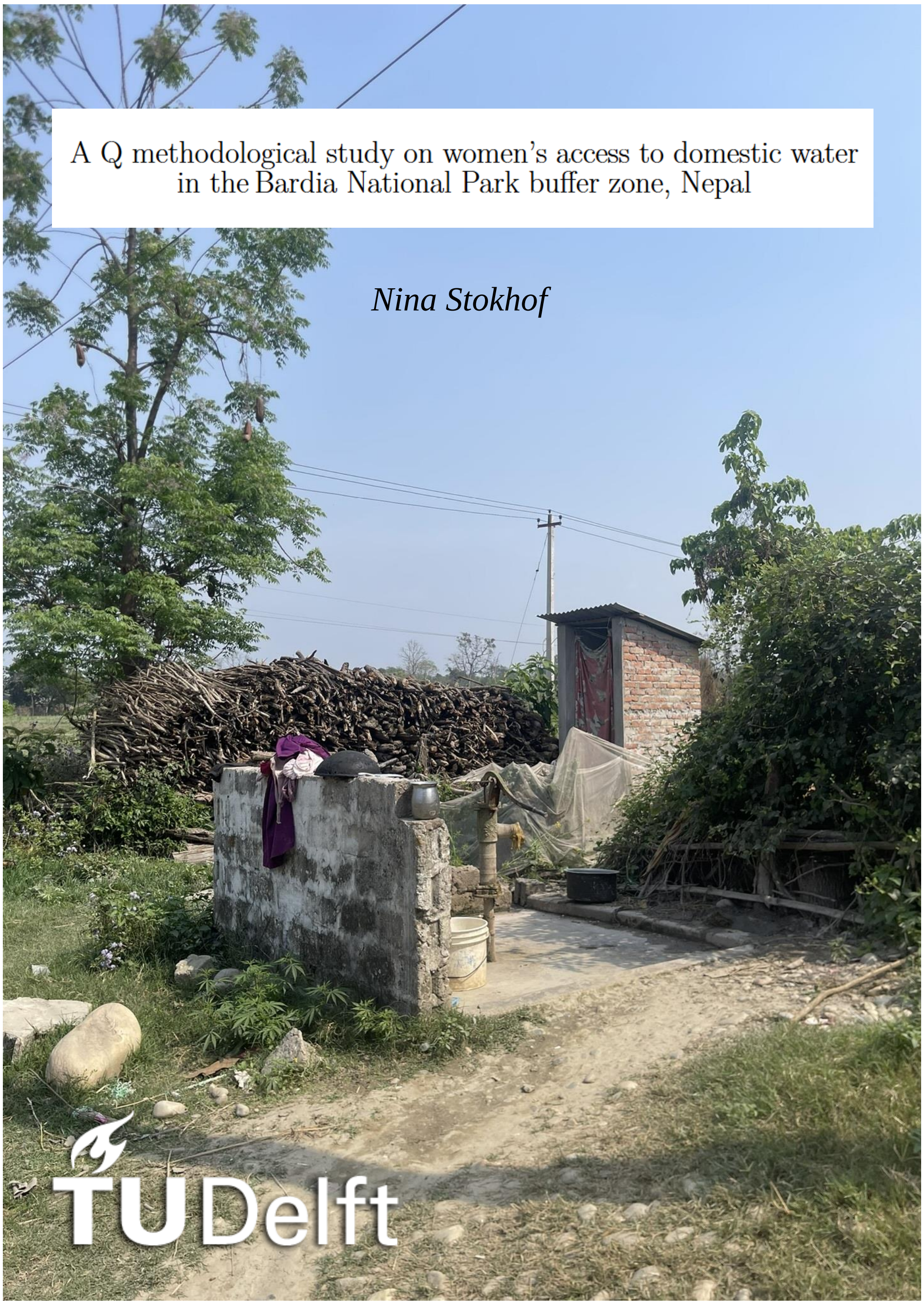
A Q methodological study on women's access to domestic water in the Bardia National Park buffer zone, Nepal

Nina Stokhof



TU Delft

A Q methodological study on women's access to domestic water in the Bardia National Park buffer zone, Nepal

by

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Abstract

Access to safe and reliable water is a fundamental human right, yet many rural communities in Nepal face persistent challenges in achieving water security. Women are disproportionately affected due to their primary role in household water management. Over the last decades there has been an increase in gendered studies on women's water burden. This study examined women's perspectives on domestic water access and use in four villages within the Bardia National Park buffer zone in the Terai region of southwest Nepal. Most households rely on hand pumps for water, though some have intermittent tap water access. Using Q methodology, this research explored women's perspectives on domestic water access and use using a set of 30 items. Principal Component Analysis (PCA) and varimax rotation resulted in a three-factor interpretation explaining 71% of the study variance. The main findings were first of all that the importance of good drinking water quality was shared across factors, but that this did not lead consistently to the adoption of household water treatment (HWT). Second, piped water was envisioned for various uses, shaped by economic considerations and differing levels of concern about fluctuating water quality and seasonal scarcity. Lastly, community meetings played a central role to the adoption of water hygiene and HWT by only one factor, which suggests that their potential may be underutilized.

Keywords: Domestic water; Seasonal water scarcity; Women's water access; Q methodology; Nepal

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- Likely procrastinated the idea of graduating indefinitely
- Certainly never gone to Nepal, a once-in-a-lifetime experience
- Completely lost my mind these last trying months behind a laptop

Thank you a thousand times.

Nomenclature

N Number

P p-value

BB5 Bhurigaon participant number 5, day 2

CFA Centroid Factor Analysis

CR Composite reliability

DMO Data Management Office

F1 Factor 1

GDPR General Data Protection Regulation

H2 Hattisar participant number 2

HREC Human Research Ethics Committee

HWT Household water treatment

KADE KenQ Analysis Desktop Edition

PCA Principal Component Analysis

PII Personally identifiable information

Q Q methodology

S22 Statement 22

SE Standard error

VDC Village Development Committee

WASH water, sanitation and hygiene

Z Standard score

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Chapter 1

Introduction

1.1 Context

Access to safe and reliable water is essential for human health and well-being, yet many rural communities in Nepal face significant challenges in achieving water security (S. Sharma et al., 2005). Despite being a water-rich country, Nepal struggles with uneven water distribution, seasonal scarcity, and contamination of water sources. In rural areas like the Terai, shallow groundwater—a primary water source—is at risk from pathogenic bacteria, pesticides, and industrial effluents (S. Sharma et al., 2005).

The lack of access to safe water contributes to widespread health and socio-economic challenges. Consuming unwashed fruits and vegetables, for example, is a significant public health concern in Nepal, as fresh produce is often contaminated with harmful bacteria (Bhandari et al., 2015; Ghimire et al., 2020; Khanal et al., 2024). Moreover, waterborne diseases are closely linked to inadequate sanitation systems and are exacerbated during floods (Neelormi, 2009). While efforts to expand piped water systems have been made, only 28% of these systems are functional, and less than 19% of the population has access to safely managed water (CBS, 2019; DWSSM, 2019).

These issues not only undermine public health but also disproportionately affect women (Bhattarai et al., 2021; S. Shrestha et al., 2019). Women face additional challenges as they are often responsible for fetching water, managing household hygiene, and ensuring water security (Gurung et al., 2019; IWMI, 2021; Water Aid, 2017). Scarcity of water has also been linked to increased risk of domestic violence for women (Choudhary et al., 2020). Gender norms limit their participation in formal decision-making regarding water management (Buchy et al., 2023; Raut et al., 2020; G. Shrestha & Clement, 2019). This exclusion perpetuates inequities, leaving women to bear the brunt of unreliable water systems without the agency to address these issues. Climate change (Dahal et al., 2020; V. P. Pandey et al., 2019) and male out migration (Khadka et al., 2023; G. Shrestha & Clement, 2019) are further pronouncing the gendered nature of water, making access to reliable water even more critical.

Engineering practices in Nepal's water resource development (including WASH) have historically prioritized a technocratic approach, failing to address deeply entrenched gender discrimination, exclusion, and masculine culture (Khadka et al., 2023; Liebrand, 2022; Udas, 2014). This perspective aligns with the notion that "since water is a natural resource, water management is a technical task, which benefits everyone, men and women, equally" (G. Shrestha & Clement, 2019, p. 8). Such thinking often leads engineers to disregard gender considerations in their work. As a result, technological implementations that overlook women's specific water needs frequently exacerbate existing inequities (G. Shrestha et al., 2023; Suhardiman et al., 2023). Similar issues arise in India, where women's domestic water needs, such as for laundry, are often overlooked in canal designs, and reduced distances to a water source have ironically increased collection times due to higher male demand (Lahiri-Dutt, 2007; Narain, 2014). Furthermore, women are not a homogeneous group. Their access to resources and perceptions of gender norms differ significantly, influenced by factors such as age and household roles (e.g., being a daughter-in-law versus a mother-in-law) (Suhardiman et al., 2023). Development interventions that fail to consider these social and cultural complexities risk exacerbating the challenges faced by marginalized women (G. Shrestha & Clement, 2018).

1.2 Problem statement

Despite Nepal's water-wealth, significant challenges remain in ensuring equitable access to safe and reliable water. Women, as primary managers of household water, bear a disproportionate burden, exacerbated by systemic gender inequities in water resource management. While policies and interventions have aimed to improve water infrastructure, they often overlook women's specific needs, perpetuating exclusion and reinforcing socio-cultural disparities. The gendered impacts of climate change and male out migration further amplify these challenges, making effective, inclusive solutions urgent.

Existing research has explored the technical aspects of water resource management, but there is limited focus on the intersection of gender and water access in rural Nepal. This study aims to address this gap by centering women's perspectives on water access, and exploring how gender-responsive interventions can foster sustainable and equitable solutions.

1.3 Study area

This research focuses on rural villages in the Terai region of western Nepal, specifically communities near the Bardia National Park. These villages face a range of challenges, including seasonal floods, droughts, and human-wildlife conflicts, which worsen water access issues. Most families in the region rely on small-scale farming for their livelihoods, making reliable access to water critical for both domestic and agricultural needs. Marginalized communities in this area frequently encounter inadequate water services due to a lack of social and economic capital (IWMI, 2021). Historical marginalization further limits their ability to access safe water supplies, perpetuating vulnerabilities related to poverty, gender inequality, and environmental stressors.

The region has undergone considerable administrative changes as part of Nepal's broader restructuring in 2017. Thakurbaba Municipality was formed by merging the Village Development Committees (VDCs) of Neulapur, Baganaha, Sivapur, and Thakurdwara, while Madhuwan Municipality was established by combining the VDCs of Sanoshree, Taratal, Suryapatawa, and Dhodhari (Wikipedia contributors, 2024). As of the 2011 Nepal Census, these municipalities each had populations of approximately 45,000 people, distributed across nine wards (CBS, 2012).

Water access in this region has transitioned significantly over the past three decades, shifting from communal wells to privately owned hand pumps. However, new challenges are emerging as plans for tap water systems progress, with concerns about reliability, affordability, and equity of access. River water remains a key resource in the Terai, primarily used for irrigation, fishing, and livestock. A small proportion of households also rely on river water for drinking, as well as for bathing and laundry (A. Sharma, Batish, & Uniyal, 2020). These uses highlight the diverse ways in which women in rural households manage their water needs, often adapting to limited or unreliable infrastructure.

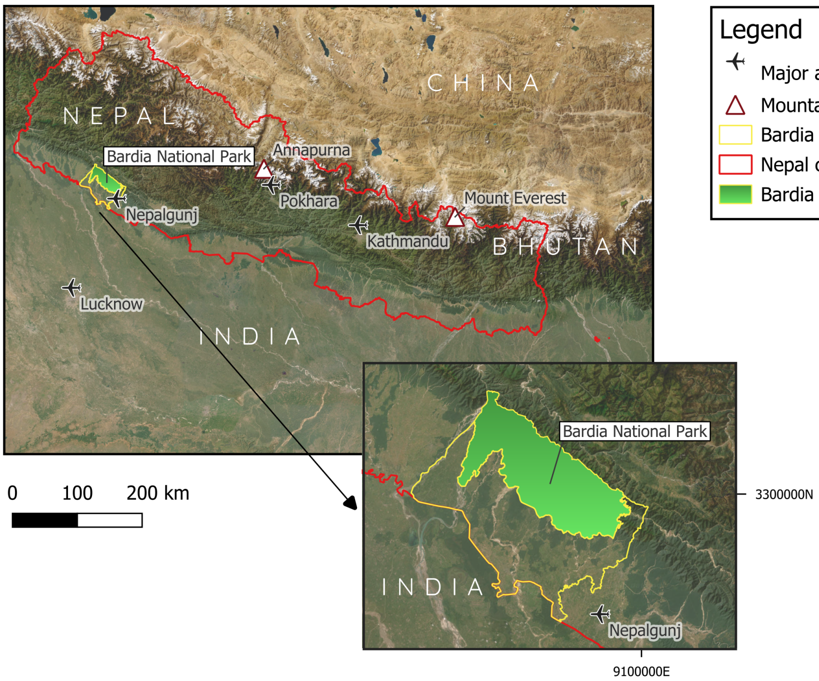


Figure 1.1: Map Bardia, South West Nepal

1.4 Research gap and objectives

This thesis aims to address the limited focus on the intersection of gender and water access in the Bardia National Park buffer zone by centering on women's perspectives through the use of Q methodology. By examining women's views on water access, this thesis seeks to contribute to the broader conversation about gender-responsive solutions in the water sector. It highlights the need for engineering designs and policies that account for the lived experiences and specific challenges faced by women in this area of rural Nepal.

The research sought to address the following question:

How do women in the Bardia National Park buffer zone perceive the challenges and opportunities related to water access?

1.5 Methodology

The focus of this research was investigating the viewpoints of women in an area of rural Nepal with respect to their access to and use of domestic water. Q methodology was deemed an appropriate method for this inquiry because it is designed to capture shared viewpoints. This approach is particularly valuable for exploring complex social issues (Watts and Stenner, 2012), such as water access and use. In the context of the rural villages selected for this study (e.g., Patarbojhi, Hattisar, Bhurigaon, Karmala), Q methodology provided insight into the nuanced water access challenges faced by women, revealing perspectives that may or may not align with traditional demographic boundaries. Water access and usage in rural communities, especially among women, involve complex social and cultural dimensions, often shaped by entrenched gender roles, local customs, and socio-economic factors that influence water access and management practices (Bhattarai et al., 2021; Choudhary et al., 2020; G. Shrestha & Clement, 2019). This complexity and subjectivity can be difficult to capture with traditional survey methods (Chambers, 1994; Cleaver, 1999), making Q methodology a more suitable approach.

Q methodology is a research technique developed by William Stephenson in the 1960s to systematically study subjectivity. Q methodology allows the researcher to explore *shared viewpoints within a group of people* (Brown, 1993; Watts and Stenner, 2012). It contrasts with traditional R methodology, which focuses on measuring objective variables and their relationships across at the population level. For more in depth information on the history of the invention of Q methodology based on R methodology refer to Appendix A – About Q methodology.

An important characteristic of Q methodology is its capacity for data-driven statistical exploration of subjective opinions without needing a pre-determined hypothesis, positioning it as a strong exploratory tool. This makes the method uniquely suited to reveal subjective perspectives by allowing participants to express their views through a structured sorting process. Q methodology, as defined by Stephenson (1952), enables by-person factor analysis by transposing the correlation matrix and defining the participant's viewpoint as the primary parameter. In contrast with R methodology, in Q methodology the sample consists of items — typically statements - whereas the participant's Q sorts are the variables. The following paragraph explains the Q sorting process.

1.5.1 Capturing subjectivity in the Q sort

The *Q sort* is a rank-ordering process involving a pre-established set of statements related to the research theme, known as the *Q set*. Participants organize these statements based on their level of agreement or disagreement. The Q set items are sampled from a larger number of items called the *concourse*. Careful development of the concourse and a balanced selection of Q set statements are essential for ensuring that the study captures a wide range of subjective perspectives (Watts and Stenner, 2012). The process of selecting the Q set must avoid bias, overlap, and overly complex statements. For more information regarding the concourse development and creating a balanced Q set, see Appendix A.3 – About concourse development and the Q set. The rank ordering is traditionally done in a forced distribution grid, with negative (disagree) items on the left and positive (agree) items on the right. This ranking process allows participants to prioritize items *based on their personal experiences and the relative importance of each statement* thereby creating a unified scale of *psychological significance* (Watts and Stenner, 2012, p. 16).

By ranking statements based on their subjective value, Q methodology enables the comparison of items that may initially lack a common measuring unit or frame of reference. Collectively, the psychological significance revealed through statistical analysis highlights the underlying patterns of shared viewpoints, also called *factors*. The factors represent the main perspectives, shared by participants who load on the same factor. The main steps involved in Q methodology are illustrated in Figure 1.2.

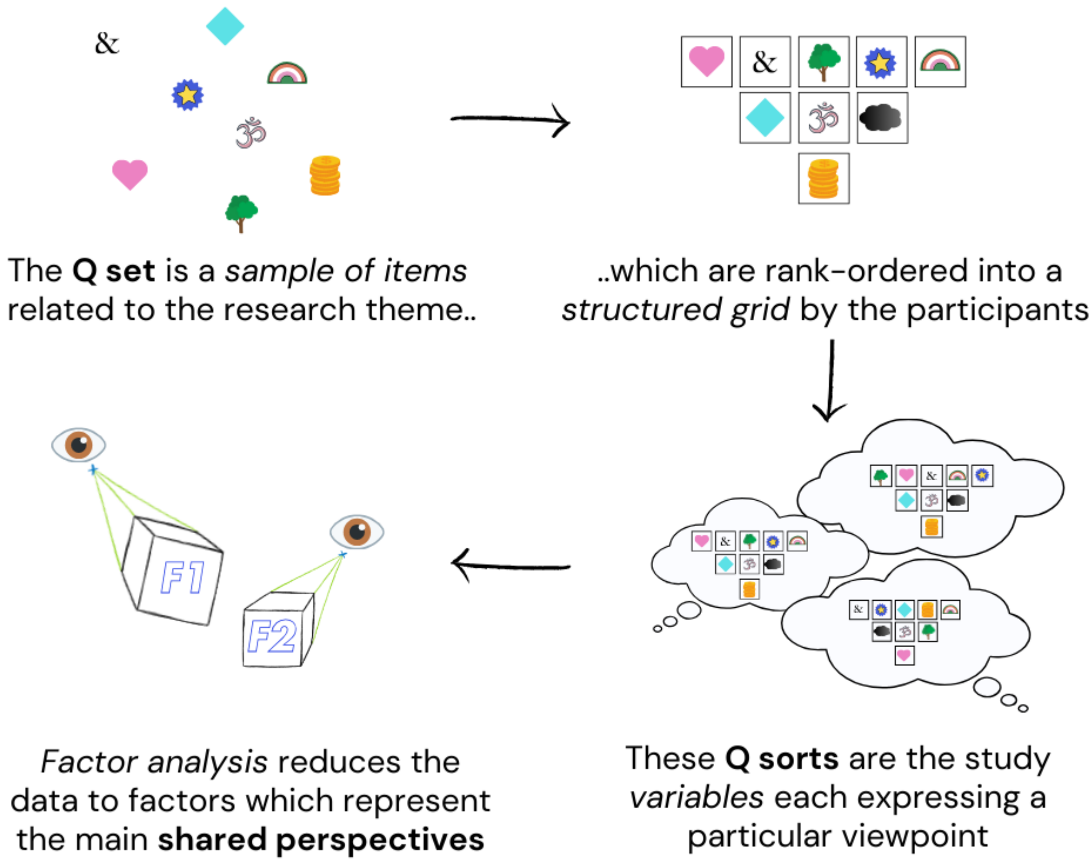


Figure 1.2: An overview of the Q sort process.

Chapter 2

Methods

This chapter outlines the methodological framework used to explore household water-related perspectives in the buffer zone of Bardia National Park. The research employs Q methodology, a qualitative approach designed to uncover subjective viewpoints through the sorting of predefined statements.

The chapter begins by addressing the ethical considerations underpinning the study, in Chapter 2.1 – Ethical considerations. These include measures to ensure participant confidentiality, obtain informed consent, and responsibly address sensitive issues such as water-related conflicts.

Subsequently, the design and execution of the Q sort are presented, from the formulation of statements to the analytical choices made during the interpretation phase. 2.2 – Q set design and content describes the development of the concourse, from its initial design through literature review. 2.3 – Q set refinement and pilot discusses the refinement of the Q set after a pilot run, culminating in the final Q set used in the study. The forced distribution pattern used during the Q sorting process is also explained in this section. Finally, the procedure used for the analysis of the Q sort is outlined in 2.4 – Analysis of Q sorts.

While the practical aspects of the fieldwork, including participant sampling and logistics, are discussed in detail in the following chapter Chapter 3 – Fieldwork, it should be noted that this content is essentially part of the methodological framework. The decision to present the theoretical justification separately from the fieldwork was made solely to manage the length of the methods chapter and improve clarity.

2.1 Ethical considerations

Prior to conducting the Q sorts, an application was submitted to the Delft University of Technology's Human Research Ethics Committee (HREC), outlining the study's purpose, data collection methods, and participant safeguards. Due to unforeseen delays in the review process, formal approval was granted later than anticipated. Given the structured nature of the research and the time-sensitive context, fieldwork began prior to receiving final approval. To facilitate data collection, a local guide was hired to assist with translation and cultural interpretation, ensuring respectful and accurate communication.

Throughout data collection, there was strict adherence to the ethical standards proposed in the application. Privacy and data protection measures, such as avoiding the collection of personally identifiable information (PII) and limiting data handling, were applied from the outset. Participants were informed about the study's goals, data usage, and confidentiality, and informed consent was obtained through verbal explanation and a witness signature (not conducted by the translator) to accommodate individuals with literacy limitations. The detailed informed consent procedure is attached in Appendix E – Informed consent statement. All data was collected anonymously, with PII minimized, and data privacy

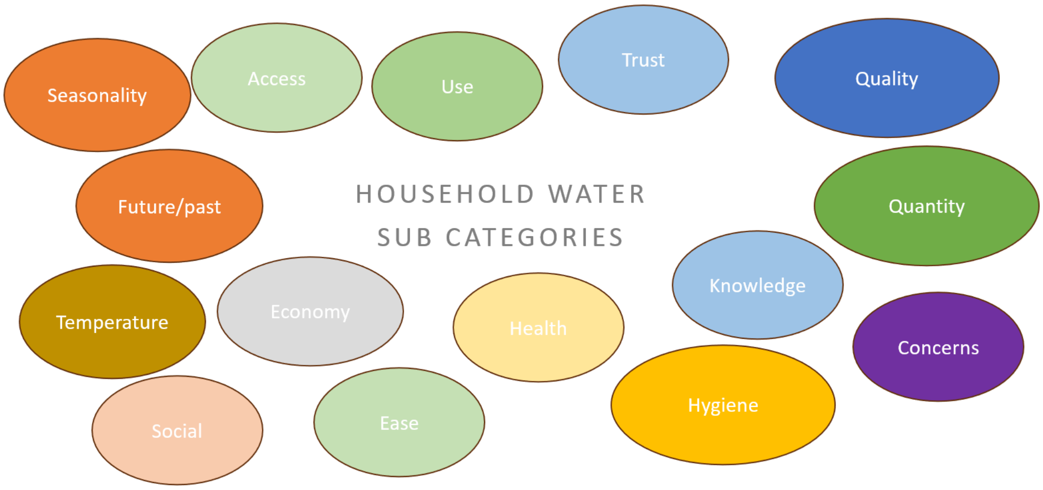


Figure 2.1: Household water related themes

was managed through anonymization, ensuring that findings published in the TU Delft repository adhere to the General Data Protection Regulation (GDPR).

All potentially sensitive topics, including socioeconomic status and household composition, were approached with respect, prioritizing participant comfort and voluntariness. For example, direct questions about financial status were avoided; instead, socioeconomic backgrounds were inferred through observable indicators such as housing type or ownership of items like motorized pumps or livestock. Participants had the option to skip any question, and a respectful approach was maintained by using a pen and paper rather than a laptop for in-situ documentation. Each participant was provided with the researcher's contact information, allowing them to withdraw their participation if desired. To protect privacy, only the researcher, translator, and participant knew the assigned research code, as no personal names were collected.

2.2 Q set design and content

2.2.1 Concourse development

The concourse, consisting of 64 statements (see Appendix B – Concourse development), was initially developed through a literature review and later expanded and refined during fieldwork using informal interviews. The concourse was developed around the theme of ***women's views on what is important regarding domestic water access and quality***. The sub-categories that were derived from a review of relevant literature and completed upon fieldwork are presented in Figure 2.1 and summarized in Table 2.1.

