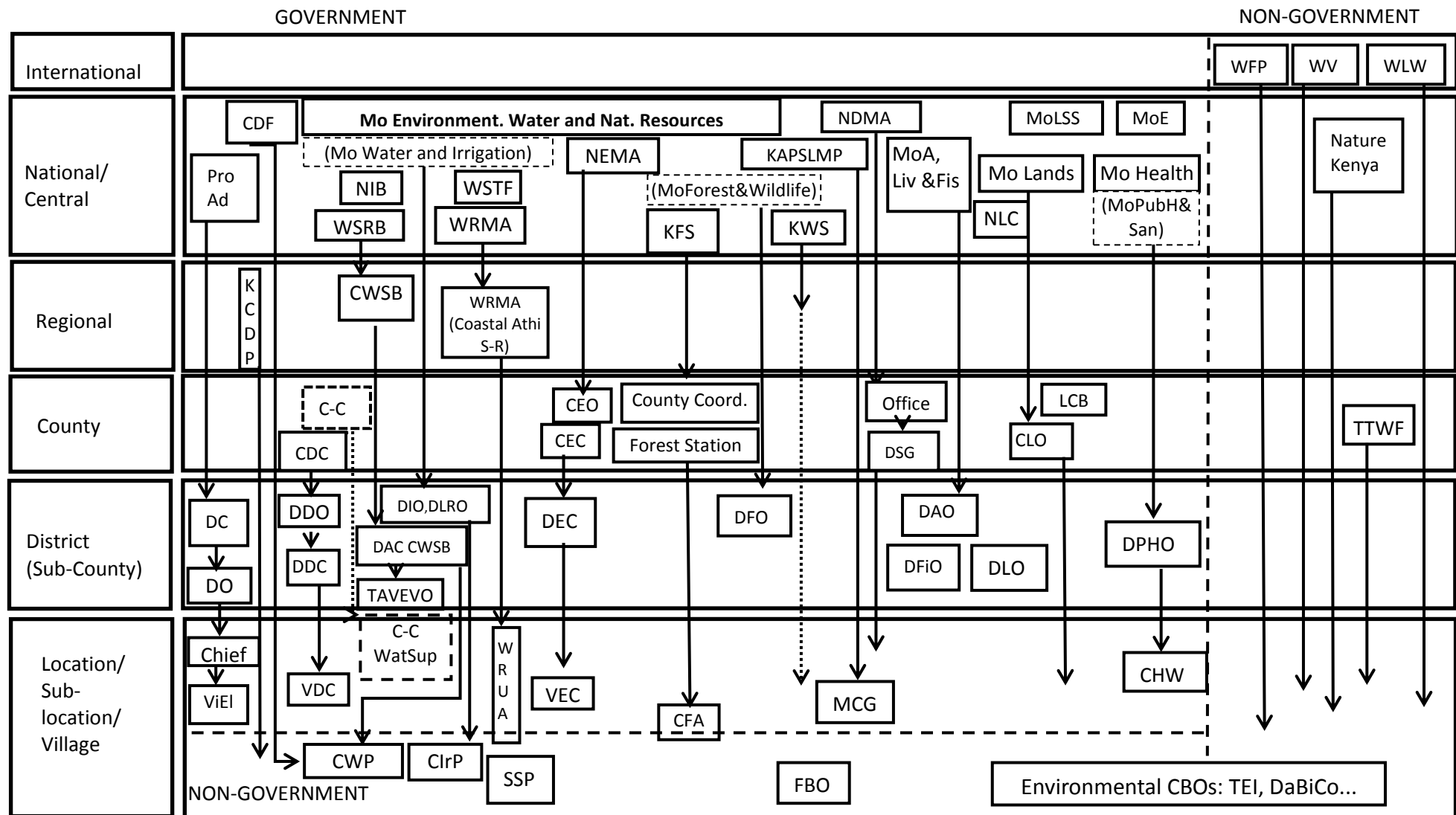


Figure 6. Institutional map of governance and management structures of water and related ecosystems

3.1.2 Roles of governance and management institutions in the study area

Having outlined the institutions involved directly and indirectly in the governance and management of water and related ecosystems, this section further describes the roles of those institutions identified during the course of the study through interviews, document reviews and observations. In this section the levels of governance from county level down are grouped into “Local” level, in order to facilitate the description, although the specific level is indicated when necessary. It should be noted, that the roles explained by or assigned to the various institutions have not always been fulfilled in practice. These challenges are further explained in section 3.6.

Water sector institutions

The roles of water sector institutions are described in Table 8. The table contains the institutions on national, regional and local (county, sub-county, location, village) scale. The institutions represented in regional and local scales have been interviewed and the roles listed consist of their recounts. However, the institutions present in the national level such as the MoWI headquarters, WSRB and WSTF were not interviewed, and hence their roles have been obtained from government documents.

Table 6. Roles of water sector governance and management institutions in the study area

Level of governance	Water sector Institution	Roles
National - Local	Dept. of Water (MoEnv, Wat& Nat Res. ²) District Water Office: 1. Water supply / CWSB District Area Coordinator (DAC CWSB) 2. Irrigation, (Drainage and Storage?) (DIO) 3. Land Reclamation (DLRO)	<ul style="list-style-type: none"> • formulation of policy and strategies for water and sewerage services, sector co-ordination and monitoring of other water services institutions • overall sector investments, planning and resource mobilisation • ownership of water resources³ <ol style="list-style-type: none"> 1. Monitor and supervise local water projects and the water company ; Design local water projects with funding coming directly from the Ministry or donors 2. Survey and design potential irrigation schemes (in collaboration with MoA); monitor and supervise projects 3. Design soil conservation and water storage structures (in collaboration with MoA)
National	Water Services Trust Fund (WSTF)	<ul style="list-style-type: none"> • Financing provision of water and sanitation to disadvantaged groups in rural and urban areas
National	Water Services Regulatory Board (WSRB)	<ul style="list-style-type: none"> • Regulation and monitoring of service provision (water services boards and providers) • Issuing of licenses to water services boards and approval of Service Provision Agreements (SAPs) • Setting standards and developing guidelines for provision of water services • Carry out tariff negotiations • Publish comparative reports for sector monitoring

² Before the Ministry of Water and Irrigation (MoWI), now exists as a department within the Ministry of Environment, Water and Natural Resources.

³The Water Act states that: “Every water resource is hereby vested in the State, subject to any rights of user granted by or under this Act or any other written law.” (Water Act, 2002).

Regional	<p>Water Resource Management Authority (WRMA) - Coastal Athi sub-regional office (Mombasa) Departments:</p> <ul style="list-style-type: none"> • Water rights and allocation • Pollution control and water quality monitoring • Groundwater monitoring • Catchment Area management 	<ul style="list-style-type: none"> • Issuing of permits and licenses in regional level, including Taita-Taveta County for all water uses (water utility, irrigation, industry...) • Planning, management, protection and conservation of water resources • Allocation, apportionment, assessment and monitoring of water resources • Water rights and enforcement of permit conditions • Regulation of conservation and extraction structures • Catchment and water quality management • Regulation and control of water use • Ground water monitoring • Capacity building of WRUAs
Regional	Coast Water Services Board (CWSB) – Coast region	<ul style="list-style-type: none"> • Rehabilitation of old and development of new infrastructure through government and donor funds • Supply water in bulk to major water companies, who are contracted under Service Provision Agreement • Register smaller water service providers and monitor them through the District Area Coordinator • Asset holder (ownership of infrastructure) on behalf of the state • Applying regulations on water services and tariffs • Ensuring equitable distribution of zoning of community service providers • Assist during drought by sending water boozers (1-2)
Local	<p>Water Resource User's Association (WRUAs):</p> <p>Upper Mwatate, Lower Mwatate Sub-Catchments</p> <p>and</p> <p>Wundanyi and Kishenyi Sub-catchments</p>	<ul style="list-style-type: none"> • to act on behalf of the WRMA in the specific sub-catchment areas • plan and implement a specific structure for action, the Sub-Catchment Management Plan (SCMP) • registering all water users in their areas, and bring them into the permit system of WRMA • to undertake various catchment management activities and involve in dispute settlement • to assist in funding water storage and catchment infrastructure e.g. at community institutions like schools and health centres • <i>(only Upper Mwatate and Kishenyi WRUAs had the plan, and none had started official activities apart from registration; though Wundanyi WRUA had started doing water resource mapping)</i>
Local	Taita – Taveta Water and Sewerage company(TAVEVO) - Urban Water Company	<ul style="list-style-type: none"> • contracted by the Coast Water Service Board under a Service Provision Agreement (SAP) • the company board consists of members of the local government (the county council) • to provide water and sewerage services to people in urban centres and maintain the water infrastructure • manages Wundanyi Water Supply • responsible for delivering water to water kiosks and supervising their operation (everyday activities operated by a women's group - custodians of kiosk)
Local	County Council – water supplies (C-C WatSup)	<ul style="list-style-type: none"> • Mwatate Water supply is still managed by the county council, mandated before to be responsible for water infrastructure.

Local	Community Water Projects (CWP)	<ul style="list-style-type: none"> • supply water to people in the rural setting where water resources can be tapped (springs, streams, rivers, underground water) through community standpoints or individual piped connections • custodians of infrastructure on behalf of government • responsible for funding themselves and take care of the maintenance of the infrastructure
Local	Community Irrigation Projects (CIRP)	<ul style="list-style-type: none"> • registered or unregistered groups that supply water for irrigation (though often water is used also for drinking by households) via pipes or via furrows (traditional system) • have a big role in vegetable production in the hills
Local	Informal small service providers (SSP)	<ul style="list-style-type: none"> • sell water from their own pipeline, or transport water from natural water courses or private boreholes and sell it further downstream during dry spells esp. in Mwatate Catchment • unofficially fill the gap or “replace” of water boozers deliveries

Other sector ministries / government departments

Other Ministries and government agencies together with initiated programmes also play a role in the local governance and management of water and related ecosystems, both in terms of water resource management and land use as well as in terms of water supply construction or regulation. The principle roles of each institution are summarized in Table 9.

Table 7. Roles of relevant government departments/ parastatals/ programmes in governance and management of water and related ecosystems in the study area

Level of Governance	Other Government Departments/ Parastatals/ Programmes	Roles
National - Local	Agriculture (DAO), Livestock (DLO) and fisheries District offices (DFiO) (Ministry of Agriculture, Livestock and Fisheries ⁴)	<ul style="list-style-type: none"> • Encourage protection of river banks e.g. through cultivating water – friendly crops • Control of cultivation in wetlands by Agricultural Act Cap 318 (Collab. with Land Reclamation Dept.) • Encourage construction of soil and water conservation structures (terraces, zai-pits, v-bunds...) • Encourage planting of trees on farm – agroforestry (e.g. fruit trees) • Excavate water pans for irrigation (Collab. with Irrigation Dept.) • Propose rehabilitation of irrigation schemes • Give knowledge on usage of proper doses of agrochemicals (but cannot control) • Work with NDMA to prepare drought assessments (e.g. monitor rainfall) • ATC dam water used for ATC purposes • Development of water pans for livestock together with Water Dept. • Development of fishponds

⁴Before May 2013 Ministry of Agriculture and Ministry of Livestock and Fisheries Development

National, Regional, Local	Kenya Agricultural Productivity and Soil and Land Management Program (KAPSLMP)	<ul style="list-style-type: none"> • Increase income from natural resource use by sustainable soil and water conservation practices; preparing micro-catchment land use plans and forming micro-catchment groups • Cooperative programme between departments (MoA, WRMA (+WRUA), NEMA , KFS etc)
National – Local	Kenya Forest Service (KFS), (Ministry of Environment, Water and Natural Resources ⁵) <ul style="list-style-type: none"> • county office • forest station • District Forest office (DFO) • Community Forest Association (CFA) 	<ul style="list-style-type: none"> • Control tree planting and cutting activities – also regarding water near sources (Policy on increasing forest cover by 10%) (Collaboration with WRMA is not easy) • Coordination of conservation of forested areas in the county (which are also water catchment areas) • Rehabilitation of riverines and water catchment areas together with local conservation NGO's and CBO's (TTWF and DaBiCo) and supposedly WRMA (which could not participate) (Forest Station Manager) • custodian of forest areas: sustainable management of forest products, tree planting, catchment protection – link with WRUAs • <i>Are not yet really operational in the study area.</i>
National - Local	National Environment Management Authority (NEMA) (Ministry of Environment, Water and Natural Resources ⁶) <ul style="list-style-type: none"> • County Environment office (CEO) • County Environment Committee (CEC) • District Environment Committee (DEC) • Village Environment Committee (VEC) 	<ul style="list-style-type: none"> • Pollution control • Overall authority to deal with violations to environment • Conducts Environmental Impact Assessments (EIAs) for large water uses such as infrastructure development (boreholes) • County level body that involves all stakeholders to discuss about environmental issues; prepares County Environment Action Plan • District level body that involves all stakeholders to discuss about environmental issues • Committee at village level to discuss of environmental issues • <i>Operation not confirmed!!</i>
National – Regional – Local	National Drought Management Authority (NDMA)(Parastatal - Office of the President) County office District Steering Group (DSG)	<ul style="list-style-type: none"> • County level food security assessments and Early Warning – monitoring of e.g. water availability i.e. distance to water and the price through community observers • Chairing the District (County) Steering Group (DSG) held quarterly
National - Local	Public Health office (Ministry of Health ⁷) District Office (DPHO) Community Health Workers (CHW)	<ul style="list-style-type: none"> • Water quality surveillance of drinking water sources including piped water (e.g. communal taps) and springs: residual chlorine testing in office and bacteriological testing in Govt. lab in Mombasa) • Keep record of water-borne diseases in the area

⁵Before May 2013 Ministry of Forestry and Wildlife.

⁶Before May 2013 Ministry of Environment and Mineral Resources

⁷Before May 2013 Ministry of Public Health and Sanitation, before District, Division, Community

		<ul style="list-style-type: none"> Disseminating information to the community about water treatment strategies like boiling and about sanitation. Report water-borne diseases.
National - Regional	<p>Kenya Wildlife Service (KWS) (Ministry of Env, Wat& Nat. Res.)</p> <p>Regional office for Tsavo East and West</p>	<ul style="list-style-type: none"> Management of National Park areas, also reg. water As Corporate Social Responsibility construct occasional boreholes to areas near national parks (Mwatate) Management of water areas in the national parks
National – Local	<p>National Land Commission (NLC)</p> <p>Land Control Board (LCB)</p> <p>County Lands office (CLO)(Ministry of Land, Housing and Urban Development⁸), depts.:</p> <ul style="list-style-type: none"> Adjudication Survey Registrar Physical Planning 	<ul style="list-style-type: none"> Taking charge of land issues in the future Decides about sales and buying of land; supposed to consider environmental factors Surveying and subdivision of land, including sometimes near water bodies Mapping of area Technical part of land use planning, works together with county council
National - Local	Ministry of Labour, Social Security and Services (MoLSS) ⁹	<ul style="list-style-type: none"> Registration and training of community based groups on running the committees
National – Local	Ministry of Education (MoE) ¹⁰	<ul style="list-style-type: none"> School water supply development (or funding) and sanitation
Local	<p>District Development Office (DDO)</p> <p>County Development Committee (CDC)</p> <p>District Development Committee (DDC)</p> <p>Village Development Committee (VDC)?</p>	<ul style="list-style-type: none"> Supervises development activities in the district, including water related; supervises CDF – funded projects; Secretary of DDC Committee involving all stakeholders in development at county level; Coordination of development activities; prepares the County Development Action Plan Similar roles as above but on district level Village level committee that discusses and presents development needs (including water) of the area (<i>operations not checked</i>)
Local	<p>County Council (C-C)</p> <p>Taita and Mwatate Districts</p>	<ul style="list-style-type: none"> Custodian of Trust Land (community land); takes actions to protect it Involved in land use and development planning (including providing water infrastructure); collects taxes from development activities Management of municipal waste in town centers

⁸Before May 2013 Ministry of Lands and Settlement

⁹Before May 2013 Ministry of Gender, Sports, Culture and Social Services and they were not interviewed for this study, but were mentioned by the other institutions

¹⁰Before 2013 Ministry of Education, Science and Technology; the district officer was interviewed only briefly, but it became clear from other interviews that the ministry plays a role in the local water management.

		<ul style="list-style-type: none"> • Custodian of water infrastructure (Mwatate and Werugha)
Regional – Local	Kenya Coast Development Project (KCDP)	<ul style="list-style-type: none"> • Funding of Community Projects related to environment and water resource management in the Coastal Region • Recently (Jan 2014) 8 CBO's in T-T county received money from KCDP¹¹
(National) – Local	Constituency Development Fund (CDF)	<ul style="list-style-type: none"> • Political Fund; Funding Community Projects including water projects.

Provincial administration

The district level administration i.e. District Commissioner (DC), District Officer (DO), Chiefs and Village Elders all have a coordinating role on the activities taking place in each level of their governance (i.e. the county, sub-county, the division, the location and sub-location, and village). Based on the interviews conducted with representatives of each of these administrative units in the study area (see Table 5 in Methods section) their roles regarding governance and management of water and related ecosystems can be summarized into the following points (Table 10).

