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Access to groundwater and link to the impact on quality of life: A look at the past, present and future public health needs in Mzimba District, Malawi

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Title: Access to groundwater and link to the impact on quality of life: A look at the past, present and future public health needs in Mzimba District, Malawi

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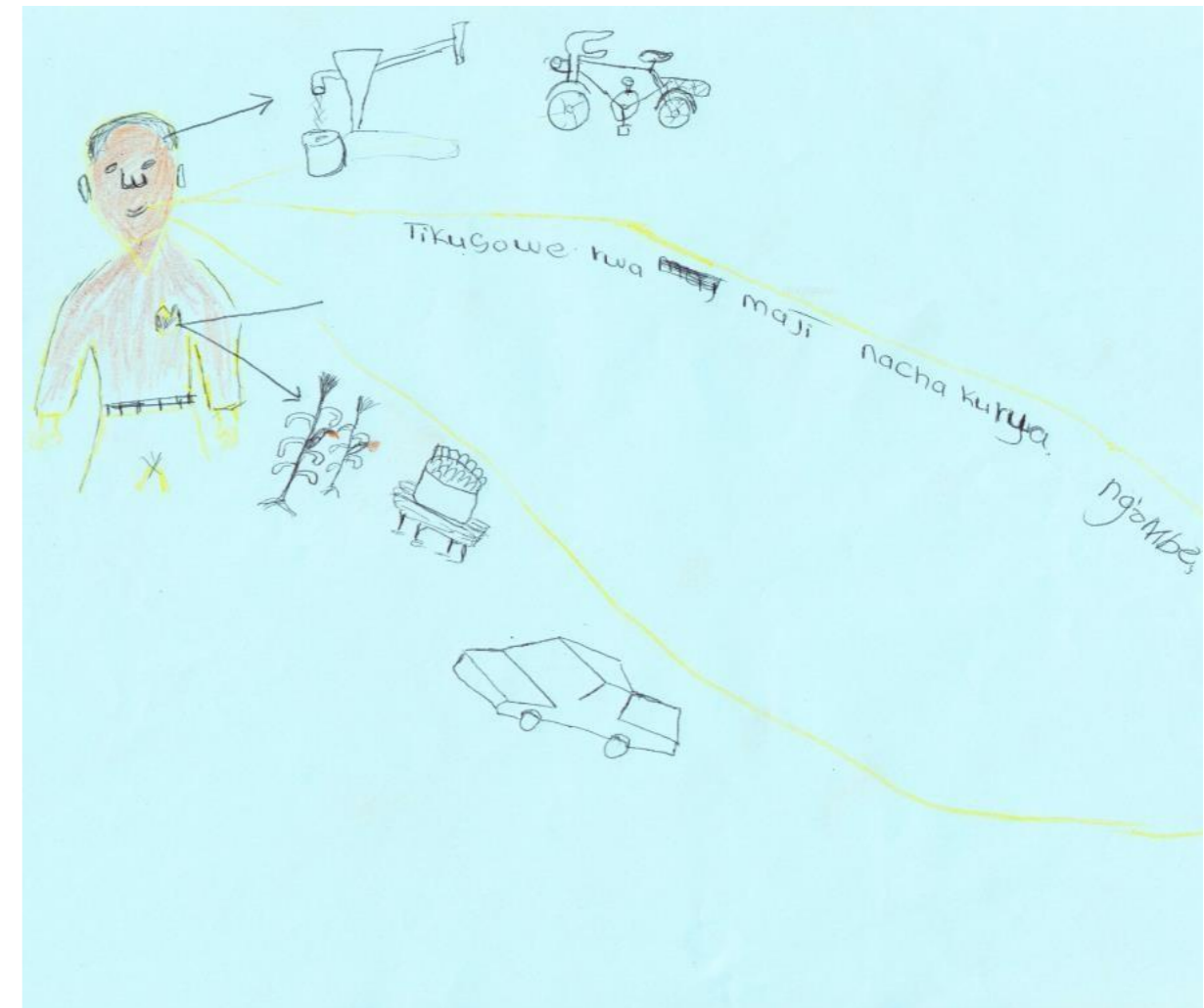
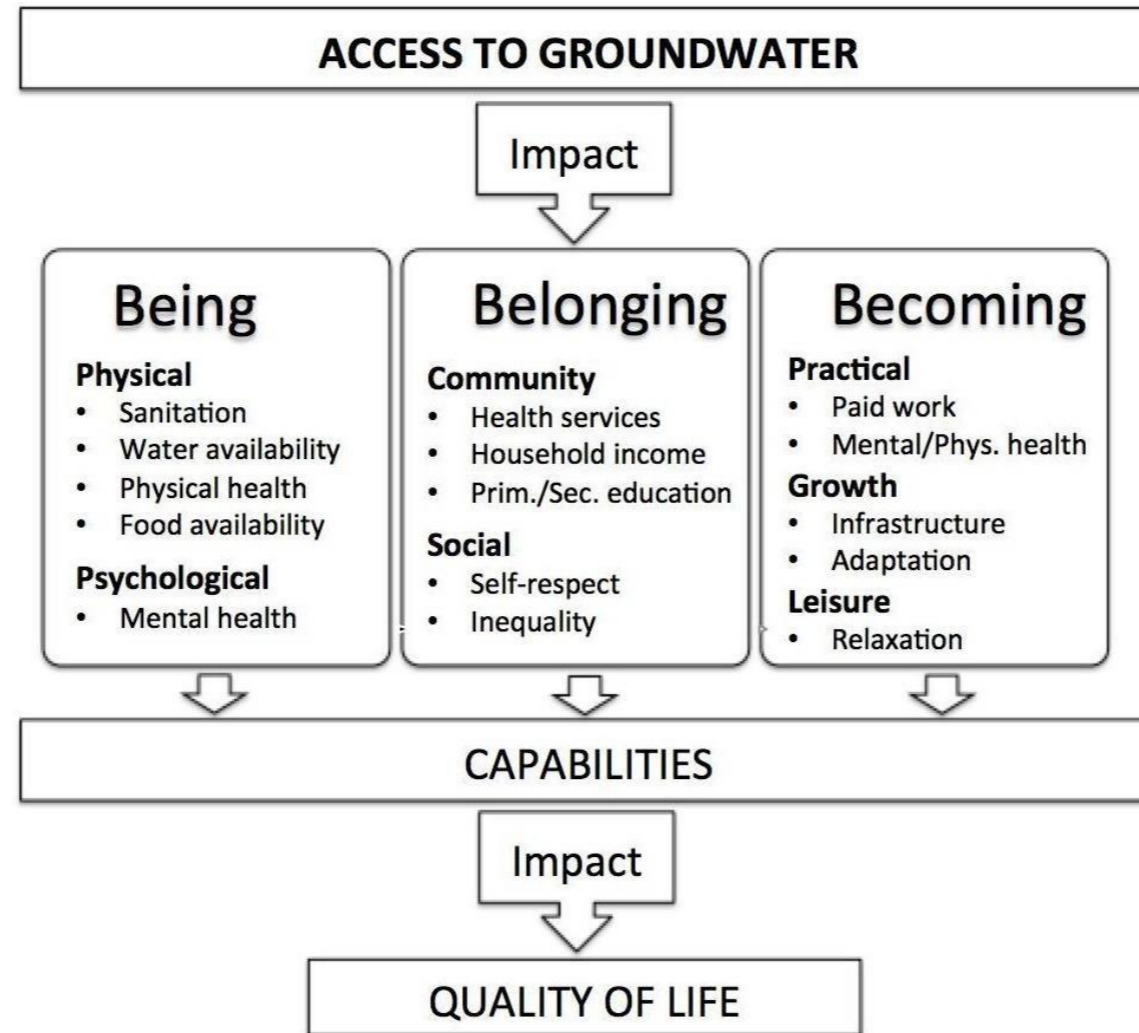
Order of Authors: Kerstin Rieger, MSc Development Practice; Rochelle Holm, PhD in Environmental and Natural Resource Sciences; Helen Sheridan, PhD in Organic Chemistry Natural Products

Abstract: Imagine a world where you have to get up at 4am to walk for two hours in the dark to fetch water. This remains true in Malawi, where the Millennium Development Goals are said to have been met. This research aimed at understanding the impact access to groundwater has on people's 'Being', 'Belonging' and 'Becoming,' as well as people's capabilities and impacts on their quality of life in Mzimba District, Malawi. Being, Belonging and Becoming define three life domains. Being reveals 'who one is,' Belonging reflects 'connections with one's environments' and Becoming relates to 'achieving personal goals, hopes and aspirations.' The study comprised of 210 households, four treatment groups (TG) based on communities consisting of households with access to a handpump and compared to four control group communities, where households had no access to a handpump. Results showed current awareness of environmental issues is linked to recognising future (5 years in advance) environmental challenges. There is a need to create awareness of water quality results within the communities and point-of-use household water treatment. Both the TG and control group (CG) had a gap in sanitation facilities, with up to 27 people (5-6 households) sharing one pit latrine. Polygamous marriages had implications on self-respect and led to neglect on the first wives. Focus group discussions revealed HIV, disabilities and mental health issues, including the use of drugs and alcohol, affect freedom, and created a burden, not only for affected individuals, but also for their extended families. Focus groups highlighted safe and clean drinking water, improved sanitation facilities, better hygiene and accessible health services as pressing public health needs. The implications of this study exhibit, rural individuals 'Being', 'Belonging' and 'Becoming' need to be considered when addressing pressing public health needs, as Malawi works toward the Sustainable Development Goals for water supply.

[REDACTED]

Highlights

- Access to groundwater impacts the three life-domains: Being, Belonging and Becoming
- Disconnect between water quality and individuals perception of safe drinking water
- Communities stressed clean water, sanitation and hospitals as top health needs
- High level of toilet sharing, also impacted by environmental issues
- Imagination exercise reveals desire of male respondents for a greener village



Tables Kerstin Rieger

Table 1

Household income versus improved pit latrines in the treatment group, Mzimba district, Malawi.

Household income/month	Proportion of households with pit latrine with slab/Ventilated pit/toilet seat (Treatment group)
Low 1-10.000MWK	34%
Medium 10000-30.000MWK	42%
High 30.000MWK+	23%

Table 2

Drinking water quality in study area, Malawi.

Village	Study group	Coliform cfu/100ml ¹
Yesaya Moyo	TG	2048
Makula	TG	1928
Kachasu	CG	1672
Ngoti Ngwira	CG	1512
Mlokota Tupa	CG	1152
Moffat	TG	1128
Bandawe	CG	512
Isaak West	TG	488
Isaak East	TG	344

¹ NRWB report, 2014

TG = Treatment group

CG = Control group

cfu = colony forming units

Figure 1

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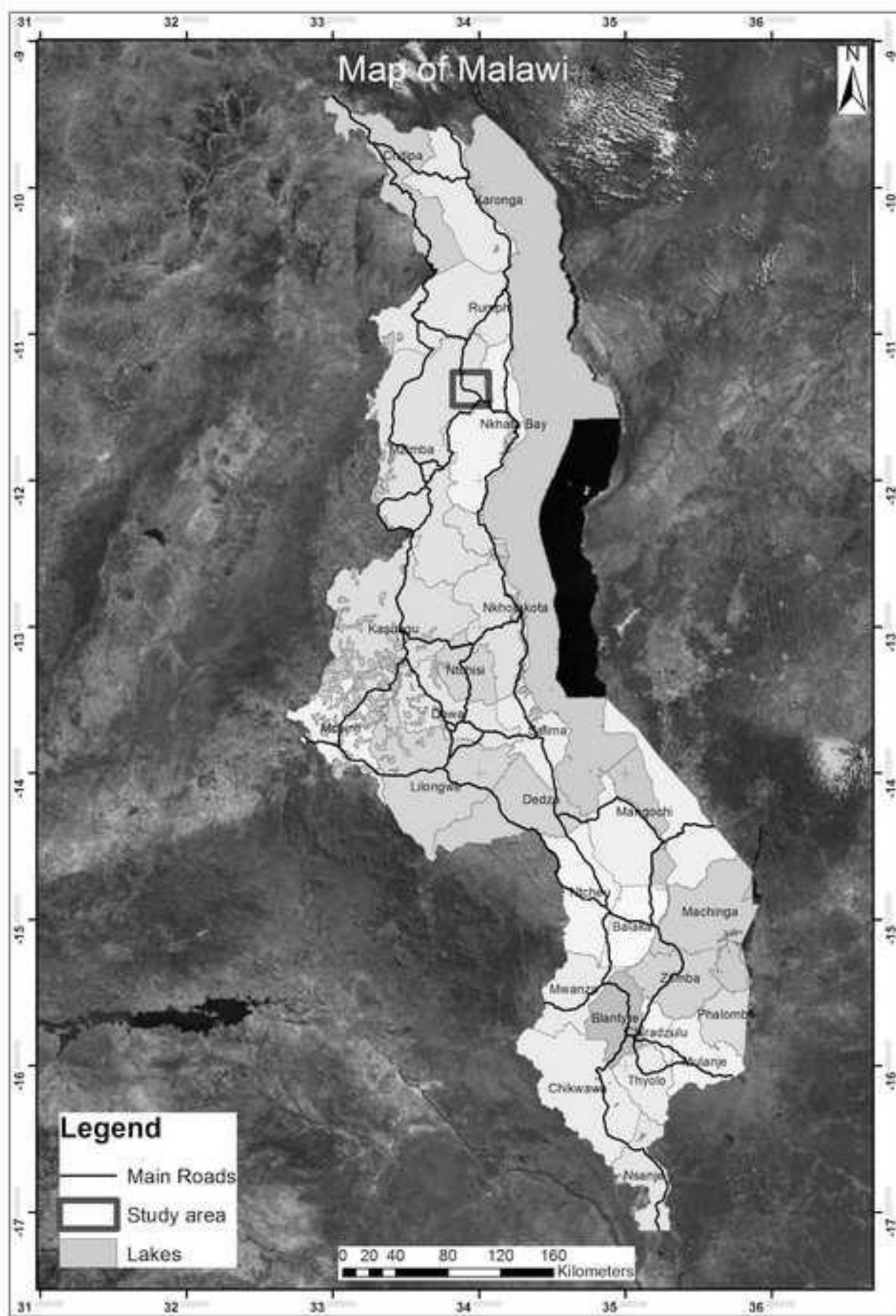