Sub-theme	**Relation to the research theme**	**Source**
Quality	Related to cleanliness and safety of drinking water.	ISF (2011), S. Sharma et al. (2005), and Sugden et al. (2014)
Quantity	The amount of water available for use and its sufficiency for different needs.	Gleick (1996)
Use	How water is utilized for drinking, cooking, gardening, and other purposes.	Davis and Whittington (1998)
Seasonality	Changes in water availability and quality depending on the time of year.	Choudhary et al. (2020), Dahal et al. (2020), and G. Shrestha and Clement (2019)
Trust	Confidence in institutions to provide safe and sufficient water.	Daniel et al. (2019) and G. Shrestha and Clement (2019)
Temperature	The importance of water temperature for personal satisfaction.	Informal interviews
Future/Past concerns	Perceptions about the availability and quality of water over time, influenced by external factors like pollution or a changing climate.	S. Shrestha et al. (2019)
Access and reliability	The availability and dependability of water sources for individuals and households.	A. Rai et al. (2021) and G. Shrestha and Clement (2019)
Economy	Financial implications related to water use and quality.	Huck (2023)
Social	Water-related interactions within the community.	Meinzen-Dick et al. (2022)
Health and hygiene	Practices and importance of water cleanliness for personal and household sanitation and its role in protecting health and preventing illness.	WHO (2018)
Knowledge	Awareness and understanding of water-related practices and issues.	Daniel et al. (2019)

Table 2.1: Sub-themes and their relation to household water perspectives

One important category found in literature, *domestic violence in relation to water scarcity* (Choudhary et al., 2020), was consciously omitted from the concourse due to ethical considerations. After consulting with the TU Delft Data Management Office (DMO), it was decided to omit topics that could potentially distress participants and require more rigorous interviewing techniques to address responsibly. Statements related to well water, obtained during preliminary literary research, were omitted from the concourse because observation on location showed that all but very few households are in possession of a hand pump, rendering this topic obsolete. Similarly, statements concerning irrigation water access were removed when the delineation of the topic of the thesis became anchored around domestic water access. After doing the exploratory fieldwork the number of statements was reduced from 64 to 30; with the full list provided in both English and Nepali in Appendix D – The Q set. The next section delves deeper into the decisions taken for selecting the Q set.

2.2.2 Size of the Q set

The number of items in a Q set can vary greatly, depending on the complexity of the topic and taking into account the expertise of the participants. According to Watts and Stenner (2012) a typical Q-set contains between 40 and 80 statements; whereas Webler et al. (2009) found that a typical range is between 20 and 60 statements. Exel and Graaf (2005) mentions a smaller range of 40-50 as typical, but that smaller or larger Q sets are certainly possible. Both Brown (1993) and Watts and Stenner (2012) emphasize the practicality of a smaller Q set when doing exploratory research with regards to maintaining participant engagement.

A relatively small sample size was deemed appropriate for this study to ensure the Q sort could be completed within a manageable time frame. This decision was primarily influenced by the fact that many participants had low literacy levels, necessitating the translation of all statements. Additionally, the women participating in the study often had young children and other household activities to attend. Given that there was no monetary compensation offered to the participants it was considered unethical to request much more than an hour of their time, including both the Q sorting and the post-sorting interviews. Consequently, the Q set was limited to 30 items to ensure the sorting process and interviews could be completed efficiently. Efficiency refers to maintaining participant focus, ensuring understanding, and completing the Q sort within a reasonable time to maximize data reliability and participant cooperation. Given the logistical challenges and ethical considerations, a Q set of 30 items strikes a balance between comprehensiveness and participant manageability, aligning with findings of Dieteren et al. (2023) from a systematic literature of 613 Q methodological studies, which shows many of them successfully employ sets within this range. Recent Q Methodological studies using a similar number of statements include: Jahanbin et al. (2023) (24 items), Maniatakou et al. (2020) (25 items), Lin et al. (2023) (26 items), Zabala (2014), Godor (2021) and Lee et al. (2021) (33 items) and finally van Dijk et al. (2022) (34 items).

Reduction of the statements was done taking into account the requirements of a balanced Q set as presented in Appendix A.3.3 – Criteria of balanced Q set, using unstructured sampling. Only those statements which could be answered regardless of the type of water access (either hand- pump water or tap water or a combination of both) were included in the Q set. This resulted in the representation of sub themes as given by Table 2.2. More detailed information on the decision making process can be found in Appendix B.2 – Sampling for the Q set.

2.3 Q set refinement and pilot

The English statements were initially translated into Nepali using Google Translate and subsequently refined by native speakers. Contributions were made by Sushila Mahatara, Resham Thapa, Chirayu Thapa and Bishal. During the Q sort process, some statements were further translated on the spot into Tharu (the local dialect) to ensure understanding among participants who were not fluent in Nepali, whether in written or spoken form. The cards used for the Q sort had the statements printed in Nepali on one side and in English on the other, along with their respective statement number. Following a small pilot session involving three women, certain statements were simplified, and others were reworded from positive to negative formulations to achieve a more balanced Q sort. This refinement process resulted in the final Q set, as presented in Appendix D – The Q set.

Sub category	No. of statements	Q set statement(s)	Example topics
Quality	12	S01, S02, S03, S04, S06, S07, S10, S19, S20, S27, S29, S30	Water filtration, boiling
Quantity	6	S05, S09, S11, S12, S13, S28	Availability of water
Use	7	S02, S13, S15, S18, S25, S28, S29	Domestic water use (depending on source)
Seasonality	3	S04, S05, S28	Water quality during the monsoon
Trust	2	S06, S07	Confidence in governent provided tap water
Temperature	1	S08	Temperature as water parameter
Future/past concerns	4	S09, S10, S11, S12	Anticipation of clean water availability
Access and reliability	9	S05, S13, S14, S15, S16, S24, S25, S26, S27	Multiple sources, dependability
Economy	3	S17, S18, S19	Cost concerns
Social	3	S14, S16, S23	Water related social dynamics
Health and hygiene	8	S01, S03, S20, S21, S22, S23, S29, S30	Contamination prevention, cleanliness
Knowledge	5	S06, S17, S22, S23, S27	Sources of information

Table 2.2: Result unstructured sampling

Ranking value	-4	-3	-2	-1	0	1	2	3	4
Number of items	1	2	4	5	6	5	4	2	1

Table 2.3: Forced-choice frequency distribution

2.3.1 Forced Q Sort Distribution

Watts and Stenner (2012) recommend that narrower Q sort distributions are preferable when participants lack expertise. Following this advice, the distribution pattern shown in Table 2.3 was decided on. The choice of the -4 to +4 distribution pattern was informed by established practices in Q methodology, which advocate for a balanced and symmetrical range to capture subjective viewpoints comprehensively. A distribution of this shape strikes a balance, providing participants with enough space to rank statements as highly positive or highly negative, while still maintaining ample room in the neutral middle for expressing relative indifference. Practical considerations also played a role in determining the distribution pattern. The layout needed to fit onto a cardboard frame of fixed dimensions to accommodate uniformly sized cards. This design choice provided enough space for a clear, organized sorting process, supported by an example and clear instructions placed at the top of the frame. Additionally, the cardboard frame served a dual purpose, acting as a windscreen during outdoor sorting activities (see Figure 3.2 on page 24).

2.4 Analysis of Q sorts

This section presents the procedure used for data analysis, beginning with factor extraction, followed by factor rotation and factor estimates and finishing with factor interpretation, explaining how the Q sorts were analyzed to uncover shared perspectives on water-related issues. More in-depth information on the respective steps in Q methodology can be found in Appendix A.6 – On factor extraction, Appendix A.7 – On factor rotation and factor estimates, and Appendix A.8 – On factor interpretation.

2.4.1 Factor extraction

Given the statistical properties of my dataset, **Principal Component Analysis** (PCA) was selected for factor extraction using KADE software (Banasick, 2019). PCA allowed for the retention of more factors in line with criteria from A.6 – On factor extraction. To ensure robustness, the results of PCA were compared with those from Centroid Factor Analysis (CFA) under a four-factor extraction. This comparison demonstrated highly similar outcomes, confirming the reliability of the factor structure (see Appendix K – Comparison PCA with CFA). Criterion no. 6 **parallel analysis** (Horn, 1965) was not conducted. Although strict application of **Humphrey's rule** (criterion no. 4) and the **scree plot** (criterion no. 5, Appendix K, Figure K.2b) suggested extracting only *one* factor, this would have oversimplified the findings. Extracting more factors was necessary to honor the diversity of viewpoints, which is central to the purpose of Q methodology. In fact, Brown (1993, p. 223) recommends initially extracting more factors than are expected to be significant, because smaller factors can improve the loadings on the larger factors after factor rotation.
As shown in Table 2.4 , the total explained variance (criterion no. 1) met Kline's 35-40% threshold (Kline, 2014) upon the extraction of a single factor and seven factors met the Kaiser- Guttman criterion (criterion no. 2) (Guttman, 1954; Kaiser, 1960). From the unrotated factor matrix (see Figure I.3 Appendix I – Raw Q sort data), four factors had two or more significantly loading Q sorts (criterion no. 3), defined as;

$$\text{Significant factor loading at the 0.01 level} = \frac{2.58}{\sqrt{N}} = \frac{2.58}{\sqrt{30}} = 0.471 \text{ rounded up to} \pm 0.48$$

with N being the number of items in the Q sort.

F3 and F4 were borderline, each possessing only two significant loadings. A more relaxed interpretation of Humphrey's rule (Watts and Stenner, 2012, p. 108) allowed four factors to meet criterion no. 4, with a threshold value in this study of;

$$\text{Standard error (SE)} = \frac{1}{\sqrt{30}} = 0.183 \text{ rounded up to} \pm 0.19$$

Finally, Watts and Stenner (2012, p. 107) recommend a ballpark estimate of one factor for every 6–8 participants in a study, which would justify extracting four or five factors in this case. Initially, four factors were extracted following this guideline. However, a comparison of the four- factor and three-factor solutions revealed that the three-factor solution offered more meaningful **factor interpretation** and **broader participant representation**. A more detailed discussion of this decision is provided in Chapter 2.4.3 – On choosing a three-factor solution.

Unrotated factors	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**
Eigenvalues [-]	12.3458	2.9127	1.7591	1.5937	1.3267	1.1212	1.0464	0.8813
explained variance [%]	44	10	6	6	5	4	4	3
cumulative explained variance [%]	44	54	60	66	71	75	79	82

Table 2.4: The unrotated factor matrix

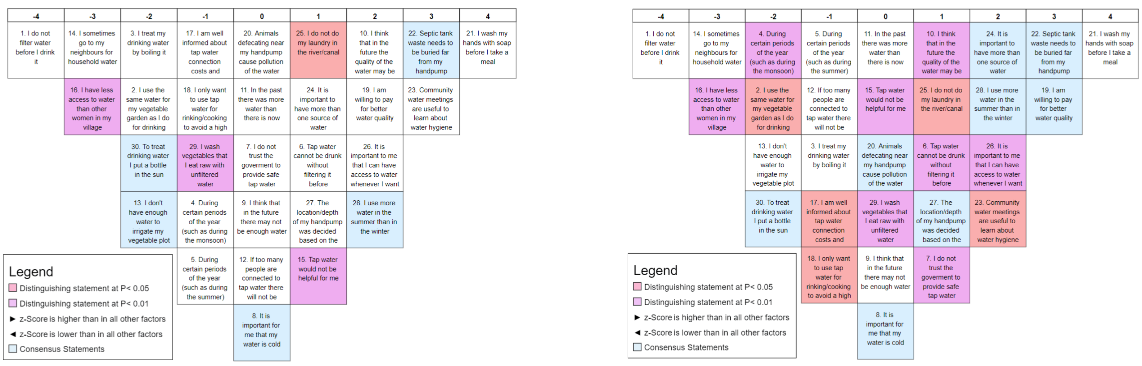
2.4.2 Factor rotation and factor estimates

Two techniques are commonly used for rotation; judgmental and varimax rotation (see Appendix A.7 – On factor rotation and factor estimates). Given that the goal of this study was to explore viewpoints without any pre conceived notions, **varimax rotation** was chosen. Ordinarily, all significantly loading Q sorts are used to create factor estimates, because this increases reliability and reduces error (Watts and Stenner, 2012, p. 131). In KADE, as in other software, this can be done automatically by selecting *auto-flag*; this flags Q sorts that load significantly *on one factor*.

The analysis of Q sorts followed the crib sheet procedure outlined by Watts and Stenner (2012). For a detailed explanation of the steps involved in creating a crib sheet, refer to Appendix A.8 – On factor interpretation. This approach was supplemented with follow-up data, including responses from the post-Q survey and detailed card placement information. To protect participant privacy, this information has been made accessible only to the thesis commission.

2.4.3 On choosing a three-factor solution

In the following paragraphs, the differences between the four- and three-factor solutions in terms of statistical analysis are presented. The number of factors selected should capture the diversity and subjectivity within the group while still providing sufficient information for meaningful interpretation of the results (Watts and Stenner, 2012). A three-factor solution was found to allow for more meaningful interpretation, primarily because it includes more distinguishing statements per factor—statements that meaningfully differentiate one factor from another. This difference is evident upon inspection of the factor arrays provided in Appendix J and M. In the three-factor solution, a greater number of statements are highlighted in purple or pink, indicating they are significant at either $p < 0.01$ or $p < 0.05$ level. An example of the factor array for F1 in both solutions is shown below in Figure 2.2.



(a) F1 factor array four-factor solution

(b) F1 factor array three-factor solution

Figure 2.2: Comparison of F1 factor arrays for the four-factor and three-factor solutions.

Furthermore, a three-factor solution increases the representation and reliability of the factor arrays. In the four-factor solution, 21 Q-sorts (75%) load significantly on the factors, whereas in the three-factor solution, 27 Q-sorts (≈96%) load significantly, leaving out the viewpoint of only one participant. This broader representation is achieved because more participants load significantly on Factor 1 and Factor 2 in the three-factor solution. Consequently, the average factor loadings for these factors are slightly lower than in the four-factor solution (see Appendix L – Four factor analysis comparison).

This reduction in average loadings is partly because the three-factor solution produces fewer confounded loadings than the four-factor solution (see Table K.2), leading to more lower-value factor loadings being included in F1 and F2[1]. However, because factor estimates are based on *weighted averages*, the relative contribution of these lower-value factor loadings diminishes. By including the Q sorts, the overall composite reliability (CR) increases. This improvement arises because factor estimates rely on averages, which become more stable as the number of defining variables increases (Watts and Stenner, 2012, p. 131). Therefore, the increased representation in the three-factor solution leads to higher composite reliability (CR) and lower standard error across all factors (see Figure L.1). Both the four-factor and three-factor solutions have high composite reliability values of $CR > 0.90$. According to Ghazali et al. (2018, p. 5), a composite reliability value of $CR > 0.70$ is considered an acceptable threshold.

Lastly, as shown in Figure L.2, the correlations between factors are almost all significant (with 0.48 constituting a significant factor loading) in both the four- and three-factor solutions. This suggests that the factors may represent *alternative manifestations of a single viewpoint* rather than distinctly unique perspectives. This consideration was integrated into the factor interpretation by acknowledging the shared common ground across the factor perspectives (Watts and Stenner, 2012, p. 141).

2.4.4 Summary analysis

A total of 28 Q sorts were inter-correlated and factor-analyzed using the dedicated software KADE (Banasick, 2019). Three factors were extracted an rotated, which together explained 71% of the study variance. 27 of the 28 Q sorts loaded significantly on only one of these three factors. Factor loadings of ≈0.48 or above were significant at the $P < 0.01$ level. Criteria used for selecting the number of factors to extract were *total explained variance*, the *Kaiser-Gutman criterion*, a *minimum of at least two significantly loading Q sorts* and a *relaxed interpretation of Humphrey's rule.* Varimax rotation was employed, resulting in the rotated factor matrix presented in Table I.4. The Q-sorts loading on a particular factor demonstrated a similar sorting pattern, indicative of a shared viewpoint. The detailed factor interpretation is provided in Chapter 4 – Results.

[1] Interestingly, five of the additional flagged Q sorts in the three-factor solution, which are confounded in the four-factor solution, are not confounded in a four-factor **CFA**. This suggests that the three-factor PCA solution captures the shared common variance in a manner similar to the four-factor CFA (see Appendix L.3 Appendix L.3 – Comparison three-factor PCA solution with four-factor CFA).

Chapter 3

Fieldwork

3.1 Fieldwork timeline

The timeline in Figure 3.1 outlines the key stages of the fieldwork conducted in Bardia, Nepal, starting with arrival on March 12th and concluding with departure on May 15th. The timeline is divided into two main phases:

Phase 1 (March 13th - April 4th): Initial exploration and concourse development in Bardia, including establishing contacts, conducting interviews, and gathering data. In between both phases there was a study break for hiking in the Himalayas.

Phase 2 (April 24th - May 6th): This phase consisted of the final preparations, the (physical) Q set creation, and conducting Q sorts in four different villages.

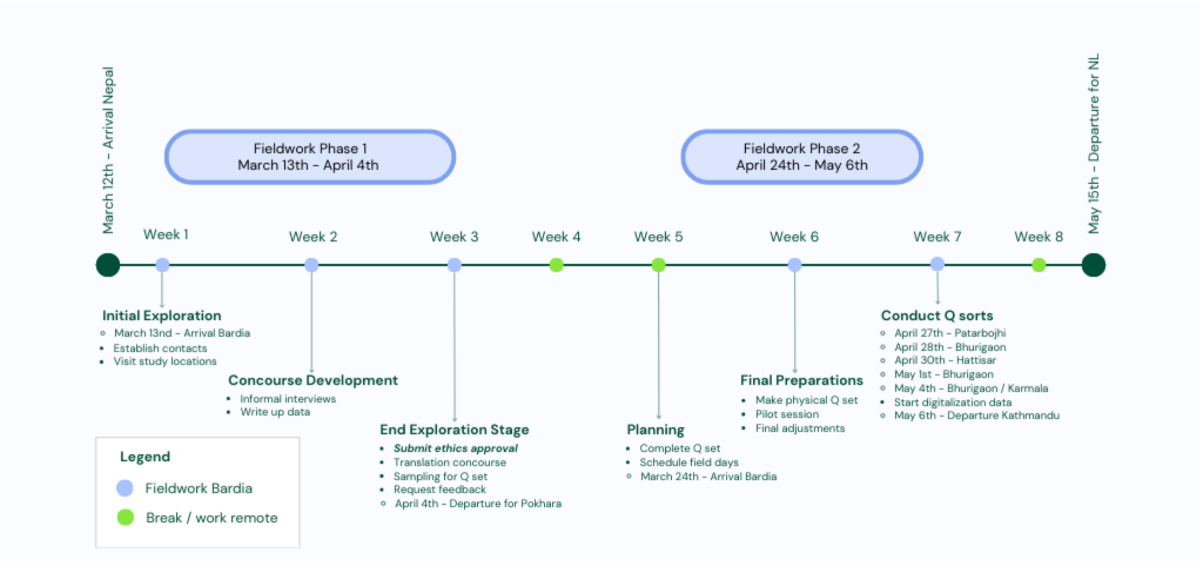


Figure 3.1: Fieldwork timeline

3.2 Study location

The study was conducted in four villages located in the buffer zone of the Bardia National Park, all within a 30-minute travel radius by scooter or tuktuk from Thakurdwara in Thakurbaba municipality, Lumbini province. This proximity helped to minimize both travel time and costs, while allowing for a comparison varying water infrastructure, groundwater levels, and economic statuses—differences that became apparent during the exploratory fieldwork. Initially, an observational trip was made to Geruwa rural municipality as a potential research site. However, due to logistical challenges, foremost of which the extended travel times over roads still under construction, the focus shifted to more accessible villages: Patarbojhi, Hattisar, Bhurigaon, and eventually Karmala. Patarbojhi and Hattisar were selected partly for the anticipated ease of recruiting research participants, aided by the translator's residency in Hattisar and familiarity with Patarbojhi. Figure 3.3 illustrates the locations of these villages, with basic descriptions and details about their water infrastructure provided in the text boxes.

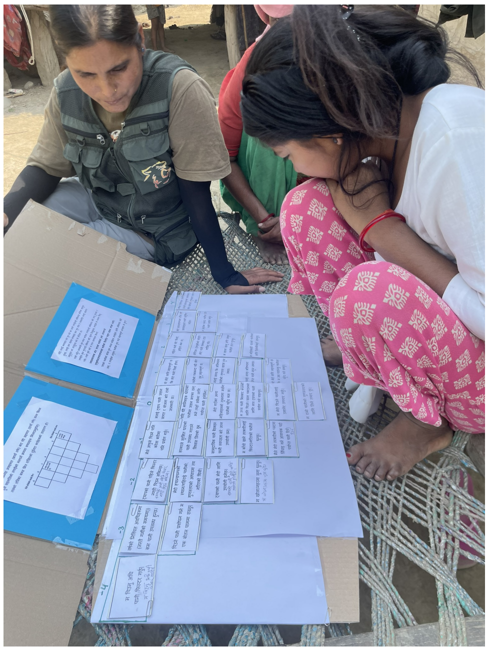


Figure 3.2: The Q sort set-up

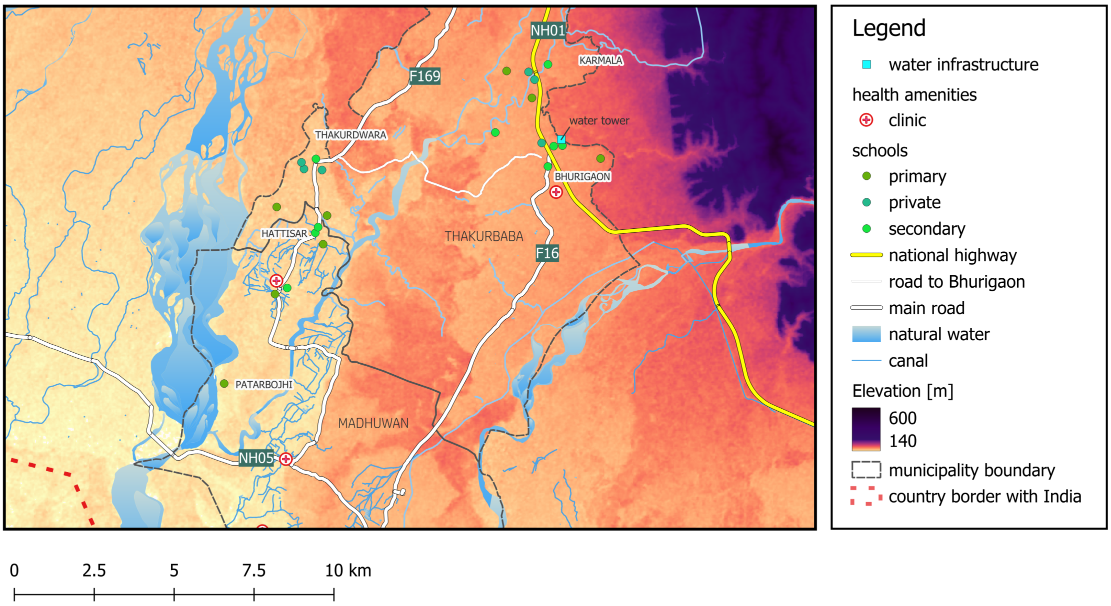


Figure 3.3: Study location

3.2.1 Village overview

Village overview: Patarbojhi

Aspect	***Details***
Location	Patarbojhi is a small farming village located in ward No. 1 of the Madhuwan municipality, bordering Thakurbaba municipality on the southwest. It is flanked by the Geruwa River to the west and the Orali River to the east.
Population	Predominantly Tharu community; estimated in the hundreds.
Economic Status	Primarily agricultural, with residents relying on farming for their livelihood.
Water infrastructure	No piped water system is available. Villagers rely primarily on hand-pumps for water and some face seasonal shortages. Some households also use river water for household purposes.
General infrastructure	Most houses are traditional. The village has basic infrastructure but lacks more advanced facilities like health centers or higher education institutions.
Challenges	Flooding from the Orali River affects some households, and conflicts with elephants over crops are common.

Village overview: Hattisar

Aspect	***Details***
Location	Hattisar is a small village located in ward No. 9 of the Thakurbaba municipality, south of and directly adjacent to Thakurdwara. It is home to the Elephant Breeding Center and serves as an access point to Bardia National Park.
Population	Predominantly Tharu community; estimated in the range of a few hundred residents.
Economic Status	The village benefits from tourism due to its proximity to the Elephant Breeding Center and nearby resorts, contributing to local commerce through small shops and homestays.
Water Infrastructure	Residents rely on hand-pumps for water. The village is located in close proximity to the Geruwa River.
General Infrastructure	Basic infrastructure includes primary education facilities, a healthcare post, and a mix of traditional and modern housing.
Challenges	Limited access to centralized water systems and reliance on hand-pumps. Proximity to the river may pose flooding risks during heavy rain.

Town overview: Bhurigaon

Aspect	***Details***
Location	Bhurigaon is a larger town located in ward No. 1 of Thakurbaba municipality, east of Thakurdwara, well connected by Nepali standards with an asphalted highway. It is situated further away from the Geruwa River.
Population	Bhurigaon has a larger population compared to neighboring villages, likely numbering in the thousands.
Economic Status	The town acts as a commercial hub for the surrounding rural areas, contributing to a diverse local economy supported by shops, schools, and various services.
Water Infrastructure	Bhurigaon has a single water tank that supplies part of the town's residents. Tap water access is timed, with one slot in the morning and another in the evening. On Saturdays, there is an additional slot in the afternoon. Despite tap water connections, many residents still rely on hand-pumps for their daily water needs.
General Infrastructure	The town has a hospital, police station, several schools of varying grades, and a commercial center. Housing ranges from traditional homes to modern, multi-story buildings.
Challenges	Limited and timed tap water supply forces residents to supplement with hand-pumps. The town's growth may strain current infrastructure.