Table 8. Roles of Provincial Administration in water management in the study area

Provincial administrator	Roles regarding water management
District Commissioner (DC)	<ul style="list-style-type: none"> • Coordination of water related activities and information sharing between department officers regarding water issues in the district ; Chair of District level stakeholder forums • Being up to date of the water situation in the District with the help of Water officer; • Monitoring water resources together with the water officer • Assessing and expressing out needs of water development in the District together with Water officer; • Ensuring policies regarding water use are followed; • Ensure that people of the District have water and contact the water supplier if need be • Involved in settling issues or disputes regarding water, when cases are brought up to District level
District Officer (DO)	<ul style="list-style-type: none"> • Arbitrate water disputes in liaison with water officer on divisional level, if Chiefs are not able to solve • Coordinating and linking between departments in enforcement situations – mobilizing the community
Chief	<ul style="list-style-type: none"> • Dissemination of information on water issues from government departments, NGO's, any other developers to the community through <i>Barazas</i> – A link to the community - mobilization • Dispute settlement on the location and village level regarding water boundaries, spring protection etc. • Supervising community electoral processes e.g. establishment of WRUAs • Taking part in water conservation activities in location e.g. tree planting along river banks • Enforcement of pollution control / water obstruction regulations and tree cutting (Chief's Act renewed)
Village Elders	<ul style="list-style-type: none"> • Dispute settlement and arbitration regarding water on the village level together with Chiefs • Experts in their experience of water situation in their areas • Reporting cases of water resources and catchment degradation within their areas to higher authorities

¹¹<http://www.kcdp.co.ke/11-million-awarded-to-taita-taveta-county-cbos>. Accessed 28.03.2014

Non-governmental Organizations (NGOs), Community Based Organizations (CBOs), Faith Based Organizations (FBOs) and companies

The roles of NGOs, CBOs, FBOs and companies in management of water and related ecosystems are described in Table 11. The specific areas of jurisdiction or operation are found in the table of interviewees (see Annex 1).

Table 9. The roles of Non-Governmental Organizations, Community Based Organizations, Faith-Based Organizations and Companies in the management of water and related ecosystems.

Level of management	Organization	Roles
International – Local	World Food Programme (WFP)	<ul style="list-style-type: none"> Food security and relief; construction of water and soil conservation structures together with WV
International – Local	World Vision (WV) (NGO)	<ul style="list-style-type: none"> Food for Assets project: construction of water and soil conservation structures by local community in exchange for food Water and Sanitation project: will build boreholes in the lower lands and train community groups to manage them
International – Local	Wildlife Works (WW) (Company)	<ul style="list-style-type: none"> REDD+¹² project: aims to monetize local landowners' biodiversity and forest assets by bringing them into international market of carbon credits¹³ 1/3 of money from selling of carbon credits given to communities near the protected areas → used for community development projects (such as schools or water projects) through Location Carbon Committees In Mwachabo location the money used to rehabilitate Ngangu water project and water catchment areas; In Landi (Mwatate district) a roof catchment built at a school
National – Local	Nature Kenya (NGO)	<ul style="list-style-type: none"> capacity building the community groups involved in water resource management directly as the WRUAs or indirectly as the Community Forest Associations (CFAs)
Local	Taita Taveta Wildlife Forum (TTWF) (NGO)	<ul style="list-style-type: none"> advocacy and awareness raising on community rights capacity building the community groups involved in water resource management directly as the WRUAs or indirectly as the Community Forest Associations (CFAs)
Local	Dawida Biodiversity Conservation project (DaBiCo) (CBO)	<ul style="list-style-type: none"> capacity building the community groups involved in water resource management directly as the WRUAs or indirectly as the Community Forest Associations (CFAs)

¹²Reducing Emissions from Deforestation and forest Degradation – a United Nations initiated climate change mitigation mechanism

¹³A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one ton of carbon dioxide or the mass of another greenhouse gas with a carbon dioxide equivalent (tCO₂e) equivalent to one ton of carbon dioxide. Currently one carbon credit goes at US\$ 6 – 8 (changes with market price) and a forest stores about 5 tonnes (i.e. 5 carbon credits) of carbon per hectare.

Local	Taita Environment Initiative (TEI) (CBO)	<ul style="list-style-type: none"> Tree planting, environmental and catchment conservation, alternative energy creation; partners with other CBOs and NGOs and the Wundanyi WRUA
Local (Mwatate)	Sisters of Mercy	<ul style="list-style-type: none"> Provisioning of water from borehole along Mwatate road

3.1.3. Local large scale water users – example of the Teita Sisal Estate

One of the world’s largest sisal estates (30 000 acres) is located in the vicinity of Mwatate town. The establishment of the estate dates back to the 1920’s -1930’s, when the British colonial government built a dam and estate on Crown Land – which actually meant the community land. According to the interviewees, ever since there have been conflicts, especially in the border areas, between the estate owners and local people who feel that the estate has occupied their ancestral lands. Due to these disputes, the reputation of the sisal estate is not very good among the local community members. Criticisms have also been presented on how much the estate is actually benefiting the community living in Mwatate area. The estate has been organized as an enclave, with own schools, shops, churches and houses for the employees – a kind of a sovereignty, where citizenship is built on labour basis. The estate attracts workers from all over the country. Some people tell that they grew up on the estate and have never seen anything else. Therefore, people who do not work at the sisal plantation, but live in Mwatate, find it hard to see the estate bringing any benefits to the area, because most of the profit does not stay in Mwatate. On the other hand, the sisal estate manager believes that there would be no Mwatate without the Sisal Estate. She bases her claim on the fact that 15% of the employees live outside the estate in Mwatate and so the Estate pays 18 million shillings/month as wages to Mwatate. The estate also pays 350 000 Kenyan shillings to County Council as taxes over the exports. Therefore the council and district administration mostly see the estate assisting the development of the area to an extent and see sisal production as a viable use of land in the area. However, not all the officials seem to be aware of the benefits derived back to the community. The sisal estate has also started many initiatives aiming to help the community, for example providing them sisal seedlings to stop wind erosion and building stony water tanks. However, many of these projects have been disabled by the local politics.

In any case, the sisal estate is by far the largest single stakeholder and water user in the Mwatate catchment area. The estate uses water for the processing of the sisal. Water is stocked in the reservoir constructed in the Mwatate River. It covers approximately 55 acres and part of it is on community land. There are also several boreholes within the estate, which provide water for the domestic use for the employees living in the estate, for cattle and for irrigating the tobacco plantations. The research has obtained contradictory information regarding the use of reservoir water and the water from the boreholes in the sisal processing. According to one informant, water from the reservoir is used commonly for the processing of the sisal. However, water from the boreholes is preferred as the silted water from the reservoir colours the fibres resulting in a lower quality product. According to another informant, the water from the reservoir is used only as an emergency for washing the sisal (hence the water from boreholes being used in principle) and it is mainly used only for irrigating the sisal seedlings and for dairy cows. However, during the time of the interviews, the water from the reservoir was used for processing the sisal, because there was not enough water in the boreholes. The waste water from the sisal processing is used for irrigating the napier grass used to feed the cattle. Removal of the green parts from the sisal leaves produces “green porridge”, which is also used for feeding the cattle and as fertilizer in the fields. Only little amount of synthetic fertilizers are used at the planting stage of the seedlings. Recently, the estate has also established a wildlife park and a tourist lodge within its premises, which might increase the water consumption.

Because of its location in the downstream area of the catchment, the sisal estate dam reservoir also suffers from the consequences of the land use activities occurring in the upstream areas. According to the estate manager, the biggest problem in the reservoir is the massive siltation that has divided the dam into two

parts. Siltation is mainly coming from the western side of the reservoir through a large gully. The Pelelesa community is using the gully to bring 5000-6000 cattle to drink to the dam during drought every year. The cattle bring diseases, but the estate owners cannot forbid this, because they cannot let the cattle die. The estate has built brick barrier structures across the gully to prevent the erosion, but they have now reached their capacity limit (Fig. 10). They plan to rehabilitate the gully by building more structures and divert water into the plantation from the above hill to reduce the flow into the gully. There is also a lot of erosion at the estate side of the reservoir and similar large gullies are found there. Within the estate the erosion is controlled by planting grass in between the sisal plants and by building gabions to protect the river banks.

3.2 What are the services provided by water in the Taita Hills?

Local representatives of the government institutions and community groups were asked to express their perceptions on the significance of the water resources and the services they provide to the community. We consider water as a main supporter of ecosystem services (ES). In general, the ES are the benefits people get from the environment and that are important for human well-being (Costanza et al., 1997; Tallis and Polasky, 2009). ES include provisioning services such as safe water and food, regulating services such as climate and water regulation, supporting services such as soil formation and nutrient cycling, and cultural services such as recreational, educational and spiritual benefits (MEA, 2005). Quality and quantity of water resources greatly depend on several other ES such as water retention by the vegetation cover and water purification by the soil (Table 12). It is important to recognise and understand the ES related to water in order to sustainably manage water resources. Institutions can play a key role in guiding resource management, implementing policies, reconciling stakeholders' values, creating incentives that support natural resource users' decisions and solving problems of 'collective action'¹⁴ (Daily et al., 2009; Poteete and Ostrom, 2004). The main aim of understanding and valuing ES is to make better decisions, which results in better actions concerning the use of land, water, and other elements of the environment.

Table 10. Water-related ecosystem services

Provisioning services	Regulating services	Cultural services	Supporting services
Fresh water for drinking, washing and irrigation	Water retention and storage capacity of vegetation and soil	Educational value of water ecosystems	Floods for replenishing soils and nutrients in the floodplains
Fish	Vegetation cover for soil erosion protection	Aesthetic values of rivers, ponds, lakes and waterfalls	
Biodiversity	Vegetation and soil for water purification Groundwater recharge Ponds and wetlands for flood control Wetlands for regulating greenhouse gasses	Cultural values related to water ecosystems	

3.2.1 Preference valuation of the water-related ES by institutions and community groups

Evaluation of ES can be done using qualitative and quantitative biophysical methods or preference-based methods (TEEB, 2010). Preference-based methods focus more on human experience and monetary or non-monetary values that people attach to the ES. For this study, we focused on non-monetary valuation of the ES related to water, since studies have shown that setting prices to ES may be complicated and possibly results in negative impacts on the environment (Heynen et al., 2007; Minoia, 2012).

¹⁴Any action taken together by a group of people whose goal is to enhance their status and achieve a common objective

According to a survey we carried out, the local institutions and groups involved in water resources management consider 'clean drinking water for humans' the most important ES in both Wundanyi and Mwatate Catchments (Fig 7.). Only one government agency representative in Mwatate Catchment did not consider this service very important, because, according to him, in the lowlands people do not care if the water is clean, because for them it is a matter of survival. There is also a high level of awareness among the respondents about the importance of the forests and soils for the hydrology of the Taita Hills. Indigenous forests, especially, are highly valued for their role in the regulation of the hydrological cycle and water retention. On the other hand, the institutions do not consider 'floods for replenishing nutrients in soils' and 'waterfalls as an aesthetic value' as very important ES in the study catchments. The importance of aesthetic values was generally ranked low in both catchments. However, the importance of the aesthetic value of forests was normally considered higher than that of waterfalls, ponds or rivers.

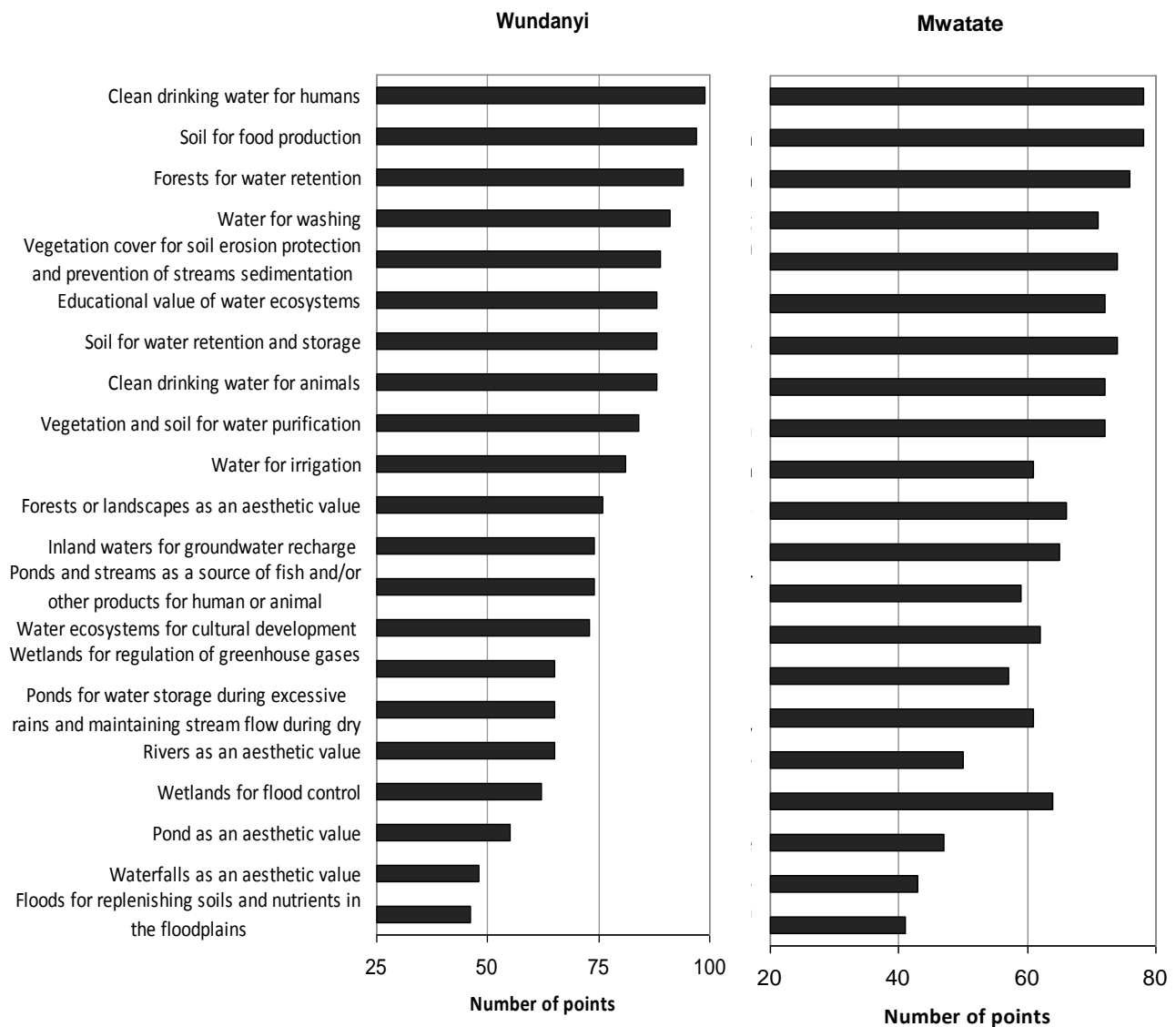


Figure 7. Valuation of water-related ES in Wundanyi and Mwatate Catchments. Total number of points varied 25-100 and 25 -80, respectively.

Respondents also value water-related ES rather differently depending on the sector they work in. For example, while the Irrigation Department values 'water for irrigation' more, the Forests Department values 'forests for water retention', and the Agriculture Department values 'soil for food production' more and so on. In general, the government agencies in Wundanyi Catchment considered 'vegetation cover for soil erosion protection' the second most important ES and ranked 'water for washing' a lot less important and 'inland waters for groundwater recharge' more important than the other respondent groups. Water project

members in the same catchment, on the other hand, considered 'water for washing' and 'educational value of water ecosystems' very important.

In general, there were no huge differences in the rankings between the catchments. The largest difference was that in Mwatate Catchment, the value of 'wetlands for flood control' was considered somewhat more important than in Wundanyi Catchment.

The results of the survey indicate that people highly value those ES they personally encounter in their home area or which they are concerned with in their everyday work. This is understandable, because it would be irrelevant to give value to ES that does not exist. For example, in Wundanyi Catchment flooding is not common and therefore, the respondents do not find the flood controlling capacity of wetlands very important there. Similarly, the aesthetic value of waterfalls was considered less important, because most of the waterfalls are small or they are hidden in between the cliffs and are difficult to reach. On the other hand, it is also understandable that aesthetic values are recognized only after the basic needs are fulfilled and therefore they are ranked lower than the life-sustaining ES.

3.2.2 Cultural and religious significance of water

Water-related rituals, such as rainmaking were commonly practiced in the Taita Hills before the arrival of Christianity (Bravman, 1998). One informant in Wundanyi catchment blamed the abandoning of these old rituals for decreasing water resources. According to him, praying for the Christian God is not that effective. Losing of old beliefs and cultural erosion have also had direct consequences to catchment degradation. Many of the remaining indigenous forest patches are or contain sacred forests, called shrines or *fighis*. As Himberg (2011) has shown, sacredness can be a powerful tool for forest conservation in the Taita Hills as it restricts people's entrance to the forests. Before there used to be many sacred forests, but since the arrival of Christianity, people have lost their faith in them and several old *fighis* have been destroyed. For example, in Mwatate workshop, Kishamba/Modambogho group member described the changes in *fighis* in the following way:

'When the white men came to Africa they told (people) that these fighis are black magic, they don't have anything, you can cut them and they agreed. Initially all the water towers were fighis, shrines. Nobody would go near there.'

Some of those respondents who believe the Christian God nowadays thought that the reason for the decreased rainfall and water levels is God's will or that God is punishing people because they have sinned.

Currently, Taita people have also formed some 'conservationist rules of thumb' based on their experiences with water resources. For example, there is a saying according to which locals believe that constructing a concrete structure around the spring and tapping it, leads to drying up of that spring. This saying, which insinuates that the concrete structure would somehow mystically suck the water or divert the flow, is more likely to tell about how some people consider human interference with natural water flows harmful.

3.3 Locals' perspectives on water problems

In the workshops, the community groups identified problems in their living areas. Those problems, which are directly related to water or ecosystems related to water provisioning, such as forests, are shown with numbers on maps in Figures 8 and 9 and their explanations are listed in Tables 13 and 14. In some cases, the local knowledge of the water resources was also mixed with other cultural and social issues, such as poverty, unemployment and alcohol and drug abuse, but these are not shown on the maps. However, these may be important driving forces behind the ecological problems and should be taken into account when the problems are analysed. In addition to problems that could be located on certain areas or point locations, there are also some general ones involving the whole catchments, which are described next.