Figure 2
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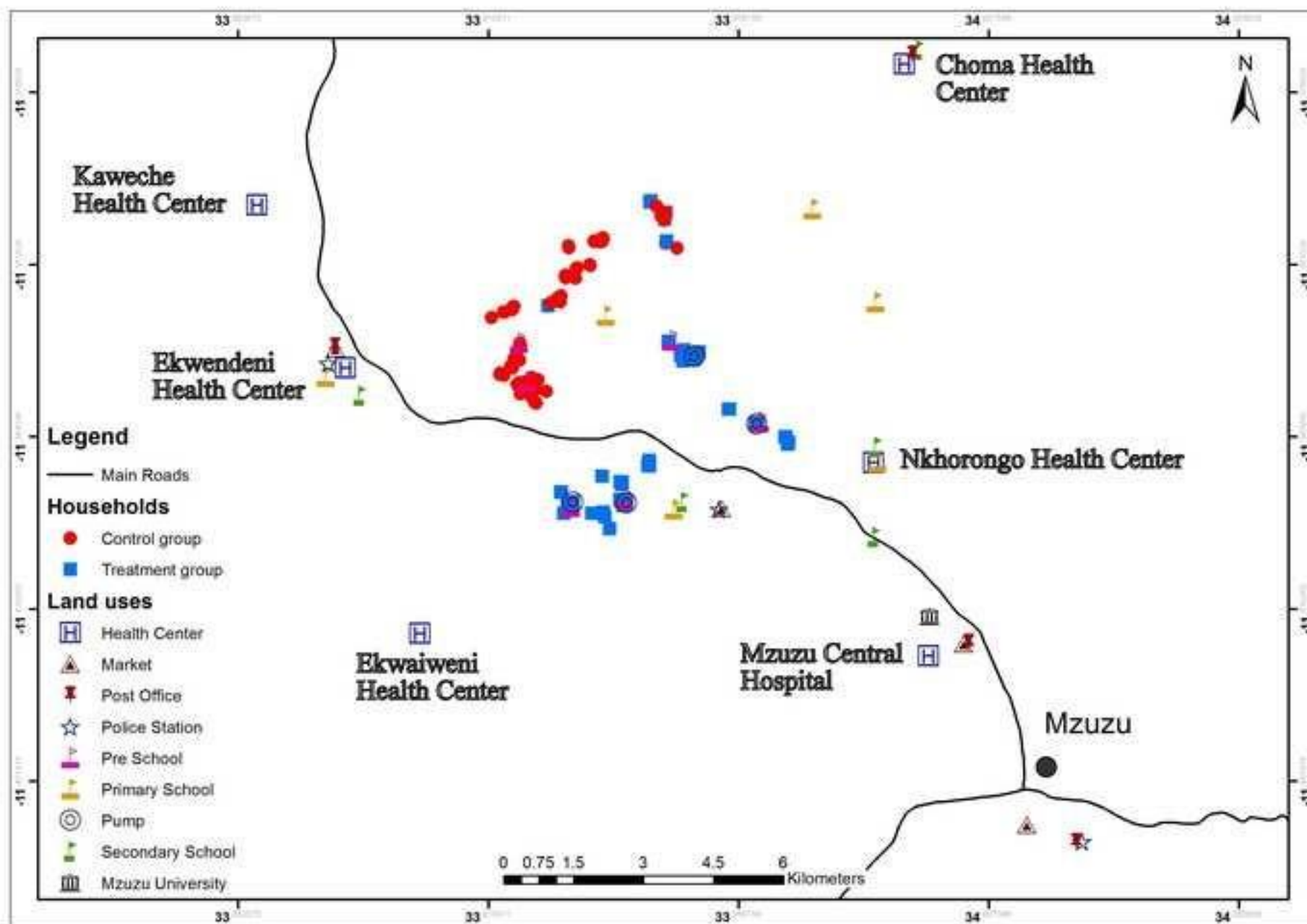


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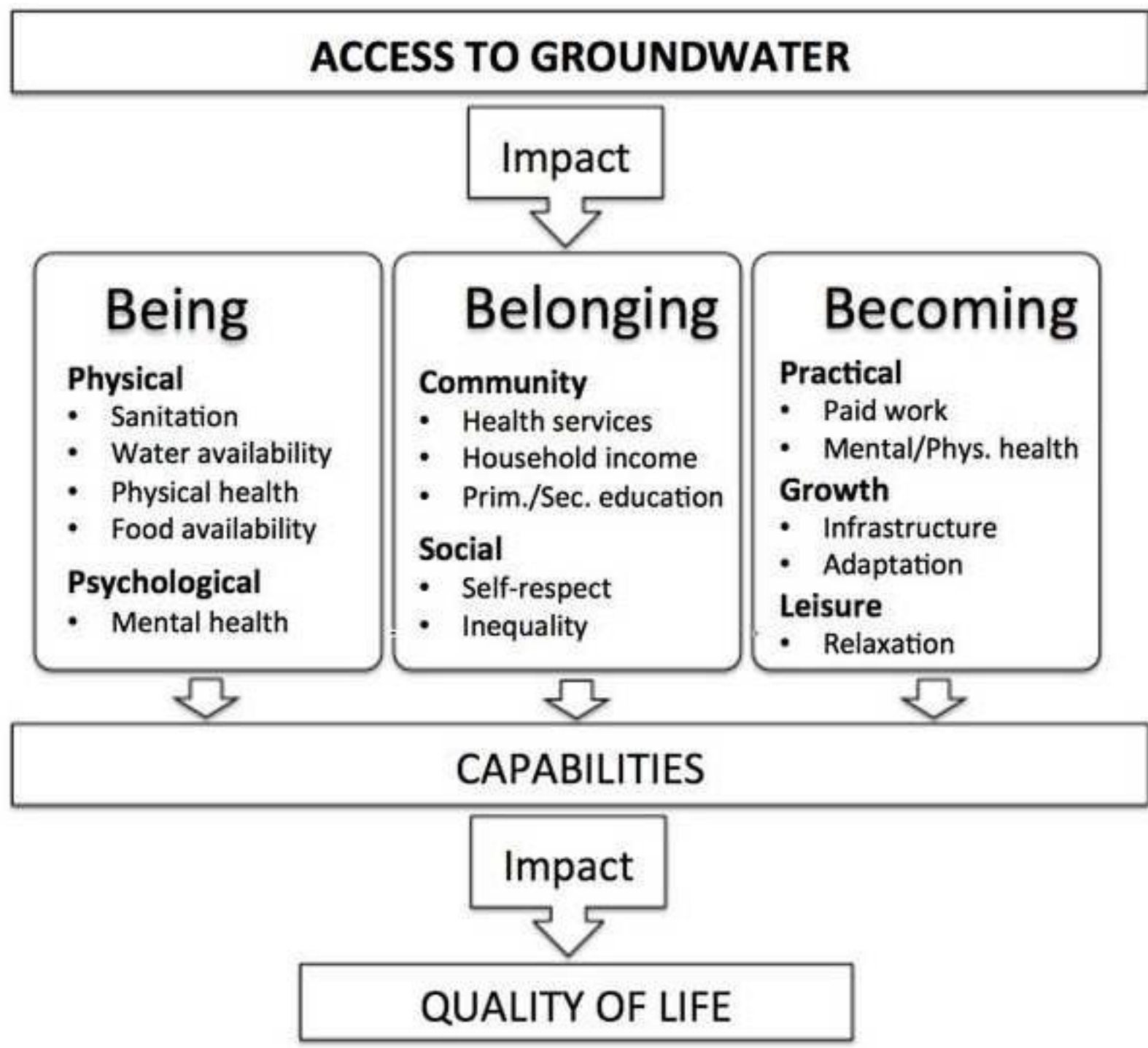


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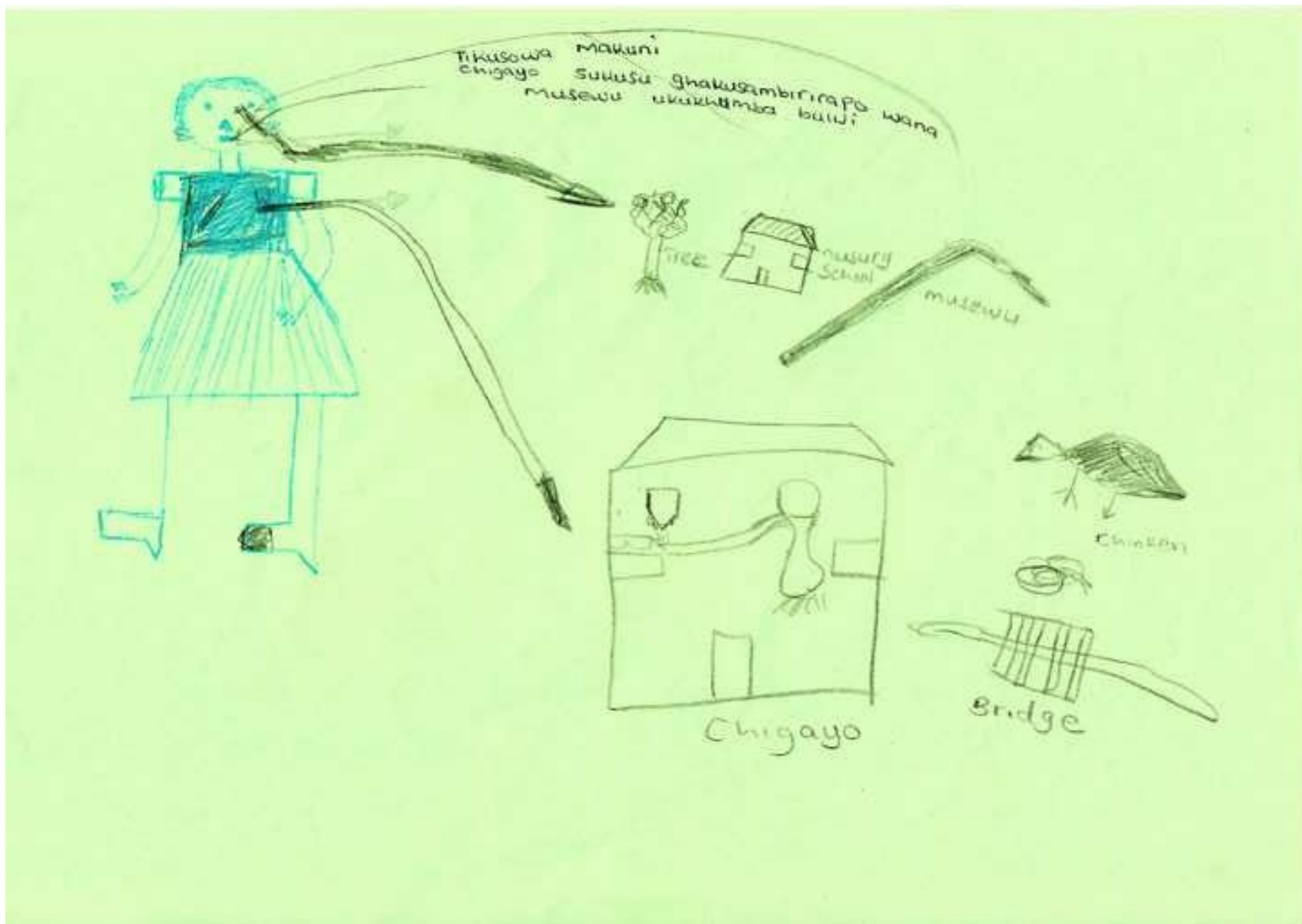


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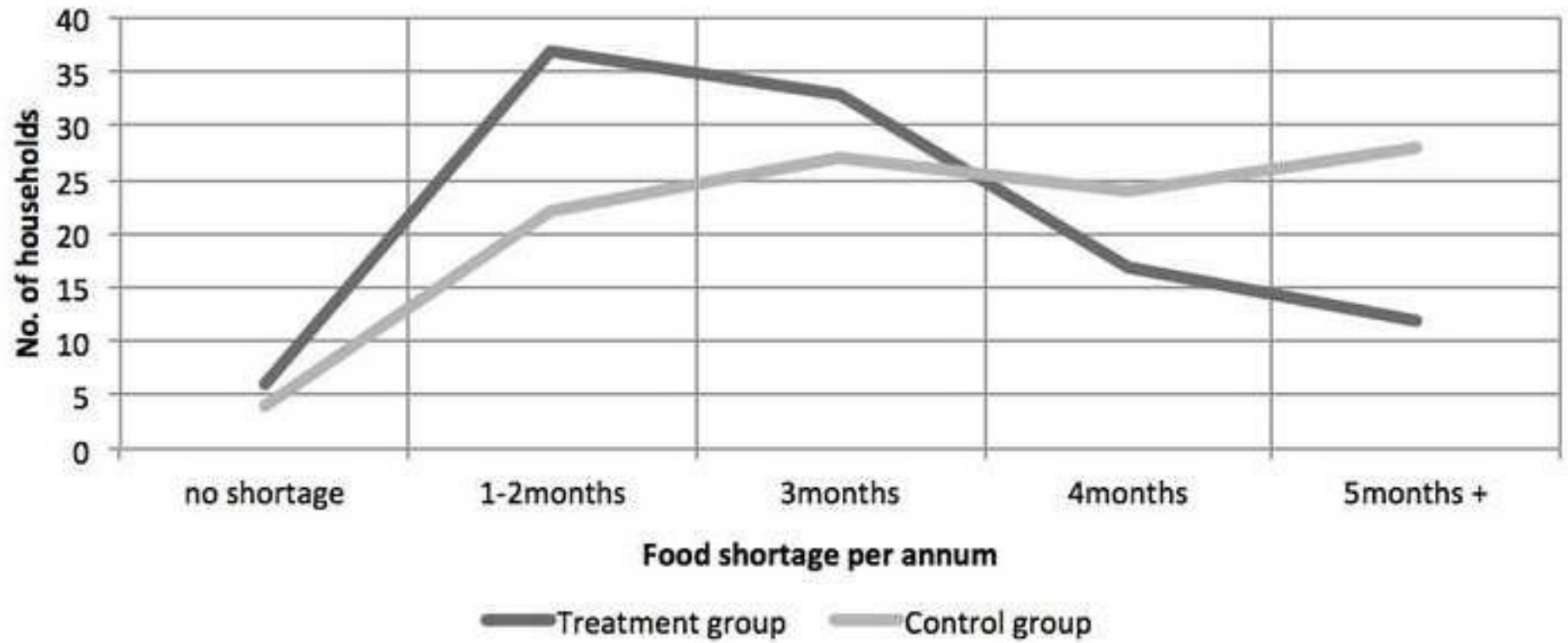


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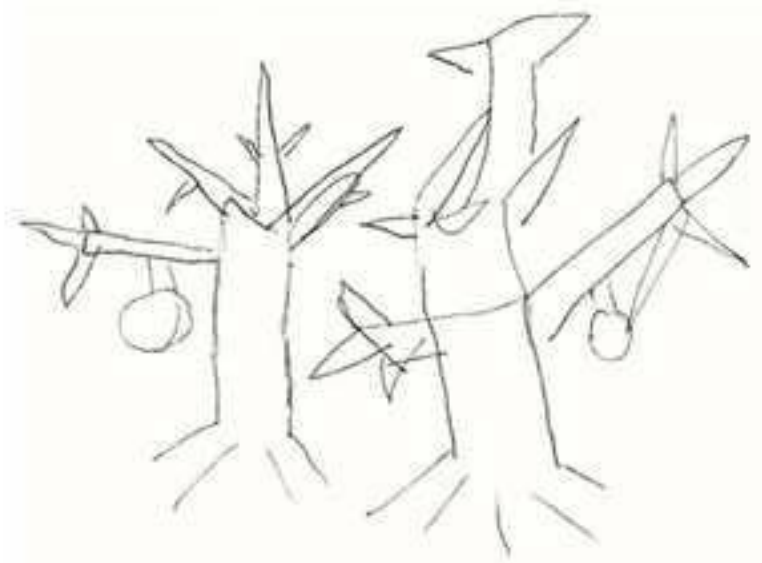
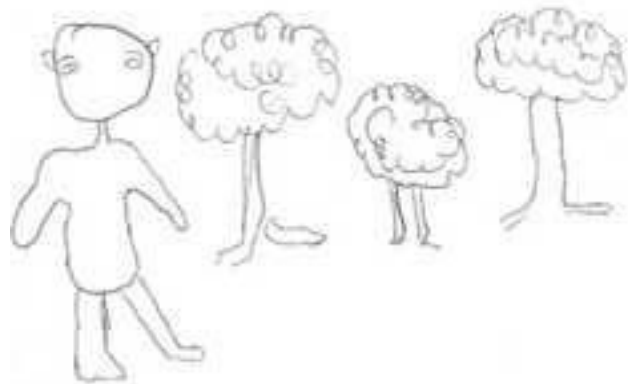


Fig. 1. Map of Malawi - study area. [27]

Fig. 2. Map of Malawi - detailed study area. [27]

Fig. 3. Analytical Framework. [27]

Fig. 4. Female drawing by the treatment group from the Mouth, Head and Heart Exercise.