Village overview: Karmala

Aspect	***Details***
Location	Karmala is a small village located in ward No. 2 in Thakurbaba municipality, adjacent to and north of Bhurigaon.
Population	The village is small, with a population likely in the low hundreds.
Economic Status	The economy is primarily based on agriculture and small-scale local trade.
Water Infrastructure	Some residents are connected to tap water, which is supplied without time limitations. However, other residents still rely on hand pumps for their daily water needs.
General Infrastructure	Karmala has schools up to the secondary level, and housing is a mix of traditional and concrete structures.
Challenges	While some residents have consistent tap water, reliance on hand-pumps for many households can pose challenges, particularly during dry seasons.

3.3 Participant sampling

To increase the likelihood that the study captured a comprehensive range of perspectives on water access and use, specific (observable) selection criteria were established. The initial selection criteria included: residency, gender, demographic diversity, primary water access and specific water challenges, which are further explained in the next paragraph. While Q methodology emphasizes diversity representative of the population's variety, the person sample does not need to be statistically representative of any specific category, such as gender or water access type (Watts and Stenner, 2012). As noted, the viewpoints that emerge from Q analysis are not predetermined by these criteria. This means that in Q studies, selecting participants from various backgrounds maximizes the potential for uncovering varied perspectives, but traditional representativeness is neither required nor assumed.

Additionally, Q methodology generally recommends that the number of participants be fewer than the number of items in the Q-set (Brown, 1993; Watts and Stenner, 2012). This guideline stems from the reasoning that, in Q methodology, the participants effectively serve as the study variables, which are naturally limited in scope within a single study. Kline (2014) even suggests a ratio of two items (statements) for every two variables (participants). However, according to Watts and Stenner (2012, p. 73), strict adherence to this guideline is not required[1], although having fewer participants than items in the Q-set remains sensible. With this in mind, a participant group of up to 29 individuals was targeted. Participant selection was informed by both informal interviews and insights provided by the translator, who contributed valuable knowledge about specific household situations.

3.3.1 Initial selection criteria

Residency: Participants were required to be permanent residents of one of the four target villages—Patarbojhi, Hattisar, Bhurigaon, or Karmala—to ensure their perspectives were grounded in personal experience.

Gender: Women were prioritized for their insights, as they are typically responsible for managing household water use and are well-positioned to comment on issues of access, quality, and reliability. However, men were also included to ensure diverse perspectives, acknowledging their potential contributions to the discussion. In some cases, their inclusion occurred inadvertently, as interviews often began with women but were occasionally taken over by their husbands. This dynamic reflects the deeply rooted patriarchal nature of Nepali society.

Demographic diversity: Efforts were made to achieve a balanced representation of various age groups and economic statuses[2] This involved selecting participants from both traditional housing and modern concrete structures to reflect a broad range of socio-economic backgrounds.

Primary water access: Participants were selected based on their access to different types of water sources, including hand pumps, tap water, and combinations of both. In areas like Bhurigaon and Karmala, where tap water was available, the study included individuals with varying degrees of access, as well as those who relied on the river for supplementary water needs. To ensure a balanced representation of perspectives from both those with and without tap water access, and given that Bhurigaon is a larger town, a greater number of participants were targeted in this area.

[1] An exception may arise if researchers aim to publish in journals where the review committee is more familiar with R analysis, which prioritizes the opposite criterion: the more participants, the better (Watts and Stenner, 2012, p. 72).

[2] Gender, in combination with age, plays a significant role in shaping climate perceptions (A. Sharma, Batish, & Uniyal, 2020). In Nepal, women often move in with their husband's family after marriage, which may influence their ability to compare 'before and after' situations in-situ.

Specific water challenges: Participants with unique challenges, such as non- functional hand pumps or a lack of water filters, were specifically sought out. The snowball sampling method was used to identify these individuals, with initial participants referring others who met the research criteria, as there were no visual cues for participants having problematic water access.

Education and employment: Initially, the plan was to track education and employment. However, initial observations revealed that the majority of women in the area are rural farmers with limited access to advanced education. Insights from the translator helped identify a small number of participants with specialized employment, the details of which are provided in Table 3.1.

3.3.2 Overview participants

The set of participants ($N = 28$) included primarily women ($N = 25$) and a small number of men ($N = 3$) from four villages in the buffer zone of the Bardia National Park. In Patarbojhi, there were ($N = 7$) participants, all from farming households. Hattisar had ($N = 6$) participants, with some holding official employment, such as a health post officer and a guide at Bardia National Park. Bhurigaon had the largest representation, with ($N = 12$) participants, including individuals employed outside of farming, such as a tap water meter collector, restaurant owner, small shop owner, and tea stall owner. Lastly, Karmala had ($N = 3$) participants, all of whom were from farming households. A participant's matrix including details of the initial selection criteria is included in Table 3.1.

3.3.3 Exclusion criteria and sampling limitations

One Q sort (participant code BB1) was excluded from the analysis after the post-sorting interview revealed that the participant was not a resident of the area and had approached the Q sort from a general perspective rather than personal experience. This did not align with the research criteria, which prioritized uncovering individual viewpoints.

Snowball sampling, specifically targeted at participants facing unique water challenges or access situations, was effective in some instances. For example, the inclusion of the village Karmala, known for its continuous tap water supply, was based on a participant's recommendation. However, snowball sampling was less successful in Patarbojhi, where participants reported neighbors with non-functional hand pumps; despite efforts, these households could not be located. A key limitation of snowball sampling is its reliance on participant networks, which may restrict the diversity of perspectives. To address this, the initial selection criteria—including snowball sampling—were applied strategically to avoid reliance on any single approach.

Once the participants were selected, the next phase involved conducting the Q sort, where participants sorted statements based on their perspectives on water access and use.

Participant code	Age	Gender	House type	Water access type			Filter	Occupation
				Hand pump	Tap water	River/canal		
Patarbojhi								
P1	23-27	Female	Traditional	✓		✓		
P2	23-27	Female	Traditional	✓		✓	✗ [1]	
P3	28-32	Male	Traditional	✓		✓		
P4	28-32	Female	Traditional	✓			✗	
P5	43-47	Male	Traditional	✓		✓	✗	
P6	33-37	Female	Concrete/brick	✓		✓		
P7	28-32	Female	Traditional	✓		✓		
Hattisar								
H1	38-42	Female	Concrete/brick	✓				Health care worker
H2	38-42	Female	Concrete/brick	✓		✓		
H3	28-32	Female	Traditional	✗ [2]		✓		
H4	28-32	Female	Concrete/brick	✓ [3]				Bardia park ranger
H5	48-52	Female	Concrete/brick	✓		✓	✗	
H6	48-52	Female	Traditional	✗ [4]		✓		
Bhurigaon								
B1	18-22	Female	Concrete/brick	✓				
B2	18-22	Female	Concrete/brick	✓				
B3	38-42	Female	Concrete/brick	✓	✓		✗	Water meter reader
B4	38-42	Female	Concrete/brick	✓				
B5	>63	Female	Concrete/brick		✓			
B6	38-42	Female	Both	✓				
B7	23-27	Female	Concrete/brick	✓	✓		candle filter	
BB2	43-47	Female	Concrete/brick		✓			
BB3	48-52	Female	Traditional	✓				
BB4	33-37	Female	Traditional	✓	✓	[5]	✗ [6]	Restaurant owner
BB5	18-22	Female	Concrete/brick	✓			✗	
BB6	58-62	Female	Two stories	✓				
Karmala								
K1	28-32	Female	Brick house	✓	✓		✗	
K2	>63	Female	Traditional		✓	✓	✗	
K3	>63	Male	Traditional	✓				Tea-stall owner

Table 3.1: Participant characteristics matrix. Check-marks indicate access to water resources.
Crosses indicate absence of water filter, or restricted domestic water access. Occupation is only specified when different from farming.

[1] filter in only one of two homes in the village
[2] Uses hand pump of neighbors.
[3] Installation connecting groundwater to storage tank on roof, pressurized water through faucets in the household.
[4] New hand pump not working
[5] Use bottled water in restaurant.
[6] No filter at home.

3.4 Conducting the Q sort

Before beginning the Q sort, the research protocol was orally communicated with the participants in Nepali by the translator, outlining issues with confidentiality, anonymity and risks associated with participation. The detailed statement can be found in Appendix E – Informed consent statement and was also provided in print so participants could keep my contact information. Participants then completed a brief survey (Appendix F – Q set survey), before receiving oral instructions for the Q sort process (Appendix G – Q sort instructions) The instructions were also included on the sorting board in Nepali (see also Figure 3.2). Each participant was assigned a **participant code** to maintain anonymity and facilitate data organization. The code consisted of the initial letter of the village name where the Q sort was conducted (P, H, B, or K), followed by the interview number conducted in that village on that day. For sessions conducted on the second day in Bhurigaon, the participant codes were prefixed with "BB" to distinguish them. Participants were given placards displaying their unique codes, enabling them to reference their data and communicate any decision to withdraw consent if needed.

The Q sorts were conducted over the course of two weeks in April 2024, with each participant completing the sorting process on the front porch of their homes in their respective villages. A photograph of the completed Q sort was taken after each session, with the data digitized in Excel at a later, convenient time.

3.5 Participant experience

During the Q sorting process, participants sometimes placed statements with which they agreed or disagreed in the 0 slot or on the opposite side (+ or -) due to limited space in their preferred section. It was emphasized to participants that this positioning did not indicate an absolute value judgment but reflected the relative importance of the statements compared to adjacent items. This aligns with the principle in Q methodology that the 0 position does not necessarily signify neutrality.

Some participants found the forced distribution slightly unsettling. An unforced distribution could have alleviated this discomfort, but it might have introduced complexity for other participants. Most individuals who found themselves with more items they agreed or disagreed with than expected accepted the explanation regarding the relative nature of the positioning. To ensure the 'true' views of participants were maintained, notes were taken on any statements placed differently due to these constraints. Additionally, adjustments were made to a few Q sorts after participants reviewed their completed sorting grid, ensuring they were satisfied with the final arrangement.

Chapter 4

Results

4.1 Three factor analysis

The following paragraphs present the three factor interpretations as derived from a three factor rotation analysis, each followed by a summary of demographic data related to the participants loading on each factor. As outlined in Chapter 2, a crib sheet procedure was followed for the interpretation of each factor. The preliminary viewpoint constructed in this way was then enhanced by the inclusion of- and comparison with qualitative data from post-Q sort interviews. Finally, these narratives were cross-referenced with demographic data collected during the pre-Q sort surveys. The crib sheets, along with additional factor characteristics (such as factor array's, participants loading on each factor) can be found in Appendix J – Factor characteristics.

For factor 1 (F1) and factor 2 (F2), a narrative style was used, which includes a number of statements from the crib sheet and their respective rankings. In contrast, for factor 3 (F3), which is considerably smaller factor, both in terms of explained study variance and participants loading, a commentary style was deemed more suitable for presenting the findings.

The demographic data presented includes a Venn diagram, the age range of the participants loading on the factor, whether households own a water filter and the village distribution of the participants loading on each factor. Participants are referred to by their participant code, the prefix of which refers to the village of residence of each participant.

4.1.1 F1 interpretation

Factor 1 explains 25% of the study variance. Thirteen participants load on this factor.

MAIN THEMES

WATER QUALITY – HYGIENE – COMMUNITY KNOWLEDGE – ADEQUATE WATER ACCESS

DESCRIPTION

Participants loading on this factor prioritize safe drinking water and emphasize hygienic practices. Community meetings are valued for the distribution of useful information regarding these topics. While their current water access is reliable year-round, they express concerns about potential future contamination that could impact water quality.

NARRATIVE

Hygiene is very important for me and so I have washed my hands with soap (S21: +4) *for a long time. For the same reason, it is important to have enough distance between the septic tank waste and our water source* (S22: +3) *because if they are close together, then rubbish and bacteria go down to the water which is bad for health.*

Good quality drinking water quality has always been a top priority for me, which is why I filter water before drinking or cooking (S01: -4) *when I learned that this was necessary. Community meetings have been useful for me in that regard* (S23: +2)*. People know more about pollution of the water; they are using more chemical fertilizers nowadays which may affect the water quality in the future* (S10: +1)*. For now, I don't have any major seasonal quality issues* (S04: -2) *but there is iron in my hand pump water.*

I also don't have any water quantity issues; even during the dry season (S05: -1) *when I use most water* (S28: +2) *there is enough to irrigate my vegetable garden* (S13: -2)*. In fact, I am not worried about future water quantity issues either* (S09: 0)*. Owning a motorized pump makes getting water easier and more accessible* (S26: +2)*, so I have never needed to go to the neighbors* (S14: -3)*. If we would have a river to do laundry* (S25: -1) *that water would be polluted anyway.*

Having tap water in addition to my other water sources (S24: +2) *could be useful for different purposes* (S18: -1)*. I am definitely willing to pay for improved water quality* (S19: +3)*. Still, I would be cautious to trust the water to be completely safe* (S07: +1) *so I would probably still filter it before drinking* (S06: +1)*. For laundry, it would be an improvement to have water without iron in it, if the supplied quantity would suffice. At the moment my situation is good and I am in no immediate need to have tap water. I agree strongly that compared to other women in my village I have more access to water* (S16: -3)*.*

KEY TAKEAWAYS

Factor 1 participants stand out for their concern about future water quality and its potential challenges. They also value community meetings as opportunities to learn about water hygiene.

4.1.2 F1 demographics

The figures on this page provide a summary of the demographic characteristics of participants associated with Factor 1.

The Venn diagram (Figure 4.1) highlights the water sources used by F1 participants, showing overlaps between hand pump, tap water, motorized pump, and river usage[1]. There are no participants solely reliable on hand pump water. The bar chart (Figure 4.2) illustrates the age distribution of participants, showing that the largest group are in their late thirties to early fifties, with smaller representation across other age groups. The pie chart (Figure 4.3) on filter ownership reveals that the majority of participants loading onto this factor own a water filter. Lastly, the village distribution pie chart (Figure 4.4) shows that participants in F1 are primarily from Bhurigaon, followed by Hattisar and Karmala. No participants from Patarbojhi loaded on F1.

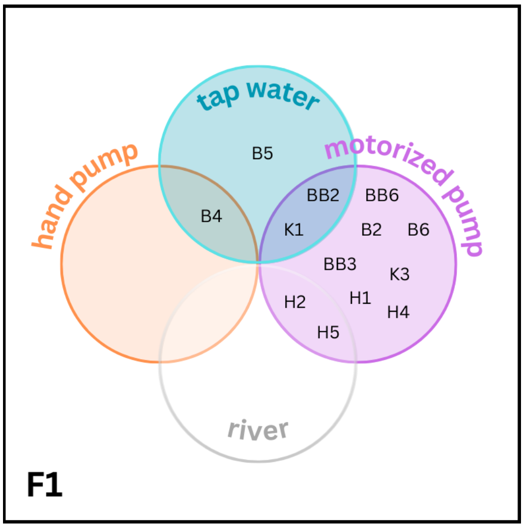


Figure 4.1: F1 water access Venn diagram.

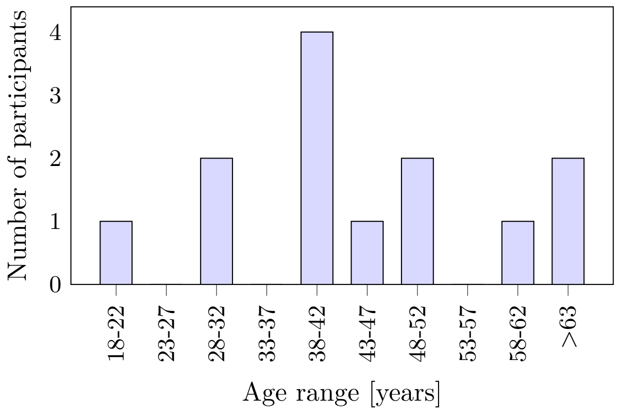


Figure 4.2: F1 age distribution.

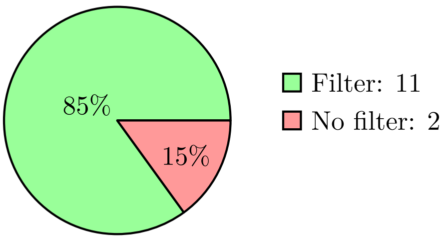


Figure 4.3: F1 filter ownership.

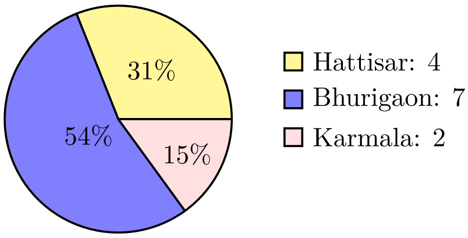


Figure 4.4: F1 village distribution.

Noteworthy observations: H5 is the only participant loading on this factor who does not filter her drinking water; she has stated this is due to the families current financial impossibility to acquire a water filter. K1 tells me that she drinks water from the hand pump instead of the tap water because in summer that water is so hot.

[1] Participant H2 only uses the river for her cattle.

4.1.3 F2 interpretation

Factor 2 explains 24% of the study variance. Ten participants load on this factor.

MAIN THEMES

WATER QUALITY – HYGIENE – WATER ACCESS CHALLENGES – MULTIPLE WATER SOURCES

DESCRIPTION

Participants loading on this factor value safe drinking water and emphasize the importance of hygienic practices. They face challenges with water access, including seasonal shortages and reliance on neighbors, which influence their desire for additional sources like tap water and in some cases their reliance on river water for their household needs. While they are cautious about the safety and cost of tap water, they believe that having multiple water sources would increase reliability and reduce access issues. Their approach to water use is pragmatic, focusing on essential uses like drinking and cooking.

NARRATIVE

Drinking water quality is very important to me, which is why I filter the water I drink (S01: -4) *and want to avoid contamination of my water source with septic tank waste* (S22: +4). *Doing these things is important for health, especially since I became a mother. I only filter the water I drink or use for cooking though; I don't use filtered water for irrigating the vegetable garden, for instance* (S02: -3)*, because that is not worth the effort.*

Water access is problematic for me, which is why I sometimes go to the neighbors for household water (S14: +3). *During certain times of the year, there is less water available* (S05: +1) *or the quality is not good* (S04: +2)*, and that affects me. I prefer doing my laundry in the river* (S25: -1) *rather than going over to my neighbor, though it's not a big problem. As it is, I currently have less access to water than other women in my village* (S16: +1)*, and this is at times a source of concern.*

In terms of having more than one water source (S24: +2)*, I think it would be really useful for me to have tap water* (S15: -3). *I wouldn't mind that tap water access is timed* (S26: -1)*; simply having multiple types of water sources would increase the chance that at least one of them is working. I trust that tap water would be safe* (S07: -2)*, although I don't know if it would be safe enough to drink without filtering it first* (S06: 0). *I'm not well informed about tap water costs and planning* (S17: -2)*, so even if I were connected, I would also use my hand pump to avoid a high bill* (S18: +1) *and perhaps limit the use of tap water to drinking and cooking* (S19: +2).

KEY TAKEAWAYS

Factor 2 participants view tap water as a potentially valuable solution to their water access problems, despite uncertainties about its affordability.

4.1.4 F2 demographics

The figures on this page provide a summary of the demographic characteristics of participants associated with Factor 2.

The Venn diagram (Figure 4.5) highlights the water sources used by F2, showing overlaps between hand pump, tap water, motorized pump[2], and river usage, indicating that participants loading on this factor use diverse and often multiple water sources. The bar chart (Figure 4.6) illustrates the age distribution of participants, which shows that mostly younger participants loaded on F2. The pie chart (Figure 4.7) on filter ownership reveals that most participants loading onto this factor own a water filter. Lastly, the village distribution pie chart (Figure 4.8) shows that the majority of F2 participants are from Patarbojhi, with smaller representations from Hattisar and Bhurigaon. No participants from Karmala loaded on F2.

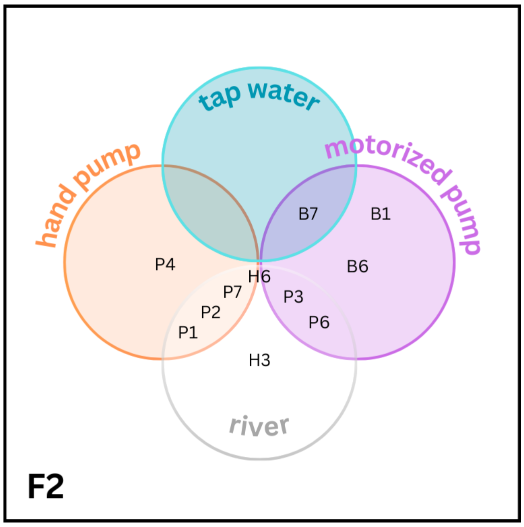


Figure 4.5: F2 water access Venn diagram.

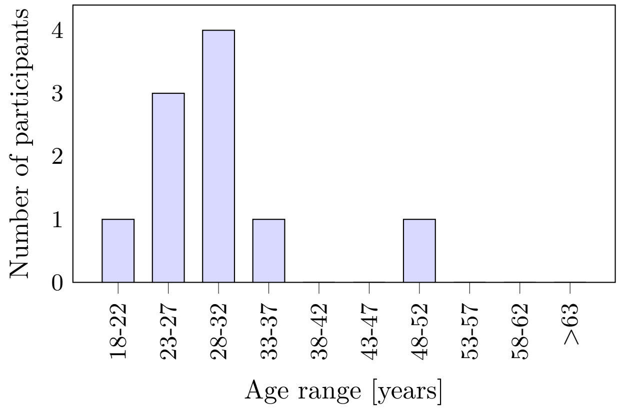


Figure 4.6: F2 age distribution.

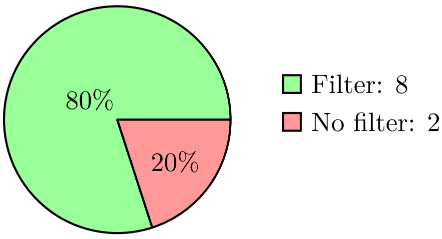


Figure 4.7: F2 filter ownership.

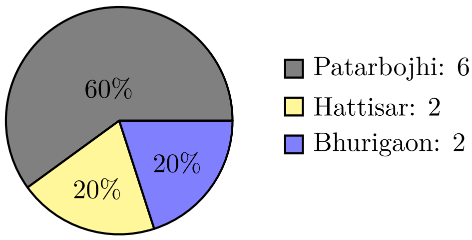


Figure 4.8: F2 village distribution.

[2]Participant H6 is in possession of a motorized pump, which was broken at the time the survey was conducted.

4.1.5 F3 interpretation

Factor 3 explains 12% of the study variance. Four participants load on this factor.

MAIN THEMES

TRUST IN WATER QUALITY – ADEQUATE WATER ACCESS

DESCRIPTION

Participants loading on this factor do not filter their drinking water and have sufficient water supply to meet their household needs.

INSIGHTS AND CONTEXT

F3 notably distinguishes itself from F1 and F2 due to participants' lack of reliance on filtering drinking water (S01: 0). For three out of the four participants associated with this factor, the shared reason for not filtering is their knowledge about and trust in the quality of their water (S07: -2, S06: -1), regardless of it's source, as revealed in the post Q sort interviews. One participant, for instance, said that

> "We have been informed by the tap water company that our water is safe to drink without additional filtering."

For the fourth participant, the reason is financial; during the survey prior to the Q-sort, they explained that their family currently lacks the means to purchase a water filter.

One participant (B3), an expert on the topic due to her work with the tap water company, provides additional insight into water practices related to the treatment conducted by the company throughout the year. She tells us that it is only during the monsoon time that the tap water is dosed with chloride. However in summer, when the tap water receives no additional treatment, she ensures safety by boiling the water before storing it in the fridge (S03: -2). Other participants boil water only in winter, primarily to make it more agreeable to drink at a warm temperature - an explanation also given by participants loading on F1 and F2.

Participants loading on F3 do not rely on their neighbors for water (S14: -3) because they face few challenges in accessing enough water to meet their household needs (S05: -1, S13: -1). Their more or less consistent access to water sources reduces the need for external support.

KEY TAKEAWAYS

Factor 3 participants generally trust the quality of their water without filtering but express potential future concerns about having sufficient quantities to meet their needs.

4.1.6 F3 demographics

The figures on this page provide a summary of the demographic characteristics of participants associated with Factor 3.

The Venn diagram (Figure 4.9) highlights the water sources used by F3 participants, showing overlaps between hand pump, tap water, motorized pump, and river usage. The bar chart (Figure 4.10) illustrates the age distribution of participants, which is spread across multiple age ranges. The pie chart (Figure 4.11) on filter ownership reveals that none of the participants loading onto this factor own a water filter. Lastly, the village distribution pie chart (Figure 4.12) shows that F3 participants are split across three villages. Hattisar is not represented among F3 participants.

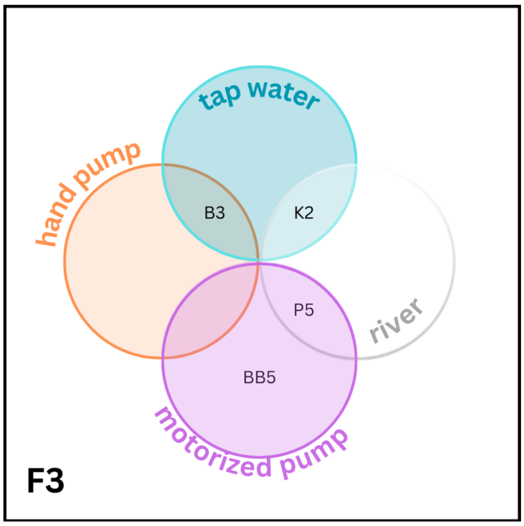


Figure 4.9: F3 water access Venn diagram.