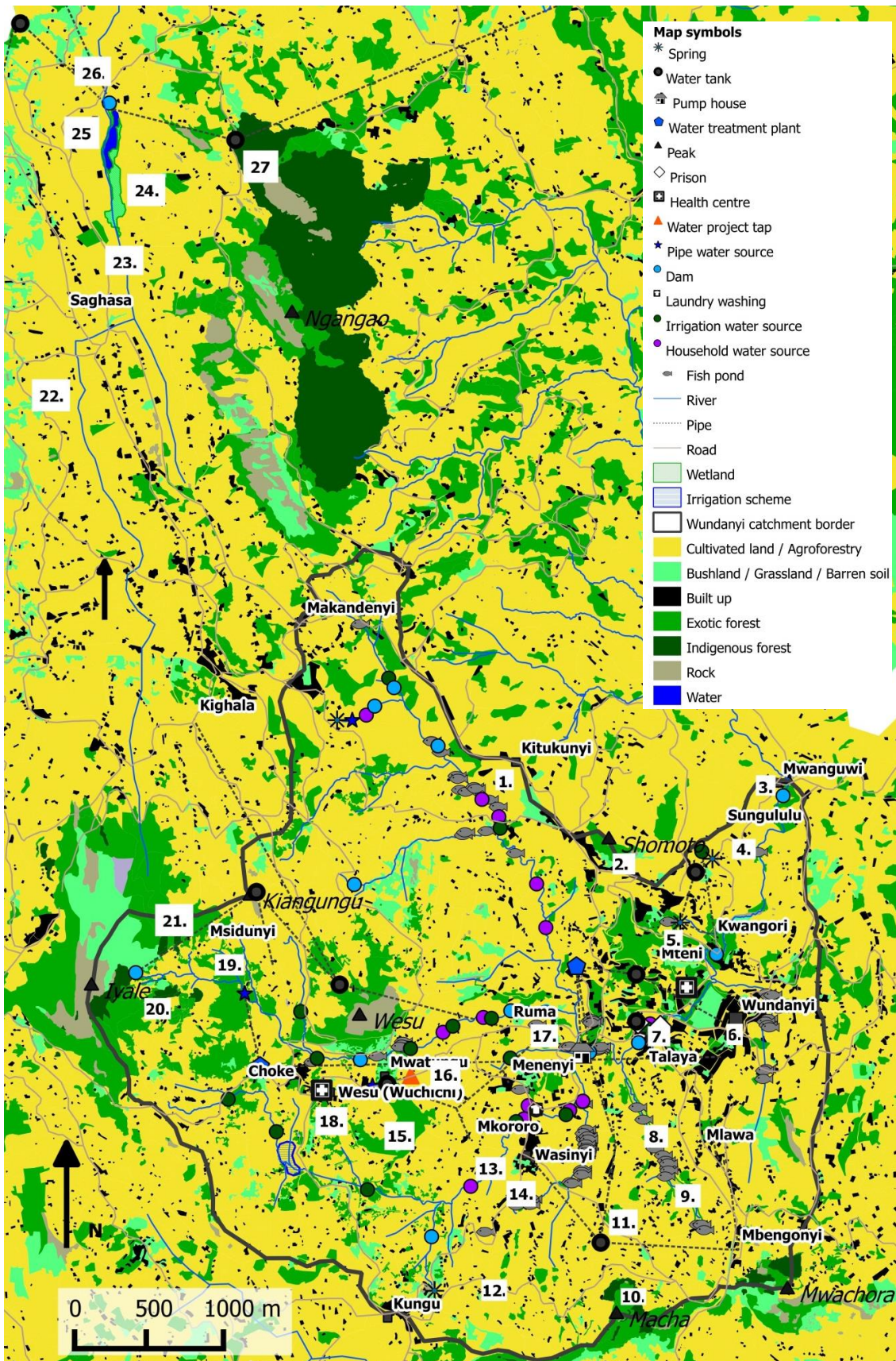


Figure 8. Wundanyi catchment map. Numbers denote the water-related problems and they are explained in Table 13.

Table 11. Water related problems in Wundanyi catchment addressed by workshop groups. The numbers are marked on the catchment map in Figure 8.

No.	Issue
Kitukunyi, Sungululu, Wundanyi	
1.	Kitukunyi: Soil erosion and lack of water and firewood
2.	Shomoto Hill: Exotic tree species, e.g., blue gum, grevillea, acacia (“migamu”) use a lot of water. Falling of rocks and landslides during the heavy rains.
3.	Mwangubi village: sand harvesting in river junction
4.	Sungululu sublocation: Amount of water has decreased, but there is still enough water, because of many springs. There is lack of proper knowledge regarding conservation and agriculture. Area has a lot of resources, but there is very little development.
5.	Shambadii mixed forest: Plans to clear the forest threat Kidakiwi spring, which feeds the community in Kwangori village, Dr. Aggrey High School with a population around 475 individuals and Wundanyi town
6.	Wundanyi village: waste water flows to river
7.	Wundanyi Prison sometimes releases waste water into the river
Shate / Mbirwa	
8.	The water level of Mbirwa river has gone down. Fish ponds along the river expose water to the direct sunlight, which increases evaporation. The water in the river is polluted, which has killed the frogs. This in turn, has increased the number of mosquitoes and hence malaria.
9.	Mbirwa wetland: Wetland is not surveyed and people living near it claim that they own the land. Needs conservation, but it is difficult, because people’s farms (shambas) are there.
10.	Macha forest: a lot of logging, people cut both exotic and indigenous trees for firewood and some to be sold as poles. Also stones are dug and sold, which enhances erosion.
11.	Ministry’s tank cannot supply water to the people in the higher areas, because the system works with gravity. The tank was placed without the consent of owners of the farm and thus it is on a disputed land. The tank does not serve all the villagers.
Wasinyi	
12.	Ikonde spring has dried up
13.	Kighononyi River is polluted because people wash and bath in it
14.	Wasinyi: Not enough water. Kiziki forest is destroyed, which leads to drying up of rivers and lack of water.
15.	Mbili forest: eucalyptus trees take a lot of water, which decreases river flow
16.	Toro water project: lack of storage tanks and pipe network; enough water, but it cannot be tapped properly, eucalyptus forest above the water source is using a lot of water
Iyale / Wesu	
17.	Ruma village: Lack of water
18.	Waste water from Wesu hospital is infiltrated to the ground near the river in a place where soil layer is shallow and waste water will potentially end up to river before it is properly purified.
19.	Iyale/Msidunyi water project needs more funding in order to cover larger areas with taps
20.	Lack of water due to cutting of trees and farming near the Msidunyi/Wesu River source
21.	Iyale Hill: Eucalyptus trees use a lot of water
Saghasa / Sangenyi	
22.	Pesticides used in the horticultural farming
23.	Diverting water for irrigation and cutting of water supply causes conflicts between the neighbouring villagers.
24.	Cultivation of wetlands and along the dam and streams
25.	Siltation of the Kishenyi dam. Also eutrophication and toxification of water by aquatic plants. Local people are not allowed to do fishing.
26.	Lack or inadequate maintenance of the water structures. Vandalism of water pipes.
27.	Ngangao Forest: Forest fires are threatening the indigenous vegetation

Map symbols

- Dam
- 🏠 Pump house
- 🏭 Water treatment plant
- 🏥 Health centre
- 🏠 Livestock farm
- Water tank
- 🐟 Fish pond
- ▲ Peak
- ▲ Borehole
- Water source point
- ▲ Shallow well
- ▲ Water project
- 🏠 Water kiosk
- * Spring
- River
- ⋯ Gully / Seasonal stream
- ⋯ Pipeline
- Road
- ⋯ Railway
- 🌿 Wetland
- ▭ Catchment border
- Land cover
- 🟡 Cultivated land
- 🟢 Burned area / Bushland / Grassland / Bare soil
- ⬛ Built up
- 🌳 Exotic forest
- 🌲 Indigenous forest
- 🪨 Rock
- 💧 Water

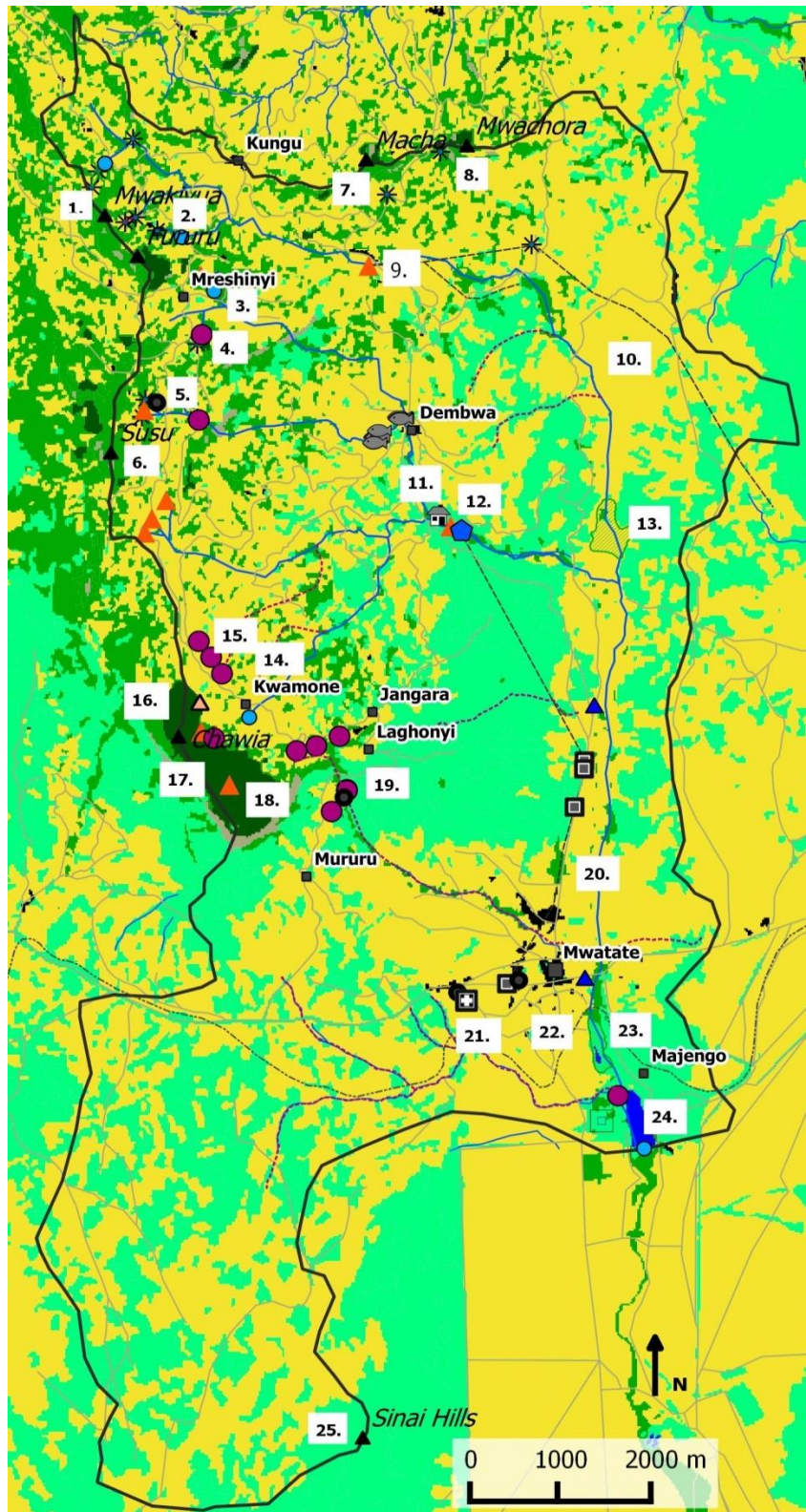


Figure 9. Mwatate catchment map. Numbers denote the water-related problems and they are explained in Table 14.

Table 12. Water-related problems in Mwatate catchment addressed by workshop groups. The numbers are marked in the catchment map in Figure 9.

No.	Problem
Kidaya / Ngerenyi	
1.	Mwakivua exotic forest: Illegal firewood harvesting and logging. Exotic trees cause drying up of springs. The exotic trees are spreading to Fururu and replace the indigenous trees there. There used to be an indigenous tree planting campaign led by the Kenya Defence Force in Mwakivua, but it was not very successful because the project was not community driven.
2.	Mwanginyi dam: The dam is dry, because people have demolished it out of ignorance. Other problems include soil erosion, population increase, logging and lack of water
3.	Mbundukinyi peak and ATC dam: Massive government sponsored deforestation took place, trees were harvested by ATC Ngerenyi board. Currently some reforestation with indigenous tree species. Too much farming has caused soil erosion and silting of the ATC dam. The ATC dam has not been benefitting the community, but proposals to get access to water are made. However, pumping water to the higher residential areas is a problem.
4.	Ndiwenyi wetland: Siltation has destroyed the Ngulu dam; massive deforestation caused by local people, high school and the Youth Polytechnic Institutions; loss of cultural site; encroachment of wetland for farming and introduction of exotic tree species particularly by Kidaya-Ngerenyi Polytechnic and Mwafunga High School workers and pupils; drying spring due to deforestation and growth of Brackens.
5.	Ikungunyi water project: Problems with management and maintenance.
6.	Susu forest: People take animals to graze in the forest; trees are cut down for timber production; forest is often put on fire.
Kishamba / Modambogho	
7.	Macha mixed forest: Illegal tree harvesting
8.	Mbengonyi forest: has been encroached and shrine inside it was abandoned because of introduction of Christianity, generation change and land demarcation. Demand for firewood and building materials.
9.	Josa-Modambogho water project: water sources and river banks have been encroached, farms in the upper parts of the river use water for irrigation, challenges in management.
10.	Kilulunyi forest: an abandoned shrine that has suffered from encroachment
11.	Mwamkute River: extensive irrigation, water source and river bank encroachment.
12.	Mwatate water supply (run by the County Council): population increase in Mwatate increases water demand, lack of reservoir tanks, poor management and technology.
13.	Ngulu wetland: siltation, encroachment, use of agro-chemicals, 30 out of 40 acres has been encroached by farming.
Chawia / Wusi	
14.	Mkolonge stream: incomplete water project, a water system with desiltation system and a tank were built, but the stream has now dried up due to the inadequate protection of the catchment area above the source. Poor management.
15.	Kwashuma stream (and streams nearby): has dried up due to poor farming methods like cultivating right to the river banks; pollution from fertilizers; stream catchment is encroached.
16.	Natural pond below the Mwaroko shallow well dries up nearly completely during the dry season and has been encroached by weeds, invasion of eucalyptus in the forest, overgrazing and animal disturbance.
17.	Chawia forest: poor management of water project, inadequate guarding of the forest.
18.	Iombonyi/Sinai water project: No water during the dry spell. Feeds a water tank below, which has never been filled with water.
19.	Overgrazing and growing of exotic tree species
Mwatate	
20.	Upper Mwatate River valley: Intensive farming on the river banks, deforestation, long dry spell
21.	Lack of water harvesting and storage equipment
22.	Poor cultivation techniques, lack of farming equipment, conflicts over water use
23.	Lower Mwatate River valley: Silting, flooding, livestock and elephants destroying the crops, lack of proper guidelines for sand harvesting, which contributes to gully formation
24.	Sisal estate dam: heavy siltation due to farming in the upper parts of the catchment. Lack of public support.
25.	Sinai Hills: Bush fires and smoke indicating charcoal burning activities

3.3.1 Reducing water quantity and quality

According to the local people, there has been a noticeable reduction in water quantities in the Taita Hills over the last 50 years. The water levels in many springs, rivers and streams have gone down and some have even dried up completely. Since communities depend mainly on local natural sources for their domestic and agricultural water needs, water scarcity has become one of the biggest challenges people currently face especially in the dry lowland areas. Water scarcity affects agricultural production causing poor crop and livestock yields. It has also reduced horticultural production, which has been a sizeable livelihood source for smallholder farmers in the area. According to the Ministry of Agriculture, approximately 20% of the smallholder farming in the Taita Hills currently relies on irrigation during the dry season. However, according to the Ministry of Water and Irrigation, lowered water quantity is a major limiting factor for irrigation in the area. This is evident because while the irrigation potential area of Wundanyi District is 582 ha and that of Mwatate District is 595 ha, the areas currently only realize 52 ha and 70 ha respectively (Ministry of water and Irrigation, an unpublished report).

People have also conceptions on the possible sources of pollution of the water resources. The most significant sources of pollution of the Wundanyi catchment streams are thought to be the prison in Wundanyi village and the Wesu hospital. We had already come across the problem of prison waste water management in 2010, when during another fieldwork, we encountered a place where waste water from the prison latrines was pouring into the river. In 2013, we decided to visit the prison and ask about their waste water management. The prison officers told us that earlier problems with the waste water management had been solved, but the fact that some of the people still consider the prison as a major source of pollution would suggest that this is still going on. However, at the workshop in 2014, the county public health officer confirmed that they had dealt with the issue at the prison, but explained that because the water table is so high in the area, there are chances that some contamination may occur. However, when they had sampled the river water near the prison and near Mwangeka high school, it was found that there was more pollution coming from the school than the prison. The officer agreed that the prison can be a risk of pollution, and should be relocated, but that this was quite difficult to achieve in practice. As for Wesu hospital, it has infiltration pits near the stream. Because the soil layer is not very thick, there is a chance that waste water flows to the river on the bedrock surface before it is properly purified. The public health officer also confirmed that they had addressed the issue of leaking soak pits at the hospital some time back, but that there is a need to keep monitoring the place with the help of the surrounding community. He also pointed out that the water pollution has not caused outbreaks of water-borne diseases in the area, and hence the situation is still under control.

Whether the Wundanyi Prison and Wesu Hospital are polluting the river or not, it is evident that one obvious source of pollution is the Wundanyi town itself. Garbage is visibly thrown to the river and waste water flows directly to the river through open ditches. Also cars and motorcycles are washed right next to the river. Increased use of agrochemicals is also a problem in some areas. For example, people think that the quality of the river flowing from the Mbirwa wetland has deteriorated because of pollution from farming activities. People do not drink water from the Mbirwa River anymore without purifying it with chemicals, which however, can have side effects. However, in this case, it is difficult to say whether this conception is based on scientific knowledge or own experience as people associated health problems with dirty water only in few cases. People have also made many observations on increased soil erosion and siltation of rivers and dam reservoirs. For example, in Mwatate, erosion has led to formation of several long and deep gullies, which carry large amounts of sediment down from the hills during the rainy season (Fig. 10). Due to strong erosion and siltation, the Mwatate River itself also tends to flood during the heavy rains and as a consequence it changes its course from time to time. Erosion is associated with clearance of forests, hilly topography, and cultivation of river banks, poor agricultural practices and sand harvesting.