Fig. 5. Male drawing by the control group from the Mouth, Head and Heart Exercise.

Fig. 6. Food shortages per annum.

Fig. 7. Focus group, Moffat village. [37]

Fig. 8. "Imagination 2034" drawing exercise, Focus group, Moffat village.

Figure Source File Interviews

start	end	Household		Gender
		Number	Village	
7/18/2014 8:53	7/18/2014 9:40	1	Yesaya Moyo	Female
7/18/2014 9:45	7/18/2014 10:33	2	Yesaya Moyo	Female
7/18/2014 10:38	7/18/2014 11:09	3	Yesaya Moyo	Female
7/18/2014 11:13	7/18/2014 12:01	4	Yesaya Moyo	Female
7/18/2014 12:30	7/18/2014 13:21	5	Yesaya Moyo	Male
7/18/2014 13:28	7/18/2014 14:14	6	Yesaya Moyo	Male
7/18/2014 14:19	7/18/2014 15:10	7	Yesaya Moyo	Male
7/18/2014 15:34	7/18/2014 16:01	8	Yesaya Moyo	Female
7/18/2014 16:05	7/18/2014 16:40	9	Yesaya Moyo	Male
7/19/2014 8:20	7/19/2014 8:55	10	Yesaya Moyo	Female
7/19/2014 9:06	7/19/2014 9:41	11	Yesaya Moyo	Male
7/19/2014 9:51	7/19/2014 10:42	12	Yesaya Moyo	Female
7/19/2014 10:50	7/19/2014 11:23	13	Yesaya Moyo	Female
7/19/2014 12:16	7/19/2014 12:48	14	Yesaya Moyo	Female
7/19/2014 12:57	7/19/2014 13:43	15	Yesaya Moyo	Female
7/19/2014 13:57	7/19/2014 14:28	16	Yesaya Moyo	Male
7/19/2014 14:36	7/19/2014 15:12	17	Yesaya Moyo	Female
7/19/2014 15:18	7/19/2014 15:46	18	Yesaya Moyo	Female
7/21/2014 8:26	7/21/2014 8:54	19	Yesaya Moyo	Female
7/21/2014 9:00	7/21/2014 9:37	20	Yesaya Moyo	Female
7/21/2014 9:43	7/21/2014 10:19	21	Yesaya Moyo	Female
7/21/2014 10:30	7/21/2014 11:13	22	Yesaya Moyo	Female
7/21/2014 11:40	7/21/2014 12:22	23	Yesaya Moyo	Female
7/21/2014 12:25	7/21/2014 13:04	24	Yesaya Moyo	Male
7/21/2014 13:15	7/21/2014 13:42	25	Yesaya Moyo	Female
7/21/2014 14:29	7/21/2014 15:02	26	Yesaya Moyo	Male
7/21/2014 15:12	7/21/2014 15:51	27	Yesaya Moyo	Male
7/22/2014 8:17	7/22/2014 8:54	28	Makula	Female
7/22/2014 9:51	7/22/2014 10:21	29	Makula	Female
7/22/2014 10:26	7/22/2014 11:19	30	Makula	Female
7/22/2014 11:37	7/22/2014 12:25	31	Makula	Female
7/22/2014 12:34	7/22/2014 13:17	32	Makula	Female
7/22/2014 13:17	7/22/2014 13:45	33	Makula	Male
7/22/2014 14:18	7/22/2014 14:53	34	Makula	Male
7/22/2014 15:08	7/22/2014 15:38	35	Makula	Female
7/22/2014 15:43	7/22/2014 16:17	36	Makula	Male
7/23/2014 8:15	7/23/2014 8:52	37	Makula	Female
7/23/2014 8:59	7/23/2014 9:21	38	Makula	Female
7/23/2014 9:32	7/23/2014 10:04	39	Makula	Female
7/23/2014 10:08	7/23/2014 10:42	40	Makula	Female
7/23/2014 10:46	7/23/2014 11:19	41	Makula	Female
7/23/2014 11:23	7/23/2014 12:02	42	Makula	Female

Supplementary Questionnaire

[Click here to download e-components: Questionnaire.docx](#)

Title:

1 Access to groundwater and link to the impact on
2 quality of life: A look at the past, present and future
3 public health needs in Mzimba District, Malawi
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Abstract

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2 Imagine a world where you have to get up at 4am to walk for two hours in the dark
3 to fetch water. This remains true in Malawi, where the Millennium Development Goals
4 are said to have been met. This research aimed at understanding the impact access to
5 groundwater has on people's 'Being', 'Belonging' and 'Becoming,' as well as people's
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17 people (5-6 households) sharing one pit latrine. Polygamous marriages had
18 implications on self-respect and led to neglect on the first wives. Focus group
19 discussions revealed HIV, disabilities and mental health issues, including the use of
20 drugs and alcohol, affect freedom, and created a burden, not only for affected
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23 health services as pressing public health needs. The implications of this study exhibit,
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26 Development Goals for water supply.
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Keywords

50 Quality of life
51 Water quality
52 Public Health
53 Sanitation and hygiene
54 Malawi
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1. Introduction

1 Improved drinking water sources became a reality for 2.3 billion people between 1990
2 and 2012 [1]. In 2015, 663 million people worldwide, mostly rural, still relied on
3 unimproved water sources such as surface water from lakes or dams for drinking,
4 cooking and hygiene purposes. In addition, globally 2.4 billion people still have no
5 access to improved sanitation facilities and only half of the rural population uses
6 improved sanitation facilities [2]. In September 2015, the United Nations announced the
7 new 17 Sustainable Development Goals (SDGs) replacing the MDGs. Goal 6 demands
8 'Clean Water and Sanitation' to "Ensure availability and sustainable management of
9 water and sanitation for all" [3].
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17 Although economic and social development in Sub-Saharan Africa is
18 fundamentally reliant on the role groundwater plays, this resource-base and its use, are
19 not sufficiently understood [4]. There is a lack of reliable data in Sub-Saharan Africa
20 and the records, when available, are gathered in an unsystematic manner. The
21 reasons are complex and numerous, including the absence of clear institutional
22 responsibilities and protocols, lack of technical expertise, inadequate resources and the
23 non-existence of database management systems [5].
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28 Malawi is a land-locked country in Sub-Saharan Africa with a population of 16.4
29 million [6] and 83.9% living in rural areas [7]. Small farm size is driven by a high
30 population density [8]. In a socio-economic context, the agriculture sector is the main
31 economic base of Malawi, with smallholder and subsistence maize farming as main
32 activities for the rural population [9]. Malawi's real GDP growth was 1.9% in 2012, and
33 World Bank figures showed an increase to 5% in 2013, a further estimated rise to 5.7%
34 in 2014 and 5.1% in 2015 [10]. These estimated increases are driven by tobacco
35 exports and growth in key sectors, including agriculture, services, and manufacturing
36 [11]. Deficits of amenities in rural communities in Malawi predominantly include water
37 and sanitation, health, education, household food security, transport and
38 communication [12]. Up to 80% of Malawians depend on renewable natural resources
39 for subsistence and rain-fed agriculture [13], yet there is limited investment in irrigation.
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48 Malawi's surface water resources are formed by a network of lakes and rivers
49 including the Shire River, Lake Malawi and Lake Chilwa [4]. The total annual rainfall is
50 over 1600mm, predominantly occurring in the wet season from November to April [4,
51 14]. The estimated annual groundwater recharge in Malawi ranges from 15 to 80mm
52 [15]. The Republic of Malawi Environmental Affairs Department [9] has environmental
53 concerns due to temperature changes and increased frequency of droughts and floods.
54 Nationwide, floods in 2013 damaged both piped water networks and boreholes, and left
55 unprotected wells, streams and rivers contaminated [16]. Malawi is currently losing
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about US\$18.5 million due to water-connected economic losses [17] which are likely to intensify with climate variability over the coming decades.

In Malawi, 89% of the population in rural areas use improved drinking-water sources, surpassing the MDG target [2]. Conversely, only 41% of the population in Malawi use improved sanitation facilities and only 3% of people have a hand washing facility at home equipped with soap and water [2]. Improved access to drinking water was identified as a top priority by the Republic of Malawi National Action Plan for Adaptation (NAPA) to climate change [18]. The National Water policy in Malawi states: *“The water services shall be provided using appropriate cost-effective technologies that are sustainable in the urban water services and for the rural areas, technologies shall conform to the Village Level Operation and Maintenance (VLOM) concept”* [19]. VLOM is tasked with: *“Promoting the diversification of appropriate technologies for the provision of water and sanitation services to the rural communities in line with prevailing standardization policy”* [19]. Yet, manual drilling for self-supply is not recognised in the 2005 policy. Policy responses to climate change that do exist in relation to groundwater mostly focus on adaptation and risk management [18] rather than on individual’s quality of life impacted by groundwater access.

Quality of life is defined by Raphael et al. [20] who describes it as *‘The degree to which a person enjoys the important possibilities of his or her life’* (p. 366) and is further defined by the three life domains of Being, Belonging and Becoming [21]. The quality of life domains are further elaborated by Solans et al. [22] who propose that Being reveals ‘who one is’ and contains sub-domains Physical-, Psychological- and Spiritual Being. Physical Being contains nutrition, personal hygiene, physical health, exercise and clothing. Psychological Being involves mental health, feelings and self-esteem, whereas Spiritual Being includes personal values and spiritual beliefs. Belonging reflects ‘connections with one’s environments’ and has sub-domains Physical, Social and Community Belonging. Physical Belonging depicts the connection a person has with its workplace, environment at home, school and community. Social Belonging includes the linkages with someone’s social environment, such as family, friends, neighbours and colleagues. Community Belonging characterises access to adequate health and social services, income, employment, educational program and community events. Becoming relates to achieving personal goals, hopes and aspirations and contains sub-domains: Practical, Growth and Leisure Becoming. Practical Becoming contains paid work, satisfying health or social needs. Growth Becoming comprises of adaptation to change and improvement or maintenance of knowledge and skills. Leisure Becoming contains activities, which promote stress reduction and relaxation.

Quality of life is reported to be more impacted by lack of freedom and lack of capabilities such as sickness and disabilities than by income; they influence the quality

of life for the whole family [23]. Nussbaum [24] outlines many privileges, stressed in the human rights movement, which are included in Nussbaum's and Sen's approach: free choice of profession, freedom of association, political rights and a range of social and economic rights [24]. Nussbaum [24] reinforces Sen's emphasis on the importance of what people essentially are able to be or to do, the significance level of their capabilities. Cohen emphasised that Sen describes capabilities as '*a reflection of a person's freedom to choose between different ways of living*' [25]. Furthermore, Cohen pointed out a capability is relevant and essential when its absence hinders the person from satisfying basic needs [25]. Sen further underlines that some *functionings*, such as being in good health and sufficiently nourished, are elementary [25]. Others may be commonly valued, however are more complex, like social integration and achieving self-respect. Sen notes that in the circumstances such as managing severe poverty in developing countries, it might be possible '*to go a fairly long distance with a relatively small number of centrally important functionings and the corresponding basic capabilities*' [25] such as to avoid preventable diseases, sicknesses and premature fatality and the ability to be well sheltered and well nourished. A little can go a long way.

The aim of this study is to interrogate the gap in understanding how access to groundwater impacts on people's capabilities and quality of life as defined by 'Being', 'Belonging' and 'Becoming,' by comparing communities with and without access to a water handpumps in Mzimba District, Malawi. The research study creates associations between natural resource management on one hand, and economic well-being, poverty reduction and development on the other. This study has four objectives investigated in the eight study villages: 1) to survey how access to groundwater through handpumps placed on shallow-dug wells in Northern Malawi impacts quality of life at a community, family and individual level, 2) to understand how access to groundwater impacts regional public health needs, 3) to investigate challenges towards securing clean drinking water which may be interlinked such as education, economic situation, sanitation and hygiene, food security, water availability and climate change and 4) to analyse water shortages and communities perception of safe and clean drinking water.

2. Materials and Methods

Ethical approval for this study was obtained from the National Commission of Science & Technology (NCST) in Lilongwe/Malawi (REF.NO.NCST/RTT/2/6). Data was collected through qualitative and quantitative methods. The primary study methods were in-depth interviews, focus group discussions (FG) and field observations by the researcher. The study area (Fig. 1) comprised of eight rural villages in the Traditional Authority (TA) of Mtwalo, in the Mzimba District, Northern Malawi. Four treatment

groups (TG) were identified purposively based on communities consisting of households with access to a handpump and compared to four control group (CG) communities consisting of households without access to a handpump. According to the most recent census, there were 140,599 people living in the Mtwalo area [26].

Fig. 1. Map of Malawi - study area. [27]

GPS data was collected during the field study to visually identify the study sites in ArcGIS in relation to land features, as well as to allow geographical analysis for trends resulting from study results. Figure 2 illustrates the TG and CG detailed study area, including main roads, households and land use such as health centres, schools, markets, post offices, police stations and handpumps. Many households are close to each other, therefore some attributes became blurred due to the closeness of the GPS data.

Fig. 2. Map of Malawi - detailed study area. [27]

The standard formula for calculating sample size introduced by Taro Yamane in 1967 was used to select a sample size representative of the population. A sample size of 203.8 people was calculated with a probability error of 0.07 [28]. Therefore the sample size contained 210 rural households, 105 each for the TG and CG.

Importantly, the study's analytical framework is presented in Figure 3. The framework is based on quality of life and the Social Diagnosis Approach by Green and Kreuter [29] who argue there is a need for community-oriented applied methods, such as community surveys and focus groups, to bring the voice of the community into development work.