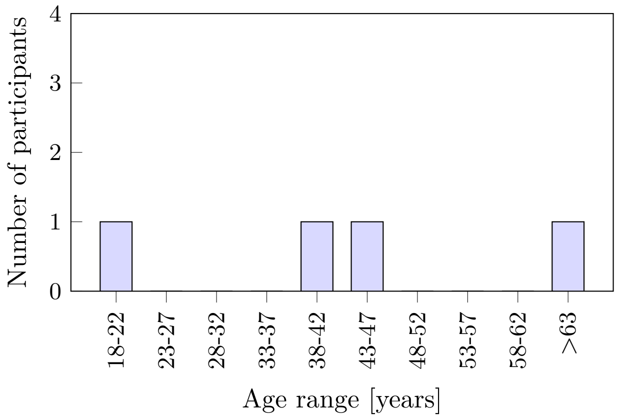


Figure 4.10: F3 age distribution.

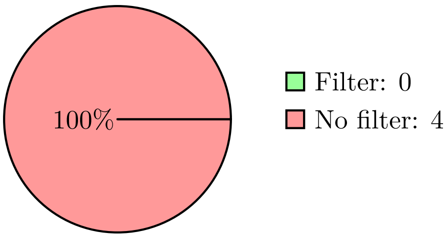


Figure 4.11: F3 filter ownership.

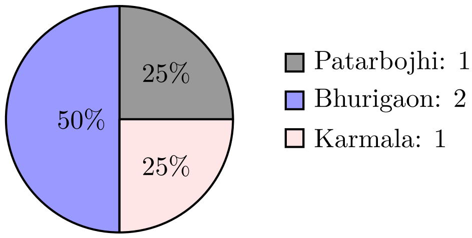


Figure 4.12: F3 village distribution.

4.2 Overview: similarities and differences across factors

This section presents a detailed comparison of the similarities, differences, and unique perspectives identified across the three factors. By analyzing the consensus and distinguishing statements, as well as the associated narratives, the results reveal nuanced insights into participants' perceptions of water.

Table 4.1 summarizes the consensus statements—those ranked similarly across all factors—highlighting common beliefs or neutral perspectives shared by participants. These statements represent areas where participants' views align, regardless of factor loading. In contrast, Table 4.2 provides a comparative overview of the three factors across **key themes** such as water quality, quantity, seasonality, and health and hygiene. It integrates distinguishing statements and factor narratives to showcase where the perspectives diverge or overlap. The distinguishing statements for each factor are listed in Appendix J.4 – Distinguishing statements for all factors, while detailed z-scores and rankings for all statements in each factor are provided in Appendix J.5 – Three-factor rotation z-scores.

No.	Statement	Quality	Quantity	Use	Seasonality	Trust	Temperature	Future/Past	Access & Reliability	Economy	Health & Hygiene
S08*	It is important for me that my water is cold						✓				
S19	I am willing to pay for better water quality	✓								✓	
S27*	The location/depth of my hand pump was decided based on the water quality	✓							✓		
S20*	Animals defecating near my hand pump cause pollution of the water	✓									✓
S30*	To treat drinking water I put a bottle in the sun	✓									✓
S28*	I use more water in the summer than in the winter		✓	✓	✓						
S22	Septic tank waste needs to be buried far from my hand pump							✓			✓
S24*	It is important to have more than one source of water								✓		

Table 4.1: Matrix of consensus statements, grouped per subcategory. *Note:* Statements marked with an asterisk (*) are non-significant at both $p < 0.05$ and $p < 0.01$, meaning they do not distinguish between factors with sufficient statistical significance.

Theme	F1	F2	F3
Quality	Prioritizes filtering drinking water for health and safety.	Strong emphasis on filtering drinking water for health and safety.	Does not filter drinking water, citing either trust in quality (i.c.w. boiling) or financial constraints.
Quantity	Has sufficient water for household needs, without needing to rely on others.	Experiences seasonal shortages and occasional reliance on neighbors for household water.	Has sufficient for household needs, without needing to rely on others.
Use	Only uses filtered water for drinking and cooking purposes. Does not use river for laundry.	Only uses filtered water for drinking and cooking purposes. Relies on the river for laundry.	Uses the same, unfiltered, water for all household purposes. River water is not preferred for laundry.
Seasonality	Water quality unaffected by seasonal changes.	Water quantity affected by seasonal changes.	Is not much affected by seasonal changes in water quality or quantity.
Trust	Cautious about the safety of tap water.	Cautious regarding the safety of tap water.	Trusts in water quality of their source.
Temperature	Cares about water temperature, but prioritizes safety.	Cares about water temperature, but prioritizes safety.	Cares about water temperature, but prioritizes safety. Uses the fridge for cool water in summer.
Future/Past concerns	Expresses concern about future deterioration of water quality.	Unsure whether their water quality will be worse in the future than at present.	Is relatively optimistic about future water quality, but is more concerned about quantity issues.
Access and reliability	Values multiple water sources for reliable access at any time. Sees tap water as potentially useful addition.	Multiple sources increase reliability during seasonal challenges. Continuous access is less important than reliability.	Values having multiple water sources to ensure reliable water access. Is not highly concerned about having continuous water access.
Economy	Unsure about the costs of tap water, but likely capable of affording it.	Would reserve tap water for drinking and cooking to save costs.	Wants to use tap water for multiple purposes.
Social	Feels advantaged in water access compared to others.	Feels less advantaged in water access compared to others in the community.	Neutral position with regards to water access in comparison to others.
Health and hygiene	Prioritizes using soap for hand washing.	Places less focus on hand washing with soap.	Prioritizes using soap for hand washing.
Knowledge	Values community meetings for knowledge on quality and hygiene.	Does not consider themselves well informed regarding tap water costs and planning.	Considers themselves well informed regarding tap water costs and planning.

Table 4.2: Comparison of main themes within factors. *Note:* Purple cells indicate statements that are significant at $P < 0.01$, pink cells indicate significance at $P < 0.05$, and blue cells represent consensus statements. Statements without highlighting cannot be compared statistically across factors; their interpretation is limited to within-factor analysis only.

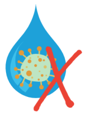
4.3 Summary of findings

This section presents the main findings derived from the analysis of the three factors identified in this study, using the significant distinguishing statements of the factors. The findings are organized into three subsections. First, the **common ground** shared by all participants is outlined, emphasizing areas of shared (dis)agreement and neutrality. Second, areas of **partial overlap** between the factors are presented, showcasing where perspectives converge on specific issues. Finally, the **unique and significant perspectives** of each factor are given, revealing distinctive factor views.

4.3.1 Common ground

Participants across factors all:

Recognize the importance of safe drinking water and personal hygiene for health and safety.



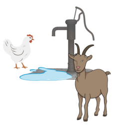
Aim to prevent contamination of their drinking water sources.

Show willingness to pay for better water quality.

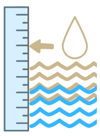
Report higher water usage in summer compared to winter.

Participants across factors do not:

Use solar disinfection as a water treatment method.



Show significant concern about animals contaminating their water source.



Select water pump depth based on water quality considerations.

4.3.2 Partial overlap between factors

Participants loading on F1 and F2 both:

Filter only the water they use for drinking and cooking.

Express caution regarding the safety of tap water; for F1 this caution is significant.

Have limited awareness of the cost and implementation of tap water.

Participants loading on F1 and F3 both:

Have sufficient water to meet their household need without relying on others.

Experience minimal disruption from seasonal water quality changes; for F1 this is significant.

Do not rely on the river for laundry.

Participants loading on F2 and F3 both:

Do not prioritize continuous water access.

4.3.3 Unique and significant perspectives

Participants loading on F1:

Express concern about future deterioration of water quality.

Value community meetings for gaining water-related knowledge.

Feel advantaged in water access compared to others in the community.

Participants loading on F2:

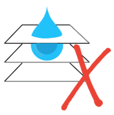
Experience seasonal shortages of water.

Occasionally rely on neighbors or river for household water during shortages.

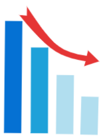
Express uncertainty regarding potential water quality deterioration.

View tap water as a potential solution but base its use on economic considerations and specific purposes.

Participants loading on F3:



Do not filter their drinking water and use the same water for all household purposes.



Display confidence in current and future water quality but express concerns about long-term resource sufficiency.

Envision uses for tap water beyond drinking and cooking.

Consider themselves well informed about tap water costs and planning.

Chapter 5

Discussion

This study aimed to explore women's perspectives on domestic water access in rural Nepal using Q methodology. The first section substantiates the findings through verifications 5.1 – Verification results. Whereas the second section outlines the study's limitations 5.3 – Study limitations. The final section offers reflections on the study's implications and areas for future research 5.2 – Reflections.

5.1 Verification results

The three identified factors revealed diverse yet overlapping perspectives on domestic water access. This aligns with G. Shrestha and Clement (2019) emphasis on the fact that women's needs and perspectives are not homogeneous, but influenced by various (intersectional) factors. For example, Liu et al. (2018) identified significant spatial heterogeneity within a small village (500m) in terms of flood risk and subsequent water contamination. This underscores how environmental challenges, such as water contamination and flooding, may be experienced differently by women depending on their geographical location—a finding also corroborated by A. Shrestha et al. (2020).

At the same time, shared viewpoints among women may stem from the commonalities in their roles in managing household water. For example, Silva et al. (2020) found in a gendered study on domestic water and sanitation in marginalized Brazilian communities that women's shared experiences influenced their decisions regarding water management and personal hygiene.

5.1.1 Validation of research findings - common to everyone

All factors emphasized the importance of good drinking water quality, challenging the statement by the Ministry of Infrastructure and Water Management deputy director that "in Nepal, people are more concerned with the quantity of water than quality" (WHO, 2018, p. 4). This study found no significant difference in the adoption of household water treatment (HWT) methods based on participants' current water sources. It is important to note that these results cannot be generalized to a larger population, as generalization falls outside the scope and aim of Q methodology. However, findings from Bhurigaon and Karmala indicate that HWT adoption was very common among households without piped water access, and the same was found for the participants from Patarbojhi and Hattisar, villages where piped water supply is absent. At first glance, this observation seems to contrast the findings of Daniel et al. (2019), who reported that households with piped water systems are more likely to adopt HWT methods. The findings of this study suggest that *awareness of* and *financial access to* HWT methods were common determinants among participants. Regarding financial constraints, participants who cannot afford HWT are unlikely to adopt piped water systems, as the associated costs may be prohibitive. Wu (2024) for instance found that the adoption of household water filters in China was strongly related to the initial purchase price, and households with limited financial means may choose to forego additional treatment (Usepa et al., 2000). Conversely, households capable of affording piped water are likely better positioned to afford HWT methods. Thus, the relationship between HWT adoption and source water access observed by Daniel et al. (2019) is not directly contradicted by this study, as financial capacity plays a critical role in both cases.

While all participants highly prioritized the prevention of drinking water contamination from septic tank waste, concerns about livestock-induced contamination were notably absent. This aligns with findings from a case study in Gulariya municipality (Bardia) by Shahi (2023), which highlighted a general lack of community awareness regarding the risks of livestock-related water contamination. In some cases however participants explained their lack of concern by noting that they did not own livestock themselves.

5.1.2 Validation of research findings - different priorities

Factor 1 participants highlighted pesticides and chemical fertilizers, reflecting an increased awareness of agricultural practices that can compromise water quality (S. Sharma et al., 2005). The increased use of pesticides and chemical fertilizers (H. P. Pandey et al., 2023) has been linked to changing climatic conditions, which exacerbate their impact on water resources (A. Sharma, Batish, & Uniyal, 2020).

F1 furthermore highlighted the importance of community meetings as platforms for promoting hygiene practices and raising awareness about water-related issues. Community engagement and knowledge dissemination have been shown to significantly influence the adoption of effective household water treatment (HWT) methods. Daniel et al. (2019) identified participation in HWT campaigns as one of the three most critical socio-economic factors driving its use, alongside education and wealth levels.

These findings align with broader evidence that targeted community knowledge and awareness initiatives are pivotal in improving hygiene behaviors and water treatment practices. For example, Kariuki et al. (2012) and Crosby et al. (2020) emphasize the role of education and community-level interventions in bridging the gap between awareness and consistent practice. Such insights reinforce the role of community meetings in supporting Factor 1's emphasis on collective action and shared responsibility for hygiene and water quality improvements.

Factor 2 participants uniquely struggle with seasonal water scarcity. Hence their reliance on the river for their household needs. Their strategy of adopting alternative, unimproved, methods to secure water from diverse sources is consistent with findings by S. Shrestha et al. (2019). Similarly, a systematic review by Daly et al. (2021) highlighted that this practice is widespread in many low- and middle-income countries. In line with the findings in this study the dry season emerges as the most critical period for water supply due to the dual pressures of increased demand and decreased availability (Raut et al., 2020).

Some F2 participants expressed a preference for using the river for laundry rather than relying on neighbors, a choice that may align with the observations of A. Sharma, Karki, et al. (2020). Sharma noted that the decision to do laundry in the river is often influenced by social factors, such as avoiding the stigma associated with menstruation by discreetly cleaning menstrual blood-stained sheets. This stigma remains a significant cultural taboo in Nepal. Additionally, during field observations, a ritualistic cleansing of a deceased person's clothing was witnessed—a practice that women explained "has to be done in the river."

Whereas participants loading on F1 expressed concerns about potential future water quality and those on F3 highlighted possible future shortages and quantity issues, participants on F2, in contrast, voiced uncertainty regarding these aspects. These observations are consistent with findings by S. Shrestha et al. (2019), who noted that the gradual nature of climate change often leads individuals and communities to perceive it as less urgent compared to more immediate challenges. For F2 participants, such immediate challenges are particularly pronounced, shaping their priorities and strategies for water access.

Participants associated with Factor 3 reported not filtering their drinking water, citing either trust in and or knowledge about the quality of their water source, sometimes in combination with financial constraints. This behavior may to some extent be related to findings from a study in Kathmandu Valley, Nepal, which indicated that households perceiving their water as clean were less likely to engage in treatment practices such as boiling or filtering (Bhatta & Karki, 2016).

Interestingly, one F3 participant, an employee at the water tank, expressed confidence in the safety of the tap water. Another participant reported that their household had been informed that the tap water was suitable for direct consumption. However, despite this, the same participant mentioned preferring hand pump water for drinking, particularly in summer, because it is cooler and more pleasant to consume.

This illustrates the complexity of human behavior, as decisions about water use are influenced not only by perceptions of quality and safety but also by personal preferences and situational factors.

5.2 Reflections

The initial categorization of statements into sub-themes revealed interesting nuances during the Q-sort process, an integral aspect of Q methodology, which relies on participant interpretations to drive thematic analysis. For instance, the sub-theme *temperature* achieved consensus primarily due to statement S08, the only explicit representation of this theme. However, post-Q-sort interviews revealed that statement S03 (boiling water for quality control) was frequently interpreted by participants as temperature-related, as they primarily boiled water during colder months. Conversely, most participants did not associate boiling water with disinfection, highlighting the diverse ways participants contextualized the statements. These findings underscore the value of participant-driven perspectives in shaping the thematic analysis and emphasize the interpretative flexibility inherent in Q methodology.

While all participants expressed a willingness to pay for improved water quality, this does not always reflect their ability to do so. Research by A. Shrestha et al. (2020) and Water Aid (2017) highlights that women, particularly those facing water scarcity, often have limited financial resources to invest in alternative water sources.

Furthermore, willingness to pay does not imply a uniform understanding of what "better water quality" means. For some, it involves investing in a water filter to improve health by reducing contaminants, while for others, it focuses on removing calcium to prevent pipe damage and reduce maintenance costs. These variations highlight how priorities around water quality are shaped by individual needs and circumstances, reflecting the diverse realities of household contexts.

Lastly, the effect of intermittent tap water supply on water quality was not directly mentioned by any participants, though research has linked intermittent supply to compromised water quality (S. K. Rai et al., 2012). Notably, only participants from Karmala, where tap water supply is continuous, stated that they had been informed their tap water was safe to drink without additional filtering. In contrast, participants from Bhurigaon, where supply is intermittent, exercised more caution. This represents an intriguing area for further investigation, as Karmala may transition to an intermittent supply model if additional households are connected.

5.3 Study limitations

While this study provides valuable insights into women's perspectives on domestic water access in rural Nepal, several limitations must be acknowledged that may have influenced the results:

5.3.1 Important limitations

1. **Language barrier:** The research relied on a translator for communication, which may have resulted in the loss of nuanced or culturally specific expressions. Furthermore, translations were provided only in Nepali rather than Tharu, the native language of many participants.

   The accuracy and inclusiveness of the data collection could have potentially been improved if study materials had been translated into Tharu instead of Nepali.

2. **Influence of researcher presence:** Despite efforts to emphasize confidentiality and employ a local translator, participants may have provided answers they believed aligned with the researcher's expectations rather than their genuine experiences. This effect may have been particularly pronounced for judgment-prone or sensitive topics, such as hygiene.

   Although self-administered Q sorts or anonymous surveys could theoretically mitigate the influence of researcher presence by offering participants greater privacy, practical challenges in the study location make these methods largely infeasible. Limited literacy levels, unfamiliarity with such tools, and logistical constraints pose significant barriers to their implementation.

3. **Lack of direct observations:** The study did not include direct observation of participants' daily hand washing practices, which limited the ability to verify self-reported behaviors. Nonetheless, several participants independently mentioned increased awareness of proper hand hygiene, particularly the use of soap, which they attributed to COVID. This aligns with nationwide campaigns and initiatives aimed at promoting hand hygiene as a public health priority during the pandemic ("Beyond Raising Awareness: Promoting Handwashing in Nepal Amid COVID 19 Crisis", 2020).

   To address the lack of direct observations, future studies could incorporate observational methods, such as shadowing participants or conducting spot-check observations of daily practices, to verify self-reported behaviors. This would provide a more accurate picture of actual hygiene practices and help distinguish between reported awareness and genuine behavioral change. Combining direct observations with interviews or Q sorts would allow for triangulation of data, thereby increasing the validity of findings.

4. **Water quality testing:** This study relied solely on participants' perceptions and self-reports to assess water quality, without conducting independent testing of the water sources. While participants expressed trust or concerns about the safety of their water, these perceptions could not be corroborated with objective data. Research from Nepal has shown that water sources, including tap water, often harbor microbial and chemical contaminants despite appearing clean or being perceived as safe (Ghimire et al., 2020; Khanal et al., 2024; S. K. Rai et al., 2012). The absence of water testing in this study limits the ability to verify whether participants' decisions, such as not filtering water, align with the actual quality of their water sources.

   Future research should incorporate water quality testing to provide a more comprehensive understanding of the relationship between perceptions and reality.

5. **Time management:** Time constraints occasionally impacted the quality of the Q-sorting process. Misunderstood statements required revisiting and clarification, while external interruptions, such as participants attending to household responsibilities, reduced the available time for the procedure. The translator's inconsistent availability and last-minute scheduling changes often left no suitable alternatives. These constraints necessitated conducting more interviews per day than initially planned, resulting in increased workload and limited opportunities for in-depth engagement with each participant, which affected the quality and depth of the responses collected.

   Allocating extra time for interviews to account for potential interruptions or clarifications, along with proper reimbursement for participants' time, would also help address these limitations.

5.3.2 Contextual limitations

1. **Gender scope:** This study focused exclusively on women's perspectives on domestic water access, providing valuable insights into their unique experiences and priorities. However, this focus limits the ability to compare these findings with the perspectives of men, who may have different priorities, challenges, or strategies related to water access.

   To address this limitation, future research could consider conducting two separate Q studies — one with women and one with men — to systematically compare and contrast their viewpoints. As suggested by Watts and Stenner (Watts and Stenner, 2012), such comparative Q studies have the potential to reveal shared and divergent perspectives between genders, providing a more nuanced understanding that could inform more inclusive policy recommendations.

2. **Intersectional inequalities:** This study did not examine other intersectional inequalities, such as caste, poverty, or ethnicity, due to ethical considerations. However, these factors are significant in shaping access to resources. For example, marginalized ethnic groups often face additional challenges in being heard within Nepal's predominantly "Nepali language dominant" institutional culture (Khadka et al., 2023), and the gendered nature of water collection (Raut et al., 2020) and sanitation coverage (S. K. Rai et al., 2012) varies among ethnic groups.

3. **Geographical limitations:** This study's geographic focus was on villages in the buffer zone of Bardia National Park, which may limit the applicability of the findings to other regions in Nepal.

4. **Quantitative data on water demand:** No quantitative data on water demand was collected, limiting its ability to explore how water needs might relate to factors such as family size (Raut et al., 2020). Participants were instead asked about the activities requiring the most water and to rank a statement regarding seasonal differences in water demand during the Q-sort exercise. While this approach provides valuable insights into general perceptions and priorities, it does not capture detailed variations in water demand across households.

5. **River depth in relation to household water use:** No data was collected regarding river depth or water levels in relation to household activity requirements. While this does not directly impact the study's findings, it represents a gap in understanding how seasonal or infrastructural changes in the Karnali basin might affect communities reliant on river water. As A. Sharma, Karki, et al. (2020) highlights, water level requirements can potentially conflict with discharge from new infrastructure, posing additional challenges for those dependent on river water.

6. **Arsenic contamination:** No data was collected about potential arsenic contamination. However, Thakur et al. (2011) found that in Bardia, compared to elsewhere in Nepal, arsenic contamination was relatively low. While this suggests arsenic may not be a significant concern for this study area, it remains a potential gap in understanding water quality risks.

7. **Impact of weather conditions:** The interviews were conducted under challenging weather conditions at the end of April, when intense heat impacted the researcher's focus and energy levels. As a result, some of the summarized notes were overly concise, limiting the richness of the data interpretation. To mitigate these challenges in the future, interviews could be scheduled during cooler seasons when possible, or adjusted to avoid the hottest parts of the day.

5.3.3 Methodological limitations

The data reduction strategy inherent to Q methodology condenses multiple perspectives into a few dominant viewpoints, potentially overlooking marginalized or less widely shared voices. This limitation arises from the inherent trade-off between achieving statistical clarity and representing the full diversity of perspectives.

Although a four-factor solution was initially considered, the final decision was to interpret a three-factor solution. This choice was made because it offered more significantly distinguishing statements, enhancing the ability to identify and compare key perspectives. However, narrowing the number of factors may have inadvertently excluded viewpoints that were less prevalent but still meaningful. This prioritization of ease of interpretation and better statistical comparison may have contributed to overlooking nuanced or minority perspectives. Future research could address this limitation by exploring alternative factor solutions or incorporating complementary methods to capture a broader range of voices.

Chapter 6

Conclusion

The study explored women's perspectives on domestic water access in rural Nepal through Q methodology, utilizing a set of 30 statements addressing critical aspects of water access and usage. These included perceptions of water quality, availability (quantity), domestic uses, seasonal variations, trust, concerns about past and future water conditions, access and reliability of water sources, economic considerations, social dynamics surrounding water, health and hygiene practices involving water, and knowledge related to these topics. A total of 28 Q sorts (25 completed by women) were analyzed, resulting in three-factor solution that explained 71% of the study variance and reflected distinct but interconnected viewpoints.

While the study effectively highlighted the diversity of women's perspectives shaped by local conditions and resource access, it was unable to fully answer the research question, "*How do women in the Bardia National Park buffer zone perceive the challenges and opportunities related to water access?*" This limitation arose from a mismatch between the research question and Q methodology, which is designed to identify and compare distinct viewpoints rather than generalize findings to a broader population. The small sample size and limited geographical scope also restricted the study's ability to capture the full range of perspectives on water access and management. Additionally, the study focused exclusively on women's perspectives, without including a comparative analysis with men, leaving the relationship between gendered viewpoints unexplored.

Despite these limitations, the study succeeded in capturing diverse and nuanced perspectives on water access, demonstrating that *women*, as a category, *do not speak with a single voice.* This highlights the importance of tailoring water management strategies to the diverse needs and experiences of women in different contexts. Key findings, such as the reliance on multiple water sources for reliability, the potential of community meetings as underutilized forums for knowledge dissemination, and varying perceptions of water quality, emphasize the need for context-specific approaches in designing inclusive and effective water management systems.

While this study does not directly address engineering practices, its findings underscore the importance of addressing localized challenges, such as agricultural contamination from pesticides and fertilizers, and promoting awareness about the risks associated with intermittent water supply. The last paragraph elaborates on these findings and their implications in greater detail.

6.1 Key findings and their implications

The study identified several key findings, some of which were shared across factors, while others were factor-specific.

A finding shared among all factors was the importance of having access to **multiple water sources** for greater reliability and adaptability. This suggests that policies and infrastructure should prioritize diversified and resilient water access systems. While planned tap water installations are generally perceived as beneficial and, by some factors, as instrumental, they do not necessarily diminish the desire for other domestic water sources, such as (motorized) hand pumps. This is particularly relevant when considering economic considerations and the adaptability offered by multiple sources. Policies and infrastructure should therefore support a system that integrates and maintains multiple complementary water sources, to ensure reliability and affordability.

Another key finding was that **community meetings** are not universally seen as beneficial for the dissemination of knowledge, indicating that their potential remains underutilized. Improving the reach and effectiveness of these platforms could enhance their impact in promoting hygiene practices and raising awareness about the potential health risks associated with water contamination, particularly from agricultural practices such as pesticide and fertilizer use. Expanding and tailoring these meetings could strengthen their role in addressing water-related concerns.