Figure 10. Gully erosion near Taita Sisal Estate reservoir, close to Mwatate town. A brick barrier was constructed to prevent the sediment from flowing to the sisal estate dam, but it has now reached its full capacity. (Hohenthal 5.2.2013)

3.3.2 Unequal access to water resources

The impacts of water scarcity are not equally distributed across the Taita Hills. Downstream water users are more affected than people living in upstream areas. Table 15 presents the costs the households that participated in this study need to pay for water. On average, the informants in Wundanyi catchment spend a bit more than KShs. 220 per month for water costs throughout the year. Many people in the Wundanyi Catchment pay a fixed monthly price to TAVEVO or some water projects who supply water to the taps in their compounds. Some people have water meters but they do not always work properly or they are not read regularly. Fixed monthly prices need to be paid even when there is no water available. People in upland areas of the Mwatate catchment, spend a similar amount on water per month as people living in the Wundanyi catchment. The general income in upland Mwatate is lower than in Wundanyi catchment, but many people fetch water from the rivers or springs for free. However in the lowland Mwatate, the water costs are higher, on average KShs. 372 during the wet season and KShs. 860 per month during the dry season. People also need to spend a larger percentage of their income on water. One respondent even informed us that she sometimes needs to buy water with credit, because the costs are so high. Most of the people fetches their water from a water kiosk, provided by TAVEVO or the county council that is shifting the responsibility of Mwatate Water Supply to TAVEVO. The TAVEVO water kiosks in Mwatate centre, normally sell water at 2 shillings per 20 liter, but during the dry spell, there is not enough water in the pipelines so that it would reach the lowland Mwatate. During those times people need to buy water with 5 shillings per 20 liters from those who sell water from the same pipeline further uphill or from the boreholes in Kipusi Valley. Water in the boreholes is often considered salty. Sometimes when the water does not reach the lower catchment areas, people also go to collect water at the main intake point, causing a threat

of contamination of the sources. Those people who have difficulties in moving or do not have enough time to fetch water by themselves are forced to buy water from the vendors and due to the transportation costs the price may be even 50 shillings per 20 liters. There are few free water sources in the lowland Mwatate area. However, some people fetch water from the Mwatate wetland or the Sisal Estate dam although the water in those is not always considered very clean. During the drought, the Sisal Estate managers sometimes also restrict the access of people to the dam, because they fear that the dam will dry up or that they will do fishing in the dam.

The main hospital in Mwatate does not have running water, but there is a plan to have it in the near future. According to an assistant from the Public Health office at the Mwatate District Hospital, during dry spells, the pipeline that brings water to a tank does not have water and hence they have to buy water from individual water vendors who bring the water from the hills with trucks. The assistant said that the Ministry of Water has not been able to help them lately. The respondents who say they sometimes get water in their homestead are those who say there is not enough water for a constant supply or that the availability is seasonal. These are mainly those who are connected to a community water project (e.g., Josa-Modambogho).

Table 13. Household water costs per month

	Cost/month (Ksh)						% of monthly income					
	Wet season			Dry season			Wet season			Dry season		
	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average	Max
Wundanyi	0	221	2000	0	222	2000	0.0	2.0	18.0	0.0	2.0	18.0
Mwatate	0	287	2500	0	622	6000	0.0	5.4	40.0	0.0	8.6	90.0
- Upland	0	119	1200	0	127	1200	0.0	2.0	20.0	0.0	2.0	20.0
- Lowland	0	372	2500	0	860	6000	0.0	7.5	40.0	0.0	12.9	40.0

Notes:

Wundanyi wet season cost: n=44

Wundanyi dry season cost: n=39

Wundanyi wet season % of monthly income: n=44

Wundanyi dry season % of monthly income: n=39

Mwatate wet season cost: all n=45, upland n=15, lowland n=30

Mwatate dry season cost: all n=43, upland n=14, lowland n=29

Mwatate wet season % of monthly income: all n=38, upland n=14, lowland n=24

Mwatate dry season % of monthly income: all n=36, upland n=14, lowland n=22

The average monthly income in Wundanyi is 11 100 KShs (n=8) and in Mwatate 5944 KShs (n=9). These may be overestimations, since many poor farmers were not able to estimate their income or it varied a lot within a year. Percentages of monthly income are calculated using these figures for 2013 interviews.

In Wundanyi Catchment, people generally spend less time for fetching water than in the Mwatate Catchment (Table 16). In the Wundanyi catchment, people rarely spend more than half an hour per day to fetch water, mostly only 5 to 15 minutes. Many households are connected to the water supply system provided by TAVEVO or community water projects. Thus they don't have to spend time for fetching water outside their compound. However, sometimes during the dry season there is not enough water in the pipelines and people need to search for water from rivers and springs. According to informants, this happens about 2-3 times a month. In some areas, water is also rationed so that during a few days in a week water is directed to other areas and blocked from the others. Some people have solved the problems caused by rationing by storing water in tanks during those days when water is available in the pipeline. During the rainy season, many people also collect rain water, which reduces money that is used for water and also saves time. During the wet season, people in lowland Mwatate actually need to spend less time for fetching water than people in the upland areas of the Mwatate catchment. However, during drought people in lowland areas of the catchment may have to spend several hours queuing for water at the source.

According to the National Drought Management Authority, in August 2013, the average distance for households in Mwatate area to access water was 2.37 km and average time to access water was 1.7 hours per household (NDMA, 2013). Some people also buy water from vendors, who transport the water from the source to the buyer. Although this is expensive, it saves time and energy.

Table 14. Time used for fetching water per day

	Wet season (h)			Dry season (h)		
	Min	Average	Max	Min	Average	Max
Wundanyi	0	0.32	2.5	0	0.59	2.5
Mwatate	0	1.01	9	0	2.94	16
- Upland	0	1.36	6	0.23	1.88	3.33
- Lowland	0	0.90	9	0	3.35	16

Notes:

Wundanyi wet season n=35

Wundanyi dry season n=23

Mwatate wet season: all n= 37, upland n = 13, lowland n=24

Mwatate dry season: all n= 24, upland n = 7, lowland n= 17

In the light of the criteria asserted by the Ministry of Water (outlined in Box 2.), for the people in the lower part of Mwatate Catchment, water is not available, accessible nor affordable, especially during the dry spells. During the dry spell, the share of the household income spent for water exceeds the 5% threshold by 7.9 percentage points in the lowland Mwatate (table 15). Even during the wet season the threshold is exceeded by 2.5 percentage points. In Wundanyi catchment and uplands of the Mwatate catchment, the share is below the 5% threshold.

In Wundanyi catchment, a clear majority of the household informants (60%) say that they have enough water throughout the year. Of the respondents 24% have enough water only seasonally and 10% say that they always struggle to make the water last for everything (6% were not asked or did not use water in their business). On the other hand, almost half of the interviewed household representatives in Mwatate indicate that they only have enough water during the rainy season. Over 24% say they never have enough water for their needs. At the time of interviews lower Mwatate was suffering from drought, which possibly affected the responses. The respondents who never suffered from water shortage lived in higher areas of the catchment (Ngerenyi, Chawia or Wusi). On the other hand, people living at elevations above the water source areas also suffer from the lack of water, because there is not enough pressure in the pipes to pump the water all the way up to the hill tops.

In the Taita Hills, the hilly topography poses challenges for fetching water, and therefore, the mere distance is not a good measure of access to the water source. Especially, the elderly people find climbing the hills difficult and therefore it may take a lot of time for them to fetch water if they are not able to pay for the vendors or get any relatives to help them. In the lowland Mwatate, the long queues especially during the dry season, need to be taken into account when the access to the source is assessed.

Box 2. Criteria for water accessibility (MoWI 2007)

Affordability: The costs of securing water should not reduce any person's capacity to purchase other essential goods and services and **should not exceed 5% of the household income**. This threshold can be achieved by offering social tariffs (cross-subsidisation) and low cost technologies.

Availability: Continuous supply of an amount sufficient for drinking, food preparation, personal and household hygiene and washing. **Basic access is defined as 20 litres per person per day**, while 50-100 litres per person per day is needed to maintain a basic level of health. 7.5 litres per person per day will provide sufficient water for survival needs. Securing sufficient water also requires a source within an acceptable distance and time under the specific conditions. This includes satisfactory opening hours for kiosks and other public suppliers.

Access: Water must be accessible close to households, educational institutions, workplaces, public installations and places, etc. **Water facilities must be publicly accessible (no dependency on private or neighbourhood providers)**, be in a secure location (physical security especially for women collecting water) and address the needs of different groups. **It should not take more than 30 minutes in urban areas to collect water (full cycle) and the distance to be covered in rural areas shall not be more than two kilometres.**

3.3.3 Water conflicts

We got somewhat contradictory answers when we asked people about the water conflicts in the study catchments. Most of the respondents told us that the conflicts occur relatively often. However, there were also some respondents who denied the existence of such conflicts. These may be individual cases where the respondents have not had any personal experience of the conflicts in his/her living area.

The most common cause of conflict is that people living in upstream areas divert water from the streams to their fields for irrigation or fish ponds or tap the water, which reduces the river flow downstream. For example, the representative of the Upper Mwatate WRUA told the following:

"they [people living in upstream] use the water for irrigating their shambas, water is there for them, but they forget that other people are downstream, they need the same water, even animals... wild animals."

A large part of irrigators are not within any registered group and have their own systems of managing their resource. Irrigation has been practised in Taita Hills already before the British came, by digging furrows (or canals) from river courses to pass several shambas (Fleuret, 1985, and local stories). These groups were formed by family lines, which usually meant the neighbouring households. They would have their own systems of regulating, who would irrigate and when. However, recently irrigation has taken forms of hose pipes and "money-makers" (water pumps) and people have started doing irrigation on their own, without respecting others. It was stated by a few older interviewees that nowadays people don't really know how to share anymore and often divert water only to their own shambas. This has made the regulation of resource use more difficult because there are no proper arrangements on the use of the resource. This results in conflicts in cases where some people irrigate crops upstream limiting stream flow thus denying access to downstream users.

Sometimes the land owners also think that a spring or a river on their land or bordering it is their property and that they have a right to restrict the access of the other people to the source. They may also use chemicals in the vicinity of the source and pollute the water. Some people also claim that there is a lot of corruption going on in the granting of permissions to use the water sources and thus the large water users, such as the Sisal Estate in Mwatate can easily get permits to use a source even though a community is against it and it is not their land.

Sometimes the conflicts take the form of vandalism. For example, Iyale-Msidunyi project members narrated that people living near the water source vandalize the pipes that are set up by the project. They believe that the reason for this is that people at the source do not want other people to benefit from the water.

Some people also refuse to pay for water to the providing organizations. That is maybe because they are used to getting water for free from the streams or springs and cannot understand why they should suddenly pay for it.

According to some elderly people, the water conflicts were not so serious in the past. This is maybe because the resources have become scarcer or because there are more users. On the other hand, they also claim that people have become more selfish. For example, the village elders in Wundanyi sub-location associate this with the losing of traditions:

“And behaviour... the way they hear people elsewhere behave, they copy that and come to do it here, but people in the old days had love (kinship)”

According to manager of WRMA, there are a lot of water-related conflicts in the Wundanyi area, for example. The manager told us that WRMA may help people to solve water-related conflicts:

“Some [times] we have solution for them, the others [...] we don't have solution for them. Those which we don't [...] we advise them to go to court. [...] So if your neighbour has closed all the water, and you're downstream, and the person is upstream, you tell him to open. If he doesn't have any permits, or then if he has a permit, and he has closed, then we regulate him.”

However, the local people do not normally mention WRMA, but talk more of local conflict resolution. In Wundanyi sub-location, for example, the village elders have organized a committee, which can be used for conflict resolution among the water users. If they are not able to solve the conflict otherwise, they may need to charge the person who is misusing the water or not paying for it or even disconnect him/her from the pipeline. In some cases, people can be taken to the chiefs, but they don't always have the power to do anything. Sometimes the chiefs call the government officers to help to solve the disputes. In some cases, nothing can be done and the person is left alone, because there are no ways to take a person for example to the court.

Conflicts between human and animal water users are also common. For example, during the dry season, elephants come closer to the hills to search for water and food destroying people's crops on their way. This occurs even in Mwatate River valley from time to time. According to Wildlife Works, in some locations outside our study areas, biological weapons have been used to fight against the invading animals. Examples of these are planting chilli threads around the crops and using bees to scare away the elephants.

3.3.4 Disappearance of fish from natural streams

Along with reduced water provisioning, food provisioning in the form of fish in the natural streams has also ceased. The older locals report that they used to do fishing in the rivers of the Taita Hills when they were young, but nowadays there is no fish because of the reduced water levels and lowered water quality. According to our study, the fish provisioning stopped between 1950's and 1960's. However, fish production has again become an important livelihood source in the hills with the recent introduction of fish ponds in the area under the Economic Stimulus Programme (ESP). However, some people claim that the fish ponds use too much water and contribute to the pollution of natural streams, even though according to the Fisheries Department, seepage and chemical and water use in the fish ponds is controlled.

3.4 What has caused the environmental degradation and the water problems?

In the workshops, the participants marked some changes that have occurred in the water resources in the timelines. All the timelines reflected the impacts of the important nation-wide phenomena, like the period

of colonialism, arrival of missionaries, World Wars, independence, and demarcation of land. However, there were also some differences between the two catchments. For example, in Wundanyi, the World Wars were not mentioned at all, whereas in Mwatate, they were considered very important, since some of the battle fields were located near Mwatate and the old railway line, still present on the southern side of Mwatate centre, but not in use nowadays, was once used for carrying soldiers and resources to the battle fields. The higher upland areas, on the other hand, obviously remained quite isolated during that time and people were not really affected by the war. The main events from the timelines are summarised in Figure 11. We analysed the timeline data together with the interview materials and identified some historical events that have somehow affected the water resources and ecosystems that they depend on.

3.4.1 Land demarcation and privatization

Many of the local institutions and community groups interviewed indicated that the reduction of water levels in the Taita Hills is caused by land use changes in the catchment areas, especially through deforestation activities and encroachment of springs and wetlands. On the other hand, several people believe that increased human population has caused considerable pressure on water-related ES especially in the highland areas of the Wundanyi and Mwatate Catchments. In the past these areas used to be very favourable for agricultural production and thus they are densely inhabited. This is the reason why population increase is usually considered to be the main driver of the environmental degradation in these areas. However, we suggest that population increase alone does not explain the deforestation and reduction of water quantity and quality in the area, but we argue that degradation originates from the land consolidation and privatization process that started in the 1960's.

During the demarcation of land, land was assigned to private owners despite their earlier communal uses. Some people were given plots in forested areas. In order to continue farming, they needed to cut down the trees, which increased the deforested area of the Taita Hills in a large scale. Some forested areas that were earlier used for grazing were also given people for farming, for instance, in Sungululu area on the slopes of the Shomoto Hill. As a consequence, livestock farmers did not have other choice but entering the remaining forest areas, where the grazing contributed to destruction of forests.

Although the land adjudication process tried to take into consideration and set aside sensitive ecosystems to be managed as communal areas by the County Council, many water areas were still left within private lands. At the same time, rivers were used as boundaries of demarcated land areas and hence the current titles to land cover areas up to the river banks. It appears that the land adjudication process did not comprehensively consider the protection of these crucial areas during the allocation of titles. It also did not give river and spring water clear status as common pool resources¹⁵. Therefore, currently many farmers consider that they own the water that crosses their land or borders it. Furthermore, land adjudication was short-sighted, since it did not consider the natural population increase, and thus privatization has made land inaccessible. Farming in small and strictly enclosed plots has also led to intensification of farming, which has resulted into reduced soil fertility. Thus, the increasing demand for agricultural land and intensification of its use has caused pressure on water sources and indigenous forest ecosystems. Local institution representatives explain that people cut trees and cultivate near riverbanks or within wetlands, because they are the only areas with constant water availability and because it seems like the only viable livelihood option. If the land adjudication had been based on commonly owned lands instead of rigidly imposed private holdings, it would be easier for farmers to use the land more flexibly for their subsistence. This would have of course, required adequate governance and a strong local monitoring system.

¹⁵A resource that benefits a group of people, but which provides diminished benefits to everyone if each individual pursues his or her own self-interest.