Fig. 3. Analytical Framework. [27]

A quantitative survey was conducted with 210 face-to-face interviews within eight rural communities. The research was carried out by questionnaire with the assistance of a local translator via a motorbike. A minimum of 19 households was interviewed per village over 12 weeks from June until August 2014. The researcher and translator visited the chiefs from all communities before the research was carried out to get permission to conduct the survey and to explain its purpose. The questionnaire contained 68 standardised survey questions, which were read aloud by the translator to respondents in the local language Chitumbuka. Data was recorded using a digital data collection tool, Open Data Kit (ODK; Seattle, Washington, USA). Each respondent gave written consent, either as a signature or thumbprint. Respondents ranged in age from 18 to 93 years. All households surveyed were without access to piped water or

1 electricity. Prior to commencing the interview, a definition of a household was read out
2 to all participants: *'The household is a group of persons related or not, living under the*
3 *same roof, under the responsibility of a head whose authority is acknowledged by all*
4 *the members. The ordinary household is composed of a head of household, his*
5 *spouse(s), his unmarried children, and possibly his relatives or other persons to whom*
6 *he is unrelated. The household can be limited to only one person or a person with his*
7 *children. In polygamous households, each wife is treated as a distinct household when*
8 *the wives live in different houses, cook separately and take decisions independently.'*
9

10 Additionally, six focus groups (FG) were held, two FG in the TG, two FG in the
11 CG and two additional FG with women self-help groups connected to St. John of God,
12 a local public health service provider. The self-help groups are small women's
13 organisations comprising of 10 to 20 women set up for village banking. FGs comprised
14 of group discussions, imagination- and drawing exercises. For each of the FG, the
15 researcher included thinking and feeling questions by conducting a picture drawing
16 exercise as in combination, they provide a better understanding, as suggested by
17 Krueger and Casey [30]: 'When listening to the brain, your study will encourage
18 participants to think about the topic and to offer their answers. These studies are often
19 used when we are seeking an array of possibilities, such as discovery of the array of
20 needs within a community. People respond in a less detached way. When listening to
21 the heart, the focus group procedures change. The moderator asks for less factual
22 information and encourages discussion on feelings' (p.50). A4 papers in different
23 colours and coloured pens were given to participants. An introductory question initiated
24 the topic of discussion, sparked participant thinking about the topic and suggested
25 expression through the medium of drawings. Three key questions were then asked.
26 The final question sought an outlook into the future by using an imagination exercise
27 introduced by Krueger et al. [30], where imagining and drawing were stimulated. Each
28 participant was asked to draw their thoughts and feelings on an A4 paper and to share
29 their drawing with the other focus group members.
30

31 Water quality was tested from five water pumps in the TG and four from surface
32 water of the CG. Each sample was collected into sterilised glasses by the researcher
33 and analysed by the Northern Region Water Board (NRWB) in Mzuzu within 24 hours
34 of sample collection.
35

36 Quantitative data was described and analysed using SPSS Statistics Version
37 21. Quantitative data analysis mainly involved simple descriptive statistics such as
38 frequency distributions, percentages, cross tabulations and multi-linear regressions.
39 Results were presented in tables, graphs, charts and other illustrations. Additional
40 graphs and charts were produced to compare the CG and TG using Microsoft Excel.
41 Qualitative data from FG discussions and observational field notes involved
42 categorising and identifying similarities across several participant accounts noting
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directions and tendencies. They were manually transcribed, ordered and analysed systematically based on content. Some accounts resulting from discussions represent stand-alone illustrations of important themes and emerging issues of the study.

3. Results

3.1 Sample profile

The average household size was 4.56 persons, which is representative, comparable with the average nationwide household size of 4.60 [31]. The TG tended to be slightly larger than the CG. TG and CG were comparable in terms of marital status and gender. Females were more represented at 55%, compared to a nationwide split of 48.7% male and 51.3% female in rural areas [31].

Males above the age of 26 had a higher likelihood than females of secondary education level. No differences were found in male secondary education between TG and CG. However, 80% of females with some secondary education belonged to the TG, indicating that females with higher education were more likely to have access to a handpump.

The main employment of household members was agriculture and trading, vegetable and tobacco cultivation. Most interviewees had more than one occupation. The CG had a higher number of people involved in paid work like trading and craftwork. Female employment was higher in education and trading, whereas males dominated in craftwork and moulding bricks. The female workforce doing paid work in the CG was higher than the TG.

Marital status by gender exhibits three times more single men (15 out of 20), 87% of them in the age group 18-25. 97% (29 out of 30) of respondents experiencing widowhood were female, and most were in the lower income bracket of 1-20,000MWK/month. 63% (n=29) of widows were respondents from the CG. Physical Being of widows in the CG was highly affected by food shortages (81%), compared to only 26% in the TG and the usage of pit latrines without slabs in the CG (81%) versus 42% in the TG.

10% (21) of interviewees stated they were in a polygamous marriage, with more polygamous marriages in the CG (62%) than the TG (38%). Physical Being of respondents in polygamous marriages seemed to be highly negatively affected by toilet sharing in both groups, CG (77%) versus TG (88%) and usage of pit without slab in the CG (92%) versus TG (75%). Big differences existed in relation to food shortages. Respondents in the CG reported 85% food shortages for a maximum of up to 5 months per annum compared to only 38% food shortages in the TG for up to a maximum of 2 months per annum.

3.2 Examining needs for a better quality of life of the regional population

The drawing exercise (Fig. 4) encouraged respondents to communicate their thoughts, through the medium of a speech bubble in The Mouth Exercise. Respondents mentioned needs such as hospitals; water, sanitation and hygiene, education, economic and well-being goods such as markets, jobs, money, food, maize mill; and trees for the environment. In the Head Exercise, listening to their head, participants drew the following: economic and well-being goods such as money, car, food, bicycle and maize mill, also water, infrastructure, schools and sanitation and hygiene. In The Heart Exercise, considering their feelings while listening to their heart, participants drew tangible objects and intangible concepts: water, education, shelter, sanitation and hygiene, infrastructure, economic goods and necessities like a bicycles, cars, food, fertilizer, maize, chickens and money.

Differences were observed between the CG and TG drawings in the areas of sanitation and hygiene, infrastructure and environment. While the TG included sanitation and hygiene when drawing about their feelings, the CG integrated these when they thought or spoke. Infrastructure was included in the Mouth, Head and Heart exercise by the TG, however the CG left out infrastructure when speaking (Mouth exercise) about their needs. Nevertheless, the CG expressed the need for infrastructure clearly when thinking or feeling. The TG, while thinking about their needs, included trees. Interestingly, the CG didn't draw trees in any of the three exercises. Good housing was raised by both the CG and the TG while expressing their feelings listening to their heart, yet was not mentioned while speaking or thinking.

Fig. 4. Female drawing by the treatment group from the Mouth, Head and Heart Exercise.

Fig. 5. Male drawing by the control group from the Mouth, Head and Heart Exercise.

3.3 Determining water scarcity in relation to access to water

Households reported an average daily water usage of 17 litres/person for the CG versus 19 litres/person for the TG. The WHO [32] defines that access to drinking water requires at least 20 litres/person per household daily. The cross tabulation in combination with the Chi-Square test showed, a significant percentage of only 17% of the CG had water all year around, compared to 61% of the TG.

Respondents reported the highest seasonal water shortages from September to November, consistent with seasonal weather. The findings for TG and CG were almost identical in October (94% TG vs. 95% CG) and November (82% TG vs. 84% CG). However, the findings varied greatly in September, where the CG faced higher

seasonal water shortages with 66% vs. the TG with 48%. Several individuals stated fetching water takes over one hour during the dry season. While water scarcity in the CG was reported as seasonal, the TG also faced scarcity, periodically, for different reasons; due to broken handpump parts and vandalism. Parts replaced were predominantly pipes (18%), rubber washers (14%) and handles (14%), and 27% miscellaneous (unknown by interviewee). 64% reported current mechanical problems with the system, including 29% with the slab, 25% with the pump, 18% with loose parts, 14% with pipes and 11% with handles.

The cross tabulation and chi-square test displays a strong statistical correlation (0.00%) between having access to a handpump and enough water year round. From the CG, 83.8% stated they do not have enough water, versus 39% from the TG. Looking at comparisons for 'time spent to fetch water' through a cross tabulation and Chi-Square test, the TG spends significantly less time fetching water than the CG, with 79% (TG) using 30 minutes or less, versus 54.4% of the CG. From the CG, 31.4% need 45min or more, versus 16.2% of the TG.

3.4 Examining future challenges with regards to access to water

The Chi-Square test showed, that there is a strong statistical significance between the biggest challenge people identified in the next three years and having access to a pump. The cross tabulation showed that the biggest challenge both groups predict will be water - in the CG (51.4%) and the TG (24.8%). The second biggest challenge in the CG will be 'health' (21.9%) in comparison to the TG's 'education' (24.8%).

Within both groups, 84% of households noted a change in rainfall pattern.

Respondents described the rainfall as heavier but less often. Interviewees (81%) reported more rainfall in 2014 lasting for a longer period. However in previous years rainfall was less. Households also showed damaged roofs from strong winds and bathing rooms and pit latrines destroyed by heavy rains to the researcher.

3.5 Investigating environmental awareness in the region

Seventy percent of the TG versus 78% of the CG stated they faced environmental issues. The most pressing environmental issue reported was deforestation. Even though the respondents seem to understand this concept, their way of describing it varied. The TG highlighted deforestation (81%), followed by lack of firewood (18%), strong winds (15%), less harvest (16%) and shortage of rainfall (15%). The CG highlighted deforestation (74%), followed by shortage of rainfall, less harvest, strong winds and lack of firewood. Household responses and field observation confirmed deforestation was impacted by the consequent need of households burning local bricks

and producing charcoal to generate income. Respondents highlighted shortage of wood for building sheds to dry tobacco and store maize.

The biggest reported environmental challenges in the next five years (2015-2020) showed only slight differences between the TG and CG. Cross tabulation revealed deforestation was predicted as significant, with 61% (TG) and 49% (CG) followed by a shortage of rainfall, strong winds and soil erosion/infertility.

Cross tabulation shows there is a strong statistical significance between awareness of current environmental issues and the prediction of the biggest environmental challenge in the next 5 years. 93% of people aware of environmental issues in 2014 said there would be environmental challenges in the next 5 years. 80% of people who did not know about environmental issues in 2014 believed there would be environmental challenges in the next 5 years, compared to 52.6% who reported no awareness of environmental issues in 2014. The Chi-Square test shows a strong statistical significance of 0.01% between the change of rainfall pattern reported and the awareness of environmental issues. The findings further show 89.8% of respondents aware of changing rainfall patterns, also described environmental issues in 2014.

3.6 Establishing sanitation and hygiene standards in the region

One of the top priority needs mentioned in the FGs was sanitation and hygiene, which are part of Physical Being. Cross tabulation shows a pit latrine without slab was the most used facility with a significant number of 92% from the CG, versus 45% of the TG using one. The TG had a staggering higher access to improved sanitation facilities¹ (54%) versus 4% in the CG. Notably, higher income was not directly related to an improved sanitation facility in the TG (Table 1).

Table 1

Household income versus improved pit latrines in the treatment group, Mzimba district, Malawi.

Household income/month	Proportion of households with pit latrine with slab/Ventilated pit/toilet seat (Treatment group)
Low 1-10.000MWK	34%
Medium 10000-30.000MWK	42%
High 30.000MWK+	23%

¹ Pit latrine with slab, ventilated improved pit latrine or toilet seat

1 The cross tabulation shows a significant number of 71.4% from the CG are
 2 sharing toilet facilities versus 51.4% from the TG, most are shared by three
 3 households. However, in some villages up to 27 people are sharing one facility.
 4
 5 Researchers observed most people shared sanitation facilities with several neighbours.
 6 The 2010 Demographic and Household Survey shows 59.2% of rural sanitation
 7 facilities in Malawi are shared [33]. This figure matches with the researcher's findings,
 8
 9 which show 65.8% of households share pit latrines without slabs.

10
 11 Lack of hygiene was observed, as hand washing facilities were only available at
 12
 13 two households. One had soap available, the other one had clearly not been used for
 14
 15 months.

16 17 18 *3.7 Establishing perception of safe and clean drinking water*

19
 20
 21 Another important aspect to consider when looking at 'Being' is the intersection of
 22
 23 drinking water and physical health. Drinking water is considered to be safe when its
 24
 25 chemical, microbial, and physical characteristics meet WHO Guidelines for Drinking
 26
 27 Water Quality [32]. Groundwater depletion or contaminations are common problems
 28
 29 arising from hand-dug wells [34]. The perception of households that the groundwater
 30
 31 was safe was 92% in the TG versus 26% for the CG. Water quality results (Table 2)
 32
 33 though showed coliform bacterial levels ranging from 344 – 2048 cfu per 100mL.
 34
 35 However, there is no data on record with the NGO 'Wells for Zoe' relating to water
 36
 37 sampling or testing before or after handpump installation [35]. An earlier research study
 38
 39 from Pritchard, Mkandawire and O'Neill [36] conducted in 2007 in the districts Balaka,
 40
 41 Chikwawa and Zomba in Southern Malawi, established the water quality of 26 shallow
 42
 43 wells. Of samples taken in the dry season from covered shallow wells, 80% of samples
 44
 45 taken in the dry season from covered shallow wells failed to meet the safe drinking
 46
 47 water limits set by the WHO, compared to 100% of samples taken in the wet season
 48
 49 [36]. The water samples in this paper were taken in the dry season only and showed
 50
 51 that shallow wells in the TG yield water of unacceptable microbiological quality.

52
 53 There was no association between people's perception "*Is the water safe*" and
 54
 55 the water quality test results. Observations in this study showed that, due to low water
 56
 57 tables, most pumps in the TG are located in valleys and there was a risk of surface
 58
 59 water pollution from chemicals (fertilisers), and human and animal waste. Furthermore,
 60
 61 57% from the CG reported problems with the taste or colour of the water, versus 16%
 62
 63 from the TG. Some respondents commented water from the handpump smelled bad.
 64
 65 Surface water was described as muddy, milky, grey, turning green or red sometimes,
 as well as smelling bad due to alga or mud. It was heavily reported that surface water
 tasted salty due to 'cows urinating in it.'

Table 2

Drinking water quality in study area, Malawi.

village	STUDY GROUP	cfu/100ml ¹
Yesaya Moyo	TG	2048
Makula	TG	1928
Kachasu	CG	1672
Ngoti Ngwira	CG	1512
Mlokota Tupa	CG	1152
Moffat	TG	1128
Bandawe	CG	512
Isaak West	TG	488
Isaak East	TG	344

¹NRWB report, 2014
 TG = Treatment group
 CG = Control group
 cfu = colony forming units

3.8 Water treatment

Water treatment in the home prior to consumption differs between the TG (49.5%) versus 58.1% from the CG. The common methods of treatment were boiling (54%), followed by usage of chemicals such as chlorine (33%) and simple settling (17%). Cross tabulation and Chi-Square test were run to establish whether people are more likely to treat their water if they have a higher education level. The Chi-Square test showed that with 18.6% there was no statistical significance between the level of education and whether people treating their water. An additional Chi-Square test displayed, there was no statistical significance between household income and people treating their water (0.31). Therefore, people with a higher income were not more likely to treat their water.