Furthermore, shared **perceptions of water quality**—such as the importance of safe drinking water and willingness to pay for improved water quality—*do not necessarily translate into adoption of household water treatment* (HWT) methods. For instance, some participants mentioned preferring to drink ”untreated but cold water” from their shallow hand pump when tap water is too warm in summer. This preference, combined with trust in the safety of water even when the last quality check occurred years ago, or economic limitations, may explain this discrepancy. The potentially unwarranted trust in water quality underscores the need for increased awareness of risks, particularly those associated with **intermittent water supply and its implications for water safety**. This highlights the importance of further research and targeted awareness campaigns to address these gaps and promote safer water practices.

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Appendix A

About Q methodology

This chapter provides an overview of the invention of Q methodology by contrasting it with R methodology. It outlines key topics in Q methodology, including the Q sort, concourse and Q set development, participant sampling, factor extraction, analysis, and interpretation. To clarify these concepts, the chapter integrates methodological theory with practical examples.

A.1 Q methodology's relation to R methodology

The following paragraph details how Q methodology was invented based on R methodology.

R methodology samples a group of people and correlates their scores on objective variables in order to discover *latent variables*. Latent variables are unseen factors that explain observed scores. For instance, a musician's skill across instruments may stem from latent abilities like airflow control or rhythmic sense. After the correlation matrix is created, scores are standardized (converted into Z-scores) because the variables used do not typically share the same measuring unit. Stephenson identified a key limitation in this approach: by standardization, R methodology disconnects the data from the individuals and can therefor never say anything about any specific individual (Watts and Stenner, 2012). To address this, he inverted the structure used in R methodology. While R methodology analyzes participants' scores on objective variables, Q methodology flips this model— participants become the variables, and their subjective viewpoints are analyzed to uncover shared perspectives. This inversion required a new type of dataset, as R methodology's variables do not typically share a uniform measuring unit. Stephenson's solution was the Q sort, which enables the systematic study of subjective viewpoints based on the concept of **psychological significance** - a term elaborated on in the next section. This *unifying factor* ensures that the measuring unit for each participant remains consistent across the entire sample of items.

Takeaways so far:

Q methodology...

- Focuses on understanding participants' subjective viewpoints
- Inverts the rows and columns used in R methodology to study people, not variables.
- Requires a new type of dataset, known as the Q sort.

A.2 The Q sorting process

The data collection process in Q methodology involves participants ranking a set of items (typically presented as statements) according to their **psychological significance**. In Q methodology, this refers to the personal relevance and meaning that participants assign to each statement as they are rank ordered. Although all items could theoretically be ranked (1 - N), this is not essential for obtaining statistically meaningful results (Balch & Brown, 1982, pp. 288–289). To simplify the process, Stephenson introduced a **prearranged frequency distribution**, known as the forced distribution or **Q sort**. Figure A.1 shows an example of a forced quasi-normal distribution grid with 41 items. Stephenson believed that "trait-measurements for one and the same person would cohere to a distribution fitting the normal curve of error" (Burt & Stephenson, 1939, p. 279), which is why the grid follows a quasi-normal distribution. Few items are placed at the extremes—reserved for strong agreement or disagreement—while many more are placed toward the middle. With regards to using the forced grid shape (Watts and Stenner, 2012, pp. 77–79) highlight the following:

Guidelines for using the forced grid

- A steeper slope, or narrow grid, is recommended when participants are not expected to be experts, as it allows more items to be placed in the middle, where participants can express relative indifference.
- The zero position does not necessarily indicate neutrality; rather, it reflects that these items are ranked between -1 and +1.
- The term *forced grid* does not imply restricting participants; instead, the grid prevents over-complication while allowing for freedom in expression. A quasi-normal distribution is practical for both the researcher and the participant.

Least Agree									Most Agree	
-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
35	24	21	39	16	40	28	7	13	2	9
	17	11	36	25	5	22	8	38	4	
		23	14	32	33	20	1	18		
			29	6	31	3	30			
			10	19	41	37	12			
				15	27	34				
					26					

Figure A.1: Example of a forced quasi-normal distribution grid with 41 items.

A.3 About concourse development and the Q set

A.3.1 Concourse development

In Q methodology, the concourse represents the full range of subjective viewpoints on a particular topic. It forms the basis for the Q-set, which participants will ultimately sort. The concourse typically consists of a wide array of statements, ideas, or opinions collected through various sources, such as literature reviews, interviews, or surveys. These items reflect the diversity of perspectives that exist within the group of people being studied. The primary purpose of the concourse is to ensure that the Q-set is both comprehensive and representative of the subject matter. This is crucial because the Q-set aims to capture the full spectrum of subjective opinions on a given issue. By drawing on a wide variety of sources, researchers ensure that the concourse is inclusive of differing perspectives.

A.3.2 Sampling for the Q set and the number of items

Once the concourse is developed, the next step is to select a subset of items, known as the Q-set, for participants to sort. The number of items in the Q-set can vary, but a typical Q-set contains **between 40 and 80 statements** (Watts & Stenner, 2005). Smaller Q sets (with fewer than 40 items) are sometimes used, especially when the topic is less complex. Conversely, larger Q-sets may be appropriate for studies with more experienced participants or more nuanced research themes. This process of sampling of items from the concourse can be approached in two ways:

1. Structured sampling: The research theme is broken down into several categories, and a roughly equal number of statements are chosen from each category. This ensures balanced coverage of key sub-themes within the research topic. For example, in a study on water access, statements might be categorized into themes like availability, quality, and social implications, with each category contributing an equal number of statements to the Q-set.

2. Unstructured sampling: Alternatively, the Q-set can be selected more freely, allowing the researcher to choose the most relevant or diverse statements from the concourse without categorizing them first. This approach is more flexible but requires careful consideration to ensure the Q-set remains balanced and representative.

A.3.3 Criteria of balanced Q set

To ensure meaningful results, the Q-set must be balanced. This means it should represent a wide range of viewpoints without being biased toward any particular perspective. When constructing the Q-set, Watts and Stenner (2012, p. 67) suggest to:

- Standardize the length and appearance of the items.
- Use simple and clear language.
- Avoid multiple propositions.
- Avoid negative items in the form *I don't*.

A.4 On participant selection

Participants in Q methodology must be selected carefully to encompass a broad range of contrasting opinions. Unlike traditional quantitative methods, Q methodology does not require participants to be representative of the overall population. Instead, it aims to explore the diversity of subjective viewpoints, making it essential to include individuals with distinct perspectives, even if those viewpoints are unique. In Q methodology, each participant's subjective perspective, expressed through their Q sort, serves as a data point. These data points are analyzed to uncover patterns of shared viewpoints. Thus, incorporating individuals with differing perspectives ensures sufficient heterogeneity within the variables. Since it is impossible to predict how any individual will order their Q sort, it is common practice to select participants from various demographic groups to capture relevant and insightful perspectives (Watts and Stenner, 2012, p. 71). This does not mean, however, that the factors extracted will align with demographic boundaries. In fact the shared viewpoints that are uncovered with the help of Q methodology can cut across age, gender, or other demographic divisions.

Lastly, the number of participants should generally not exceed the number of items in the Q set to ensure meaningful factor analysis (Brown, 1993). Most studies have around 40-60 participants, but a smaller study group is also acceptable, again because the research goal is to explore subjective viewpoints in depth rather than statistical representation (Brown, 1993; Watts and Stenner, 2012).

Once participants are selected, the next step is to engage them in the Q sorting process, where their individual perspectives are systematically captured.

A.5 On conducting the Q sort

Before participants begin the Q sorting process, a clear explanation of the procedure and the broader context of the study is given and consent for their participation in the study is obtained. The researcher emphasizes the importance of participants expressing their own subjective viewpoints, with no "right" or "wrong" answers. Simple instructions are given regarding how to sort the statements using the forced distribution grid, and any questions are addressed.

The **sorting process** requires participants to rank the statements, usually from strong agreement to strong disagreement. To streamline this process, participants are often asked to first categorize statements into three broad groups: agree, disagree, and neutral/unsure. Then, they refine their choices by placing the most strongly agreed and disagreed statements at the extremes of a distribution grid, such as the quasi-normal distribution grid introduced earlier. Once participants finish their sort, researchers typically engage in a brief post-sorting interview. This allows participants to reflect on their sorting process, explain any particularly difficult choices, or clarify their reasoning behind certain rankings.

Once all the Q sorts are obtained, the next step is the analysis of the data, beginning with factor extraction, followed by factor rotation, factor estimates and finally factor interpretation.

A.6 On factor extraction

This section presents two different factor extraction methods used in Q methodology, followed by the presentation of free software and (statistical) considerations for determining the number of factors to extract.

A.6.1 Choosing the factor extraction method

Factor analysis can be performed using either *Principal Component Analysis* (PCA) or the older method of *Centroid Factor Analysis* (CFA). Both are exploratory data reduction techniques that aim to condense large datasets into smaller sets by identifying underlying structures using variance. However, PCA and CFA differ in their approach, computational complexity, and interpretation. In some cases, researchers combine the strengths of both methods. PCA can be used to inform decisions in CFA, such as determining the number of factors to extract. Another strategy is to compare the outcomes of both methods to increase the robustness of the findings. PCA and CFA ordinarily lead to very similar results in terms of the factors or components extracted (Maxwell & Harman, 1968). The choice for either method depends on the specific research goals. The following paragraphs briefly summarize and compare both methods.

Centroid Factor Analysis (CFA)
CFA is the historically preferred method in Q methodology, notably supported by Watts and Stenner (2005), who argue it is the only genuine factor extraction method. CFA works by extracting factors from clusters of correlated variables or Q-sorts, representing these clusters as centroids in a multidimensional space. Each centroid represents a factor that accounts for the common variance shared by the correlated variables. The factors produced by CFA explain **common variance** (shared viewpoints or characteristics), while unique variance (differences between individual Q-sorts) and errors are not factored into the model. This makes CFA particularly suitable for uncovering shared perspectives, aligning well with the general goal of Q methodology. However, CFA lacks the iterative precision of more modern methods,

which means the factors extracted might not be as mathematically refined.

Principal Component Analysis (PCA)
PCA is a more recent and mathematically advanced technique compared to CFA. It reduces data by combining variables into principal components that explain the **maximum total variance**, rather than just common variance. Unlike CFA, PCA does not distinguish between common, specific, and error variances, treating all variance equally important in generating components. A key feature of PCA is that the components are orthogonal (uncorrelated), making it easier to identify the main components. However, this can also lead to components that may be difficult to interpret theoretically. While PCA is valued for its mathematical rigor, the components it generates may not always align with meaningful theoretical constructs, which can complicate interpretation.

Comparing CFA with PCA

The main differences between CFA and PCA are as follows:
Computational complexity: PCA is more mathematically intensive, whereas CFA is simpler and can even be performed by hand.
Variance accounted for: PCA maximizes total variance, while CFA focuses on common variance.
Orthogonality: PCA produces orthogonal (uncorrelated) components, whereas CFA does not necessarily result in orthogonal factors.
Interpretability: CFA tends to generate more interpretable factors in the context of shared viewpoints, while PCA focuses on statistical variance, which may lead to less interpretable components.

A.6.2 Factor extraction - choosing the number of factors

Factor extraction is nowadays done by statistical software which is freely available, such as PQMethod (Schmolck, 2002) or KenQ Analysis Desktop Edition (KADE) (Banasick, 2019). The software identifies portions of the data which share common variance (for CFA) or maximizes the total variance captured by the extracted factors (PCA). When selecting CFA the researcher has to decide how many factors to extract, for PCA automatically generates 7 factors, which Brown (1993, p. 223) believes to be a generally suitable number as a starting point. There are several criteria used for deciding how many factors to retain, as discussed by Watts and Stenner (2012) and presented in the text box on page 61.

Criteria for retaining factors

1. Total explained variance: A strong solution should ensure that the retained factors together account for at least 35-40% of the total variance in the study, as recommended by Kline (2014).

2. Eigenvalues (or the Kaiser-Guttman criterion): According to the Kaiser-Guttman rule (Guttman, 1954; Kaiser, 1960), factors with eigenvalues greater than 1 are considered significant. The eigenvalue (EV) is the sum of the squared factor loadings of all the Q sorts that load on a particular factor.

$$\text{Eigenvalue (EV)} = \sum \left(\text{Factor loading}^2\right)$$

This criterion suggests that a factor explains at least as much variance as one original variable, which makes it meaningful for interpretation. The Kaiser-Guttman criterion is a good starting point but might result in retaining too many factors (Brown, 1993; Kline, 2014).

3. Two (or more) significantly loading Q sorts: A factor should have at least two Q sorts with significant factor loadings to be retained. Significant factor loadings at the 0.01 level can be calculated using the following equation (Watts and Stenner, 2012, p. 107):

$$\text{Significant factor loading} = \frac{2.58}{\sqrt{N}}$$

4. Humphrey's rule: This rule states that if the absolute value of the cross-product of the two highest loadings for a factor exceeds twice the standard error, then the factor is considered significant. The standard error is calculated as follows (Watts and Stenner, 2012, p. 107)

$$\text{Standard error} = \frac{1}{\sqrt{N}}$$

However, Watts and Stenner (2012, p. 108) also suggest a less strict interpretation of the rule, where the cross product of the two highest factor loadings only needs to exceed the standard error to be considered significant.
where:

- 2.58 is the z-score for the 0.01 significance level (for a two-tailed test).
- N is the number of items in the Q set.

This indicates that the factor represents a shared perspective among multiple participants, rather than being an isolated view.

5. The scree test: The scree test involves plotting the eigenvalues of the factors and looking for a point where the slope changes, also known as the "elbow." Factors above this elbow are considered significant, while those below are likely due to random error or noise. It is designed for use only in the context of PCA (Watts and Stenner, 2012, p. 108). When performing CFA, Watts and Stenner (2012) recommend using the scree test on PCA extracted components for informing the amount of factors to extract.

6. Parallel analysis: Parallel analysis compares the actual eigenvalues from the data to those generated from random data, keeping only those whose eigenvalues exceed those from the random data.

A.7 On factor rotation and factor estimates

Factor rotation is the process by which the position of the initially extracted factors relative to the Q sorts is changed, in order to improve the alignment between the Q sorts and the (rotated) factors. Rotation can be either done by hand (judgemental) or using varimax rotation, which automatically applies statistical criteria. A comparison of the two technique is given in the text box. A key point is that rotation does not change in any way how the Q sorts relate to each other, it only corrects the angle of the lens through which the Q sorts are observed. Therefore, factor loadings and the variances explained by each factor change after rotation, but the correlations between the individual Q sorts and the total variance present in the data do not.

Varimax versus judgemental rotation

Varimax rotation, introduced in the 1950s, is a purely mathematical technique that maximizes the sum of the variance of squared loadings for each factor. It keeps the factors independent (orthogonal), making them more easily interpretable. When applied to centroid factor analysis, varimax adjusts the factors to be as uncorrelated as possible, potentially overriding some original correlations that could have been meaningful. This trade-off enhances clarity but may lose subtle relationships between factors.

Judgmental rotation, by contrast, was initially used by William Stephenson in Q methodology. This manual, subjective technique allows the researcher to adjust factor loadings to reflect their theoretical understanding. While it can capture more nuanced or theoretically informed factors, it introduces researcher bias, making it less suitable for exploratory studies where the goal is to let the data reveal underlying viewpoints naturally.

Factor estimates are constructed via the weighted average of all the Q sorts that load significantly *on only one factor*. They are used to construct the *factor array*, which is a single synthesized Q sort that represents a particular factor. To calculate the factor estimate, the factor loading of each significantly loading Q sort is used as a weight. The formula for each statement in the factor array is as follows:

$$\text{Factor estimate} = \frac{\sum(\text{Factor loading of Q sort} \times \text{Score of Q sort})}{\sum(\text{Factor loadings})}$$

To allow for comparison between different factors, the weighted score for each statement is then converted into a **standard (Z) score**. Z-scores normalize the values by indicating how far each statement's weighted score deviates from the average score across all factors. These Z-scores are then used to construct the **factor array**, providing a visual representation of the viewpoints captured by each factor.

A.8 On factor interpretation

The last step in Q methodology is factor interpretation. Although Stephenson presented no general guidelines for this critical part of the process, Watts and Stenner (2012) recommend using a so-called *crib sheet* as the starting point of factor interpretation. The following paragraphs outline the steps involved.

Essentially a crib sheet is a comparison of the placements of all the statements on the factor array for a certain factor with the placement of the same statement of the other factors. The procedure for making one is explained in the accompanying text box. By comparing the placement of all the statements the researcher avoids focusing only on the statements at the edges of the grid, or on those statements that have been 'significantly ranked differently'. Using a crib sheet also allows for the items ranked (near) zero to better inform the viewpoint of the factor in question (Watts and Stenner, 2012, p. 155). By looking closely at the way all the statements have been ranked, the holistic nature of Q methodology is respected.

Crib sheet procedure

Take the factor arrays for the different factors and run past each item. Write down:

- Items ranked highest and possibly second highest
- Items ranked higher in the factor array than in the others, including those that are tied.
- Items ranked lower in the factor array than in the others, including those that are tied.
- Items ranked lowest and possible second lowest.

For the items in the crib sheet, ask yourself *'Why the items is ranked as it is, what does its position mean in the light of the overall viewpoint?'*. After this step, go over all the remaining items which were excluded from the crib sheet and try to relate those to the viewpoint.

Appendix B

Concourse development

The final concourse consisted of the following 64 statements, organized per main category in Table B.1. Statements incorporated in survey related to the water profile of the participants are presented in Table B.2. Reasoning behind excluding certain statements is presented in Table B.3. Finally, adjustments for Q set refinement are found in Table B.4.

B.1 The concourse

Table B.1: Concourse development

#	**Concourse statement**	**sub category**
1	There is a lot of iron in the water from my hand-pump.	*quality, knowledge*
2	I filter the water before I drink it.	*quality, health and hygiene*
3	I use unfiltered/raw water for cooking.	*quality, use*
4	I use filtered water for irrigating my vegetable garden.	*quality, use*
5	I treat my drinking water by boiling it.	*quality, health and hygiene*
6	Tap water quality is better than hand-pump water quality.	*quality, trust*
7	The water quality from my hand-pump is good.	*quality*
8	The water quality from my hand-pump is not good for drinking/cooking.	*quality, use*
9	During the monsoon the water quality of my hand-pump is worse.	*quality, seasonality*
10	Tap water can be drunk without filtering it before.	*quality, trust, knowledge*
11	I trust that the government will provide safe tap water.	*trust, quality*
12	It is important for me that my water is cold.	*temperature*
13	There are regular quality checks of the water I use.	*quality, trust*
14	During dry periods, my hand-pump is dry.	*seasonality, access and reliability*
15	The hand-pump is a reliable water source.	*access and reliability*
16	Tap water is a more reliable water source.	*access and reliability*
17	The river becoming more dry affects the availability of water in my hand-pump.	*future/past concerns, environmental concerns*
18	In the future there may not be enough water.	*future/past concerns, quantity*
19	In the past there was more water than there is now.	*future/past concerns, quantity*

Continued on next page

Table B.1 – *Continued from previous page*

#	Concourse statement	sub category
20	If too many people are connected to tap water there will not be enough water for everyone.	*future/past concerns, quantity*
21	Drinking untreated water makes me sick.	*quality, health and hygiene*
22	Irrigating my vegetable garden gives me access to more healthy food.	*use, health and hygiene*
23	I use more water because I have a motorized water pump.	*quantity, economy, use*
24	I have enough water to irrigate my vegetable plot when needed.	*access and reliability, quantity, use*
25	I sometimes go to my neighbor's for household water.	*access and reliability, social*
26	I am happy with the water from my hand-pump.	*social*
27	Tap water would be helpful for us.	*access and reliability, use*
28	I have less access to water than other women in my village.	*access and reliability, social*
29	I am not interested in using tap water.	*access and reliability, use*
30	I am able to pay for connection to tap water connection.	*economy*
31	I know what it costs to get a tap water connection.	*knowledge, economy*
32	I only want to use tap water for drinking/cooking to avoid a high water bill.	*use, economy*
33	I am willing to pay for better water quality.	*economy, quality*
34	It is important to avoid contamination of my water source.	*quality, health and hygiene*
35	Animals defecating near my hand-pump cause pollution of the water.	*quality, health and hygiene*
36	It is important to use soap when washing my hands.	*health and hygiene*
37	I wash my hands with soap before I take a meal.	*health and hygiene*
38	Waste from the septic tank causes water pollution.	*quality, health and hygiene*
39	Septic tank waste needs to be buried far from my hand-pump.	*health and hygiene, knowledge*
40	Community water meetings are useful to learn about water hygiene.	*health and hygiene, knowledge, social*
41	If I use tap water, I do not use my hand-pump.	*use, access and reliability*
42	It is important to have more than one source of water.	*access and reliability*
43	If the tap water does not work I will use the hand-pump.	*access and reliability, use*
44	Using tap water is easier than using a hand-pump.	*use*
45	I will spend less time on collecting water using tap water than using a hand-pump.	*access and reliability, use*
46	A motorized water pump saves a lot of time.	*economy, use*
47	It is easier to do my laundry in the river/canal.	*access and reliability, use*
48	It is important to me that I can have access to water whenever I want.	*access and reliability*
49	The fact that tap water access is timed is not an issue to me.	*access and reliability, use*
50	The location/depth of my hand-pump was decided based on information from a government official.	*quality, knowledge*
51	I go to information meetings about domestic water.	*knowledge, social*
52	I know who is in charge of the tap water/ I know who to contact for tap water access.	*knowledge, access and reliability*
53	I feel responsible for the quality of my hand-pump.	*quality*

Continued on next page

Table B.1 – *Continued from previous page*

#	**Concourse statement**	**sub category**
54	I would like to be involved in the decisions about tap water.	*knowledge*
55	I regularly maintain my hand-pump.	*access and reliability*
56	If the tap water pipes break it is fixed quickly.	*access and reliability*
57	I use more water in the summer than in the winter.	*use, quantity, seasonality*
58	Because hand-pumps were an improvement to well water, tap water will be an improvement to hand-pump water.	*future/past concerns, quality, trust*
59	Wildlife eat the crops I grow in my vegetable garden.	*future/past concerns, use*
60	I eat raw vegetables.	*health and hygiene, use*
61	I wash vegetables with raw water.	*quality health and hygiene, use*
62	I have had to change the location of my hand-pump because it did not work anymore.	*access and reliability*
63	To treat drinking water I put a bottle in the sun.	*quality, knowledge, health and hygiene*

B.2 Sampling for the Q set

Nr.	Concourse statement
1	There is a lot of iron in the water from my hand pump.
7	The water quality from my hand pump is good.
8	The water quality from my hand pump is not good for drinking/cooking.
13	There are regular quality checks of the water I use.
14	During dry periods, my hand pump is dry.
17	The river becoming more dry affects the availability of water in my hand pump.
23	I use more water because I have a motorized water pump.
30	I am able to pay for connection to tap water.
54	I would like to be involved in the decisions about tap water.
55	I regularly maintain my hand pump.
56	If the tap water pipes break, they are fixed quickly.
62	I have had to change the location of my hand pump because it did not work anymore.

Table B.2: Statements changed to questions related to participant's water profile

Nr.	Reason for exclusion
3	Partially represented by Q set S29; focus shifted to raw vegetable washing for broader applicability.
6	Covered by Q set S06 which emphasizes distrust in tap water safety and quality.
15	Q set S14 and S24 provide related insights on access and reliance on different water sources.
16	Implicitly covered by Q set S15, questioning the helpfulness of tap water for participants.
21	Addressed by Q set S01 and S03 focusing on water treatment practices such as filtering and boiling.
22	Excluded due to lack of focus on water quality of irrigation water; more relevant statements in Q set (e.g., S02, S13).
26	Partially represented by statements related to trust and preference for water sources (e.g., S06, S07, S15).
29	Represented by Q set S15 which explores attitudes toward the helpfulness of tap water.
34	Partially covered by Q set S20 and S22 focusing on pollution sources and water safety.
41	Addressed by Q set S24 emphasizing the importance of having multiple water sources.
44	Other Q set statements, such as S26, focus on broader aspects of access rather than convenience.
45	Less relevant as Q set focuses on broader issues of access (e.g., S14, S26).
46	Excluded due to less focus on time-saving aspects; Q set targets general water use and access (e.g., S02, S24).
49	Excluded due to low awareness among participants; Q set statements address general access concerns (e.g., S26).
51	Addressed by Q set S27 focusing on water quality considerations in location choice.
52	Covered by Q set S23 on community water meetings and their usefulness.
53	General information covered by S17 regarding awareness of connection planning and costs.
54	Covered by Q set S20 and S22 related to pollution and quality management practices.
59	Already implied by statements on trust and quality (e.g., S06, S15).
60	Not relevant as Q set focuses on household water use and quality (e.g., S02, S13).

Table B.3: Overview of concourse statements and reasons for exclusion or relation to Q set statements

B.3 Q set refinement

Statement	Details
S10	Introduced as a counterpart of S09, discussing quality in addition to quantity.
S04	Modified wording of concourse nr.9 to include all possible water sources instead of focusing solely on hand-pumps.
S05	Modified wording of concourse nr.14 to include all possible water sources instead of focusing solely on hand-pumps.
S28	Merges original concourse nr.60 and nr.61.
S26	Adaptation of concourse nr.50, changing the emphasis to water quality.
S01, S06, S07, S13, S15, S24	Adjusted after the pilot to create direct opposites for better balance between agree/disagree statements.
S09	Concourse nr.18 was adapted to be more personalized using constructions like *I think*.