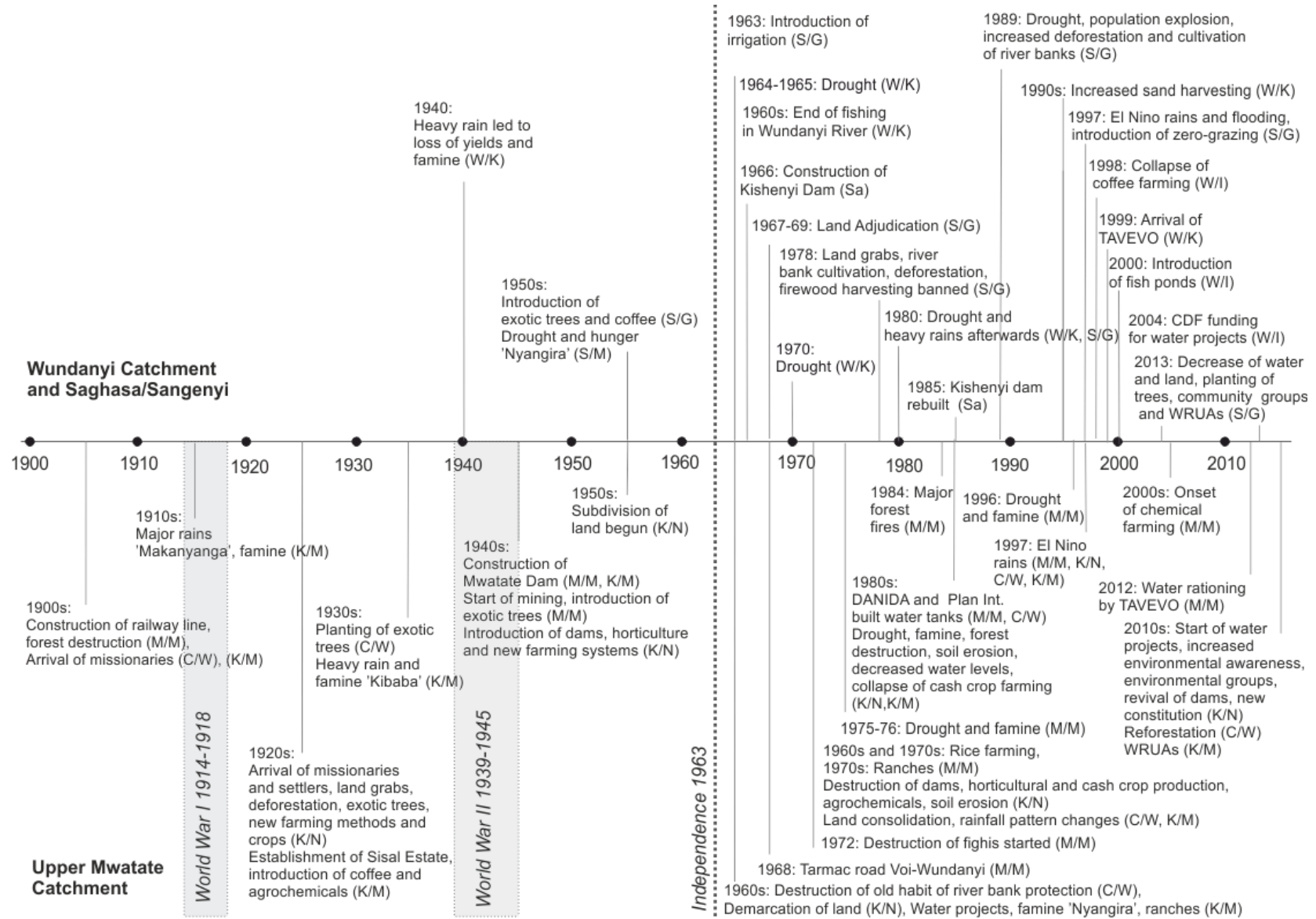


Figure 11. Combined results of timelines from Wundanyi and Mwatate catchments. Groups: K/W =Kitukunyi/Wasinyi, W/I= Wesu/Iyale, S/M= Shate/Mbirwa, M/G= Mogho/Sungululu, M/M= Mwatate/Mwachabo, C/W = Chawia/Wusi, K/N= Kidaya/Ngerenyi, K/M= Kishamba/Modambogho, Sa=Saghasa/Sangenyi

Even today there are still some lands, such as forests and wetlands that have not been demarcated and which no one is supposed to encroach. However, illegal logging and cultivation have become common in those areas due to lack of enough fertile land in privately owned areas. One example of an area, where we learnt that a lot of illegal encroachment takes place is the Kipusi valley, which forms the central eastern part of the Mwatate Catchment. It contains one of the most important wetlands in this area. Although this wetland is natural, the locals call it 'Ngulu Dam'. We learnt that its encroachment started during a severe drought in 1978 when the area chief had to allow the local farmers to cultivate the land around the wetland in order to produce food. However, the clearing and cultivation of land did not stop after the drought and people still feel that the wetland is the only place they can have reliable agricultural production, given the generally dry conditions in the lowlands of the Mwatate Catchment. According to estimations by local people, the size of the wetland has reduced by up to 75-90% due to severe encroachment. Although this important wetland is considered as community land under the protection of the County Council, there is no adequate control of the activities within Kipusi valley. This is because the institutions feel they do not have enough power or legislative backing to enforce protective practices. Thus the wetland seems to be facing extinction in the near future, although after heavy rains of October – December 2013, the dam was recharged with water draining from the hills in Chawia. The Kipusi valley also has cultural significance because it has a sacred forest, Kilulunyi shrine, within it. Before the agricultural expansion began within it, the valley was covered with indigenous forests but today there are only small remnants left.

Land demarcation had also important social implications, because people believed that there was a lot of corruption and unequal distribution of land and that those who had more money were given land in fertile areas while the poorer ones were given the less productive land. A person from Sungululu/Mogho area recounted that, *'If you were absent working in other towns like Mombasa, your land was given away to somebody else'*. Losing of land in such ways deteriorated the quality of life and caused hatred and conflicts.

3.4.2 Loss of the indigenous forests

Like outlined above, the demarcation of land led to increased cutting down of indigenous trees in the catchments. This has formed a vicious circle in relation to water provisioning. This is because the removal of indigenous trees reduces the water retention capacity of the catchments and exposes land to increased soil erosion (Bruijnzeel, 2004). This decreases soil fertility and together with sand harvesting, increases the siltation of rivers and dams. According to older residents, the gradual reduction in water levels reached its peak during the 1980's and 1990's. Before that, the Taita Hills area and especially in the hilly upper zones of the Wundanyi and Mwatate Catchment is said to have been wet throughout the year:

'The area was wet [...] because of those indigenous trees, whenever you passed below the forests, you will think it's raining, but it's not raining, every time the ground was wet.'

Also according to the local institutions, deforestation in one of the main sub-catchments at Iyale Hill within the Wundanyi Catchment has caused most of the springs in the area to dry up. Some respondents blamed the introduction of power saws in the area, which have made the felling of trees for timber quite easy. General poverty and lack of employment also drive people to turn to the local forest resources for their livelihood needs.

3.4.3 Introduction of the exotic tree species

Some respondents also consider the exotic trees, mostly the *Eucalyptus* species, to be responsible for the falling water levels (Fig. 12.). According to local people, they were introduced in the 1930's in Mwatate and in the 1950's in Wundanyi by the colonial settlers and later their planting was supported by the Kenyan government. These trees draw a lot of water from the soils (Scott and Lesch, 1997; Scott et al., 2005), and in fact according to local people, were initially used to drain off excess water from the areas designed for cultivation, construction or recreation. One such dried area is the Dawson Mwanyumba stadium in

Wundanyi River valley (Fig. 13). This former marshland is currently a famous place for sports and other events.



Figure 12. Badly eroded hill slope with Eucalyptus trees in Sungululu area (Hohenthal 11.8.2011)



Figure 13. Dawson Mwanyumba Stadium - the former wetland next to Wundanyi town (Hohenthal 30.1.2014)

However, later the local people realized that these fast growing trees could also be sold for timber and turned into money, which increased plantation of the trees in other parts of the catchments. Most of the trees were planted without any planning or advice, which led to an uncontrolled destruction of the indigenous forests. However, the planting of eucalyptus was also a planned undertaking by the government to get timber for electric poles. This happened in Shomoto hill, which was gazetted by the government and planted with eucalyptus trees. The residents of Sungululu shared that this hill used to be only covered with grass and it was used as a common recreational area for picnics, and sometimes also for taking animals to graze. Some residents believe that after the introduction of the eucalyptus on the hill, various springs dried up in its surrounding. The eucalyptus was also introduced in the Iyale forest. A member of the Iyale/Wesu group describes the change that took place in Iyale forest in the following way:

'[...] when civilization was coming in, we had all trees indigenous but now we got [...] eucalyptus. [...] we started receiving trees from other countries [...]. So the water level started going down instead of going up. So this is a problem we are facing. We need also to maintain the forest and to plant indigenous trees, so we can have [...] more water.'

In Mwatate workshop, people also discussed the changes that have occurred in catchment forests. Kidaya/Ngerenyi group member described the change in Mwakivua forest in the following way:

'The example of Mwakivua forest, this forest was so dense and it used to be so foggy even during the day and when you happened to be in that forest it seemed like it was raining all the time. That's why it is called Mwakivua. Mvua means rain. So there is need to plant more indigenous trees and rehabilitate the forest.'

Most institutions now value indigenous trees because they recognize their higher climate and water regulatory properties, and have therefore started encouraging their replanting. However, most local people still prefer exotic trees because they grow faster and produce quicker economic returns, while indigenous trees take many years to mature. *'In fact you might die before you get the products'*, one respondent stated. Kenya Forest Service (KFS) also supports commercial forestry, which uses exotic tree species especially for timber, and they have argued that without them the demand for timber would not be met.

3.4.4 Agricultural expansion

The majority of the present farming in the Taita Hills is subsistence farming. Along with staple crops such as maize, some vegetables like tomatoes, cabbages and cucumbers are grown in the moist areas. The use of chemical fertilizers and pesticides is also common. Of the global cash crops, coffee and to a minor extent tea, were introduced in the Taita Hills in the 1950's and then abandoned in the 1990's due to a drop in world market prices. These plantations not only contributed to forest clearance, but also affected the current land ownership because during land demarcation, cash crop farmers received plots in more fertile and moister areas.

Also livestock rearing is common in Taita (Table 17). The livestock consumes lots of water and can decrease the sustainability of the water use. On the other hand owning livestock can mean that the household is wealthier than it otherwise would be.

Table 17. Livestock owned in the two catchments

Livestock owned	Wundanyi	Mwatate
none	39.1 %	34.6 %
1-3	49.9 %	46.2 %
more than 3	11 %	19.2 %

3.4.5 Changes in precipitation

Many respondents also state that rainfall variability has increased in the Taita Hills and indicate that it is currently common that seasonal rains arrive late or are scarce. Some people believe that this is related to ongoing global climatic change. Whether this is the case or not, it is obvious that irregularity of rainfall affects natural water provisioning and change the seasonality of ecosystem functions.

In Wundanyi workshop, people described the changes that have occurred in rainfall in the area. Shate/Mbirwa group told that

'Before independence [...] It was easy to know when it will rain and so easy to plan farming activities. There was this period in May after the 20th when it rained for a maximum of 8 days. This type of rain was known as Kittuo. Before it started, the wise women would collect and store more than enough firewood and food for use at that period, because it would rain day and night. The unprepared women would be going to the wise ladies to beg for firewood and food. After the Kittuo, temperatures went low and it became too cold. Only the wise people would wash their bodies, some felt it was too cold and decided to stay without taking bath. This was good time for the boys to get married. They felt that a good wife is one who bathed even at the time it was too cold.'

However, currently things are different:

'[...] one] can no longer predict when it will rain. No Kittuo except this May 2013. However, it arrived too early and with more rainfall than used to be.'

Although people said that the rains used to be more regular and often also more abundant in the past, also some periods of drought also occurred. For example, according to Shate/Mbirwa group, the drought in the 1950's was very severe. This is illustrated by the fact that people were forced to take the animal skins that were normally used for making beds and cook them for food. Some food aid was also provided during that time. This was yellow flour made of maize that tasted bitter, which gave the time period its name *Nyangira*. The Sungululu/Mogho group considered the big drought in the 1980's the onset of the water problems in the area, because it was followed by many seasons of scarce rain. The El Niño also affects the rainfall pattern in the Taita Hills. Many people in Wundanyi and Mwatate catchments remember how in 1997, El Niño rains caused severe flooding in the area and destroyed crops and killed livestock.

3.5 How have the institutions and community groups responded to the local water problems?

As local institutions and community have become more aware of the problems with water and the related ecosystems, they have introduced different responses in order to reverse the negative development. Some of these are part of the national scale legislative reforms, such as the introduction of the WRUAs, or inspired by the other national or even international environmental initiatives, such as tree planting. However, all the responses aim to serve the solving of the local problems.

3.5.1 Tree planting

Many local institutions are also currently involved in tree planting and reforestation initiatives. Tree planting has been widely adopted and institutions are undertaking massive tree planting campaigns as well as encouraging local people to establish tree nurseries and plant trees to protect water catchments. Tree planting is mainly motivated by the Forest Policy, implemented through the Forest Act (2005) by KFS, which requires them to attain a 10% tree cover in Kenya, as stipulated in the National Constitution, within the decade (GoK, 2010a; MEMR, 2007). One important strategy highlighted in the Forest Policy and the Forests

Act (2005) for increasing national forest cover is 'Farm forestry' (GoK, 2005; MEMR, 2007). It has been strongly adopted by the Ministry of Agriculture, which highlights the need for the realization of a 10% tree cover in its policy, the Agricultural Sector Development Strategy (ASDS) (GoK, 2010b). Hence the Agriculture Act on Farm Forestry Rules (2009), require farm owners to maintain at least 10% forest cover in their land holdings (GoK, 2012a, Cap 318). These rules provide guidelines on the types of trees to be planted, indicating that 'the species or varieties of trees planted should not have adverse effects on water sources, crops, livestock, soil fertility and the neighbourhood and should not be invasive'. Specifically, the rules direct that no agricultural landowner is allowed to grow or maintain any *Eucalyptus* species in wetlands and riparian areas.

Reforestation has, however, faced challenges in the Taita Hills and in the past, many tree planting activities have failed due to poor coordination and organization. For example, farmers have been encouraged to grow tree seedlings but once they are ready for planting, there is no system in place to buy the seedlings for distribution. Furthermore, there has been low capacity to sustain planted trees to maturity. Sometimes locals do not offer full support for these initiatives or curtail the efforts owing to their traditional beliefs. In one occasion, for example, a local institution planted 40,000 seedlings to rehabilitate a degraded area. However, some locals started a forest fire during the dry season and destroyed all the trees, due to their belief that this practice would attract rainfall.

3.5.2 Education and awareness-raising

Other interventions by institutions include education and awareness programs. For example, the Ministry of Agriculture educates farmers about environment-friendly cultivation techniques to mitigate catchment degradation. The Ministry of Livestock and local NGOs are also training people to explore alternative livelihood options that demand less land and water, such as bee keeping, poultry and rabbit farming. Local institutions also emphasize the need to increase rainwater harvesting. However, they say that required facilities are not available as funds are limited. Therefore, much of the rainwater that could be stored in the wet season and used during the dry season is wasted.

Furthermore, to ensure the sustainability of interventions as well as to provide validity and 'ownership' of responses, institutions are increasingly using local communities to manage the ecosystems while encouraging community-driven initiatives. This is because in the past, institutions introduced and implemented projects with little community involvement. However, most of these interventions were abandoned by the community as soon as they were handed over to them, because they felt that projects were imposed on them. Ultimately, maintaining and improving local farmers' income should be the key target of resource management, because only in that way it is possible to reduce the pressures on water-related ES in the long-term.

3.5.3 Soil conservation and protection of water resources

Several institutions also carry out interventions related to soil and water conservation. The Ministry of Agriculture and World Vision, for example, have established structures that can conserve soil on the farms. These structures include *terraces* on the hilly areas to control erosion. *Zai pits* and *V-bunds* absorb rainwater and maintain soil moisture for longer periods, enabling crops to grow even during the dry season.

Another activity the Ministry of Agriculture along with KFS and locals NGOs undertake is riverbank protection. For the just ended (2012-2013) financial year, the Wundanyi office had set a target to implement 35 kilometers of riverbank protection and conservation activities. The strategy behind this is that, instead of completely banning cultivation along riverbanks, the farmers are encouraged to plant crops that do not need regular cultivation such as napier grass, sugarcane and bananas.

The KFS officers together with local NGOs and WRUAs have also conducted assessments of water resources, especially the condition of riparian areas and springs. Already some area chiefs together with CBOs have planted indigenous trees along the riverine areas. Attempts to fence wetlands and springs have also been carried out, though at times these activities are challenged by inadequate funds. Some institutions have also suggested even more drastic measures such as resettling people living in the hills to the lowlands and planting trees in the higher areas in order to reverse catchment degradation and restore the areas to their original condition.

3.5.4 Water conflict resolution

In order to prevent the overuse of water resources by a few users, the County Council and the Ministry of Water together with the local chiefs carry out regular patrols along the rivers, when the water levels at the intakes decrease. They inspect the streams for cases of water diversion for irrigation to ensure people downstream too get water. The chief in Chawia told that she has several hoses in her office that have been confiscated during drought spells along the rivers. Water conflicts between local users are normally mediated by the chiefs and village elders and the water office. The commonly used strategy is talking sense to the people and making them understand the consequences of thoughtless behaviour e.g. stream diversion during drought spells. Likewise in cases of vandalism the water projects may call the chiefs to assist them in solving the issue in case the problem cannot be solved amongst the community members. Often the reasons for conflicts are perceived unfairness, where some benefit from the source and not others. The Dembwa-Wusi water project had a great strategy to deal with this problem – they installed structures next to the source, but outside the fence, so that people living around the source could continue getting water.

3.5.5 Search for new water sources

Since some of the major water sources in the Taita Hills have now become seasonal, some institutions, for example the Mwatate County Council is now forced to look for other reliable sources elsewhere. These include developing alternative water sources such as boreholes, dams, water pans and shallow wells in drier lowland areas of the catchments. Some larger scale ideas include sourcing water from neighbouring districts from permanent sources such as Mzima Springs or Lake Challa.

3.6 What are the challenges of water governance and management?

While some challenges faced by the different stakeholders in water sector governance and management have already been mentioned in the previous sections, in this section a few central challenges are further highlighted.

3.6.1 Inadequate resources, weak governance and conflicting policies

Water and natural resource managers face numerous challenges in trying to implement the interventions to sustain water-related ES. Some of these challenges stem from practical aspects such as limited technical and financial capacity, while some arise because of the absence of adequate legislation or authority to enforce regulations. Many of the institutions are under-staffed. Therefore, lack of field staff and extension officers has made it difficult for government agencies to follow up the implementation of regulations such as those concerning riverbank protection and water abstraction. In fact the extension services for all the government departments have become “demand-driven” meaning that the communities themselves are responsible for seeking guidance. However, many community groups have complained that they have to pay “allowance” for the officers, i.e. for transportation. The community members feel that they should not pay for this, and in order to save their money, they come up with their own solutions. Another fact is that the officers are often shifted rather quickly from various areas, which makes it impossible for them to understand the local situation. The community members have complained that the officers don't really know or care about their problems, and therefore are discouraged to seek for their assistance.