3.9 Determining regional public health needs

Nutrition is part of Physical Being, and regarding access to water in relation to food shortages, the most significant observation shown by the Cross tabulation and Chi-Square test was, that the TG experienced substantial shorter periods of food shortages.

Fig. 6. Food shortages per annum.

The question “*What health needs do you have in your community?*” brought up explicit priorities. All FGs stated three imperative and top priority needs: water, sanitation and hygiene, and hospitals. Explicitly, they stated the need for clean and safe water, better sanitation, good hygiene, and good toilets with one for each household, as well as health facilities, hospitals and ambulances. The need for health services connects with the life domain of Belonging [21]. Health Services are part of Community Belonging and interviews illustrated 55% of households had to walk for more than 2 hours to the next health service and an additional 35% had to walk between 1-2 hours. There was no difference between CG and TG.

Fig. 7. Focus group, Moffat village. [37]

Ekwendeni and Choma Health Centres in Northern Malawi are large facilities used for healthcare by the interviewees. Observations revealed Choma is located in a remote area and only two nurses were on duty, with no doctor. This raises questions: why no doctors are available in a regional health centre and whether nurses are qualified enough to help all patients in need. As well, the Ekwendeni Health Centre was closed at 3.30pm on a working day and questions have to be asked whether these health centres are practical for local people, especially their opening hours, as many people have to walk between two and ten hours to reach them. Some FGs pointed out good infrastructure is essential, especially bridges and good roads to access health facilities and hospitals.

Four out of six FGs raised health needs, such as good clean houses and food security. Chipeta [38] underlines the point of good housing, but outlines Malawians mostly cannot afford good houses due to their low income. Windows were mentioned, as essential to keep the houses clean from dust, and household items like mosquito nets, bedframes, mattresses, blankets and clotheslines, as well as enough food. The need for food security became obvious in all categories. Two female FGs stated the need for food diversity and in particular nutritious food. Mkandawire et al. [39] likewise emphasised, that access to good quality food is problematic in Malawi. Moreover, bins and appropriate waste management were raised by two female FGs, both based in urban settings.

Mental health problems are also part of Practical Becoming, as part of current and future with major challenges to satisfy health needs. Leisure Becoming, as defined by Raphael et al. [21] involves challenges in achieving stress reduction. The outcome of the question “*What mental health problems do you have in your community?*” was consistent and unambiguous between groups. All FGs highlighted smoking marijuana

as the top health concern for mental illnesses; this was followed by stress due to too much thinking and consumption of alcohol, which were highlighted by four out of six FGs, both male and female. Furthermore, three female FGs identified a delay in the treatment of malaria as a contributor to mental health issues.

Participants in the FGs were invited to use their imagination in a drawing exercise 'Imagination 2034' and to depict how their community would look like in 20 years time. Male participants from the TG drew nature, such as trees, grass, stars and a cow (Fig.8).

Fig. 8. 'Imagination 2034' drawing exercise, Focus group, Moffat village.

Figure 8 shows drawings of trees and nature and underlines deforestation in this local community. The researcher therefore asked a personal question after the FG had finished drawing: *"You all imagined your community with a lot of nature and in particular a lot of trees. How will you make sure that your community will look like this in 2034 if you cut trees in your community now? Is every one of you cutting trees at the moment?"* Everybody nodded. *"So how will you make sure that your community will look like your drawings in 20 years' time?"* Silence. Then Joseph aged 60 plus, spoke: *"Due to our discussion and FG we have realised the importance of planting trees for each one we cut! We will be planting trees now so we still have plenty in 2034! Thank you for coming to our village."* This is a good example of *Practical Becoming*, which looks at satisfaction of personal needs: men are cutting trees to fulfill their need of paid work and survival. *Growth Becoming* is reflected in improvement of knowledge and adaptation to change, which the men clearly showed by committing to plant trees. Nevertheless, the one man who had drawn a cow stood out to the researcher for he had different thought processes to the rest of the group. For him the question *'how he imagines his community in 20 years time'* inspired him to include a cow, which could be interpreted as a desire to develop and start a business by selling milk, or to be able to buy cows through loans to sell milk. This is a noteworthy FG outcome and showed what can be done with drawings and dialogues. The female participants of the TG drew a combination of things for how they imagine their community in 20 years time. Infrastructure and nature were dominant themes, with houses, preschools and paved roads to markets as well as forests and fruit trees. Manual maize mills, water pumps, electricity and one electric maize mill were drawn, as well as chickens, birds, a cow and a fight with a snake. This outcome highlights *Practical Becoming*: to satisfy their personal needs, such as paid work and good health. *Growth Becoming* is revealed by adaptation through alterations in infrastructure and access to electricity. Both groups drew mostly about nature such as trees, mountains, grass and flowers together with houses, some with tin roofs and toilets outside of the main houses and infrastructure. In

comparison, male FGs drew a hospital, an ambulance and schools. One participant drew an uprooted tree due to strong winds.

4. Discussion

4.1 Life-Domain 'Being'

The study looks at the quality of life domain "Being" as defined by Raphael et al. [21]. Nussbaum and Sen [25] also highlight that some '*functionings*' of Being can be elementary, for example good health and sufficient food.

Physical Being is determined by nutrition and personal hygiene. The results of this study have identified that longer periods of food shortages for the CG interlinked with considerably higher water scarcity, are possibly additionally linked to the lack of irrigation. This shows a disadvantage for communities without handpump access.

Widows in the CG in particular were highly affected with regard to food shortages. Lack of improved sanitation facilities and destroyed bathrooms due to environmental issues added to their sanitation concerns. Many interviewees reported that heavy rainfall and strong winds destroyed toilets and bathrooms, both separate structures from the house, which leads to more toilet sharing. Observations revealed many people practiced open defecation in the dark and likewise bathing in the open using darkness and banana trees as shelter. This affects the "Being" of women especially during their menstruation, as they would need toilet facilities more often than men, and also during the day. Results exhibited higher access to improved sanitation facilities in the TG. Observations by the researcher revealed sanitation interventions had been implemented by NGO's to promote and implement 'pits with slabs' in the TG, which may account for the difference in percentage slab toilets vs non-slab ones between TG and CG. Field observations revealed some toilets are a five-minute walking distance and have no entrance cover for privacy. Most toilets were observed by the researcher to be well ventilated. The high number of shared toilets in both groups highlighted the need for more improved sanitation facilities and correlated with the FG findings.

Good health, part of the life domain "Being" is associated with having access to adequate clean drinking water. The study found TGs face less water scarcity. Water management will be critical in the future as the competition for water resources increases due to a growing population and rising economic activities [7] as well as changing weather patterns. Clearly, it is critical to have water availability all year round. Better water resource management is needed, in particular during the dry season and droughts. Water resource management academic programs (such as BSc and MSc) need to be strengthened and policies harmonised to focus on sustainable development, utilisation and food security. The effect on the sustainability of rural water supplies is a key uncertainty associated with the impacts of climate change in Malawi

[21]. The expected effects of climate change in Malawi are increased occurrence of floods, droughts and irregular and unpredictable rainfall [40]. Serious consequences will arise from the unpredictability of the intensity and duration of rainfall [41]. The household observations of the change in rainfall patterns, is supported by historical rainfall data from 1984 through to 2007, in which five crop seasons 1986/87, 1991/92, 1993/94, 2003/04, and 2004/05 have been identified as significant drought periods [42].

Although most of the population in rural areas reported using an improved drinking-water source, this does not necessarily reflect functionality of the handpump, good water quality, or a positive impact on their quality of life linked to the water source. Though the biggest challenge respondents considered they would be facing in the next 3 years differed based on having access to a pump. It is crucial to understand how water resources will be affected by changing climatic conditions, and how people will be able to respond to, and will build the necessary resilience to face associated challenges. Understanding the physical parameters and human interactions will play an important role in predicting possible future impacts.

Results showed a need to create awareness amongst all actors (Government, INGO's/NGO's, academics and local communities) of water quality and household point-of-use drinking water treatment. Although the TG handpumps were provided by NGO's, water testing after installation or as part of on-going monitoring, was absent thus the safety of improved water sources was unconfirmed. This is despite water quality testing capacity being available at the NRW.

4.2 Life Domain 'Belonging'

Community Belonging characterises access to adequate employment, income, educational programs and health/social services. In comparison to UN statistics [43, table 4], which look at '*At least some Secondary education*', the study households had 3-4 percentage points less secondary education than national standards. This may be due to this study being conducted in a rural area or to the year's difference between the studies. Children in Malawi start primary school at the age of six and the primary educational system consists of eight years of schooling. However, observations revealed, a majority of students need to repeat classes. Secondary school consists of four years of schooling. The education split of TG and CG did not differ. Although not all children attain the highest education level, the majority of people (55-56%) have some primary education. This percentage is nevertheless lower compared to the Integrated Household survey [31], which claims that 71.4% in rural Northern Malawi have some primary education.

Income is also part of Raphael et al.'s [21] life domain of Community Belonging. The monthly household income comparison between TG and CG shows that the CG

has a higher income overall. This finding is surprising and illustrates that access to a water handpump in the study was not connected to a higher monthly income. Earlier work found the cost to Malawi resulting from unsustainable use of natural resources was 200US\$ per household deriving from shortage or changing rainfall, deforestation in catchment areas around the main urban centres where firewood supply and charcoal production were jeopardised and from reduced agricultural productivity due to soil degradation [13].

Social Belonging is defined as '*connection with one's environment*,' for example, social integration and achieving self-respect [21]. An observation by the researcher, in keeping with the work of Slonim-Nevo et al. [44] and Broude [45] is that polygamous marriages seem to be the norm in some villages and first wives are commonly neglected. The first wives seldom had any personal assets and looked after the children from their husband's second marriage. From the interviews, the researcher noted a lower level of self-respect in this small group of respondents. Additional observations revealed widowed respondents, which prompted additional questions by the interviewer. These supplementary questions revealed most causes of widowhood were HIV which compares to those previously highlighted by Kirkpatrick [46], malaria, TB and meningitis. Furthermore, particular widows revealed they were unable to remarry and they had to look after their children and earn a living at the same time. Most of these widows, as well as some of their children, were HIV positive themselves. It is likely that these conditions would affect their Belonging – their social integration and self-respect. Nevertheless, a positive example of Social Belonging was apparent when women shared their way of fetching water from a pump. Women would usually go with their children, neighbours and friends to fetch water and it seemed to be a means and place to chat, promoting connection within the community and social integrity. As Sorenson et al. [47] pointed out, the social aspect of fetching water is often discussed sporadically and anecdotally.

4.3 Life Domain '*Becoming*'

Raphael et al. [21] refer to Leisure Becoming as activities that reduce stress and facilitate relaxation. The duty of water sourcing was particularly gender pinpointed, with 87% of women fetching water. This obligation clearly divided by gender (87%), did not change after handpump installations, which affected women's productivity vastly. Interviewees (76.2%) felt life had changed for those who had fetched water prior to handpump installation; in particular, less sickness, time saved, better health, good life and less tiredness. However, the installation of a handpump and consequent change in responsibility in fetching water may also have had negative implications. The number of girls and boys aged 5 to 17 fetching water increased after the installation of a

1 handpump, resulting from the water source being closer to the village after pump
2 installation, with the work of girls increasing 423% and boys, 480%. This is an
3 observation not previously reported in Malawi. Unfortunately, it was not possible to
4 further examine the impact, but it is likely to affect school attendance, punctuality and
5 stress levels and thus impact adversely on an age group which had previously been
6 less affected by water access issues. These extra duties may cause difficulties or even
7 impede children in achieving their hopes and personal goals. Looking at comparisons
8 for 'time spent to fetch water', the TG spends significantly less time fetching water than
9 the CG. Women from the CG were observed to be restricted in achieving goals as their
10 daily duty of fetching water has implications on their time for relaxation. Crow et al. [48]
11 pointed out that there is very little data on this work, however fragmented proof from
12 Asia and Africa indicates that the time women spend collecting water is significant.
13 Nevertheless, people, particular women, who have access to a handpump spend less
14 time fetching water. Field interviews confirmed that women commonly used the time
15 gained from fetching water for relaxation. The WHO defines access to drinking water
16 *'that a water source be less than 1km away from its place of use'* [32]. The researcher
17 questions the completeness of this definition as it depends on variables such as terrain
18 and density of vegetation. For example, traversing 1km in a mountainous area such as
19 the study site, would be much more challenging than level ground.

20
21 Yaron and Initiative [13] highlight forest resources are diminishing at 2.6% per
22 annum. The main causes in this study are agricultural expansion due to population
23 growth, and cutting of wood for fuel, which is a distinct problem in catchment areas
24 surrounding urban centres. The drawing exercise 'Imagination 2034' revealed different
25 perspectives by gender. Most men in the TG earned their living by moulding bricks with
26 a consequent high demand of cutting trees to burn bricks. This could be one reason for
27 male respondents indicated the desire to have a green village in 2034, and illustrates
28 Leisure Becoming, such as relaxation and reduced stress. In contrast, women seem to
29 be more future thinking and business orientated. Their illustrations contained a variety
30 of improvements ranging from electricity and paved roads to markets to sell fruits,
31 vegetables, and possibly milk. One male respondent obviously envisaged continuing
32 climate disruption into the future drew an uprooted tree due to strong winds. His
33 drawing reflected that the future was not just about the improvements which human
34 intervention might bring about. Environmental challenges will have an influence on
35 "Becoming" and it remains to be seen how people will adapt to deforestation, food
36 shortages, change of rainfall, soil erosion and infertility, strong winds and water
37 shortages.

4.4 Interrelationships

1 “The capability of a person depends on a variety of factors, including personal
 2 characteristics and social arrangements” [49]. Social arrangements can greatly
 3 influence mental health. This is reflected in this study while looking at the outcomes of
 4 the FGs, in particular with regard to dealing with stress, the consumption of alcohol and
 5 the use of marijuana. Obot [50] highlighted, traditional drinks such as homemade
 6 distilled beverages, contribute to the overall consumption of alcohol in Africa while not
 7 being recorded in official statistics. Kauye [51] emphasised research on mental illness
 8 in Malawi is minimal and lack of data is a major detriment to tackling the problem in
 9 Malawi.