Table B.4: Overview of Q set statements and modifications

Appendix C

Exploratory fieldwork

C.1 Overview exploratory fieldwork

Subject name/code	Village	Date	Approx. duration	Notes/topic	Documentation
Resham Thapa*	Geruwa and Gola municipalities	18-03-2024	Half a day	Observational trip on back of motorcycle (see Table C.2)	Summarized voice memos
IP0	Patarbojhi	20-03-2024	30 min	Key water-related themes (see Table C.3)	Summary of interview notes
Bishal*	Thakurdwara	21-03-2024	1.5 hrs	4 local women were group interviewed on Key water-related themes (see Table C.3)	In-situ transcription
IP1	Patarbojhi	22-03-2024	20 min	Concourse development	Summarized interview notes + Excel
IP2	Patarbojhi	22-03-2024	20 min	Concourse development	Summarized interview notes + Excel
IP3	Patarbojhi	22-03-2024	20 min	Concourse development	Summarized interview notes + Excel
ID1	Dalla	22-03-2024	20 min	Concourse development	Summarized interview notes + Excel
IB1	Bhurigaon	23-03-2024	25 min	Concourse development	Summarized interview notes + Excel
IB2	Bhurigaon	23-03-2024	25 min	Concourse development	Summarized interview notes + Excel
IB3	Bhurigaon	23-03-2024	25 min	Concourse development	Summarized interview notes + Excel
IB4	Bhurigaon	23-03-2024	25 min	Concourse development	Summarized interview notes + Excel

Table C.1: Overview of exploratory research. Entries marked with an asterisk (*) indicate individuals who served as guides or translators rather than interviewees.

Observational Topics	
Water Sources	**Water Storage**
1. Types of water sources available (e.g., taps, wells, springs, rivers). 2. Amount of water in river/canals near households. 3. Distance to the nearest water source from households. 4. Distance from water source to latrine. 5. Infrastructure for water collection (e.g., water tanks, buckets). 6. Presence of queues or lines at water sources?	9. Condition and cleanliness of water storage containers. 10. Location of water storage containers within households. 11. Quantity of water stored (relative to household size and daily usage).
Water Collection	**Water Usage**
7. Carrying methods (e.g., head carrying, shoulder carrying). 8. Types of water storage containers used (e.g., buckets, jerry cans).	12. Accessibility of water for livestock and agriculture. 13. Any gender disparities in water usage patterns.
Infrastructure and Facilities	**Social Dynamics**
14. Condition of sanitation facilities (e.g., toilets, latrines). 15. Availability of handwashing stations and hygiene practices. 16. Visible infrastructure for water treatment or purification.	17. Social interactions and cooperation at water sources. 18. Presence of community initiatives or organizations related to water management.
Environmental Factors	
19. Visible signs of environmental degradation or pollution affecting water sources.	

Table C.2: Key observational topics for water-related field research

1. Historical water sources and transition to hand pumps
2. Current water quality checks and filtration practices
3. Household water uses, including kitchen, laundry, and irrigation
4. Sanitation practices and wastewater management
5. Seasonal water practices, such as boiling in monsoon
6. Minimal governmental support and reliance on community resources
7. Adaptation to timed water access in case of piped water installation
8. Perspectives on rainwater harvesting
9. Hand pump depth, seasonal availability, and issues with access
10. Reliance on neighboring households for water access as needed
11. Variation in hand pump effectiveness due to depth and maintenance
12. Awareness of government tap water plans and opinions on costs
13. Anticipated dual use of hand pumps and tap water for specific purposes
14. Participation (or lack thereof) in community water-related meetings
15. Observed hygiene practices related to water use

Table C.3: Key water-related themes from informal interviews

C.2 Observation notes

Observational Notes from Thakurdwara to Gola, Bardia District

I traveled on the back of a motorcycle from Thakurdwara to Gola, reaching the inlet of the Geruwa River, where the Kailali district begins on the opposite bank. Along the way, I observed a mix of concrete and dug irrigation channels—some carrying water, while others were dry. The road was predominantly flat, with varying surfaces: some stretches were sandy, others gravelly, and parts were asphalted. Construction work was ongoing to extend the asphalt coverage in several areas.
I did not see a water tower, but I noticed a structure under construction that could either be a small water tower or a sturdy watchtower. On the road, various women were carrying sacks, such as lentils, on their heads. Near the community forest road around Bheri, I saw a woman with a bucket containing cleaning supplies, possibly for dishes or laundry. At the Budi Kulo river channel, I observed eight women fishing together using two large nets (four women per net). Further upstream, two women were fishing with individual nets. Near Seti, close to the Budi Kulo, women were engaged in rice planting in wet fields, while nearby concrete irrigation channels remained dry.
Other agricultural activities included women sifting mustard seeds. Many households along the way had animals, mostly tethered, with drinking troughs visible in some cases. In most households, animal fodder was placed near the animals (e.g., goats and buffaloes). The animals were housed close to hand pumps, often within a few meters. In one household, I noticed an old-model water tap, which Resham explained was installed by an NGO but was now out of order. This household also had a black water tank mounted on the roof of what appeared to be a toilet.

Figure 1 Woman carrying basket

Figure 2 Women fishing

Figure 3 Livestock near handpump

Hand pump setups varied along the route. Some were open, while others were fenced with brick walls, reed, or cornstalk barriers. Some hand pumps had concrete basins around them; others did not. Housing types were diverse as well, ranging from concrete structures to traditional clay and straw houses with thatched roofs. These houses were sometimes clustered together but occasionally interspersed. Most homes were single-story, but a few had a second floor. At one house, runoff water from a hand pump was directed to a small irrigated vegetable plot in front of the house.
On several concrete house rooftops, I observed green water tanks. At three locations, I saw women doing laundry in the river. Near the river intake, a woman washed laundry in a shallow section of the river using a bucket. Further downstream, closer to the Indian border, a woman was cleaning a sack used for harvest produce, while two other women nearby washed clothes as part of a custom performed 11 days after a death in the family. At another spot, a woman bathed in a channel connected to the Ghaghara River near her house. In several households, I observed women washing themselves or their children at hand pumps, drying dishes, and hanging laundry on clotheslines.

C.3 Summarized interview notes: Patarbojhi

Notes from informal interview with respondent P01 - Patarbojhi, March 20th

Purpose: Obtain a preliminary overview of the water challenges identified by women in Patarbojhi, a village at lower elevation facing seasonal water scarcity and flooding. Additionally, gather historical insights into the progression of drinking water sources and methods in the village.

- **Hand pump issues:** Some households report problems with their hand pumps. In previous years, a depth of 15-20 feet was adequate to access water, but now they need to dig down to 40-45 feet. During the dry season, some hand pumps do not provide water at all. Residents believe this is related to a decrease in the river's water level.

- **Neighborly assistance:** When their own hand pumps face issues, some households use their neighbors' hand pumps to meet their water needs.

- **Impact of depth:** Villagers note that the depth of a hand pump—whether shallow or deep—is a major factor in its reliability. Deeper pumps tend to work more consistently.

- **Water quality checks:** Occasionally, projects come through the village to check water levels and assess hand pump quality. One household reported that inspectors noted good quality in their hand pump but mentioned that other areas in the village had high iron content in their water. This iron causes the water to appear yellow when left overnight, leading residents to filter it before drinking.

- **Awareness of tap water plans:** Residents have heard about government plans to provide tap water but are unsure about the timeline. No one from the government has approached them directly about it.

- **Mixed views on tap water:** When asked about their thoughts on receiving tap water, the women in the household (along with neighboring women who joined the discussion) expressed different opinions. They anticipate that piped water will be treated and of better quality than hand pump water, but they are concerned about the costs associated with the network pipes, which they expect might be high.

- **Hand pump reliance despite tap water:** When asked about the potential impact of tap water on hand pump use, they did not directly address the question. Instead, they stated that they would still rely on hand pumps for their livestock. They noted that if they received tap water, they would likely only use it for drinking to keep the bill manageable.

- **Historical timeline of water sources:** Around 24-26 years ago, villagers primarily used well water, with only 4-5 wells available for the entire village. During this period, some residents also drank directly from the river, a practice that has since ceased.

- **Water use priorities:** Opinions vary on the primary areas of water use. One woman identified the kitchen as the main site for water consumption, another cited laundry, and a third mentioned irrigation for the vegetable garden.

- **Meeting attendance and awareness:** No one from the household attends Water User Association meetings, and it is unclear whether they are fully aware of such meetings. Occasionally, other community meetings include discussions on drinking water and hand pumps, and either the husband or wife will attend, depending on availability.

- **Observation of hygiene practices:** When offered chocolate, participants rinsed their hands with water before eating, though they did not use soap.

C.4 Summarized interview notes: Thakurdwara

Notes from informal interview - Thakurdwara, March 21st

Four local women were invited by the owner of the Rastabar (Bishal) to participate in an informal interview. Unfortunately, during the interview, the translator often answered questions himself rather than allowing the women to respond, despite attempts to address the women directly.

- **Historical water use:** Originally, villagers drank river water filtered only through a cloth to remove sand, around 25-30 years ago. This was followed by the use of communal wells, with wells sometimes dug to depths of 20-25 feet and covered at night. The introduction of hand pumps about 25-30 years ago gradually replaced wells. Today, water from hand pumps is noted for high iron content, which varies by location.
- **Hand pump installation and maintenance:** Households are fully responsible for installing and maintaining hand pumps. A reliable hand pump setup costs approximately 20,000-25,000 rupees, with an additional 4,000-5,000 rupees for a pump set. Installation can take about a week as the sand must be pumped out first.
- **Water quality testing:** Households have no formal water testing equipment, relying instead on visual cues like iron sedimentation. Water left overnight can show yellow lines if iron is present. During monsoon seasons, water quality can worsen due to contaminants on the surface being drawn into shallower wells.
- **Tap water interest:** The women expressed interest in tap water primarily for drinking, as they expect it to be of higher quality. However, they plan to continue using hand pumps for other purposes to keep tap water bills manageable. Estimated monthly costs for tap water ranged around 600-700 rupees for drinking purposes alone. If tap water costs reach 1,000 rupees per month, households would restrict its use to drinking and cooking only.
- **Sanitation practices:** Newer homes have septic tanks, while older practices involved composting waste in pits. Septic tanks are increasingly common, but households still largely manage their waste individually.
- **Household water use and cooking fuel:** The women reported spending 5-6 hours daily on tasks like cooking, cleaning, and laundry. Wood is the preferred cooking fuel due to cost and availability, except during the monsoon when they switch to gas due to wet wood. All the women are part of a community forest group, which allows them to collect firewood as members.
- **Additional observations:** The women expressed limited interest in rainwater harvesting, stating that nearby rivers provide ample water. They are, however, aware of the timing system for tap water in cities like Kathmandu, where water is supplied only during specific hours. In their region, such timing is unfamiliar, but they expressed willingness to adapt if tap water is similarly timed in the future.

C.5 Summarized interview notes: Patarbojhi and Dalla

Summarized interview notes, Patarbojhi and Dalla, March 22nd
Purpose: Inquire more deeply into water concerns of different households to compile concourse for Q-methodology and create a general overview.
Translator: Sushila Mahatara, **Duration:** Approx. 13-20 minutes per interview

Interview respondent P01

- **Biofilter use:** When needed, water is filtered within a few minutes.
- **Water meetings:** Family members attend occasional village drinking water workshops on filtration methods.
- **Biogas use:** Family uses septic tank waste mixed with cattle dung to produce biogas for cooking.
- **History/future:** Ten years ago, no hand pumps ran dry; now, some face seasonal issues. They view tap water as potentially helpful.

Interview respondent P02

- **Water collection (30 years ago):** An older lady recalled using buckets to collect water from a well; she values the convenience and reliability of hand pumps.
- **Water meetings:** Last meeting took place before the recent monsoon.
- **Quality checks:** Last occurred 7-8 years ago post-flood; WaterGuard tablets were provided for ten days.
- **Piped water:** They are aware of costs but uncertain of amount. They view piped water as an improvement over hand pumps, similar to how hand pumps replaced wells.

Interview respondent P03

- **Biofilter use:** Flooding and high arsenic/iron levels prompted municipal provision of a filter, recommended to all.
- **Piped water:** Unsure about using tap water beyond cooking and drinking due to availability and cost concerns.
- **Septic tank:** Circular design, cleaned by hired workers.

Interview respondent D01

- **Canal use:** Besides irrigation, the canal is used for laundry. The participant began filtering drinking water after advice from local health workers.
- **Irrigation:** Two young girls assist with the vegetable garden.
- **Piped water:** No one has approached the family, though nearby hotels have tap water access.
- **Water tank:** Tank is used for home stay guests; family members rely on the hand pump for bathing.

General observations:

- Most households know neighbors with hand pump issues, but they are hard to locate. Rainwater is not collected as water is perceived as sufficient.
- Hand pump installation is estimated at 25-30 years ago. Some hand pumps are elevated for flood prevention.
- Boiling for water safety is now mainly done in winter.

C.6 Summarized interview notes: Bhurigaon

Summarized interview notes, Bhurigaon, March 23rd
Purpose: Inquire into water concerns of different households to compile concourse for Q-methodology and create a general overview.
Translator: Sushila Mahatara, **Duration:** Approx. 15-27 minutes per interview

Interview respondent B01

- **Hand pump and tap water use:** Rarely uses hand pump due to iron content. Tap water is usually good, but connection issues arise as more people connect. Timed access (6-10 AM, evening, and Saturday afternoons).
- **Water storage and temperature:** Uses a 1000L automated tank; prefers hand pump water for bathing in summer due to heat in stored tap water.
- **Community engagement:** Attends Water User Association (WUA) meetings covering hygiene and water distribution. Believes food cooked on firewood is tastier, prefers it over gas.

Interview respondent B02

- **Water quality checks:** hand pump checked by authorities; good quality reported. Household aware of who to contact for tap connection.
- **Agricultural challenges:** Vegetables often stolen by monkeys and boars, leading to reliance on purchased food.
- **WUA participation and tap water interest:** Village leaders attend WUA meetings, but participant does not. Initially uninterested in tap water but later expressed concern over potential costs.

Interview respondent B02

- **Hand pump and maintenance:** Recently installed hand pump and motor for household tasks; has had to replace motor due to wear. Not interested in tap water.
- **Cooking Fuel Preferences:** Does not enjoy using biogas as a cooking source since ceasing cattle ownership.

Interview respondent B02

- **Tap water reliability and maintenance issues:** Uses hand pump if tap water connection fails; repair costs vary depending on whether leaks occur inside or outside property.
- **Calcium concerns:** Calcium buildup affects tap water pipes, leading to frequent breakages. Participant would pay extra if calcium was removed.
- **Installation costs and storage:** Entire installation, including tank and plumbing, cost approx. 15,000 rupees.

General observations:

- Households often describe water use collectively; may benefit from a different question approach, such as using cards with images to prioritize water needs.

Appendix D

The Q set

D.1 Q set - english

S01 I do not filter water before I drink it

S02 I use the same water for my vegetable garden as I do for drinking

S03 I treat my drinking water by boiling it

S04 During certain periods of the year (such as during the monsoon) the quality of my water is worse

S05 During certain periods of the year (such as during the summer) there is less water available

S06 Tap water cannot be drunk without filtering it before

S07 I do not trust the government to provide safe tap water

S08 It is important for me that my water is cold

S09 I think that in the future there may not be enough water

S10 I think that in the future the quality of the water may be worse

S11 In the past there was more water than there is now

S12 If too many people are connected to tap water there will not be enough water for everyone

S13 I don't have enough water to irrigate my vegetable plot when needed

S14 I sometimes go to my neighbours for household water

S15 Tap water would not be helpful for me

S16 I have less access to water than other women in my village

S17 I am well informed about tap water connection costs and planning

S18 I only want to use tap water for drinking/cooking to avoid a high water bill

S19 I am willing to pay for better water quality

S20 Animals defecating near my hand-pump cause pollution of the water

S21 I wash my hands with soap before I take a meal

S22 Septic tank waste needs to be buried far from my hand-pump

S23 Community water meetings are useful to learn about water hygiene

S24 It is important to have more than one source of water

S25 I do not do my laundry in the river/canal

S26 It is important to me that I can have access to water whenever I want

S27 The location/depth of my hand-pump was decided based on the water quality

S28 I use more water in the summer than in the winter

S29 I wash vegetables that I eat raw with unfiltered water

S30 To treat drinking water I put a bottle in the sun

D.2 Q set - Nepali

1. म पिउनुअघि पानी छान्दिन
2. म मेरो तरकारी बगैंचाका लागि उस्तै पानी प्रयोग गर्छु जुन म पिउने पानीको लागि गर्छु
3. म मेरो पिउने पानी उमालेर शुद्ध बनाउँछु
4. वर्षको केही समयमा (जस्तै मनसुनमा) मेरो पानीको गुणस्तर खराब हुन्छ
5. वर्षको केही समयमा (जस्तै गर्मीमा) कम पानी उपलब्ध हुन्छ
6. फिल्टर नगरी धाराको पानी पिउन सकिँदैन
7. म सरकारलाई सुरक्षित धाराको पानी उपलब्ध गराउनेमा विश्वास गर्दिन
8. मेरो लागि मेरो पानी चिसो हुनु महत्त्वपूर्ण छ
9. भविष्यमा पर्याप्त पानी नहुन सक्छ भन्ने लाग्छ
10. भविष्यमा पानीको गुणस्तर बिग्रन सक्छ भन्ने लाग्छ
11. अतीतमा अहिले भन्दा बढी पानी थियो
12. धेरै मानिसहरू धाराको पानीमा जोडिए भने सबैका लागि पर्याप्त पानी हुनेछैन
13. मलाई आवश्यकता परेको बेला मेरो तरकारी बगैंचालाई सिँचाइ गर्न पर्याप्त पानी छैन
14. म कहिलेकाहीँ घरायसी पानीको लागि मेरा छिमेकीकहाँ जान्छु
15. धाराको पानीले मलाई मद्दत गर्दैन
16. मेरो गाउँका अन्य महिलाहरूको भन्दा मेरो पानी पहुँच कम छ
17. मलाई धाराको पानी जडान खर्च र योजना बारे राम्रो जानकारी छ
18. म उच्च पानी बिलबाट बच्न मात्र पिउने/खाना पकाउनेका लागि धाराको पानी प्रयोग गर्न चाहन्छु
19. म राम्रो पानीको गुणस्तरको लागि तिर्न इच्छुक छु
20. मेरो हात पम्पको नजिक जनावरहरूले दिसा गर्दा पानी प्रदूषण हुन्छ
21. म खाना खानुअघि साबुनले हात धुन्छु
22. सेप्टिक ट्याङ्कको फोहोर मेरो हात पम्पबाट टाढा गाड्नुपर्छ
23. पानी स्वच्छता बारे सिक्न समुदायका पानी बैठकहरू उपयोगी हुन्छन्
24. एकभन्दा बढी पानीको स्रोत हुनु महत्त्वपूर्ण छ
25. म नदी/नहरमा कपडा धुँदिन
26. म जबसुकै पानी पहुँच गर्न सक्नु महत्त्वपूर्ण छ
27. मेरो हात पम्पको स्थान/गहिराई पानीको गुणस्तरको आधारमा निर्णय गरिएको थियो
28. म गर्मीमा जाडोभन्दा बढी पानी प्रयोग गर्छु
29. म काँचै खाने तरकारी अनफिल्टर्ड पानीले धुन्छु
30. पिउने पानी शुद्ध बनाउन म बोतललाई घाममा राख्छु

Appendix E

Informed consent statement

E.1 Informed consent - English

You are invited to participate in a study on domestic water access, conducted by Nina Stokhof for her Master's thesis in Environmental Engineering at TU Delft. The study aims to understand women's domestic water use in Thakurbaba municipality, Bardia district, to identify challenges and help develop potential solutions. Participation will take about one hour and involves questions on domestic water access and (water) related possession; such as motorized water pumps or water filters and livestock, household composition and age.

Your responses will be kept confidential; personal data like name and address will not be collected. Data will be stored securely and referenced anonymously (e.g., "Village woman 1"). Only the researcher and her thesis committee will have access to the raw data. After the study concludes, all raw data will be deleted, and only the thesis will be published.
Participation is voluntary, and you can skip questions or withdraw at any point. If you wish, your responses can be removed after the study by contacting the researcher.

Kind regards, Nina Stokhof

E.2 Informed consent - Nepali

यह अध्ययनमा सहभागी हुन तपाईंलाई निमन्त्रणा गरिएको छ, जसलाई TU Delft को वातावरणीय इन्जिनियरिङ्को मास्टर्स थेसिसका लागि नीना स्टोखोफद्वारा गरिदैँछ। अध्ययनको उद्देश्य थाकुरबाबा नगरपालिकाको महिलाहरूको घरेलु पानी प्रयोगलाई बुझ्न, चुनौतीहरूको पहिचान गर्न र सम्भावित समाधानहरू विकास गर्न मद्दत गर्नु हो। सहभागी हुन लगभग एक घण्टा लाग्नेछ र यसमा घरेलु पानी पहुँच र (पानी) सम्बन्धी सम्पत्तिहरू जस्तै मोटरयुक्त पानी पम्प, पानी फिल्टर र पशुपालन, परिवारको संरचना र उमेर सम्बन्धी प्रश्नहरू समावेश छन्।

तपाईंको जवाफ गोप्य राखिनेछ; नाम र ठेगानाजस्ता व्यक्तिगत डेटा सङ्कलन गरिने छैन। डेटा सुरक्षित रूपमा भण्डारण गरिनेछ र अज्ञात रूपमा सन्दर्भ गरिनेछ (जस्तै, "गाउँकी महिला १")। कच्चा डेटा केवल अनुसन्धानकर्ता र उनको थेसिस समिति मात्रले हेर्न सक्नेछन्। अध्ययन सम्पन्न भएपछि, सबै कच्चा डेटा मेटिनेछ र केवल थेसिस मात्र प्रकाशित गरिनेछ।
सहभागिता स्वैच्छिक हो, र तपाईंले कुनै प्रश्नहरू छोड्न वा जुनसुकै समयमा सहभागीता अन्त्य गर्न सक्नुहुन्छ। तपाईंको इच्छाअनुसार, अध्ययनपछि अनुसन्धानकर्तासँग सम्पर्क गरेर तपाईंको जवाफहरू मेटाउन अनुरोध गर्न सक्नुहुन्छ।

अनुसन्धानका बारेमा, अनुसन्धानका परिणामहरू, वा अन्य कुनै प्रश्नहरू भएमा n.stokhof@student.tudelft.nl मा वा WhatsApp मा +31624907342 मावा मेरो नेपाली नम्बर 9706840399 मामा सम्पर्क गर्न नहिचकिचाउनुहोस्।

शुभेच्छा सहित, नीना स्टोखोफ

Appendix F

Q set survey

Participant number:

Age: 15-17 18-22 23-27 28-32 33-37 38-42 43-47 48-52 53-57 58-62 >63

Village: Patarbojhi Hattisar Bhurigaon Karmala

Sources: handpump tap water canal/river other:___________

Marital status: married unmarried widow other:___________

Husband at home or abroad? home abroad other:___________

Children: 0 1-2 3-5 >5

Household composition: nuclear family composite family living with in-laws

Number of people in household? (incl. children) _____

Cooking fuel: wood Alpi gas Gobar gas other:____________

Type of house: concrete traditional two-storeys other:____________

Water related possession: motorized pump bio sand filter other:____________

Septic tank type: ____________________

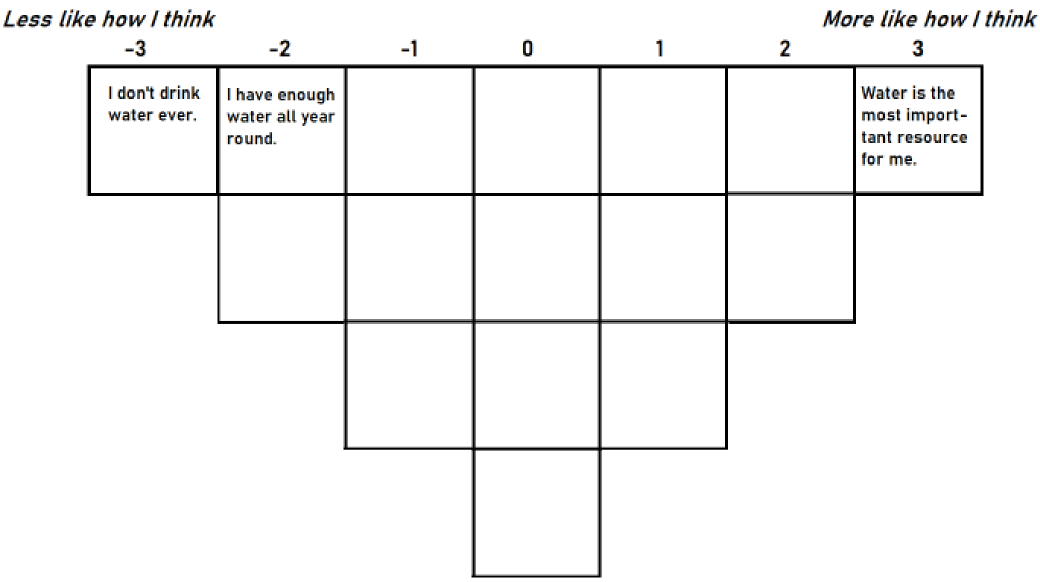
Waste buried: near home far away on field estimation from pump: ____ m

Livestock: buffalo ____ goat ____ chicken ____ other:____________ ____

Appendix G

Q sort instructions

Please arrange the statements in your preferred order of agreement varying from most disagreeable (on the left) to most agreeable (on the right). The picture below is an example of three cards put inside of the boxes.