An example of an under-staffed and inadequate extension is the regional Water Resource Management Authority (WRMA) office, which is located in Mombasa, 179 km from the Taita Hills. The WRMA officers do not visit the area very often due to the fact that the WRMA office has a mere “skeleton staff”, as several officers there referred to themselves. When looking at the sectoral funding (Figure 14) it is clear that water resources management is not getting adequate funding especially comparing to water supply which has received more (Rampa, 2011). This was also evident while visiting the office complex of WRMA and CWSB in Mombasa. Just comparing the amount of vehicles available for CWSB and WRMA (practically none) is evidence that WRMA lacks resources, both human and financial. In the study area this has resulted in the slow response to issues and has made the implementation of Catchment Management Plans in the Taita Hills difficult, including capacity building of the Water Resources Users’ Associations (WRUAs), which usually consist of ordinary community members with no expertise or technical know-how concerning water management. Most local institutions are aware of the existence of WRMA but have not collaborated with them in any way. The Upper Mwatate Sub-Catchment Management Plan blames the lack of sensitization by WRMA for illegal abstractions. In addition, no water allocation plan has been made for the area yet (Upper Mwatate WRUA, WRMA & other stakeholders, 2012).

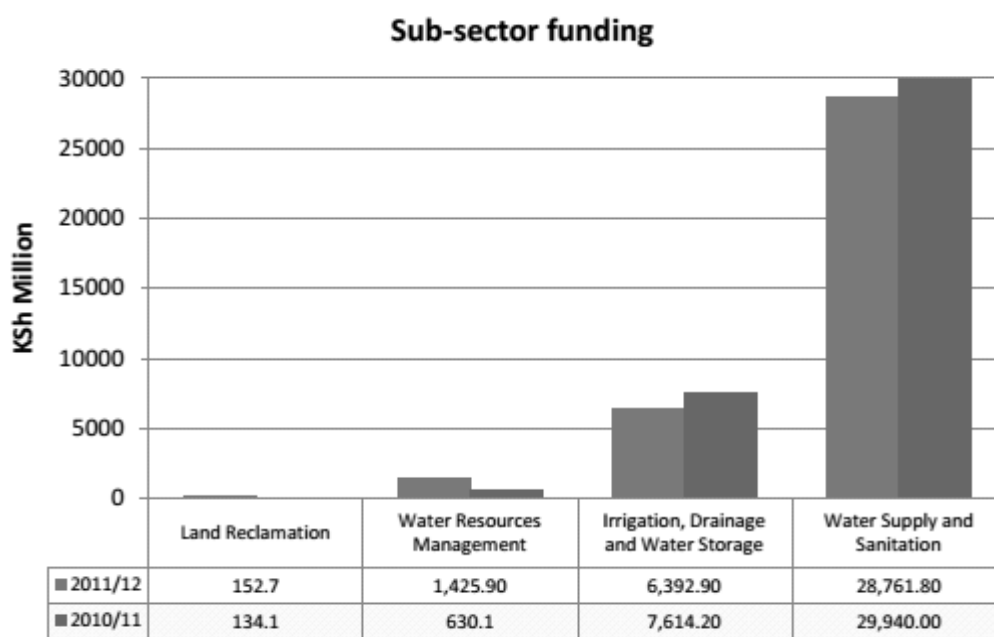


Figure 14. Funding of water sub-sectors (Source: MoWI, 2013)

As was mentioned earlier, the water reform process has given a more responsible role to NGOs in supporting the community level water service providers (water projects) as well as the water resource management groups, to the WRUAs. By so doing the process has decentralized the role of the state institutions to a supervising one. However, as was stated by one of the respondents, the NGOs are very confined to their specific projects, and therefore they are only able to support the community groups e.g. the WRUAs, but not directly involve in their projects. Therefore, the support of the regulatory institutions, in this case the WRMA, remains essential in capacity building the community.

Local institutions also indicate that law enforcement has been difficult since the last amendment of the Chiefs’ Act in 1997, which reduced significantly the local chiefs’ authority. In its current form, the Chiefs' Act gives local administration officers a mandate to issue orders for preventing the pollution or obstruction of water sources, for regulating the cutting of timber and prohibiting destruction of trees (GoK, 2012b). However, their power is limited by the weak sanctions they can impose on defaulters, the fines not exceeding 500 shillings (5.78 US dollars) - an amount that can be very easily raised by any defaulter.

According to the Ministry of Lands, the officers have no control over private land once it is registered. Protection of riparian areas is regulated by the Agriculture Act on Basic Land Usage Rules, 1965, issued by

the Ministry of Agriculture, which restricts cultivation, soil disturbance, vegetation clearing or livestock grazing on any land lying within 2 metres from a small watercourse and 30 metres from a large watercourse (GoK, 2012c, Cap 318). However, local officers express frustration for not being able to interfere with any land use or even to stop the illegal logging of indigenous trees, for example, in large ranches near Mwatate.

3.6.2 Challenges with water service providers and water supply development in the area

Despite the fact that the sectoral funding for water supply is much higher than for water resource management, the water service providers still face many challenges. To begin with the county water company, TAVEVO, does not get adequate funds from the revenue it collects from the customers, but have to source for donor funding to rehabilitate or develop water infrastructure. One of the major problems is the poor state of the aging infrastructure which challenges the viability of operations. Another problem is drought, which forces the company to ration the water.

The community water projects consist of differently established groups, sometimes but not always from the initiative of the community themselves. Before the Water Act 2002, the government had already started the “handing over” process of some of the water supply infrastructure to community groups. Some groups, like the Dembwa-Wusi water project in Mwatate catchment was started like this, and further developed with funds from the Constituency Development Fund (CDF). Many projects in Wundanyi catchment, were initiated by the community, and sometimes by politicians through the CDF. Some were started by Donor organizations like DANIDA (e.g. J-M project), which were more or less initiated by the donors themselves, not the community. However, for all projects, a registered management committee with a constitution and by-laws has to be established in order to get the funds. The projects are supposed to fund themselves and take care of the maintenance of the infrastructure.

The projects face a lot of challenges in terms of technical management and financing their activities. In both catchment areas, people reported that a common problem with the community water projects is the lack of funds for the maintenance of the infrastructure (Fig. 15). Most of the infrastructure is old or has not even been taken into use because of declining water levels. Leaking pipes and junctions are really a problem because they are wasting the valuable water. Another general problem of the water infrastructure in the catchment is also vandalism as people are stealing metal structures and selling them as scrap metal.



Figure 15. In many cases, the maintenance of the water structures falls on the community members themselves, who might not have the technical knowledge or funds to repair the water infrastructure. These pipes on the top of Kiangungu hill were leaking in February 2013 and thus a village nearby had been without water supply for three weeks (Kivivuori 2013)

A contributing problem to the difficulties in operating the projects seems to be that once people have owned the project, they feel that it is theirs, and that they shouldn't have to pay for it any longer. This happens especially with CDF funded projects, as the budget comes, in the end, from taxpayers. Another factor, especially in the drier areas of low lands is that water doesn't often reach down, and water is rationed so that it comes only once or twice a week. Already poverty struck people, might not feel the sense of paying for occasionally appearing water from a pipeline, and if capable, they resort to getting water from the natural courses, which is free. Hence the maintenance of the infrastructure becomes difficult, with only scarce assistance from the Ministry of Water with its limited budget. The reform further encourages the principle of cost – recovery, making the communities even more responsible for financing their activities. However, since the socio-economic situation of people in the area varies so much, it is vital and ethical that the challenged members of the community are considered in the economy of the projects.

It seems that water supply development in the area is scattered, and done by several different organizations, projects and groups. This has been admitted by the local water officers in the area, who have mentioned cases of even other government entities coming up with water infrastructures without informing the appropriate office. Water supply and infrastructure development in particular seem to suffer from “charity syndrome”, that is the fact that it is not done in a systematic and state-led development manner, but rather as a scattered effort by various actors. This brings a great challenge to the coordination of activities, as the coordinating bodies (e.g. Former District Development Committees) don't themselves have the specific mandate of looking into water supply development in the District. As was stated by several interviewees, the problem in the district is poor leadership in the matter, and therefore it is hoped that the new county government will be able to answer to the water needs of its citizens.

3.7 How could the water resources of the Taita Hills be revived?

In the “Water and livelihoods” workshops held in February 2013 and 2014, the participants were asked to give ideas on how to improve the current water situation in their area. These are presented and discussed below. Also the representatives from different institutions gave good suggestions. Finally we add some of our own ideas.

Removal of exotic trees and planting of indigenous species

During both workshops, the local community participants in both catchments generally considered the removal of eucalyptus trees from water catchment areas as important. The local residents shared their experiences of seeing springs drying up after planting eucalyptus, and were therefore for the idea that they should be immediately removed from hilly areas and water catchments. Another reason for their removal, as expressed by a participant, was that they increase the risk of forest fires. However, the KFS officers expressed the need for their *gradual* removal from water catchment areas in order to avoid the risk of landslides, but emphasized that because of the economic benefits of eucalyptus, they should remain in individual farmlands. The local residents further expressed that they should also benefit from the removal of the eucalyptus trees. This would require proper policy and agreement formulation between the community and the government as well as between government institutions.

Both community and officers from the participating institutions agreed that planting indigenous trees was an important task especially in water catchment areas. Indigenous trees should be planted especially at the river banks and springs in order to protect both the sources and the rivers. It was suggested by KFS that bamboo trees would be planted as they grow fast and they are water friendly trees. In Mwatate workshop, Kidaya/Ngerenyi group also suggested that the indigenous forest patches should be fenced in order to avoid illegal logging and encroachment. Protection of shrines was also seen as very vital and it was suggested that committees would be established to look over them. In both workshops, however, the community highlighted that there should be appropriate guidance and financial support for the tree planting activities. In Wundanyi catchment the community also requested that the tree seedlings should be free because they benefit the whole community and area, not just the individual. The response from KFS to this request was that people would not take care of them properly if they didn't feel the pinch of paying “something small”,

in form of the already subsidized rates. However, all agreed that attention should also be put in monitoring to ensure that the planted tree seedlings survive and grow, instead of just planting them. The power saws were also feared to cause rapid destruction unless regulated by the forest officers. The chiefs and village elders were also asked to be careful when admitting the permits to cut trees so that useful trees near water sources would not be cut.

Despite the many benefits of tree planting, we would like to mention that reforestation also contains controversial issues that should be considered. Although the local informants claim that there used to be more water available in the past when the indigenous tree cover was larger, there is not enough scientific research done regarding the forest-water nexus and complex feedbacks and trade-offs between different ES in this area. As the review by Ellison et al. (2012) shows, reforestation may decrease water provisioning in a small scale (<1-10 km²), but increase it in regional and global scales through the intensification of the water cycle. Thus, there is a chance that the direct benefits of reforestation regarding the water remain mainly external to the area. Even if the water retention service of the forests increased the water availability in lowland areas, it might be difficult to convince people living in upstream areas of the benefits of reforestation because it reduces the area of land available for cultivation or growing exotic trees. Therefore, motivating people to plant trees in their fields, would require introduction of new ways, and in some cases, reinventing the old ways (e.g. collection of medicinal plants), to use the forests consisting of indigenous tree species.

Improvement of waste management and pollution control

The second thing that was mentioned in the workshops was that the waste management should be improved in order to protect the water quality. This came up especially in Wundanyi workshop, where the local residents expressed the fear that the Wundanyi prison, and some schools polluted the river with waste water. The public health officer at the 2014 workshop shared that measures had been undertaken to curb the pollution but he confirmed that they would continue the monitoring and would address the issues of waste management in town areas. The officer also requested assistance from the community in monitoring and reporting polluters to their office and NEMA.

Increase of rain water harvesting

The workshop participants of both catchments considered that rain water harvesting, storage and treatment should also be encouraged in order to gain alternative water sources, improve the quality of water used by households as well as to control erosion. The use of rain water for bathing and doing the laundry would also reduce the pollution of the rivers. Treating of tapped rain water is also easier than treating of dirty river water. The community in Wundanyi catchment also suggested that the government should introduce rainwater harvesting systems to public institutions and so give an example of its importance. A participant from Kidaya-Ngerenyi group in Mwatate Catchment suggested that there could be a policy like in Rwanda, where if one builds an iron sheet roof, there must be gutters and some trenches that would take the water for irrigation. That would decrease the run-off from roofs to rivers. It was also requested by the community participants that all households should be provided with water storage tanks and gutters by the county government. Lack of knowledge and funds are normally the main reasons why households are not harvesting the rainwater. Therefore there have been also some initiatives to start building water storage containers from less expensive materials. For example, in Wusi, Chawia, Ngerenyi and Fururu area in the Mwatate catchment, the Plan International used to have a project, which taught women to construct water storage containers from saw dust, gunny bags (made of sisal) and cement, but the knowledge did not spread out of that area and construction was stopped when the project was over.

In both catchments the construction of other water harvesting structures was also considered as an important way to increase the amount of available water for various uses as well as in helping the control of erosion. It was suggested that rock catchment structures could be built to harness rain water for example near Wesu rock. Also on-farm water harvesting could be done by digging a small pit on the land to gather

rain water that could be used for irrigation. Harvesting water from the roadside with dug ponds was also a creative idea suggested by the locals. The Iyale/Wesu group also specifically suggested that a dam could be constructed at the prison farm. This would assist Iyale/Msidunyi water project to supply water further down to Mbale, because there would be enough pressure in the pipes and it would also guarantee the water supply during the dry spells. Another reservoir could also be built below the Iyale peak at a place where a lot of rain water accumulates during the rainy season. The Iyale/Msidunyi water project would also need bigger tanks to store water. In Mwatate Catchment the participants suggested that dams and water pans should be built in valleys and even along gullies to harvest rain water. Dams and water pans would raise the water table in the lower lands and would provide an alternative source of water. It was suggested that this was to be done even if land owners had to be compensated, which had been a problem in the past in both catchments and which had even resulted in destruction of some dams.

Protecting water sources and wetlands

Protecting water sources was seen as a vital strategy in order to maintain the water resources in good shape. For instance, in Mwatate catchment, the Upper Mwatate WRUA shared their plans to protect four springs in each of the locations they cover. The springs to be protected would be the following: Kidaya – Ngerenyi: Mokonde (community land), Mwanjengo (community land), Kwashate (community land), and Takale; Chawia: Mwakishola, Mulungunyi, Mkolonge, and Mwatalu; Kishamba: Rinda, Isaenyi, Embelonyi, and Mbengonyi.

In addition to fencing the springs, the Ngulu dam and the Kilulunyi shrine should also be fenced and people should be educated not to cultivate there. The Lands officers should come to the ground and identify the catchment areas and engage in protecting them together with the WRUAs.

In the Wundanyi workshop, participants also suggested that the Mbirwa wetland should be surveyed so that its boundaries are known and conservation and rehabilitation work can start. The group also wants the wetland to be fenced to avoid encroachment. In Mwatate workshop, a suggestion was made that the wetland surrounding the Mwatate River should be rehabilitated. Pegs (sticks / cemented beacons) should be put up to show the boundaries of the wetland and tell people not to do farming there.

Improving farming methods

In both catchments coming up with better farming methods and practices was seen as an important way to improve the returns from the livelihood, improve food security and protect the water resources and environment in general. In Mwatate catchment it was suggested that new cash crops that give good yields without destroying the environment should be introduced in Taita to improve the economic situation of the people. One such crop could be tea, which is grown in Rift Valley. It was also suggested that people should go for growing traditional food crops like sorghum, sweet potato, pumpkin, green grams and cowpeas which tolerate drought better than maize and do well without much fertilizers. There was also a rightly fear expressed by some community members that the use of agrochemicals would destroy bees and earthworms, which play a vital role in the ecosystems, and also affect the water quality. The officer from agricultural department in Wundanyi also expressed the need to improve the fertilizing practices e.g. using both manure and chemical fertilizers, in order to avoid the run-off of excess fertilizers into rivers and springs leading to their eutrophication. The use of biogas manure to fertilize crops was also suggested as way to improve yields and protect the environment. Soil conservation methods were also encouraged.

Alternative livelihoods and sources of energy to reduce stress on environment

Alternative options for economic livelihoods and everyday practices that would reduce stress on the environment were also discussed in both catchments. In Wundanyi, the TTWF suggested that indigenous trees, specifically the *Prunus Africana* could also provide an alternative livelihood for the locals. The bark of the tree has medicinal values and so it could be sold for high returns, provided that it would be linked to

wider markets. Other suggestions included livelihoods options that don't rely on water or land resources that could be found for example in the service industry. Also the growing of small livestock like rabbits and poultry would reduce pressure on land. Handicrafts and butterfly farming were also good suggestions. The county government representative in Wundanyi also expressed that the community should come to the governor's office to air out their grievances so that viable development options could be explored.

The alternative energy options were also discussed. The use of biogas instead of firewood for cooking purposes could be explored further since there is available support from the biogas project in Wundanyi. Alternatively the Jikos that use less firewood could also be more extensively used.

Empowerment of WRUAs

The central role of the WRUAs in the management of the water resources and related ecosystems came up in both catchments during both workshops. Especially in Mwatate Workshop in 2014, there was confusion about the powers of and relationship between WRMA and WRUA. The fact that WRMA office is giving out permits to various local water users without being on the ground and without involving the WRUA, created a lot of dismay among the local administrators. The chief in Mwachabo questioned why he was taken to court because he tried to stop someone from irrigating, while the aim was to let the people downstream get the water to drink! Even the water officer said that the WRUA should be the body to make sure people get an equal share of water. The Upper Mwatate WRUA also expressed frustration about WRMA's powers to give permits without their consent and about fact that they pay for their own transports to WRMA office in Mombasa, and yet they don't yet have funds to start the activities properly. It was demanded by the locals that WRUAs should be financed and given more power to control the water uses in the catchments. In this way the WRUAs could act as community planning agencies, for example by using the participatory mapping method, and they could follow up on issues like setting aside land for water sources. Once given funds and further empowerment, the WRUAs could also become more active in conflict management between different water users. This is because currently, the legal power they have been given to resolve the conflicts at the community level has been constrained by lack of funds to take people to court.