10 Sen [23] pointed out that income is only a small contributor quality of life.
 11 Impacts such as the lack of freedom and capabilities, as well as problems such as
 12 sickness and disability, influence the quality of life of the whole family. When the
 13 researcher constructed the interrelationships between Being, Belonging, Becoming and
 14 respondents’ capabilities (Fig. 3), it became evident that the use of these capabilities
 15 impacts their quality of life strongly. The lack of capabilities could hinder a person
 16 achieving their goals, restricting their quality of life. The researchers’ field observations
 17 in one particular village showed how disability and disease could affect the entire
 18 family. One woman’s husband died from HIV. She is HIV positive herself, has to raise
 19 two children, earn a living and look after her own mother who has paralyses. Whatever
 20 the strengths of this woman’s personal characteristics, her social and family
 21 arrangement restrict her in her life-domain Becoming. Achieving personal goals are
 22 curtailed by her lack of freedom. Contracting HIV has lessened her own personal
 23 potential, thus her “Becoming” as well as her “Being” is limited. These findings interlink
 24 with the ‘capability approach’. The approach highlights what Sen and Nussbaum [24]
 25 insist is the importance of what people are able to do and be. It focuses on inequalities,
 26 especially for women in their families: inequality in opportunities and resources,
 27 educational deficits, that housework or caring work is not recognised as work. This is
 28 linked to the findings earlier, in particular to the educational advantages in secondary
 29 education for males, inequalities for women, especially those in polygamous marriages
 30 and the time impacts of females’ duty of to fetch water. Health facilities were identified
 31 as a priority need in the study. The study results also correlate to the Malawi’s
 32 Demographic and Health Survey, as 55.5% of women aged 15-49 have problems in
 33 accessing health care due to distance to health facilities [6].

57 **5. Conclusion**

58 The research exhibits how access to groundwater from handpumps impacts quality of
 59 life in rural communities in Northern Malawi. Not even every fifth household of the CG
 60 had water all year around compared to at least every second household of the TG.
 61
 62
 63
 64
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Sanitation and hygiene standards also differed, with the TG fairing better mainly due to NGO interventions. There was a greater environmental awareness present in the communities with over 70% of all households stating environmental challenges, such as deforestation, lack of firewood, strong winds, shortage of rainfall and less harvest.

All households reported that accessing clean water will be their biggest challenge in the next three years, with rainfall changes resulting in food shortages, and also contributing to destruction of bathrooms and toilets. Focus groups highlighted safe, clean drinking water, improved sanitation facilities, better hygiene and accessible health services as pressing regional health needs. The top health needs were stressed in both quantitative methods and the 'Imagination exercise' provided a picture of what people personally desire for the years to come. This prompted a variety of identified needs, ranging from health facilities, water, education, sanitation and hygiene, trees, economic goods to good housing. This analysis also sheds new light on the quality of water compared to individual perception of water as safe from a handpump. The research illustrates that access to groundwater impacts on the three life-domains of Being, Belonging and Becoming. These impacts are both positive (those with handpumps having more time and fewer food shortages) and negative (water quality and handpump access increases the number of boys and girls fetching water). In some cases unexpected impacts (toilet sharing) and in others surprising impacts (mental health issues and impacts of widowhood on social integration) were documented.

Four areas, that require additional research were identified in the context of Northern Malawi: a) Measuring and understanding the impact on children's lives, especially on school attendance, stress and concentration levels, imposed by the increased burden of work placed on both boys and girls of fetching water from handpumps after installation. This burden had previously not fallen on children; b) How diseases, disability, and mental health issues, including the use of drugs and alcohol impact on freedom and create a burden for affected people and their families and are linked to groundwater access; c) How to create reliable access for all citizens to functioning and effective health facilities whether fixed or mobile to enhance the quality of life of individuals; and d) Water sample testing for microbiological quality should be undertaken for all handpumps in both wet and dry season.

As Malawi works toward the Sustainable Development Goal for water supply, the pressing public health needs of rural individuals, their 'Being', 'Belonging' and 'Becoming' need to be fully addressed.

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Title:

Access to groundwater and link to the impact on quality of life: A look at the past, present and future public health needs in Mzimba District, Malawi

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Abstract

Imagine a world where you have to get up at 4am to walk for two hours in the dark to fetch water. This remains true in Malawi, where the Millennium Development Goals are said to have been met. This research aimed at understanding the impact access to groundwater has on people's 'Being', 'Belonging' and 'Becoming,' as well as people's capabilities and impacts on their quality of life in Mzimba District, Malawi. Being, Belonging and Becoming define three life domains. Being reveals 'who one is,' Belonging reflects 'connections with one's environments' and Becoming relates to 'achieving personal goals, hopes and aspirations.' The study comprised of 210 households, four treatment groups (TG) based on communities consisting of households with access to a handpump and compared to four control group communities, where households had no access to a handpump. Results showed current awareness of environmental issues is linked to recognising future (5 years in advance) environmental challenges. There is a need to create awareness of water quality results within the communities and point-of-use household water treatment. Both the TG and control group (CG) had a gap in sanitation facilities, with up to 27 people (5-6 households) sharing one pit latrine. Polygamous marriages had implications on self-respect and led to neglect on the first wives. Focus group discussions revealed HIV, disabilities and mental health issues, including the use of drugs and alcohol, affect freedom, and created a burden, not only for affected individuals, but also for their extended families. Focus groups highlighted safe and clean drinking water, improved sanitation facilities, better hygiene and accessible health services as pressing public health needs. The implications of this study exhibit, rural individuals 'Being', 'Belonging' and 'Becoming' need to be considered when addressing pressing public health needs, as Malawi works toward the Sustainable Development Goals for water supply.

Keywords

Quality of life
Water quality
Public Health
Sanitation and hygiene
Malawi

1. Introduction

Improved drinking water sources became a reality for 2.3 billion people between 1990 and 2012 [1]. In 2015, 663 million people worldwide, mostly rural, still relied on unimproved water sources such as surface water from lakes or dams for drinking, cooking and hygiene purposes. In addition, globally 2.4 billion people still have no access to improved sanitation facilities and only half of the rural population uses improved sanitation facilities [2]. In September 2015, the United Nations announced the new 17 Sustainable Development Goals (SDGs) replacing the MDGs. Goal 6 demands 'Clean Water and Sanitation' to "Ensure availability and sustainable management of water and sanitation for all" [3].

Although economic and social development in Sub-Saharan Africa is fundamentally reliant on the role groundwater plays, this resource-base and its use, are not sufficiently understood [4]. There is a lack of reliable data in Sub-Saharan Africa and the records, when available, are gathered in an unsystematic manner. The reasons are complex and numerous, including the absence of clear institutional responsibilities and protocols, lack of technical expertise, inadequate resources and the non-existence of database management systems [5].

Malawi is a land-locked country in Sub-Saharan Africa with a population of 16.4 million [6] and 83.9% living in rural areas [7]. Small farm size is driven by a high population density [8]. In a socio-economic context, the agriculture sector is the main economic base of Malawi, with smallholder and subsistence maize farming as main activities for the rural population [9]. Malawi's real GDP growth was 1.9% in 2012, and World Bank figures showed an increase to 5% in 2013, a further estimated rise to 5.7% in 2014 and 5.1% in 2015 [10]. These estimated increases are driven by tobacco exports and growth in key sectors, including agriculture, services, and manufacturing [11]. Deficits of amenities in rural communities in Malawi predominantly include water and sanitation, health, education, household food security, transport and communication [12]. Up to 80% of Malawians depend on renewable natural resources for subsistence and rain-fed agriculture [13], yet there is limited investment in irrigation. Malawi's surface water resources are formed by a network of lakes and rivers including the Shire River, Lake Malawi and Lake Chilwa [4]. The total annual rainfall is over 1600mm, predominantly occurring in the wet season from November to April [4, 14]. The estimated annual groundwater recharge in Malawi ranges from 15 to 80mm [15].

The Republic of Malawi Environmental Affairs Department [9] has environmental concerns due to temperature changes and increased frequency of droughts and floods. Nationwide, floods in 2013 damaged both piped water networks and boreholes, and left unprotected wells, streams and rivers contaminated [16]. Malawi is currently losing

about US\$18.5 million due to water-connected economic losses [17] which are likely to intensify with climate variability over the coming decades.

In Malawi, 89% of the population in rural areas use improved drinking-water sources, surpassing the MDG target [2]. Conversely, only 41% of the population in Malawi use improved sanitation facilities and only 3% of people have a hand washing facility at home equipped with soap and water [2]. Improved access to drinking water was identified as a top priority by the Republic of Malawi National Action Plan for Adaptation (NAPA) to climate change [18]. The National Water policy in Malawi states: *“The water services shall be provided using appropriate cost-effective technologies that are sustainable in the urban water services and for the rural areas, technologies shall conform to the Village Level Operation and Maintenance (VLOM) concept”* [19]. VLOM is tasked with: *“Promoting the diversification of appropriate technologies for the provision of water and sanitation services to the rural communities in line with prevailing standardization policy”* [19]. Yet, manual drilling for self-supply is not recognised in the 2005 policy. Policy responses to climate change that do exist in relation to groundwater mostly focus on adaptation and risk management [18] rather than on individual’s quality of life impacted by groundwater access.

Quality of life is defined by Raphael et al. [20] who describes it as *‘The degree to which a person enjoys the important possibilities of his or her life’* (p. 366) and is further defined by the three life domains of Being, Belonging and Becoming [21]. The quality of life domains are further elaborated by Solans et al. [22] who propose that Being reveals ‘who one is’ and contains sub-domains Physical-, Psychological- and Spiritual Being. Physical Being contains nutrition, personal hygiene, physical health, exercise and clothing. Psychological Being involves mental health, feelings and self-esteem, whereas Spiritual Being includes personal values and spiritual beliefs. Belonging reflects ‘connections with one’s environments’ and has sub-domains Physical, Social and Community Belonging. Physical Belonging depicts the connection a person has with its workplace, environment at home, school and community. Social Belonging includes the linkages with someone’s social environment, such as family, friends, neighbours and colleagues. Community Belonging characterises access to adequate health and social services, income, employment, educational program and community events. Becoming relates to achieving personal goals, hopes and aspirations and contains sub-domains: Practical, Growth and Leisure Becoming. Practical Becoming contains paid work, satisfying health or social needs. Growth Becoming comprises of adaptation to change and improvement or maintenance of knowledge and skills. Leisure Becoming contains activities, which promote stress reduction and relaxation.

Quality of life is reported to be more impacted by lack of freedom and lack of capabilities such as sickness and disabilities than by income; they influence the quality

of life for the whole family [23]. Nussbaum [24] outlines many privileges, stressed in the human rights movement, which are included in Nussbaum's and Sen's approach: free choice of profession, freedom of association, political rights and a range of social and economic rights [24]. Nussbaum [24] reinforces Sen's emphasis on the importance of what people essentially are able to be or to do, the significance level of their capabilities. Cohen emphasised that Sen describes capabilities as '*a reflection of a person's freedom to choose between different ways of living*' [25]. Furthermore, Cohen pointed out a capability is relevant and essential when its absence hinders the person from satisfying basic needs [25]. Sen further underlines that some *functionings*, such as being in good health and sufficiently nourished, are elementary [25]. Others may be commonly valued, however are more complex, like social integration and achieving self-respect. Sen notes that in the circumstances such as managing severe poverty in developing countries, it might be possible '*to go a fairly long distance with a relatively small number of centrally important functionings and the corresponding basic capabilities*' [25] such as to avoid preventable diseases, sicknesses and premature fatality and the ability to be well sheltered and well nourished. A little can go a long way.

The aim of this study is to interrogate the gap in understanding how access to groundwater impacts on people's capabilities and quality of life as defined by 'Being', 'Belonging' and 'Becoming,' by comparing communities with and without access to a water handpumps in Mzimba District, Malawi. The research study creates associations between natural resource management on one hand, and economic well-being, poverty reduction and development on the other. This study has four objectives investigated in the eight study villages: 1) to survey how access to groundwater through handpumps placed on shallow-dug wells in Northern Malawi impacts quality of life at a community, family and individual level, 2) to understand how access to groundwater impacts regional public health needs, 3) to investigate challenges towards securing clean drinking water which may be interlinked such as education, economic situation, sanitation and hygiene, food security, water availability and climate change and 4) to analyse water shortages and communities perception of safe and clean drinking water.

2. Materials and Methods

Ethical approval for this study was obtained from the National Commission of Science & Technology (NCST) in Lilongwe/Malawi (REF.NO.NCST/RTT/2/6). Data was collected through qualitative and quantitative methods. The primary study methods were in-depth interviews, focus group discussions (FG) and field observations by the researcher. The study area (Fig. 1) comprised of eight rural villages in the Traditional Authority (TA) of Mtwalo, in the Mzimba District, Northern Malawi. Four treatment

groups (TG) were identified purposively based on communities consisting of households with access to a handpump and compared to four control group (CG) communities consisting of households without access to a handpump. According to the most recent census, there were 140,599 people living in the Mtwalo area [26].

Fig. 1. Map of Malawi - study area. [27]

GPS data was collected during the field study to visually identify the study sites in ArcGIS in relation to land features, as well as to allow geographical analysis for trends resulting from study results. Figure 2 illustrates the TG and CG detailed study area, including main roads, households and land use such as health centres, schools, markets, post offices, police stations and handpumps. Many households are close to each other, therefore some attributes became blurred due to the closeness of the GPS data.

Fig. 2. Map of Malawi - detailed study area. [27]

The standard formula for calculating sample size introduced by Taro Yamane in 1967 was used to select a sample size representative of the population. A sample size of 203.8 people was calculated with a probability error of 0.07 [28]. Therefore the sample size contained 210 rural households, 105 each for the TG and CG.

Importantly, the study's analytical framework is presented in Figure 3. The framework is based on quality of life and the Social Diagnosis Approach by Green and Kreuter [29] who argue there is a need for community-oriented applied methods, such as community surveys and focus groups, to bring the voice of the community into development work.

Fig. 3. Analytical Framework. [27]

A quantitative survey was conducted with 210 face-to-face interviews within eight rural communities. The research was carried out by questionnaire with the assistance of a local translator via a motorbike. A minimum of 19 households was interviewed per village over 12 weeks from June until August 2014. The researcher and translator visited the chiefs from all communities before the research was carried out to get permission to conduct the survey and to explain its purpose. The questionnaire contained 68 standardised survey questions, which were read aloud by the translator to respondents in the local language Chitumbuka. Data was recorded using a digital data collection tool, Open Data Kit (ODK; Seattle, Washington, USA). Each respondent gave written consent, either as a signature or thumbprint. Respondents ranged in age from 18 to 93 years. All households surveyed were without access to piped water or

electricity. Prior to commencing the interview, a definition of a household was read out to all participants: *'The household is a group of persons related or not, living under the same roof, under the responsibility of a head whose authority is acknowledged by all the members. The ordinary household is composed of a head of household, his spouse(s), his unmarried children, and possibly his relatives or other persons to whom he is unrelated. The household can be limited to only one person or a person with his children. In polygamous households, each wife is treated as a distinct household when the wives live in different houses, cook separately and take decisions independently.'*

Additionally, six focus groups (FG) were held, two FG in the TG, two FG in the CG and two additional FG with women self-help groups connected to St. John of God, a local public health service provider. The self-help groups are small women's organisations comprising of 10 to 20 women set up for village banking. FGs comprised of group discussions, imagination- and drawing exercises. For each of the FG, the researcher included thinking and feeling questions by conducting a picture drawing exercise as in combination, they provide a better understanding, as suggested by Krueger and Casey [30]: 'When listening to the brain, your study will encourage participants to think about the topic and to offer their answers. These studies are often used when we are seeking an array of possibilities, such as discovery of the array of needs within a community. People respond in a less detached way. When listening to the heart, the focus group procedures change. The moderator asks for less factual information and encourages discussion on feelings' (p.50). A4 papers in different colours and coloured pens were given to participants. An introductory question initiated the topic of discussion, sparked participant thinking about the topic and suggested expression through the medium of drawings. Three key questions were then asked. The final question sought an outlook into the future by using an imagination exercise introduced by Krueger et al. [30], where imagining and drawing were stimulated. Each participant was asked to draw their thoughts and feelings on an A4 paper and to share their drawing with the other focus group members.