Which statement cards regarding water access are most applicable to you and what do you value most, that is what you should take in mind. There are no right or wrong answers!

It is easier if you start with the statements that you feel the most strongly about, starting with those you agree with and then going to those that you don't agree with.

Appendix H

Follow up questions

H.1 Follow up questions

Q1 How was it to fill in the Q sort?

Q2 Is there any topic you felt was missing?

Q3 Could you explain the placement of this item?

Q4a Do you have a problem with iron in the water?

Q4b How do you deal with this? (For instance, do you leave water overnight in a bucket?)

Q5 Is the quality from your hand pump good for drinking/cooking?

Q6 How long have you used a water filter for?

Q7a Do you have (seasonal) water problems?

Q7b How do you go about these problems?

Q8a Is your hand pump sometimes dry?

Q8b What do you do then?

Q8c What do you think the reason for the problem is?

Q9 How deep is your water pump?

Q10 How long have you had the water pump / tap water connection?

Q11a Did you ever change the location of your hand pump?

Q11b Why was that?

Q12 Do people (from the government) come check water quality?

Q13 Would you like to be involved in government or community decisions about drinking water?

Q14a Do you ever go to water meetings?

Q14b What kind of things are discussed?

Q15 Would you be able to pay for a tap water connection?

Q16 What do you mostly use water for?

Q17 Is there anything you would like to see improved in your water situation?

Explanatory note

The follow-up questions and the total number of questions asked varied based on several factors: the participant's time availability following the Q sort, the household situation as assessed through the initial survey, and other contextual elements. For participants from the same village with similar pump depths, questions regarding iron in the water were not repeated to every individual.

Appendix I

Raw Q sort data

Table I.1 shows the raw data matrix of the conducted Q sorts. Table I.2 presents the correlation matrix.

Code	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30
P1	-4	-1	0	4	-3	-2	-1	1	1	1	2	0	-1	2	-2	0	0	0	0	3	2	2	-1	1	-2	1	-2	3	-1	-3
P2	-4	-2	2	1	-1	0	-1	0	-2	-1	3	-1	-3	1	-3	0	-1	0	1	1	3	4	-2	2	-2	2	0	2	1	0
P3	-4	0	-1	2	1	0	-2	0	1	0	1	-2	-2	2	-3	-1	-1	0	2	-2	4	1	1	3	-3	0	2	3	-1	-1
P4	0	-1	-4	0	1	0	-1	-3	0	2	1	-2	-1	2	-2	1	-1	0	3	-3	-2	4	1	3	-2	2	2	0	1	-1
P5	2	-1	0	0	1	-3	-2	-2	2	-4	2	-1	-1	-2	-3	-1	0	0	3	1	3	4	0	1	1	-1	0	2	1	-2
P6	-1	-4	-1	3	2	0	-2	1	1	0	2	0	-1	2	-3	-2	-2	0	1	1	1	3	-1	0	2	-3	0	4	-1	-2
P7	-4	-3	-1	2	2	-1	-1	-1	0	0	2	0	1	2	-2	1	-2	0	1	-1	3	3	0	4	-3	-2	0	1	1	-2
H1	-4	-3	-1	1	1	1	0	-2	0	0	-1	0	-2	-1	-3	0	-2	0	2	-1	4	3	2	3	1	2	1	2	-1	-2
H2	-4	-3	-1	2	-1	0	0	-1	1	1	0	0	-1	-2	0	-3	-2	0	2	3	4	3	1	1	2	1	-1	2	-2	-2
H3	-4	-2	-1	1	-1	0	0	0	-2	1	-1	0	-3	3	-2	3	-1	0	2	1	4	2	0	1	-3	-2	2	1	2	-1
H4	-4	-1	-1	-1	-2	0	0	0	0	2	0	-1	-2	-2	1	-3	0	-2	3	2	3	4	2	2	1	1	1	1	-3	-1
H5	-1	2	-2	-1	-2	0	0	0	1	3	1	-1	-1	-4	0	-3	-2	0	0	-2	4	3	1	2	2	2	1	1	-1	-3
H6	-4	-3	-2	1	1	0	0	-1	-1	-1	0	0	1	4	-3	1	-2	0	-1	1	2	3	0	2	3	-1	-2	2	2	-2
B1	-4	-2	1	-1	0	-1	-2	1	0	0	-3	-2	2	3	-2	-1	-1	0	4	-1	1	2	0	3	1	1	0	2	2	-3
B2	-4	-3	0	-1	1	0	0	-2	-2	-1	1	0	-2	1	-1	-1	-2	0	3	1	1	2	0	3	2	4	2	2	-1	-3
B3	-1	-1	4	2	-1	1	-2	-2	2	2	0	-3	-2	-1	-4	-2	1	-3	1	0	3	-1	1	3	0	1	0	0	2	0
B4	-4	-2	1	1	-2	2	0	-1	-2	3	-3	0	-1	-2	-1	-1	0	1	2	1	4	1	0	3	2	-1	0	2	-3	0
B5	-4	-1	0	0	1	0	0	-1	0	2	1	-2	1	-1	1	-3	-3	-2	2	-2	3	2	-2	4	-1	2	0	3	1	-1
B6	-4	-1	0	-3	1	2	0	-1	-2	2	0	-2	-1	-3	0	-2	0	-1	2	-1	4	3	3	1	1	2	0	1	1	-2
B7	-4	-2	0	0	2	1	0	-2	0	-1	1	-1	-3	3	-1	-3	-1	3	2	-2	4	2	0	1	0	1	-1	1	2	-2
BB2	-4	-2	2	1	-1	2	2	0	0	0	-1	0	-1	-2	-1	-3	3	-3	3	-1	4	1	1	1	0	2	-2	1	0	-2
BB3	-4	-3	-2	1	-1	2	-2	0	0	3	0	-1	-3	2	-1	-1	-2	0	2	-2	4	1	2	1	3	1	0	1	0	-1
BB4	-4	-1	-2	3	1	-1	0	-3	2	1	1	2	0	-1	-1	0	1	-3	2	-2	4	1	0	2	0	-2	0	3	-1	-2
BB5	1	1	2	3	-2	-1	-1	-2	0	-1	0	-1	-2	-3	-2	2	1	0	0	-4	4	1	0	2	2	0	-1	3	1	-3
BB6	-4	-2	-1	-3	1	0	0	3	1	-1	0	-2	-2	0	-2	-1	-1	0	3	-3	4	1	1	2	2	1	0	2	2	-1
K1	0	-3	-1	0	-2	-1	0	3	1	0	0	0	-2	-4	-2	-3	-1	-2	4	-1	1	3	1	2	1	1	2	2	2	-1
K2	-2	1	1	-2	0	-1	-1	2	0	-2	0	-3	0	-3	-1	-1	3	-4	3	0	4	2	1	2	-2	1	1	2	-1	0
K3	-4	-2	-2	-2	-1	0	1	-2	-1	0	0	2	-3	-3	1	-1	0	0	0	-1	4	3	2	1	1	2	2	3	1	-1

Figure I.1: Q sort results

Code	P1	P2	P3	P4	P5	P6	P7	H1	H2	H3	H4	H5	H6	B1	B2	B3	B4	B5	B6	B7	BB2	BB3	BB4	BB5	BB6	K1	K2	K3
P1	100	65	54	9	25	52	54	39	58	50	39	19	47	35	35	28	34	34	8	34	35	36	45	25	16	19	19	19
P2	65	100	63	29	40	45	62	59	47	64	42	20	48	42	62	42	37	53	40	61	42	44	31	30	45	35	39	43
P3	54	63	100	47	35	49	73	69	43	63	43	35	38	52	48	46	39	59	39	64	37	60	61	34	58	33	47	36
P4	9	29	47	100	24	20	49	45	7	35	21	24	26	37	43	13	-1	37	27	35	-3	36	25	8	25	28	6	22
P5	25	40	35	24	100	50	37	42	39	15	26	27	28	28	34	29	5	22	23	35	19	10	37	49	35	50	44	27
P6	52	45	49	20	50	100	56	47	55	35	26	12	63	38	40	16	28	30	10	45	14	48	46	16	34	36	2	15
P7	54	62	73	49	37	56	100	63	41	67	25	14	67	54	45	25	28	58	29	58	24	44	64	22	42	21	21	29
H1	39	59	69	45	42	47	63	100	74	55	63	52	57	55	77	42	65	59	68	65	57	74	63	43	65	51	35	71
H2	58	47	43	7	39	55	41	74	100	32	81	57	45	38	62	31	70	55	58	49	59	64	55	22	42	50	29	61
H3	50	64	63	35	15	35	67	55	32	100	31	3	52	44	39	22	42	28	29	49	25	52	41	16	40	20	20	39
H4	39	42	43	21	26	26	25	63	81	31	100	66	17	35	58	30	67	55	72	33	61	57	45	10	45	57	57	65
H5	19	20	35	24	27	12	14	52	57	3	66	100	5	18	35	25	43	56	65	28	37	49	36	43	45	54	35	61
H6	47	48	38	26	28	63	67	57	45	52	17	5	100	58	51	10	30	34	25	55	18	53	41	16	44	9	-6	29
B1	35	42	52	37	28	38	54	55	38	44	35	18	58	100	58	33	38	56	44	54	40	51	29	17	65	40	35	22
B2	35	62	48	43	34	40	45	77	62	39	58	35	51	58	100	22	45	57	57	62	42	56	35	15	54	41	25	60
B3	28	42	46	13	29	16	25	42	31	22	30	25	10	33	22	100	38	39	37	30	55	40	34	46	31	35	42	13
B4	34	37	39	-1	5	28	28	65	70	42	67	43	30	38	45	38	100	44	55	33	57	60	45	31	35	31	28	50
B5	34	53	59	37	22	30	58	59	55	28	55	56	34	56	57	39	44	100	62	54	50	49	54	24	55	45	44	48
B6	8	40	39	27	23	10	29	68	58	29	72	65	25	44	57	37	55	62	100	54	66	60	35	25	65	47	55	74
B7	34	61	64	35	35	45	58	65	49	49	33	28	55	54	62	30	33	54	54	100	45	65	38	25	65	22	13	49
BB2	35	42	37	-3	19	14	24	57	59	25	61	37	18	40	42	55	57	50	66	45	100	45	53	36	51	48	59	51
BB3	36	44	60	36	10	48	44	74	64	52	57	49	53	51	56	40	60	49	60	65	45	100	46	26	66	40	12	54
BB4	45	31	61	25	37	46	64	63	55	41	45	36	41	29	35	34	45	54	35	38	53	46	100	46	35	30	35	49
BB5	25	30	34	8	49	16	22	43	22	16	10	43	16	17	15	46	31	24	25	25	36	26	46	100	28	30	29	33
BB6	16	45	58	25	35	34	42	65	42	40	45	45	44	65	54	31	35	55	65	65	51	66	35	28	100	60	51	55
K1	19	35	33	28	50	36	21	51	50	20	57	54	9	40	41	35	31	45	47	22	48	40	30	30	60	100	50	51
K2	19	39	47	6	44	2	21	35	29	20	57	35	-6	35	25	42	28	44	55	13	59	12	35	29	51	50	100	35
K3	19	43	36	22	27	15	29	71	61	39	65	61	29	22	60	13	50	48	74	49	51	54	49	33	55	51	35	100

Figure I.2: Correlation matrix (generated by KADE)

Nm	Participant	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
1	P1	0,5563	0,3519	0,219	**0,4853**	-0,0338	-0,1729	-0,2232	-0,0194
2	P2	0,7207	0,2675	0,1535	0,0329	-0,1747	-0,2074	-0,1206	0,308
3	P3	0,7722	0,2614	0,195	-0,1144	-0,208	0,133	-0,2072	-0,0987
4	P4	0,4138	0,2785	-0,1033	**-0,5797**	0,1023	0,2387	-0,3604	-0,1892
5	P5	0,4827	0,05	**0,5573**	-0,1964	0,4958	-0,1603	0,0962	0,1859
6	P6	0,553	0,4733	0,1141	0,2028	0,4209	-0,1893	0,1308	-0,2128
7	P7	0,6884	**0,5526**	0,1003	-0,065	-0,0522	0,0934	-0,2083	-0,0209
8	H1	**0,9085**	0,0133	-0,1146	-0,0128	0,0774	0,1579	0,039	0,0705
9	H2	**0,7879**	-0,151	-0,1465	0,4211	0,2647	-0,1496	-0,0219	-0,0753
10	H3	0,6031	0,4316	-0,0657	0,0606	-0,3062	0,0564	-0,184	0,2905
11	H4	0,7355	-0,4296	-0,185	0,1822	0,0694	-0,2101	-0,287	-0,067
12	H5	0,5812	-0,5233	-0,063	-0,0488	0,2999	0,2503	-0,1308	-0,1526
13	H6	0,5818	**0,5763**	-0,1889	0,0968	0,1296	-0,0344	0,2746	0,0487
14	B1	0,6628	0,2173	-0,0603	-0,2576	-0,196	-0,2751	0,2419	-0,2598
15	B2	0,7535	0,0697	-0,2942	-0,1241	0,1014	-0,184	-0,0009	0,1228
16	B3	0,5052	-0,1626	0,4471	0,0496	-0,3726	0,1072	0,2154	-0,264
17	B4	0,655	-0,2308	-0,203	0,4595	-0,1585	0,0863	0,0701	-0,0744
18	B5	0,7477	-0,0914	-0,0437	-0,1556	-0,1052	0,0134	-0,1687	-0,2671
19	B6	0,7384	-0,4486	-0,2486	-0,1774	-0,1039	0,0337	0,0527	0,1011
20	B7	0,7297	0,2619	-0,1698	-0,1689	-0,0721	0,0741	0,2613	0,1556
21	BB2	0,673	-0,4042	0,1124	0,203	-0,3062	-0,0859	0,1737	0,0349
22	BB3	0,7752	0,0493	-0,3309	0,0594	-0,0364	0,1967	0,1992	-0,191
23	BB4	0,6783	0,0664	0,229	0,233	0,0907	0,3466	-0,1654	-0,0867
24	BB5	0,4357	-0,1409	**0,5473**	0,0497	0,107	0,4908	0,2813	0,1594
25	BB6	0,744	-0,0942	-0,0721	-0,3702	-0,0722	-0,126	0,3092	0,0365
26	K1	0,6086	-0,3516	0,1853	-0,2171	0,283	-0,2633	-0,0003	-0,1174
27	K2	0,5135	-0,4427	0,4309	-0,1801	-0,2525	-0,2992	-0,199	0,1064
28	K3	0,7002	-0,3338	-0,2631	-0,015	0,1751	0,1668	-0,0889	0,4177

Figure I.3: Unrotated factor matrix. Note: significant loadings at 0.01 level are highlighted yellow and two highest factor loadings (absolute value) are marked bold.

Nm	Q-sort	Factor 1	Factor 2	Factor 3
1	P1	0,0664	0,6062	0,3308
2	P2	0,2559	0,6512	0,3535
3	P3	0,276	0,676	0,4118
4	P4	0,155	0,4852	0,0035
5	P5	0,0516	0,3004	0,6732
6	P6	0,0368	0,7057	0,2085
7	P7	0,0858	0,8538	0,2302
8	H1	0,6511	0,5972	0,2413
9	H2	0,6828	0,3969	0,2031
10	H3	0,1735	0,72	0,0756
11	H4	0,8319	0,1529	0,2104
12	H5	0,7318	-0,027	0,2817
13	H6	0,1257	0,8276	-0,0753
14	B1	0,34	0,5931	0,1508
15	B2	0,5912	0,5563	0,0084
16	B3	0,2423	0,1603	0,6302
17	B4	0,6663	0,2557	0,1193
18	B5	0,5753	0,4088	0,2667
19	B6	0,8729	0,1452	0,1586
20	B7	0,4057	0,6787	0,0682
21	BB2	0,6455	0,1087	0,4477
22	BB3	0,634	0,5575	-0,0117
23	BB4	0,3155	0,4638	0,4498
24	BB5	0,1392	0,1247	0,6887
25	BB6	0,5869	0,4066	0,2405
26	K1	0,539	0,1022	0,4768
27	K2	0,4234	-0,048	0,681
28	K3	0,7846	0,2103	0,1056
% Explained Variance		25	24	12

Figure I.4: Rotated factor matrix. Flagged Q sorts are highlighted green.

Appendix J

Factor characteristics

This Appendix presents the data used for the three-factor interpretation of each of the factors; the Q sorts loading to the factor, the factor array (called composite Q sort in KADE) and the crib sheet. Additionally, the distinguishing statements for all factors are grouped together in section J.4 and all factor z-scores are presented in section J.5.

J.1 F1 factor characteristics

-4	-3	-2	-1	0	1	2	3	4
1. I do not filter water before I drink it	14. I sometimes go to my neighbours for household water	4. During certain periods of the year (such as during the monsoon)	5. During certain periods of the year (such as during the summer)	11. In the past there was more water than there is now	10. I think that in the future the quality of the water may be	24. It is important to have more than one source of water	22. Septic tank waste needs to be buried far from my handpump	21. I wash my hands with soap before I take a meal
	16. I have less access to water than other women in my village	2. I use the same water for my vegetable garden as I do for drinking	12. If too many people are connected to tap water there will not be	15. Tap water would not be helpful for me	25. I do not do my laundry in the river/canal	28. I use more water in the summer than in the winter	19. I am willing to pay for better water quality	
		13. I don't have enough water to irrigate my vegetable plot	3. I treat my drinking water by boiling it	20. Animals defecating near my handpump cause pollution of the water	6. Tap water cannot be drunk without filtering it before	26. It is important to me that I can have access to water whenever I want		
		30. To treat drinking water I put a bottle in the sun	17. I am well informed about tap water connection costs and	29. I wash vegetables that I eat raw with unfiltered water	27. The location/depth of my handpump was decided based on the	23. Community water meetings are useful to learn about water hygiene		
			18. I only want to use tap water for rinking/cooking to avoid a high	9. I think that in the future there may not be enough water	7. I do not trust the goverment to provide safe tap water			
				8. It is important for me that my water is cold				

Legend
- Distinguishing statement at P< 0.05
- Distinguishing statement at P< 0.01
- ► z-Score is higher than in all other factors
- ◄ z-Score is lower than in all other factors
- Consensus Statements

(a) F1 factor array for three factor analysis

Q sort	Weight	Loading
B6	10.0000	0.8729
H4	7.3673	0.8319
K3	5.5663	0.7846
H5	4.2967	0.7318
H2	3.4885	0.6828
B4	3.2679	0.6663
H1	3.0823	0.6511
BB2	3.0178	0.6455
BB3	2.8911	0.6340
B2	2.4786	0.5912
BB6	2.4415	0.5869
B5	2.3451	0.5753
K1	2.0718	0.5390

(b) F1 Q sort weights and loadings for three factor analysis.[a]

[a] Turquoise cell color indicates tap water access.

Figure J.1: F1 factor array and Q sort weights and loadings for three factor analysis

#	Statement	F1	F2	F3
Highest ranked statements				
S21	I wash my hands with soap before I take a meal	4	3	4
S22	Septic tank waste needs to be buried far from my hand pump	3	4	2
S19	I am willing to pay for better water quality	3	2	2
Statements ranked higher in F1 array than in other factor arrays				
S26	It is important to me that I can have access to water whenever I want	2	-1	0
S23	Community water meetings are useful to learn about water hygiene	2	0	1
S10	I think that in the future the quality of the water may be worse	1	0	-2
S25	I do not do my laundry in the river/canal	1	-1	0
S06	Tap water cannot be drunk without filtering it before	1	0	-1
S27	The location/depth of my hand pump was decided based on the water quality	1	0	0
S07	I do not trust the government to provide safe tap water	1	-2	-2
S15	Tap water would not be helpful for me	0	-3	-4
S20	Animals defecating near my hand pump cause pollution of the water	0	0	-1
S08	It is important for me that my water is cold	0	-1	-1
Statements ranked lower in F1 array than in other factor arrays				
S24	It's important to have more than one source of water	2	2	3
S11	In the past there was more water than there is now	0	1	1
S29	I wash vegetables that I eat raw with unfiltered water	0	1	1
S09	I think that in the future there may not be enough water	0	0	1
S05	During certain periods of the year (such as during the summer) there is less water available	-1	1	-1
S04	During certain periods of the year (such as during the monsoon) the quality of my water is worse	-2	2	1
S13	I don't have enough water to irrigate my vegetable plot when needed	-2	-1	-1
Lowest ranked statements				
S14	I sometimes go to my neighbours for household water	-3	3	-3
S16	I have less access to water than other women in my village	-3	1	0
S01	I do not filter water before I drink it	-4	-4	0

Table J.1: Crib sheet for F1 for three factor analysis

J.2 F2 factor characteristics

-4	-3	-2	-1	0	1	2	3	4
1. I do not filter water before I drink it	2. I use the same water for my vegetable garden as I do for drinking	3. I treat my drinking water by boiling it	8. It is important for me that my water is cold	10. I think that in the future the quality of the water may be	29. I wash vegetables that I eat raw with unfiltered water	24. It is important to have more than one source of water	14. I sometimes go to my neighbours for household water	22. Septic tank waste needs to be buried far from my handpump
	15. Tap water would not be helpful for me	7. I do not trust the goverment to provide safe tap water	12. If too many people are connected to tap water there will not be	20. Animals defecating near my handpump cause pollution of the water	11. In the past there was more water than there is now	28. I use more water in the summer than in the winter	21. I wash my hands with soap before I take a meal	
		17. I am well informed about tap water connection costs and	13. I don't have enough water to irrigate my vegetable plot	27. The location/depth of my handpump was decided based on the	5. During certain periods of the year (such as during the summer)	4. During certain periods of the year (such as during the monsoon)		
		30. To treat drinking water I put a bottle in the sun	26. It is important to me that I can have access to water whenever I want	23. Community water meetings are useful to learn about water hygiene	18. I only want to use tap water for rinking/cooking to avoid a high	19. I am willing to pay for better water quality		
			25. I do not do my laundry in the river/canal	9. I think that in the future there may not be enough water	16. I have less access to water than other women in my village			
				6. Tap water cannot be drunk without filtering it before				

Legend
- Distinguishing statement at P< 0.05
- Distinguishing statement at P< 0.01
- ► z-Score is higher than in all other factors
- ◄ z-Score is lower than in all other factors
- Consensus Statements

(a) F2 factor array for three factor analysis.[a]

[a] Turquoise cell color indicates tap water access

Q sort	Weight	Loading
P7	8.59095	0.8538
H6	7.16312	0.8276
H3	4.07709	0.7200
P6	3.83378	0.7057
B7	3.43158	0.6787
P3	3.39496	0.6760
P2	3.08347	0.6512
P1	2.61364	0.6062
B1	2.49517	0.5931
P4	1.73063	0.4852

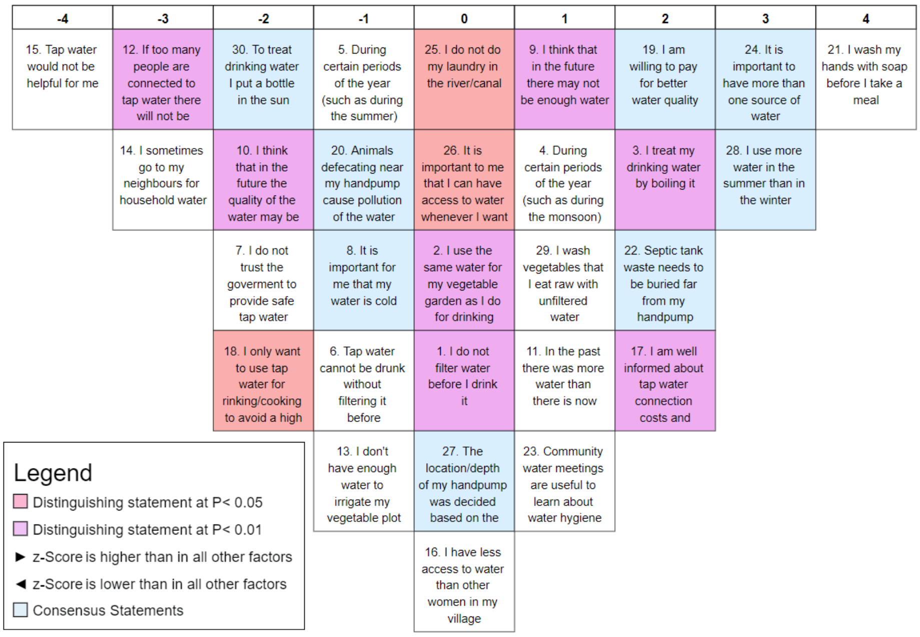
(b) F2 Q sort weights and loadings for three factor analysis

Figure J.2: F2 factor array and Q sort weights and loadings for three factor analysis

#	Statement	F2	F1	F3
Highest ranked statements				
S22	Septic tank waste needs to be buried far from my hand pump	4	3	2
S14	I sometimes go to my neighbors for household water	3	-3	-3
S21	I wash my hands with soap before I take a meal	3	4	4
Statements ranked higher in F2 array than in other factor arrays				
S04	During certain periods of the year (such as during the monsoon) the quality of my water is worse	2	-2	1
S29	I wash vegetables that I eat raw with unfiltered water	1	0	1
S11	In the past there was more water than there is now	1	0	1
S05	During certain periods of the year (such as during the summer) there is less water available	1	-1	-1
S18	I only want to use tap water for drinking/cooking to avoid a high water bill	1	-1	-2
S16	I have less access to water than other women in my village	1	-3	0
S20	Animals defecating near my hand pump cause pollution of the water	0	0	-1
S08	It is important for me that my water is cold	-1	0	-1
S12	If too many people are connected to tap water there will not be enough water for everyone	-1	-1	-3
S13	I don't have enough water to irrigate my vegetable plot when needed	-1	-2	-1
Statements ranked lower in F2 array than in other factor arrays				
S19	I am willing to pay for better water quality	2	3	2
S24	It's important to have more than one source of water	2	2	3
S27	The location/depth of my hand pump was decided based on the water quality	0	1	0
S23	Community water meetings are useful to learn about water hygiene	0	2	1
S09	I think that in the future there may not be enough water	0	0	1
S08	It is important for me that my water is cold	-1	0	-1
S26	It is important to me that I can have access to water whenever I want	-1	2	0
S25	I do not do my laundry in the river/canal	-1	1	0
S03	I treat my drinking water by boiling it	-2	-1	2
S07	I do not trust the government to provide safe tap water	-2	1	-2
S17	I am well informed about tap water connection costs and planning	-2	-1	2
Lowest ranked statements				
S15	Tap water would not be helpful for me	-3	0	-4
S02	I use the same water for my vegetable garden as I do for drinking	-3	-2	0
S01	I do not filter water before I drink it	-4	-4	0

Table J.2: Crib sheet for F2 for three factor analysis

J.3 F3 factor characteristics



(a) F3 factor array for three factor analysis

Q sort	Weight	Loading
BB5	3.57276	0.6887
K2	3.4633	0.6810
P5	3.35751	0.6732
B3	2.85084	0.6302

(b) F3 Q sort weights and loadings for three factor analysis.[a]

[a]Turquoise cell color indicates tap water access.