Capacity building and change in attitudes

It became clear in all workshops that there is a need for more education on water issues but also just pure change in attitude. The community and institutions felt that more capacity building was necessary in the form of civic education, technical education and also awareness raising on environmental conservation. For example further education for the community is needed concerning the importance of tree planting especially in protecting river banks, and in the dangers of cultivating next to water courses. Also education on using alternative energy sources like biogas and solar energy was suggested in order to reduce the need to cut trees. These should take place in the village level meetings or in chief's barazas. It was clear that the community should be involved in all conservation efforts, and be made aware of the issues they can solve themselves so that they could take responsibility of their own resources. However, incentives to take part in conservation efforts might be needed to change some farmers' negative attitude towards conservation.

Concerning the issue of equal access to water, the people felt that there should be more love between the citizens especially between those living upstream and downstream, as water is God given. Likewise people living near springs should not be selfish but allow others to get water despite it being on their own land. The religious beliefs in the area could be used to create harmony among all the citizens and water users.

However, the community members also raised key constrains in putting the knowledge into action. One issue that came up was that guidance from the government offices is inadequate as they do not speak one language. Every department often puts emphasis only in their particular sector, and that there are often conflicting messages that the community is being told. For instance, on the one hand they are told to irrigate to grow vegetables, on the other to establish fishponds, and contradicting these is the fact that water should be released for domestic needs. This is a clear indication that there is also *a need for capacity building among the government offices and also NGOs* in order to integrate the conflicting water needs. As

one participant rightly expressed, everything should not be blamed on the *wananchi*, but that there should be collaborative efforts from both sides to come up with best solutions together. Another constraint was also the financial capacity of farmers, and the conflicting need for making a livelihood from the scarce resources. Alternative livelihoods should thus be made available. This would truly need a larger, united effort by all stakeholders.

Solving the problem of lack of land and private land ownership

As a solution to the lack of adequate land and people cultivating on steep or forested areas, some of the participants suggested that a compensating settlement scheme should be established to the lowlands. This could be done if the county government could allocate land from national parks or ranches and if water for irrigation was made available in the lower lands. This would be supported by large scale tree planting activities in the hills to rehabilitate the water catchment areas. However, others thought that better family planning would be a better solution. Some of the participants were of the opinion that Christianity had destroyed the old culture of protecting land and migrating. Suggestion of settling in the lowlands brought up further discussion about wildlife interfering with the farming and destroying crops. It was suggested that Kenya Wildlife Service should construct water pans in order to keep the animals in the national parks. Also monkeys introduced by KWS to the highlands, have become a nuisance. As a final joke it was suggested that also family planning should be organized for the animals, because some of them like monkeys have become pests. Finally, the TTWF representative suggested that there should be a system whereby those living in downstream areas should pay for people upstream for protecting the indigenous forests and thus maintaining the water flow downstream. In this way the people upstream would get compensation for the farm land they have lost for forests. Less drastic alternatives like making use of forests in a sustainable way, e.g. beekeeping and intensifying the use of land by use of greenhouses were also suggested.

Regarding the development of water projects, it was suggested that the private land owners should simply be compensated and given land in other areas in order to construct dams or boreholes for the benefit of the community.

In this study, we identified the land demarcation and privatization as the main driver behind the changes that have occurred in water resources. There is no easy solution to the problems caused by the private ownership of the land, but we warmly suggest that all these are discussed, not rhetorically, but concretely, e.g. with maps. For instance, community maps and transect walks could show if there are still communal lands whose use could be regulated, for instance to allow regeneration of lands to those who have experienced a decrease of fertility in their fields. However, we are cautious about the approach of payment for ecosystem services (PES) to the people living in the hills, as the people in the lower lands already face challenges in getting water from upstream due to diversions for irrigation and hence having to pay for people upstream to protect catchments might lead to conflicts. In addition, water or water catchment areas should be considered as a common resource, not owned by any particular people.

Policy level interventions and improving law enforcement

The government officers present in the 2014 workshops also expressed frustration about the current situation in terms of policy implementation. Currently everyone can do whatever they want, and the laws are not properly enforced. There is a need for the county government to align the laws governing environmental issues as well as water management to address the issues affecting people in the area and give out clear policies on the way forward. Some community members were also frustrated about poor planning of water management activities and hoped that this would be addressed by the county government. Specifically the land issues should be addressed on policy level by the county government. According to the officers the law about cultivation near rivers and springs is very clear about leaving 6 meters space in between and that the only problem is that it is not enforced accordingly. The Wundanyi Chief expressed that even if its enforcement means taking people to jail, it should be done in order to serve as a warning and example to others. This is because the law and regulation of water uses should make sure

that priority is first given to drinking water. This means that the fact that there is a disparity between upper and lower Taita in terms of accessing water should be considered in law enforcement and conflict resolution as well. It was also suggested that more extension officers should be employed in the government offices so that they could reach people at the grassroots level. Some community members also suggested that they should also come up with their own laws and not only rely on government laws.

Improving cooperation between stakeholders in planning and implementing water resource management

In both catchments the question of improving cooperation between stakeholders raised a lot of discussion. In Mwatate Catchment the institutions expressed the need for all the water users including farmers and land owners and government bodies to be involved, and informed about the water situation in the area. This would also include the politicians from whom political goodwill is necessary to enable cooperation and achieving the set goals. In this way a policy on the priority hierarchy for water uses could be created and implemented and a body e.g. a task-force to follow-up the activities could be established. Such a common forum could be established by WRMA or the county government. This forum should not exclude anyone based on their office rank, but everyone involved in the issues should take part and be informed, including the community members. There is a need for good leadership and meetings should be organized regularly (preferably quarterly or twice a year) to ensure integrated planning and enhanced follow-up.

The community members also suggested that a community action plan could be made where domestic water is prioritized over other uses and that a special committee could be appointed in the village to follow-up and ensure equal access to water. Some community members were frustrated that they have to pay the government officers to come and check problems with the water pipes and yet they already pay water bills but don't get water. However, cooperation and maintaining good relations with the government was also seen as important, in order to implement conservation activities like fencing of wetlands and establishing tree nurseries. The Wundanyi WRUA suggested that the county government would be an important body that could set aside money for environmental protection. They would then bring all community groups and government departments that deal with environment together, and start working together to conserve and manage water resources and related ecosystems. The fact that there are 200 CBOs with about 1200 members in Wundanyi and Mwatate alone expresses the fact that there is enough interest from the community to act concerning environmental issues. It was expressed by a participant from Mwatate Catchment that the CBOs could be further used to spread the "gospel" of environmental protection to the farmers and other community members. Also other media like Chief's barazas as well as churches or the local radio could be used to spread and share information among the people. The Social Services department could also be more involved in training the communities on outreach skills. The NEMA office also expressed the need to strengthen the community Environment Committees in all levels so that they could take more active role in planning. The community members also expressed the wish that they should be allowed to suggest solutions to the problems they've created and owned. The TTWF suggested that a working group involving the CBO's, WRUAs and the NGOs should be formed in order to harmonize the activities and source for international funds.

It was discussed that the coordination of activities and information sharing among stakeholders would prevent repetition of activities, which actually make the community feel over-engaged without seeing any tangible feedback or outcome. Also the establishment of databases for information sharing was seen as very important in trying to harmonize efforts, avoiding duplication and learning from past mistakes. It was further suggested that new ideas might also come up if the community groups could visit other areas in Kenya to share their experiences and learn new skills from each other. It was also suggested that there could be further information sharing between the Taita Research Station and all the concerned stakeholders. For example a documentation center could be established where all research findings would be documented and made available to people. It was suggested that there could also be a task force that would link the researchers at the station with the community members in order to facilitate their cooperation and sharing of information.

Improving of community participation in water resource management

In order to improve community participation in water resource management, it was suggested that water committees could be formed on village or sub-locational levels to plan and implement actions. This would complement the activities of the WRUAs. The World Vision also pointed out that active community members and WRUA members could just visit the sub-county water office and plan or implement, for instance catchment protection activities, even before the funds are available.

During previous and current research, it was experienced that local people have in-depth historical knowledge on the local environment that is difficult, if not possible, for the government officers to achieve during their short-term positions in the area. Earlier research by Himberg (2011) has also shown that Taita people have traditional ecological knowledge especially regarding the role of indigenous forests in regulating the hydrological cycle. For example, Taita people consider specific tree species capable of attracting rains (e.g., Mngima – *Prunus Africana* and Mkuyu – *Ficus sycomorus*); or forecast them (e.g., Mora – *Nuxia congesta*, Msuruwachi – *Albizia gummifera*, *Erythrina abyssinica*, and *Ficus lutea*); to retain water (e.g., *Myrica salicifolia*); and protect soil from erosion and control water quality (e.g., *Nuxia congesta*, *Ocotea usambarensis*, *Rapanea sp.*, *Maesopsis eminii* and *Osyris lanceolata*). In our study, people also narrated that ficus trees are normally connected to presence of water and therefore the boreholes are constructed near those trees, for example, in Mbirwa valley in Wundanyi catchment. The methods that we used in this study - participatory mapping, timelines, transect walks and interviews - can be used for collecting such traditional information. There are also unstudied communities in the more remote areas of the Taita Hills that may have some interesting knowledge on the local environmental or social issues and who should be integrated into water resources management planning.

3.8 Common systematic understanding of drivers, pressures, state, impacts and responses

The aim of managing water resources is to safeguard human well-being while sustainably maintaining related ecosystems and their services. It is therefore important to understand the current state of water ecosystems and how these are changing with time (Kristensen, 2004). This can inform decisions, strategies, regulations and policies at different scales that will shape the future management and use of the water related ES (Atkins et al., 2011). A framework proposed to facilitate this understanding is the DPSIR (Drivers, Pressures, States, Impacts, and Responses) model. This framework has found broad application in ecosystem assessments due to its ability to improve communication between policymakers, stakeholders, and scientists (Kelble et al., 2013). The DPSIR model presents a chain of causal links (Fig. 16) starting with 'Drivers'- the underlying factors promoting environmental change. These *drivers* create several or many 'Pressures' on the system. These *pressures* change the 'State' of the system, causing 'Impacts' on ecosystems and society, eventually leading to 'Responses', which again affect all the other parts (Atkins et al., 2011; Mace & Baillie, 2007; Santos-Martín et al., 2013).

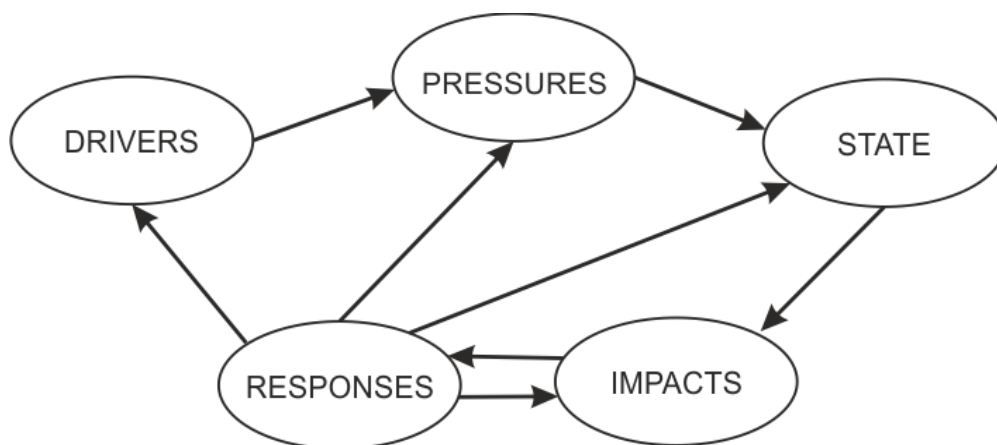


Figure 16. The DPSIR framework (after Kelble et al. 2013)

In our study, we used the DPSIR framework to analyze how local institution representatives and community groups in the Taita Hills perceive the water-related ES and changes that have occurred in them. Figure 17 summarises the issues discussed throughout this report in the DPSIR framework.

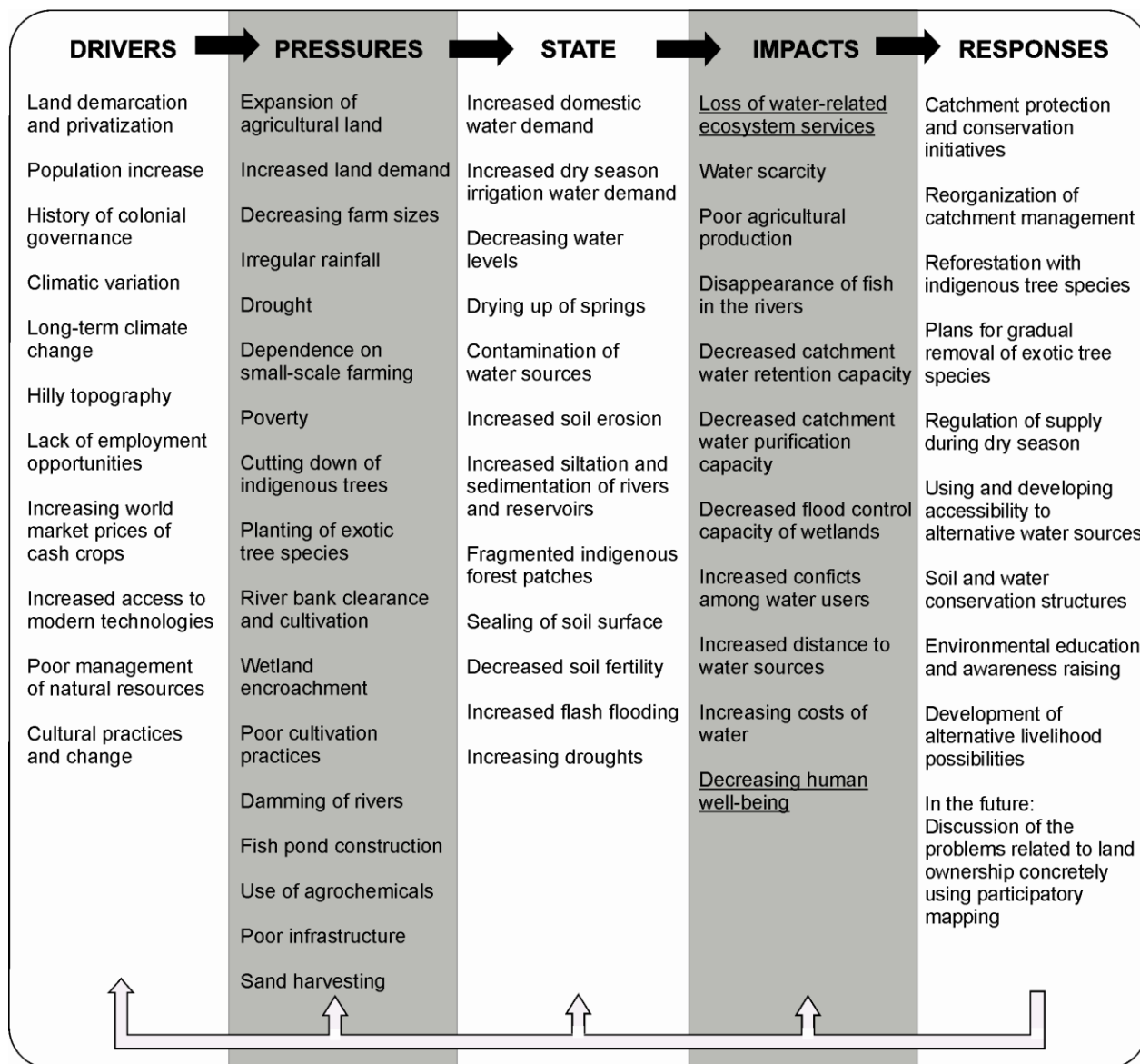


Figure 17. DPSIR model for the water-related ES in the Taita Hills.

4 Discussion and Conclusions

4.1 Towards community participation in water management

Focus on collective action, rather than on individual interests, should be the guiding principle in management of 'common-pool' resources, such as water, for sustaining their long-term use. Commonality in natural resource management is generally considered more sustainable than private ownership (Ostrom, 1990). The integration of local knowledge in resource management is a prerequisite for the functional co-management of the common natural resources (Carlsson and Berkes, 2005, Ayre and Mackenzie, 2013).

4.1.1 Potential of using participatory methods in water management

Participation has also been a buzz-word for the past decades, and its use in legal documents and development projects has increased tremendously. What does participation actually mean? There are many ways in which community can “participate” in resource management and decision making about development needs. According to Arnstein (1969) theory of citizen involvement, there are several forms of participation:

- **Therapy:** experts treating citizens as if they need help to make the right decisions
- **Informing:** one-way flow of information from experts to citizen
- **Consultation:** invitation of opinions from citizens
- **Placation:** the treatment of citizens as token representatives
- **Partnership:** distribution of power equally between citizens and power-brokers
- **Delegated power:** citizens being given power over certain decisions by the elite.

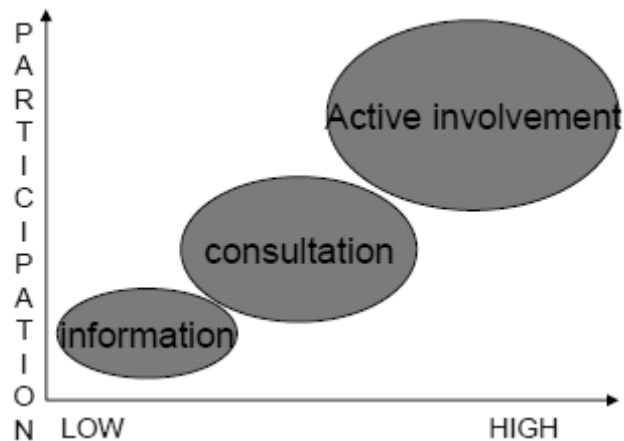


Figure 18. Levels of participation.