Water quality was tested from five water pumps in the TG and four from surface water of the CG. Each sample was collected into sterilised glasses by the researcher and analysed by the Northern Region Water Board (NRWB) in Mzuzu within 24 hours of sample collection.

Quantitative data was described and analysed using SPSS Statistics Version 21. Quantitative data analysis mainly involved simple descriptive statistics such as frequency distributions, percentages, cross tabulations and multi-linear regressions. Results were presented in tables, graphs, charts and other illustrations. Additional graphs and charts were produced to compare the CG and TG using Microsoft Excel. Qualitative data from FG discussions and observational field notes involved categorising and identifying similarities across several participant accounts noting

directions and tendencies. They were manually transcribed, ordered and analysed systematically based on content. Some accounts resulting from discussions represent stand-alone illustrations of important themes and emerging issues of the study.

3. Results

3.1 Sample profile

The average household size was 4.56 persons, which is representative, comparable with the average nationwide household size of 4.60 [31]. The TG tended to be slightly larger than the CG. TG and CG were comparable in terms of marital status and gender. Females were more represented at 55%, compared to a nationwide split of 48.7% male and 51.3% female in rural areas [31].

Males above the age of 26 had a higher likelihood than females of secondary education level. No differences were found in male secondary education between TG and CG. However, 80% of females with some secondary education belonged to the TG, indicating that females with higher education were more likely to have access to a handpump.

The main employment of household members was agriculture and trading, vegetable and tobacco cultivation. Most interviewees had more than one occupation. The CG had a higher number of people involved in paid work like trading and craftwork. Female employment was higher in education and trading, whereas males dominated in craftwork and moulding bricks. The female workforce doing paid work in the CG was higher than the TG.

Marital status by gender exhibits three times more single men (15 out of 20), 87% of them in the age group 18-25. 97% (29 out of 30) of respondents experiencing widowhood were female, and most were in the lower income bracket of 1-20,000MWK/month. 63% (n=29) of widows were respondents from the CG. Physical Being of widows in the CG was highly affected by food shortages (81%), compared to only 26% in the TG and the usage of pit latrines without slabs in the CG (81%) versus 42% in the TG.

10% (21) of interviewees stated they were in a polygamous marriage, with more polygamous marriages in the CG (62%) than the TG (38%). Physical Being of respondents in polygamous marriages seemed to be highly negatively affected by toilet sharing in both groups, CG (77%) versus TG (88%) and usage of pit without slab in the CG (92%) versus TG (75%). Big differences existed in relation to food shortages. Respondents in the CG reported 85% food shortages for a maximum of up to 5 months per annum compared to only 38% food shortages in the TG for up to a maximum of 2 months per annum.

3.2 Examining needs for a better quality of life of the regional population

The drawing exercise (Fig. 4) encouraged respondents to communicate their thoughts, through the medium of a speech bubble in The Mouth Exercise. Respondents mentioned needs such as hospitals; water, sanitation and hygiene, education, economic and well-being goods such as markets, jobs, money, food, maize mill; and trees for the environment. In the Head Exercise, listening to their head, participants drew the following: economic and well-being goods such as money, car, food, bicycle and maize mill, also water, infrastructure, schools and sanitation and hygiene. In The Heart Exercise, considering their feelings while listening to their heart, participants drew tangible objects and intangible concepts: water, education, shelter, sanitation and hygiene, infrastructure, economic goods and necessities like a bicycles, cars, food, fertilizer, maize, chickens and money.

Differences were observed between the CG and TG drawings in the areas of sanitation and hygiene, infrastructure and environment. While the TG included sanitation and hygiene when drawing about their feelings, the CG integrated these when they thought or spoke. Infrastructure was included in the Mouth, Head and Heart exercise by the TG, however the CG left out infrastructure when speaking (Mouth exercise) about their needs. Nevertheless, the CG expressed the need for infrastructure clearly when thinking or feeling. The TG, while thinking about their needs, included trees. Interestingly, the CG didn't draw trees in any of the three exercises. Good housing was raised by both the CG and the TG while expressing their feelings listening to their heart, yet was not mentioned while speaking or thinking.

Fig. 4. Female drawing by the treatment group from the Mouth, Head and Heart Exercise.

Fig. 5. Male drawing by the control group from the Mouth, Head and Heart Exercise.

3.3 Determining water scarcity in relation to access to water

Households reported an average daily water usage of 17 litres/person for the CG versus 19 litres/person for the TG. The WHO [32] defines that access to drinking water requires at least 20 litres/person per household daily. The cross tabulation in combination with the Chi-Square test showed, a significant percentage of only 17% of the CG had water all year around, compared to 61% of the TG.

Respondents reported the highest seasonal water shortages from September to November, consistent with seasonal weather. The findings for TG and CG were almost identical in October (94% TG vs. 95% CG) and November (82% TG vs. 84% CG). However, the findings varied greatly in September, where the CG faced higher

seasonal water shortages with 66% vs. the TG with 48%. Several individuals stated fetching water takes over one hour during the dry season. While water scarcity in the CG was reported as seasonal, the TG also faced scarcity, periodically, for different reasons; due to broken handpump parts and vandalism. Parts replaced were predominantly pipes (18%), rubber washers (14%) and handles (14%), and 27% miscellaneous (unknown by interviewee). 64% reported current mechanical problems with the system, including 29% with the slab, 25% with the pump, 18% with loose parts, 14% with pipes and 11% with handles.

The cross tabulation and chi-square test displays a strong statistical correlation (0.00%) between having access to a handpump and enough water year round. From the CG, 83.8% stated they do not have enough water, versus 39% from the TG. Looking at comparisons for 'time spent to fetch water' through a cross tabulation and Chi-Square test, the TG spends significantly less time fetching water than the CG, with 79% (TG) using 30 minutes or less, versus 54.4% of the CG. From the CG, 31.4% need 45min or more, versus 16.2% of the TG.

3.4 Examining future challenges with regards to access to water

The Chi-Square test showed, that there is a strong statistical significance between the biggest challenge people identified in the next three years and having access to a pump. The cross tabulation showed that the biggest challenge both groups predict will be water - in the CG (51.4%) and the TG (24.8%). The second biggest challenge in the CG will be 'health' (21.9%) in comparison to the TG's 'education' (24.8%).

Within both groups, 84% of households noted a change in rainfall pattern. Respondents described the rainfall as heavier but less often. Interviewees (81%) reported more rainfall in 2014 lasting for a longer period. However in previous years rainfall was less. Households also showed damaged roofs from strong winds and bathing rooms and pit latrines destroyed by heavy rains to the researcher.

3.5 Investigating environmental awareness in the region

Seventy percent of the TG versus 78% of the CG stated they faced environmental issues. The most pressing environmental issue reported was deforestation. Even though the respondents seem to understand this concept, their way of describing it varied. The TG highlighted deforestation (81%), followed by lack of firewood (18%), strong winds (15%), less harvest (16%) and shortage of rainfall (15%). The CG highlighted deforestation (74%), followed by shortage of rainfall, less harvest, strong winds and lack of firewood. Household responses and field observation confirmed deforestation was impacted by the consequent need of households burning local bricks

and producing charcoal to generate income. Respondents highlighted shortage of wood for building sheds to dry tobacco and store maize.

The biggest reported environmental challenges in the next five years (2015-2020) showed only slight differences between the TG and CG. Cross tabulation revealed deforestation was predicted as significant, with 61% (TG) and 49% (CG) followed by a shortage of rainfall, strong winds and soil erosion/infertility.

Cross tabulation shows there is a strong statistical significance between awareness of current environmental issues and the prediction of the biggest environmental challenge in the next 5 years. 93% of people aware of environmental issues in 2014 said there would be environmental challenges in the next 5 years. 80% of people who did not know about environmental issues in 2014 believed there would be environmental challenges in the next 5 years, compared to 52.6% who reported no awareness of environmental issues in 2014. The Chi-Square test shows a strong statistical significance of 0.01% between the change of rainfall pattern reported and the awareness of environmental issues. The findings further show 89.8% of respondents aware of changing rainfall patterns, also described environmental issues in 2014.

3.6 Establishing sanitation and hygiene standards in the region

One of the top priority needs mentioned in the FGs was sanitation and hygiene, which are part of Physical Being. Cross tabulation shows a pit latrine without slab was the most used facility with a significant number of 92% from the CG, versus 45% of the TG using one. The TG had a staggering higher access to improved sanitation facilities¹ (54%) versus 4% in the CG. Notably, higher income was not directly related to an improved sanitation facility in the TG (Table 1).

Table 1

Household income versus improved pit latrines in the treatment group, Mzimba district, Malawi.

Household income/month	Proportion of households with pit latrine with slab/Ventilated pit/toilet seat (Treatment group)
Low 1-10.000MWK	34%
Medium 10000-30.000MWK	42%
High 30.000MWK+	23%

¹ Pit latrine with slab, ventilated improved pit latrine or toilet seat

The cross tabulation shows a significant number of 71.4% from the CG are sharing toilet facilities versus 51.4% from the TG, most are shared by three households. However, in some villages up to 27 people are sharing one facility. Researchers observed most people shared sanitation facilities with several neighbours. The 2010 Demographic and Household Survey shows 59.2% of rural sanitation facilities in Malawi are shared [33]. This figure matches with the researcher's findings, which show 65.8% of households share pit latrines without slabs.

Lack of hygiene was observed, as hand washing facilities were only available at two households. One had soap available, the other one had clearly not been used for months.

3.7 Establishing perception of safe and clean drinking water

Another important aspect to consider when looking at 'Being' is the intersection of drinking water and physical health. Drinking water is considered to be safe when its chemical, microbial, and physical characteristics meet WHO Guidelines for Drinking Water Quality [32]. Groundwater depletion or contaminations are common problems arising from hand-dug wells [34]. The perception of households that the groundwater was safe was 92% in the TG versus 26% for the CG. Water quality results (Table 2) though showed coliform bacterial levels ranging from 344 – 2048 cfu per 100mL. However, there is no data on record with the NGO 'Wells for Zoe' relating to water sampling or testing before or after handpump installation [35]. An earlier research study from Pritchard, Mkandawire and O'Neill [36] conducted in 2007 in the districts Balaka, Chikwawa and Zomba in Southern Malawi, established the water quality of 26 shallow wells. Of samples taken in the dry season from covered shallow wells, 80% of samples taken in the dry season from covered shallow wells failed to meet the safe drinking water limits set by the WHO, compared to 100% of samples taken in the wet season [36]. The water samples in this paper were taken in the dry season only and showed that shallow wells in the TG yield water of unacceptable microbiological quality.

There was no association between people's perception "*Is the water safe*" and the water quality test results. Observations in this study showed that, due to low water tables, most pumps in the TG are located in valleys and there was a risk of surface water pollution from chemicals (fertilisers), and human and animal waste. Furthermore, 57% from the CG reported problems with the taste or colour of the water, versus 16% from the TG. Some respondents commented water from the handpump smelled bad. Surface water was described as muddy, milky, grey, turning green or red sometimes, as well as smelling bad due to alga or mud. It was heavily reported that surface water tasted salty due to 'cows urinating in it.'

Table 2

Drinking water quality in study area, Malawi.

village	study group	cfu/100ml ¹
Yesaya Moyo	TG	2048
Makula	TG	1928
Kachasu	CG	1672
Ngoti Ngwira	CG	1512
Mlokota Tupa	CG	1152
Moffat	TG	1128
Bandawe	CG	512
Isaak West	TG	488
Isaak East	TG	344

¹ NRW report, 2014
 TG = Treatment group
 CG = Control group
 cfu = colony forming units

3.8 Water treatment

Water treatment in the home prior to consumption differs between the TG (49.5%) versus 58.1% from the CG. The common methods of treatment were boiling (54%), followed by usage of chemicals such as chlorine (33%) and simple settling (17%). Cross tabulation and Chi-Square test were run to establish whether people are more likely to treat their water if they have a higher education level. The Chi-Square test showed that with 18.6% there was no statistical significance between the level of education and whether people treating their water. An additional Chi-Square test displayed, there was no statistical significance between household income and people treating their water (0.31). Therefore, people with a higher income were not more likely to treat their water.

3.9 Determining regional public health needs

Nutrition is part of Physical Being, and regarding access to water in relation to food shortages, the most significant observation shown by the Cross tabulation and Chi-Square test was, that the TG experienced substantial shorter periods of food shortages.

Fig. 6. Food shortages per annum.

The question “*What health needs do you have in your community?*” brought up explicit priorities. All FGs stated three imperative and top priority needs: water, sanitation and hygiene, and hospitals. Explicitly, they stated the need for clean and safe water, better sanitation, good hygiene, and good toilets with one for each household, as well as health facilities, hospitals and ambulances. The need for health services connects with the life domain of Belonging [21]. Health Services are part of Community Belonging and interviews illustrated 55% of households had to walk for more than 2 hours to the next health service and an additional 35% had to walk between 1-2 hours. There was no difference between CG and TG.

Fig. 7. Focus group, Moffat village. [37]

Ekwendeni and Choma Health Centres in Northern Malawi are large facilities used for healthcare by the interviewees. Observations revealed Choma is located in a remote area and only two nurses were on duty, with no doctor. This raises questions: why no doctors are available in a regional health centre and whether nurses are qualified enough to help all patients in need. As well, the Ekwendeni Health Centre was closed at 3.30pm on a working day and questions have to be asked whether these health centres are practical for local people, especially their opening hours, as many people have to walk between two and ten hours to reach them. Some FGs pointed out good infrastructure is essential, especially bridges and good roads to access health facilities and hospitals.

Four out of six FGs raised health needs, such as good clean houses and food security. Chipeta [38] underlines the point of good housing, but outlines Malawians mostly cannot afford good houses due to their low income. Windows were mentioned, as essential to keep the houses clean from dust, and household items like mosquito nets, bedframes, mattresses, blankets and clotheslines, as well as enough food. The need for food security became obvious in all categories. Two female FGs stated the need for food diversity and in particular nutritious food. Mkandawire et al. [39] likewise emphasised, that access to good quality food is problematic in Malawi. Moreover, bins and appropriate waste management were raised by two female FGs, both based in urban settings.

Mental health problems are also part of Practical Becoming, as part of current and future with major challenges to satisfy health needs. Leisure Becoming, as defined by Raphael et al. [21] involves challenges in achieving stress reduction. The outcome of the question “*What mental health problems do you have in your community?*” was consistent and unambiguous between groups. All FGs highlighted smoking marijuana

as the top health concern for mental illnesses; this was followed by stress due to too much thinking and consumption of alcohol, which were highlighted by four out of six FGs, both male and female. Furthermore, three female FGs identified a delay in the treatment of malaria as a contributor to mental health issues.