The ideal forms of participation are the ones where the citizens are actively involved (Fig. 18), e.g. in a form of partnership. This would mean genuine participation and respect between the actors. Participation should not mean transferring all the responsibility to the local communities or using them as a free work force. Instead it should be cooperative, and the higher level institutions should have a responsibility to empower the local level groups and provide them with enough technical and financial support. The local knowledge that people have on the natural resources and their changes should be integrated into scientific and technical knowledge that the trained officers possess, in order to adjust that knowledge into local circumstances. The participatory methods, especially the participatory mapping and timelines, used in this research, may be able to provide new ideas for water management planning in the Taita Hills. For example the water problem map (e.g., Fig 8 and 9) could be used as a basis for targeting the protective actions, and it should be updated from time to time, for example once a year. All stakeholders could then begin to work together to find a common solution to the problem of declining water resources, as it affects everyone. When stakeholders come together, they can make it possible to understand the reasons behind the changes in water quantity and qualities, accessibility, distance, costs, factors causing increased demand, and problems caused by scarcity. Stakeholders can also better share roles and offer ideas on how to improve the situation. Only then can long lasting solutions be found.

Views from institutions and community members on the use of participatory mapping in water resource management

During the 2014 workshops held in both catchments the participatory mapping tool used by the researchers was presented as a possible tool to be used for planning and monitoring the water resources and related ecosystems in the areas. The response from both the institutions and community members was generally positive. The institutions thought that it would motivate the community members to be responsible for their own resources and would also assist in monitoring the changes taking place in the resources. The map could also be used in planning interventions in specific areas and then be used to follow up on the progress. It was seen that especially the WRUAs would benefit from the use of the mapping. For example the areas to be protected and where people should not cultivate could be drawn on the map. The map was also seen as a possible tool to improve the cooperation between the government and the community. It was suggested

that the problem map should be taken to the county government so that they would also know the key problem areas and community needs and source for funding to address them.

However, also some criticism was raised about the mapping exercise used by the researchers. The Upper Mwatate WRUA expressed that a wider range of water users should have been involved in making the maps e.g. the disabled and the representatives of wildlife (KWS). Others also suggested that a larger area could be covered, involving more people. Some participants also wondered why certain villages were not included in the maps. Also the mapping had not involved the following up of water sources and their ends to see the coverage areas. All of these critiques are well argued, and the researchers can only explain the omissions by the shortage of time and inexperience in the area. However, as the exercise in the research was more of a demonstration of something that could be used in the future, it is suggested that the omissions would be dealt with by the future mapping exercises hopefully done by the institutions and community members.

4.1.2 Potential shortcomings of the participatory methods

Despite the clear advantages community participation has in providing ecological knowledge and contributing to conservation of natural resources, we must also be aware of some shortcomings the participatory methods may have in knowledge production. First, people may remember things incorrectly. For example, in the timeline exercises of this project, only few groups referred to same events or timed them similarly. Second, it is also possible that in the participatory activities, only the 'loudest' persons and those with a higher social status may be heard, even though they are not always those ones who would have the best knowledge of the issue at hand. For example, in our study, women were generally agreeable to participate in the interviews and expressed their own opinions concerning the water use and water resources. However, in many cases, if a male household head (normally husband or a father) was at home, he was the one who took the role of the main respondent. There were also a few women who did not seem to be comfortable with answering the questions themselves, but took us to her husband or father or if that was not possible, answered very reticently. This may be problematic since we were also told that women take care of most of the farming, cooking, cleaning and water fetching, so they would have the first-hand knowledge of the water issues. On the other hand, we must remember that even though participation should be encouraged, it should never be forced and thus everybody has a right to refuse taking part in it.

A third problem is formed by the flawed scientific perceptions. We noticed that Taita people are generally well educated and have some knowledge of the natural sciences that they can use for explaining changes in their environment. However, during the project, we also noticed that sometimes pieces of such knowledge were used in a wrong way or inaccurately. These were often used as rhetorical methods by the more educated people when they tried to raise environmental awareness among the community. Typical of these "scientific" claims was that they were true in some other part of the world, but unlikely to occur in the Taita Hills or even in East Africa. Despite the good intention of these environmentalists, exaggeration of the threats is probably not beneficial to any efforts of environmental conservation. It is likely to produce only wrong kind of actions and unnecessary fear among the community. It is also sometimes good to be critical towards the 'official' scientific explanations, especially those that are presented in the media. Scientific theories are not always correct and they should be adapted to local circumstances.

There are also some practical issues related to the participatory mapping and timeline methods. For example, some issues and memories cannot be spatialized and recorded as points or areas on sketch maps. Therefore qualitative analysis of people's stories is also needed. The timeline method, on the other hand, may suffer from vague historical periodization, especially if the informants are allowed to decide it by themselves. In the Wundanyi workshop, held first in this study, people classified events for example occurring 'before independence' and 'after independence' or as 'old things that are no more'. Therefore, in the Mwatate workshop timeline exercise, we chose to mark the decades in the papers in advance. However, this does not necessarily mean that people would remember the exact timing of the events any better, but that they are just forced to place them next to some decade. One solution to this challenge could be to give a reference list of well-known historical events and their timing (for example Kenyan independence 1963) in the beginning of the exercise and to ask participants to use them in dating the important events.

4.2 Concluding remarks and the way forward

4.2.1 Ways forward in water supply and resource management in Taita Hills

Integrative efforts to sustain the available water resources, including the ecosystems that maintain them, and improving access and, if possible, providing alternative sources, are needed. Both long term and short term solutions must be sought, involving all stakeholders, while taking into consideration their needs, priorities, perceptions and values. Ultimately, community participation in decision-making concerning water supply and resource management is crucial for ensuring equity and fairness in allocation and access to water by all stakeholders. There is also a need to understand the historical causes and underlying issues behind the environmental changes and decreasing water resources. Considering water as a commons and not just as a singular resource, and recognising all ecosystems related to water, is a first step towards better decisions when using water, land, forests, and other components of the environment that are interconnected with water.

Our exercise was aimed to understand short term and long term drivers of change and their impacts. We believe that this initiative allows understanding systematically how all kinds of management actions put in place by different stakeholders, i.e. from political and normative acts until normal subsistence actions, produce changes to the environment, as well as to entitlements to natural resources and thus, to livelihoods. Changes are perceived and suffered differently according to the people's acknowledgement of the causes of the problems, and their distinctive capacity to negotiate their rights. Empowerment is a key issue, and we believe that participatory workshops may be used as a governance tool to involve villages in catchments' control.

Incorporating local peoples' knowledge of water resources and the related ecosystems into resource management at all governance levels will produce more timely and coherent practices that will enable sustainable solutions in the long run. However, as was stated earlier, true participation of the community does not only mean information gathering or sharing, but genuine and respectful engagement of the community members in the decision making processes concerning the resources they depend on. This requires changes in attitude and openness from *all* actors, not just community members. Without well-grounded trust between actors, cooperative efforts to manage the common resources will be killed by conflicts, the signs of which were already visible in our study. While power can never be excluded from such joint efforts nor from the struggle of accessing means for water and development, it is hoped that justice and genuine goodwill would remain the main principles, which guide the governance of natural resources. Reviving an unforced spirit of communality in managing the land and water resources could enhance the well-being of the people and environment in the Taita Hills.

The most urgent issue to be dealt with by the local resource governance is water scarcity in lower lands of Mwatate Catchment, and also as we were told but could not confirm, of lower areas of Wundanyi catchment. The results of this research indicated that for the people in the lower zones water is not available, accessible nor affordable during the dry spells, as per the criteria set by the Ministry of Water (MoWI, 2007). In order to tackle this problem, the County has to come together and see how water could be made available to everyone, including the poorer parts of the society. It is clear that the water sector lacks resources to deal with drought spells, and that the information of the actual situation and needs is not always available. Achieving equity in water distribution therefore requires leadership from the County government and coordination with all parties. It is suggested by the research team, that the coordinating organs present in the area could take part in the nation-wide coordinating mechanism- Water and Environmental Sanitation Coordination (WESCOORD)¹⁶. On a practical level, the county officials could also consider the use of the presented participatory mapping method in order to get a comprehensive view of the water sources of the community and improve the planning of water infrastructure development, as well

¹⁶ WESCOORD is a sectoral specialist group under the Kenya Food Security Steering Group (KFSSG) lead by the Ministry of Environment, Water and Natural Resources (MEWNR), Ministry of Health (MOH) and co-chaired by United Nations Children's Fund (UNICEF) (see: <http://www.wescoord.or.ke/Home.php> for more details).

as water resource management. Systematic longer term efforts are needed to rehabilitate the water catchment areas. Mapping together with the community would also enable a faster response to drought as people would feel a part of the process and could cry out quicker in cases of severe water shortage. In addition to this, the county should consider solidarity solutions to improve water accessibility and availability, for example by subsidizing more affordable water supplies for communities farther away from the sources in order to prevent marginalization of people especially in the lower Mwatate catchment area. The individual ability to pay for water or infrastructure should not determine the access to water, as water is considered a human right.

4.2.2 What should be further studied?

What could the role of the Taita Research Station be in the future considering the issues identified in this study? In the final workshop, the participants were also requested to give their views and suggestions on what would be important to study further. One area of research recommended by the participants was on agriculture and land resource management, which would bring further knowledge on ways to improve the water catchment areas and livelihoods of Taita Hills. For example, studies on best farming and sustainable land management practices were thought to be important as this knowledge would benefit the farmers in the area, and in the long term also the water resources and related ecosystems. Also research on soil mineral content and deficits and possibilities to reclaim abandoned land was suggested. A study on micro-enterprises was also requested as an important research topic that would bring information on opportunities for the economic development of the area. Another suggestion was to study the possibilities of using renewable and sustainable energy in the area.

The participants requested that further research on water, focusing on hydrological aspects, could still be done. One important research area recommended by the participants was water harvesting, and more specifically calculating potential water volumes that could be harvested either by pans or even evaporation nets. There should also be a survey done to determine best places to construct water pans or dams in the upland and lowland areas. It was also requested that current water levels and volumes in water sources be studied, which would enable a more systematic monitoring of the resources in the future and assist in creation of a water master plan for the area. It was also requested that the effect of fishponds on water distribution downstream should be researched on. The actions and priorities regarding water uses by the county government were also asked to be studied, together with the opportunities in getting funding for developing water infrastructure and conservation measures. Especially, opportunities to curb the water scarcity situation in Mwachabo and other lower Mwatate catchment areas like Manoa, Chunga-unga, Kwakele, Mfuko, Mkengerenyi, Maribongonyi, Tarama and Sinai e.g. by putting up boreholes was requested as an important and urgent research endeavor in order to help the suffering people in those areas.

We hope that in the future these areas of research could be further explored and carried out in joint efforts with the government departments and community members. However, while research can be an important tool to gain further knowledge of the natural environment as well as about how people behave, only sustained and persevered action will finally lead to changes in local situations and environments.

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Annex 1: Institutions and experts interviewed

Institution / expert , office base	Jurisdiction / area of coverage
Government Departments and Agencies	
District Agricultural Office, Wundanyi	Taita District
District Agricultural Office, Mwatate	Mwatate District
Kenya Agricultural Productivity & Sustainable Land Management Programme (KAPSLMP), Wundanyi	Taita -Taveta County
Agricultural training center (ATC), Kidaya Ngerenyi	Mwatate District
Kenya Forest Services (KFS) Dept., Wundanyi	Taita -Taveta County
Kenya Forest Services Dept., Mwatate	Mwatate District
Ministry of Lands, Land adjudication dept., Wundanyi	Taita -Taveta County
Kenya Wildlife Service, Voi	Tsavo – East and West National Parks, and other parks
District Land reclamation Office, Wundanyi	Taita -Taveta County
District Water Office, Mwatate (CWSB District Area coordinator office)	Mwatate District
County Council Water Office, Mwatate	Mwatate Water Supply
District Water Office, Wundanyi (CWSB District Area coordinator office)	Taita District
District Irrigation Office, Wundanyi	Taita, Mwatate and Voi Districts
NEMA County Office, Wundanyi	Taita -Taveta County
Divisional Public Health office, Wundanyi	Wundanyi Division
Assistant of Divisional Public Health Office, Mwatate	Mwatate District
National Drought Management Authority office, Wundanyi	Taita -Taveta County
Geology County dept., Wundanyi	Taita -Taveta County
Livestock Office, Wundanyi	Taita District
Livestock Office, Mwatate	Mwatate District
Water Resources Management Authority (WRMA) sub-regional office, Mombasa	Coastal Athi Catchment , sub region
Coast Water Services Board (CWSB) office, Mombasa	Former Coast Province area
District Fisheries Office, Wundanyi	Taita district
Kenya Coastal Development Project (KCDP) Hazina ya Maendeleo Pwani (HMP) Liaison Office	Taita Taveta county
Companies (Public and Private)	
Taita-Taveta Water and Sewerage Company (TAVEVO), office, Voi	Taita -Taveta County
Teita Sisal estate Ltd.	Mwatate District
Wildlife Works, Carbon Credit, Maungu	Maungu, Mwachabo, Mwatate, Voi etc.
VegPro office, Wundanyi	Not known

Institution / expert , office base	Jurisdiction / area of coverage
Provincial Administration	
District Commissioner's office, Mwatate	Mwatate District
District Officer's office, Wundanyi	Wundanyi Division
County Council Clerk's office, Wundanyi	Taita and Mwatate District
Chiefs' offices (Mwatate District)	Chawia, Kishamba, Mwatate, Kidaya – Ngerenyi, and Mwachabo Location
Chiefs' offices (Taita District)	Sungululu, Mteni-Mteni-Kitukunyi and Shigaro sub-locations
Village Elders (Mwatate District)	Mwatate location (Soko ya Zamani, Kariobangi, and Pelelesa Villages); Chawia location (Buro and Lagho villages); Kishamba location (Kishamba, Mwachawaza, Kaya-Ilole sublocations); Kidaya Ngerenyi location (Ngerenyi, Macha, Kisagalla and Kidaya sub-locations)
Village Elders (Taita District)	Sungululu sub-location (Ndonga, Mlambenyi, Mwanda, Kilili, Kwangori villages); Wundanyi sub-location (Talaya, Wasinyi, Mkororo, Menenyi villages); Mteni sub-location (Mlawa and Kitukunyi villages)
Non-Governmental Organizations in Mwatate and Taita Districts	
Nature Kenya, Wundanyi	Taita Hills
Taita Taveta Wildlife Forum, Wundanyi	Taita -Taveta County
World Vision, Water, Sanitation and Health (WASH) project office, Mwatate	Mwatate and Voi District
Community Based Organizations (water resource management, water supply etc)	
Lower Mwatate Water Resources Users Association (WRUA)	Lower Mwatate Sub-Catchment
Upper Mwatate WRUA	Upper Mwatate Sub-Catchment
Wundanyi WRUA	Lower Voi River Sub-Catchment
Kishenyi WRUA	Upper Voi River Sub-Catchment
Dembwa-Wusi Water association (Project)	Wusi – Josa, Dembwa – Ilole sub-loc (Chawia, Kishamba Loc)
Josa Modambogho Water project (Mwatate)	Josa – Kishamba, Mbumbunyi – Masungunyi – Mwandango – Mwachawaza – Mwajengo - Kaya – Mkamenyi – Mwandala – Msisenyi – Msonenyi – Landi (Mwatate District)
Iyale Msidunyi Water project	Msidunyi, Ruma, Kigala, Kitegate villages (Wundanyi and Werugha loc)
Kidakiwi water Project	Kwangori village (Sungululu sub-loc)
Tambaru Irrigation project	Part of Sungululu sub-loc
Toro Water project	Magongonyi, Toro villages (Wundanyi sub-loc)
Iombonyi-Mwaroko Water project	Chawia-Mwaroko
Mtango Water project	Wusi
Mwasineyi Water project	Kipusi Valley, Kishamba
Water kiosk, Star CBO (TAVEVO), Mwatate town	Mwatate town
DaBiCo, Wundanyi	Taita Hills
Taita Environment Initiative (TEI)	Taita, Mwatate District
Other experts (academics...)	
University of Nairobi, Department of Geography and Environmental studies	
Total interviews conducted	72

Annex 2: Workshop participants

Annex 2a. Participants in Wundanyi workshop in Taita-Taveta Social Hall in Wundanyi 6th February, 2013

<i>Group</i>	<i>Activity</i>
Chapa Kazi	Agriculture
Irienyi	Tree nursery
Iyale CFA	Forest
Iyale/Msidunyi Water Project	Water
Kidakiwi Water Project	Water
Kitivo	Agriculture
Kajire group	Agriculture
Lukundo	Agriculture
Mbirwa Caregivers	Agriculture
Mwakishesha Irish Potato Group	Agriculture
Wundanyi Fishpond group	Fish farming
Toro Water Project	Water
TTWF	Conservation
Wesu/Mbili/Weni Mwana CFA	Forest
WRUA Wundanyi	Water

Annex 2b. Participants in Mwatate workshop in CDF Hall in Mwatate 22nd February, 2013

<i>Group</i>	<i>Activity</i>
Chawia Environment Committee	Conservation
DaBiCo	Conservation
Kipusi valley banana development group	Agriculture
KFS representative	Forest
TEI	Tree nursery
Kidaya Ngerenyi Network	Conservation
Mabono/Wichwala (Susu Forest)	Forest
Mseto	Tree nursery
Ngulu Dam Group	Water
Star W.G.	Tree nursery
SuNdiFu CFA	Forestry
Mambisi Dam	Water
Mwasineyi water project	Water
Lower Mwatate WRUA	Water
Upper Mwatate WRUA	Water
TTWF	Conservation

Note: The participants of the Workshop held in 2014 included all the participants from the 2013 workshops as well as representatives from relevant government departments, the county government and local NGOs.