Participants in the FGs were invited to use their imagination in a drawing exercise 'Imagination 2034' and to depict how their community would look like in 20 years time. Male participants from the TG drew nature, such as trees, grass, stars and a cow (Fig.8).

Fig. 8. 'Imagination 2034' drawing exercise, Focus group, Moffat village.

Figure 8 shows drawings of trees and nature and underlines deforestation in this local community. The researcher therefore asked a personal question after the FG had finished drawing: *"You all imagined your community with a lot of nature and in particular a lot of trees. How will you make sure that your community will look like this in 2034 if you cut trees in your community now? Is every one of you cutting trees at the moment?"* Everybody nodded. *"So how will you make sure that your community will look like your drawings in 20 years' time?"* Silence. Then Joseph aged 60 plus, spoke: *"Due to our discussion and FG we have realised the importance of planting trees for each one we cut! We will be planting trees now so we still have plenty in 2034! Thank you for coming to our village."* This is a good example of *Practical Becoming*, which looks at satisfaction of personal needs: men are cutting trees to fulfill their need of paid work and survival. *Growth Becoming* is reflected in improvement of knowledge and adaptation to change, which the men clearly showed by committing to plant trees. Nevertheless, the one man who had drawn a cow stood out to the researcher for he had different thought processes to the rest of the group. For him the question *'how he imagines his community in 20 years time'* inspired him to include a cow, which could be interpreted as a desire to develop and start a business by selling milk, or to be able to buy cows through loans to sell milk. This is a noteworthy FG outcome and showed what can be done with drawings and dialogues. The female participants of the TG drew a combination of things for how they imagine their community in 20 years time. Infrastructure and nature were dominant themes, with houses, preschools and paved roads to markets as well as forests and fruit trees. Manual maize mills, water pumps, electricity and one electric maize mill were drawn, as well as chickens, birds, a cow and a fight with a snake. This outcome highlights *Practical Becoming*: to satisfy their personal needs, such as paid work and good health. *Growth Becoming* is revealed by adaptation through alterations in infrastructure and access to electricity. Both groups drew mostly about nature such as trees, mountains, grass and flowers together with houses, some with tin roofs and toilets outside of the main houses and infrastructure. In

comparison, male FGs drew a hospital, an ambulance and schools. One participant drew an uprooted tree due to strong winds.

4. Discussion

4.1 Life-Domain 'Being'

The study looks at the quality of life domain "Being" as defined by Raphael et al. [21]. Nussbaum and Sen [25] also highlight that some '*functionings*' of Being can be elementary, for example good health and sufficient food.

Physical Being is determined by nutrition and personal hygiene. The results of this study have identified that longer periods of food shortages for the CG interlinked with considerably higher water scarcity, are possibly additionally linked to the lack of irrigation. This shows a disadvantage for communities without handpump access. Widows in the CG in particular were highly affected with regard to food shortages. Lack of improved sanitation facilities and destroyed bathrooms due to environmental issues added to their sanitation concerns. Many interviewees reported that heavy rainfall and strong winds destroyed toilets and bathrooms, both separate structures from the house, which leads to more toilet sharing. Observations revealed many people practiced open defecation in the dark and likewise bathing in the open using darkness and banana trees as shelter. This affects the "Being" of women especially during their menstruation, as they would need toilet facilities more often than men, and also during the day. Results exhibited higher access to improved sanitation facilities in the TG. Observations by the researcher revealed sanitation interventions had been implemented by NGO's to promote and implement 'pits with slabs' in the TG, which may account for the difference in percentage slab toilets vs non-slab ones between TG and CG. Field observations revealed some toilets are a five-minute walking distance and have no entrance cover for privacy. Most toilets were observed by the researcher to be well ventilated. The high number of shared toilets in both groups highlighted the need for more improved sanitation facilities and correlated with the FG findings.

Good health, part of the life domain "Being" is associated with having access to adequate clean drinking water. The study found TGs face less water scarcity. Water management will be critical in the future as the competition for water resources increases due to a growing population and rising economic activities [7] as well as changing weather patterns. Clearly, it is critical to have water availability all year round. Better water resource management is needed, in particular during the dry season and droughts. Water resource management academic programs (such as BSc and MSc) need to be strengthened and policies harmonised to focus on sustainable development, utilisation and food security. The effect on the sustainability of rural water supplies is a key uncertainty associated with the impacts of climate change in Malawi

[21]. The expected effects of climate change in Malawi are increased occurrence of floods, droughts and irregular and unpredictable rainfall [40]. Serious consequences will arise from the unpredictability of the intensity and duration of rainfall [41]. The household observations of the change in rainfall patterns, is supported by historical rainfall data from 1984 through to 2007, in which five crop seasons 1986/87, 1991/92, 1993/94, 2003/04, and 2004/05 have been identified as significant drought periods [42].

Although most of the population in rural areas reported using an improved drinking-water source, this does not necessarily reflect functionality of the handpump, good water quality, or a positive impact on their quality of life linked to the water source. Though the biggest challenge respondents considered they would be facing in the next 3 years differed based on having access to a pump. It is crucial to understand how water resources will be affected by changing climatic conditions, and how people will be able to respond to, and will build the necessary resilience to face associated challenges. Understanding the physical parameters and human interactions will play an important role in predicting possible future impacts.

Results showed a need to create awareness amongst all actors (Government, INGO's/NGO's, academics and local communities) of water quality and household point-of-use drinking water treatment. Although the TG handpumps were provided by NGO's, water testing after installation or as part of on-going monitoring, was absent thus the safety of improved water sources was unconfirmed. This is despite water quality testing capacity being available at the NRW.

4.2 Life Domain 'Belonging'

Community Belonging characterises access to adequate employment, income, educational programs and health/social services. In comparison to UN statistics [43, table 4], which look at *'At least some Secondary education'*, the study households had 3-4 percentage points less secondary education than national standards. This may be due to this study being conducted in a rural area or to the year's difference between the studies. Children in Malawi start primary school at the age of six and the primary educational system consists of eight years of schooling. However, observations revealed, a majority of students need to repeat classes. Secondary school consists of four years of schooling. The education split of TG and CG did not differ. Although not all children attain the highest education level, the majority of people (55-56%) have some primary education. This percentage is nevertheless lower compared to the Integrated Household survey [31], which claims that 71.4% in rural Northern Malawi have some primary education.

Income is also part of Raphael et al.'s [21] life domain of Community Belonging. The monthly household income comparison between TG and CG shows that the CG

has a higher income overall. This finding is surprising and illustrates that access to a water handpump in the study was not connected to a higher monthly income. Earlier work found the cost to Malawi resulting from unsustainable use of natural resources was 200US\$ per household deriving from shortage or changing rainfall, deforestation in catchment areas around the main urban centres where firewood supply and charcoal production were jeopardised and from reduced agricultural productivity due to soil degradation [13].

Social Belonging is defined as '*connection with one's environment*,' for example, social integration and achieving self-respect [21]. An observation by the researcher, in keeping with the work of Slonim-Nevo et al. [44] and Broude [45] is that polygamous marriages seem to be the norm in some villages and first wives are commonly neglected. The first wives seldom had any personal assets and looked after the children from their husband's second marriage. From the interviews, the researcher noted a lower level of self-respect in this small group of respondents. Additional observations revealed widowed respondents, which prompted additional questions by the interviewer. These supplementary questions revealed most causes of widowhood were HIV which compares to those previously highlighted by Kirkpatrick [46], malaria, TB and meningitis. Furthermore, particular widows revealed they were unable to remarry and they had to look after their children and earn a living at the same time. Most of these widows, as well as some of their children, were HIV positive themselves. It is likely that these conditions would affect their Belonging – their social integration and self-respect. Nevertheless, a positive example of Social Belonging was apparent when women shared their way of fetching water from a pump. Women would usually go with their children, neighbours and friends to fetch water and it seemed to be a means and place to chat, promoting connection within the community and social integrity. As Sorenson et al. [47] pointed out, the social aspect of fetching water is often discussed sporadically and anecdotally.

4.3 Life Domain '*Becoming*'

Raphael et al. [21] refer to Leisure Becoming as activities that reduce stress and facilitate relaxation. The duty of water sourcing was particularly gender pinpointed, with 87% of women fetching water. This obligation clearly divided by gender (87%), did not change after handpump installations, which affected women's productivity vastly. Interviewees (76.2%) felt life had changed for those who had fetched water prior to handpump installation; in particular, less sickness, time saved, better health, good life and less tiredness. However, the installation of a handpump and consequent change in responsibility in fetching water may also have had negative implications. The number of girls and boys aged 5 to 17 fetching water increased after the installation of a

handpump, resulting from the water source being closer to the village after pump installation, with the work of girls increasing 423% and boys, 480%. This is an observation not previously reported in Malawi. Unfortunately, it was not possible to further examine the impact, but it is likely to affect school attendance, punctuality and stress levels and thus impact adversely on an age group which had previously been less affected by water access issues. These extra duties may cause difficulties or even impede children in achieving their hopes and personal goals. Looking at comparisons for 'time spent to fetch water', the TG spends significantly less time fetching water than the CG. Women from the CG were observed to be restricted in achieving goals as their daily duty of fetching water has implications on their time for relaxation. Crow et al. [48] pointed out that there is very little data on this work, however fragmented proof from Asia and Africa indicates that the time women spend collecting water is significant. Nevertheless, people, particular women, who have access to a handpump spend less time fetching water. Field interviews confirmed that women commonly used the time gained from fetching water for relaxation. The WHO defines access to drinking water *'that a water source be less than 1km away from its place of use'* [32]. The researcher questions the completeness of this definition as it depends on variables such as terrain and density of vegetation. For example, traversing 1km in a mountainous area such as the study site, would be much more challenging than level ground.

Yaron and Initiative [13] highlight forest resources are diminishing at 2.6% per annum. The main causes in this study are agricultural expansion due to population growth, and cutting of wood for fuel, which is a distinct problem in catchment areas surrounding urban centres. The drawing exercise 'Imagination 2034' revealed different perspectives by gender. Most men in the TG earned their living by moulding bricks with a consequent high demand of cutting trees to burn bricks. This could be one reason for male respondents indicated the desire to have a green village in 2034, and illustrates Leisure Becoming, such as relaxation and reduced stress. In contrast, women seem to be more future thinking and business orientated. Their illustrations contained a variety of improvements ranging from electricity and paved roads to markets to sell fruits, vegetables, and possibly milk. One male respondent obviously envisaged continuing climate disruption into the future drew an uprooted tree due to strong winds. His drawing reflected that the future was not just about the improvements which human intervention might bring about. Environmental challenges will have an influence on "Becoming" and it remains to be seen how people will adapt to deforestation, food shortages, change of rainfall, soil erosion and infertility, strong winds and water shortages.

4.4 Interrelationships

“The capability of a person depends on a variety of factors, including personal characteristics and social arrangements” [49]. Social arrangements can greatly influence mental health. This is reflected in this study while looking at the outcomes of the FGs, in particular with regard to dealing with stress, the consumption of alcohol and the use of marijuana. Obot [50] highlighted, traditional drinks such as homemade distilled beverages, contribute to the overall consumption of alcohol in Africa while not being recorded in official statistics. Kauye [51] emphasised research on mental illness in Malawi is minimal and lack of data is a major detriment to tackling the problem in Malawi.

Sen [23] pointed out that income is only a small contributor quality of life. Impacts such as the lack of freedom and capabilities, as well as problems such as sickness and disability, influence the quality of life of the whole family. When the researcher constructed the interrelationships between Being, Belonging, Becoming and respondents' capabilities (Fig. 3), it became evident that the use of these capabilities impacts their quality of life strongly. The lack of capabilities could hinder a person achieving their goals, restricting their quality of life. The researchers' field observations in one particular village showed how disability and disease could affect the entire family. One woman's husband died from HIV. She is HIV positive herself, has to raise two children, earn a living and look after her own mother who has paralyses. Whatever the strengths of this woman's personal characteristics, her social and family arrangement restrict her in her life-domain Becoming. Achieving personal goals are curtailed by her lack of freedom. Contracting HIV has lessened her own personal potential, thus her “Becoming” as well as her “Being” is limited. These findings interlink with the ‘capability approach’. The approach highlights what Sen and Nussbaum [24] insist is the importance of what people are able to do and be. It focuses on inequalities, especially for women in their families: inequality in opportunities and resources, educational deficits, that housework or caring work is not recognised as work. This is linked to the findings earlier, in particular to the educational advantages in secondary education for males, inequalities for women, especially those in polygamous marriages and the time impacts of females' duty of to fetch water. Health facilities were identified as a priority need in the study. The study results also correlate to the Malawi's Demographic and Health Survey, as 55.5% of women aged 15-49 have problems in accessing health care due to distance to health facilities [6].

5. Conclusion

The research exhibits how access to groundwater from handpumps impacts quality of life in rural communities in Northern Malawi. Not even every fifth household of the CG had water all year around compared to at least every second household of the TG.

Sanitation and hygiene standards also differed, with the TG fairing better mainly due to NGO interventions. There was a greater environmental awareness present in the communities with over 70% of all households stating environmental challenges, such as deforestation, lack of firewood, strong winds, shortage of rainfall and less harvest. All households reported that accessing clean water will be their biggest challenge in the next three years, with rainfall changes resulting in food shortages, and also contributing to destruction of bathrooms and toilets. Focus groups highlighted safe, clean drinking water, improved sanitation facilities, better hygiene and accessible health services as pressing regional health needs. The top health needs were stressed in both quantitative methods and the 'Imagination exercise' provided a picture of what people personally desire for the years to come. This prompted a variety of identified needs, ranging from health facilities, water, education, sanitation and hygiene, trees, economic goods to good housing. This analysis also sheds new light on the quality of water compared to individual perception of water as safe from a handpump. The research illustrates that access to groundwater impacts on the three life-domains of Being, Belonging and Becoming. These impacts are both positive (those with handpumps having more time and fewer food shortages) and negative (water quality and handpump access increases the number of boys and girls fetching water). In some cases unexpected impacts (toilet sharing) and in others surprising impacts (mental health issues and impacts of widowhood on social integration) were documented.

Four areas, that require additional research were identified in the context of Northern Malawi: a) Measuring and understanding the impact on children's lives, especially on school attendance, stress and concentration levels, imposed by the increased burden of work placed on both boys and girls of fetching water from handpumps after installation. This burden had previously not fallen on children; b) How diseases, disability, and mental health issues, including the use of drugs and alcohol impact on freedom and create a burden for affected people and their families and are linked to groundwater access; c) How to create reliable access for all citizens to functioning and effective health facilities whether fixed or mobile to enhance the quality of life of individuals; and d) Water sample testing for microbiological quality should be undertaken for all handpumps in both wet and dry season.

As Malawi works toward the Sustainable Development Goal for water supply, the pressing public health needs of rural individuals, their 'Being', 'Belonging' and 'Becoming' need to be fully addressed.

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