Figure J.3: F3 Factor array and Q sort weights and loadings for three factor analysis

#	Statement	F3	F1	F2
Highest ranked statements				
S21	I wash my hands with soap before I take a meal	4	4	3
S24	It is important to have more than one source of water	3	2	2
S28	I use more water in the summer than in the winter	3	2	2
Statements ranked higher in F3 array than in other factor arrays				
S26	It is important to me that I can have access to water whenever I want	2	-1	0
S24	It is important to have more than one source of water	3	2	2
S03	I treat my drinking water by boiling it	2	-1	-2
S17	I am well informed about tap water connection costs and planning	2	-1	-2
S09	I think that in the future there may not be enough water	1	0	0
S29	I wash vegetables that I eat raw with unfiltered water	1	0	1
S11	In the past there was more water than there is now	1	0	1
S02	I use the same water for my vegetable garden as I do for drinking	0	-2	-3
S01	I do not filter water before I drink it	0	-4	-4
S13	I don't have enough water to irrigate my vegetable plot when needed	-1	-2	-1
Statements ranked lower in F3 array than in other factor arrays				
S22	Septic tank waste needs to be buried far from my hand pump	2	3	4
S19	I am willing to pay for better water quality	2	3	2
S27	The location/depth of my hand pump was decided based on the water quality	0	1	0
S05	During certain periods of the year (such as during the summer) there is less water available	-1	1	-1
S20	Animals defecating near my hand pump cause pollution of the water	-1	1	1
S08	It is important for me that my water is cold	-1	0	-1
S06	Tap water cannot be drunk without filtering it before	-1	1	-1
S10	I think that in the future the quality of the water may be worse	-2	1	0
S07	I do not trust the government to provide safe tap water	-2	1	-2
S18	I only want to use tap water for drinking/cooking to avoid a high water bill	-2	1	-1
Lowest ranked statements				
S12	If too many people are connected to tap water there will not be enough water for everyone	-3	-1	-1
S14	I sometimes go to my neighbors for household water	-3	-3	3
S15	Tap water would not be helpful for me	-4	0	-3

Table J.3: Crib sheet for F3 for three factor analysis

J.4 Distinguishing statements for all factors.

Distinguishing Statements by Factor			
No.	**Statement**	**z-score**	**Array score**
	Factor 1		
S26*	It is important to me that I can have access to water whenever I want	1	+2
S23	Community water meetings are useful to learn about water hygiene	0.97	+2
S10*	I think that in the future the quality of the water may be worse	0.85	+1
S25	I do not do my laundry in the river/canal	0.82	+1
S06*	Tap water cannot be drunk without filtering it before	0.48	+1
S07*	I do not trust the government to provide safe tap water	0.07	+1
S15*	Tap water would not be helpful for me	-0.18	0
S29*	I wash vegetables that I eat raw with unfiltered water	-0.27	0
S17	I am well informed about tap water connection costs and planning	-0.43	-1
S18	I only want to use tap water for drinking/cooking to avoid a high water bill	-0.48	-1
S04*	During certain periods of the year (such as during the monsoon) the quality of my water is worse	-0.53	-2
S02	I use the same water for my vegetable garden as I do for drinking	-1.00	-2
S16*	I have less access to water than other women in my village	-1.28	-3
	Factor 2		
S14*	I sometimes go to my neighbors for household water	1.68	+3
S21*	I wash my hands with soap before I take a meal	1.67	+3
S05*	During certain periods of the year (such as during the summer) there is less water available	0.48	+1
S18*	I only want to use tap water for drinking/cooking to avoid a high water bill	0.17	+1
S10*	I think that in the future the quality of the water may be worse	-0.06	0
S26	It is important to me that I can have access to water whenever I want	-0.43	-1
S25	I do not do my laundry in the river/canal	-0.52	-1
S17	I am well informed about tap water connection costs and planning	-0.95	-2
S02	I use the same water for my vegetable garden as I do for drinking	-1.53	-3
	Factor 3		
S03*	I treat my drinking water by boiling it	1.15	+2
S22*	Septic tank waste needs to be buried far from my hand pump	1.1	+2
S17*	I am well informed about tap water connection costs and planning	0.88	+2
S09*	I think that in the future there may not be enough water	0.65	+1
S25	I do not do my laundry in the river/canal	0.19	0
S26	It is important to me that I can have access to water whenever I want	0.15	0
S02*	I use the same water for my vegetable garden as I do for drinking	0.04	0
S01*	I do not filter water before I drink it	0.03	0
S10*	I think that in the future the quality of the water may be worse	-0.95	-2
S18	I only want to use tap water for drinking/cooking to avoid a high water bill	-1.17	-2
S12*	If too many people are connected to tap water there will not be enough water for everyone	-1.35	-3

Table J.4: Distinguishing statements by factor *Note:* Statements marked with an asterisk (*) are significant at $p < 0.01$, those without are significant at $p < 0.05$.

J.5 Three-factor rotation z-scores

No.	F1 z-score	F1 rank	F2 z-score	F2 rank	F3 z-score	F3 rank
S01	-2.31	30	-2.36	30	0.03	16
S02	-1.00	25	-1.53	28	0.04	15
S03	-0.43	21	-0.54	24	1.15	5
S04	-0.53	24	0.95	6	0.50	9
S05	-0.35	19	0.48	10	-0.35	19
S06	0.48	10	-0.21	18	-0.75	22
S07	0.07	12	-0.58	25	-1.02	26
S08	-0.34	18	-0.31	19	-0.66	21
S09	-0.31	17	-0.19	17	0.65	8
S10	0.85	8	-0.06	13	-0.95	25
S11	-0.08	13	0.60	9	0.35	11
S12	-0.41	20	-0.36	20	-1.35	28
S13	-1.01	26	-0.43	22	-0.85	23
S14	-1.27	28	1.68	2	-1.60	29
S15	-0.18	14	-1.56	29	-1.68	30
S16	-1.28	29	0.10	12	-0.28	18
S17	-0.43	22	-0.95	26	0.88	7
S18	-0.48	23	0.17	11	-1.17	27
S19	1.28	3	0.75	7	1.22	4
S20	-0.24	15	-0.07	14	-0.57	20
S21	2.29	1	1.67	3	2.44	1
S22	1.68	2	1.76	1	1.10	6
S23	0.97	7	-0.12	16	0.33	12
S24	1.15	4	1.45	4	1.36	2
S25	0.82	9	-0.52	23	0.19	13
S26	1.00	6	-0.43	21	0.15	14
S27	0.31	11	-0.08	15	-0.01	17
S28	1.05	5	1.24	5	1.27	3
S29	-0.27	16	0.63	8	0.48	10
S30	-1.01	27	-1.16	27	-0.91	24

Table J.5: Factor z-scores and rankings

Appendix K

Comparison PCA with CFA

Applying either centroid factor analysis (CFA) or principal component analysis (PCA) to the data leads to similar results in terms of the constructed factors and participant loading as well as distinguishing statements. In order to give an example of this, one comparison between both methods is done in detail, going into general factor characteristics, participant loadings, and distinguishing statements.

K.1 General factor characteristics

Figure K.1 gives an overview of the correlations between factor loading values, factor characteristics and standard errors for differences in factor z-scores. As can be expected, PCA leads to generally lower correlations between factors. This is because PCA, unlike CFA, is designed to minimize correlations between factors whilst maximizing variance. In Table K.1 it can be seen that 26 participants load on three factors in CFA versus 21 on four factors in PCA. The average reliability coefficient has a fixed value of 0.8 for all factors and is consistent across methods. This indicates that 80 % of the variance of the factors is due to Q-sorts loading onto it as opposed to measurement error. The composite reliability (CR) is high for both CFA and PCA, with all values scoring $CR > 0.9$. This implies that for both CFA and PCA the factors are well represented by the Q-sorts that load on them. With regards to errors, PCA reports higher standard errors (SE) on average for the differences in Factor Z Scores. This is logical considering that there are fewer participants loading on the factors in PCA, which increases the SE according to equation K.1.

$$SE = \frac{\sigma}{\sqrt{n}} \tag{K.1}$$

As the sample size n decreased, the SE increases because fewer participants contribute to the estimation, thus making it less precise. Nevertheless, the differences in SE between PCA and CFA are not significant.

K.2 Scree plots

Figure K.2 presents the scree plots for both methods. For the CFA scree plot F3 and F5 (visible as dips) are abnormalities. They are both factors with an eigenvalue close to zero, with zero participants loading on it, followed by a factor with a greater eigenvalue.

K.3 Participant loadings

Table K.1 on page 95 gives an overview of the participants loading in order of magnitude on 4 factors with varimax rotation and auto-flagging at $P < 0.05$.
A comparison of both methods (see Table K.1) shows that using PCA results in the same participants flagged for F1 and F2, albeit in a different order of loading magnitude and with additional participants flagged on using CFA. Notably the participant flagged for F4-CFA are the same as for F3-PCA. Double (or triple) loading accounts for some (N = 5) of the participants not being flagged in PCA that are flagged using CFA (these are highlighted yellow). These account for the total difference in participants being auto- flagged between CFA and PCA. There are no participants flagged in PCA that are omitted in CFA. Three participants that load on F1 and F2 respectively in CFA constitute the loadings flagged on F4-PCA(in bold), a factor which does not exist in CFA. Two participants (out of 28) are not flagged in CFA due to double loading; H1-CFA (F1/F2)[1] and BB4-CFA (F4/F2). These participants also load double on the same respective factors in PCA.

[1]The shorthand notation used is: participant - method ($Factor_{highestload}$ / $Factor_{secondhighestload}$ / $Factor_{thirdhighestload}$).

Factor	Participants loading CFA	No.	Participants loading PCA	No.
F1	B6 H5 H4 K3 H2 BB3 BB2 B2 K1 B4 B5 **BB6**	12	H4 B6 H2 K3 B4 H5 BB2 BB3	8
F2	P7 H6 H3 P3 B7 P2 P6 **B1** P1 **P4**	10	P1 H6 P7 P6 H3 P2	6
F3		0	K2 P5 BB5 B3	4
F4	K2 BB5 P3 P5	4	**P4 BB6 B1**	3
F1-4		26		21

Table K.1: Participant loading using CFA or PCA

K.4 A deeper look into double loadings

Table K.2a and Table K.2b presents the loadings of the 5 participants who in CFA are flagged for factor F1 and F2 respectively but are not flagged for these or other factors in PCA. For comparison all the loadings are given.[2]

PCA Multiple Loading	Loading values (PCA)				Loading values (CFA)			Ranking
	F1	**F2**	**F3**	**F4**	**F1**	**F2**	**F4**	
B2 (F1/F4/F2)	0.5292	0.4036	0.0229	0.4807	0.5892	0.5524	0.0097	9/12
K1 (F3/F1)	0.4638	0.0031	**0.5153**	0.3079	**0.5535**	0.1119	0.4061	10/12
B5 (F1/F4)	0.5079	0.2828	0.2882	0.4153	0.5382	0.4106	0.2794	11/12

(a) PCA double loadings which load on F1 in CFA

PCA Multiple Loading	Loading values (PCA)				Loading values (CFA)			Ranking
	F1	**F2**	**F3**	**F4**	**F1**	**F2**	**F4**	
P3 (F2/F4/F3)	0.2201	0.5783	0.4045	0.4114	0.2473	0.6652	0.4061	**4/10**
B7 (F4/F2)	0.335	0.5159	0.0757	0.5237	0.398	0.6545	0.0992	**5/10**

(b) PCA double loadings which load on F2 in CFA

Table K.2: Comparison of PCA double loadings across CFA factors.

It should be mentioned again that F4-CFA corresponds to F3-PCA and that F4 in PCA has no equivalent in CFA using 4 factors for rotation. Hence for CFA, only three factors (F1, F2 and F4) are selected. The differences in loadings between F1 across methods are smaller (order 0.03-0.09) than those in F2 (order 0.09-0.15), the three highest of which are the participants of Bhurigaon (denoted prefix B). The differences between F3-PCA and F4-CFA range from small/negligible for the participants from Bhurigaon and Patarbojhi to moderate for K1 from Karmala (difference = 0.1092). Most participants load in similar order for F1-F4 respectively across both methods. In four cases F4-PCA takes place of F2-CFA (this happens for; B2, K1, B5 and B7). Clearly, having an extra factor on which participants load weakens the strength of loading on F2 in PCA. Most notable is the shift of loading order for K1 which shows a reversal of order where F1>F4 in CFA but F3>F1 in PCA (notated bold). In short: applying either CFA or PCA results in the roughly the same participants being selected for three factors, with an additional factor created in PCA which has no equivalent in CFA.

[2]Flagged values are highlighted green. Highlighted yellow are those values which have confounded loadings, either double or triple. Bold notation marks values of interest.

Correlations between Factor Scores

	Factor 1	Factor 2	Factor 4
Factor 1	1	0.5368	0.5662
Factor 2	0.5368	1	0.4076
Factor 4	0.5662	0.4076	1

Factor Characteristics

	Factor 1	Factor 2	Factor 4
No. of Defining Variables	12	10	4
Avg. Rel. Coef.	0.8	0.8	0.8
Composite Reliability	0.98	0.976	0.941
S.E. of Factor Z-scores	0.141	0.155	0.243

Standard Errors for Differences in Factor Z scores
(Diagonal Entries Are Stnd. Err. Within Factors)

	Factor 1	Factor 2	Factor 4
Factor 1	0.199	0.21	0.281
Factor 2	0.21	0.219	0.288
Factor 4	0.281	0.288	0.344

(a) CFA factor characteristics

Correlations between Factor Scores

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	1	0.454	0.5122	0.473
Factor 2	0.454	1	0.3721	0.5454
Factor 3	0.5122	0.3721	1	0.3966
Factor 4	0.473	0.5454	0.3966	1

Factor Characteristics

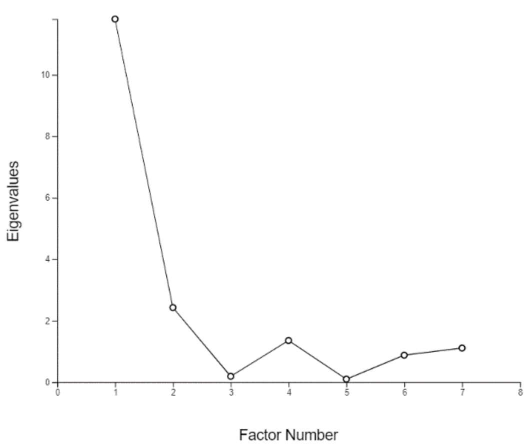
	Factor 1	Factor 2	Factor 3	Factor 4
No. of Defining Variables	8	6	4	3
Avg. Rel. Coef.	0.8	0.8	0.8	0.8
Composite Reliability	0.97	0.96	0.941	0.923
S.E. of Factor Z-scores	0.173	0.2	0.243	0.277

Standard Errors for Differences in Factor Z scores
(Diagonal Entries Are Stnd. Err. Within Factors)

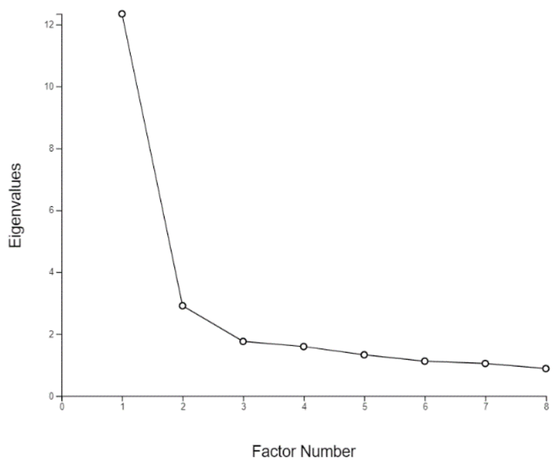
	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	0.245	0.264	0.298	0.327
Factor 2	0.264	0.283	0.315	0.342
Factor 3	0.298	0.315	0.344	0.368
Factor 4	0.327	0.342	0.368	0.392

(b) PCA factor characteristics

Figure K.1: Comparison between CFA and PCA factor characteristics



(a) CFA scree plot



(b) PCA scree plot

Figure K.2: Scree plots for 7 factor extraction CFA and PCA

Appendix L

Four factor analysis comparison

This Appendix presents the main differences and similarities between a three- and four-factor solution. Furthermore, a brief observation is made about the similarities between the PCA three-factor solution and the CFA four factor extraction as discussed in Appendix K.

L.1 Comparison of factor characteristics

Factor Characteristics

	Factor 1	Factor 2	Factor 3	Factor 4
No. of Defining Variables	8	6	4	3
Avg. Rel. Coef.	0.8	0.8	0.8	0.8
Composite Reliability	0.97	0.96	0.941	0.923
S.E. of Factor Z-scores	0.173	0.2	0.243	0.277

(a) Factor characteristics four-factor solution

Factor Characteristics

	Factor 1	Factor 2	Factor 3
No. of Defining Variables	13	10	4
Avg. Rel. Coef.	0.8	0.8	0.8
Composite Reliability	0.981	0.976	0.941
S.E. of Factor Z-scores	0.138	0.155	0.243

(b) Factor characteristics three-factor solution

Figure L.1: Comparison of factor characteristics between four-factor and three-factor solutions.

Correlations between Factor Scores

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	1	0.454	0.5122	0.473
Factor 2	0.454	1	0.3721	0.5454
Factor 3	0.5122	0.3721	1	0.3966
Factor 4	0.473	0.5454	0.3966	1

(a) Factor correlations four-factor solution

Correlations between Factor Scores

	Factor 1	Factor 2	Factor 3
Factor 1	1	0.5548	0.5432
Factor 2	0.5548	1	0.4145
Factor 3	0.5432	0.4145	1

(b) Factor correlations three-factor solution

Figure L.2: Comparison of factor correlations between four-factor and three-factor solutions.

L.2 Overview participants and factor loadings

Tables L.1 until L.4 present a comparison between participants loading on the different factors in either the four- or three-factor solution. Participants highlighted yellow in the three-factor solution are not present in the four-factor solution. Participants highlighted orange are present in F4 of the four-factor solution. For participants present in both solutions, the one with the highest factor loading across the two solutions is marked bold.

L.3 Comparison three-factor PCA solution with four-factor CFA

Interestingly, the three additional Q sorts (**B2, B5, and K1**) that load significantly on F1 in the three-factor solution (see Table L.1) are **confounded** in the four-factor PCA solution but load significantly on F1 in CFA (see Table K.2). Similarly, two of the four additional participants (**B7 and P3**) that load significantly on F2 in

F1			
Four-factor solution		Three-factor solution	
Participant code	**Loading**	**Participant code**	**Loading**
H4	0.8457	**B6**	0.8729
B6	0.7984	H4	0.8319
H2	0.7534	**K3**	0.7846
K3	0.7511	**H5**	0.7318
B4	0.7508	H2	0.6828
H5	0.6962	B4	0.6663
BB2	0.6695	H1	0.6511
BB3	0.6155	BB2	0.6455
-	-	BB3	0.6340
-	-	B2	0.5912
-	-	BB6	0.5869
-	-	B5	0.5753
-	-	K1	0.5390
Total participants	**8**	**Total participants**	**13**
Average loading	0.7351	**Average loading**	0.6763

Table L.1: Participants loading on and factor loadings for F1 (four-factor vs. three-factor solution).

F2			
Four-factor solution		Three-factor solution	
Participant code	**Loading**	**Participant code**	**Loading**
P1	0.773	P7	**0.8538**
H6	0.7694	**H6**	0.8276
P7	0.7577	**H3**	0.7200
P6	0.7368	P6	0.7057
H3	0.6676	B7	0.6787
P2	0.6132	P3	0.6760
-	-	**P2**	0.6512
-	-	P1	0.6062
-	-	B1	0.5931
-	-	P4	0.4852
Total participants	**6**	**Total participants**	**10**
Average loading	0.7196	**Average loading**	0.6798

Table L.2: Participants loading on and factor loadings for F2 (four-factor vs. three-factor solution).

F3			
Four-factor solution		Three-factor solution	
Participant code	**Loading**	**Participant code**	**Loading**
K2	0.7150	**BB5**	0.6887
P5	0.6809	K2	0.6810
BB5	0.6762	P5	0.6732
B3	0.6205	**B3**	0.6302
Total participants	**4**	**Total participants**	**4**
Average loading	0.6731	**Average loading**	0.6683

Table L.3: Participants loading on and factor loadings for F3 (four-factor vs. three-factor solution).

F4				
Four-factor solution		Three-factor solution		
Participant code	**Loading**	**Participant code**	**Factor**	**Loading**
P4	0.7465	P4	F2	0.4852
BB6	0.6059	BB6	F1	0.5869
B1	0.5408	**B1**	F2	0.5931
Total participants	**3**	**Total participants**		-

Table L.4: Participant loading on and factor loadings for F4 in four-factor solution compared to loadings of the same participants in three-factor solution.

the three-factor solution are flagged for CFA analysis but are confounded in the four-factor PCA solution.

Because PCA maximizes total variance while CFA focuses on shared common variance, this finding suggests that the *three-factor PCA solution captures the shared common variance similar to that of the four-factor CFA*. However, with an additional three Q sorts loading significantly in CFA (26 in CFA, see Table K.1), the three-factor PCA solution also captures more total variance compared to a four-factor CFA.

Appendix M

Four-factor factor characteristics

This Appendix presents the data used for the four-factor interpretation of each of the factors; the Q sorts loading to the factor, the factor array (called composite Q sort in KADE) and the crib sheet.

M.1 F1 factor characteristics

-4	-3	-2	-1	0	1	2	3	4
1. I do not filter water before I drink it	14. I sometimes go to my neighbours for household water	3. I treat my drinking water by boiling it	17. I am well informed about tap water connection costs and	20. Animals defecating near my handpump cause pollution of the water	25. I do not do my laundry in the river/canal	10. I think that in the future the quality of the water may be	22. Septic tank waste needs to be buried far from my handpump	21. I wash my hands with soap before I take a meal
	16. I have less access to water than other women in my village	2. I use the same water for my vegetable garden as I do for drinking	18. I only want to use tap water for rinking/cooking to avoid a high	11. In the past there was more water than there is now	24. It is important to have more than one source of water	19. I am willing to pay for better water quality	23. Community water meetings are useful to learn about water hygiene	
		30. To treat drinking water I put a bottle in the sun	29. I wash vegetables that I eat raw with unfiltered water	7. I do not trust the goverment to provide safe tap water	6. Tap water cannot be drunk without filtering it before	26. It is important to me that I can have access to water whenever I want		
		13. I don't have enough water to irrigate my vegetable plot	4. During certain periods of the year (such as during the monsoon)	9. I think that in the future there may not be enough water	27. The location/depth of my handpump was decided based on the	28. I use more water in the summer than in the winter		
			5. During certain periods of the year (such as during the summer)	12. If too many people are connected to tap water there will not be	15. Tap water would not be helpful for me			
				8. It is important for me that my water is cold				

Legend
- Distinguishing statement at P< 0.05
- Distinguishing statement at P< 0.01
- ► z-Score is higher than in all other factors
- ◄ z-Score is lower than in all other factors
- Consensus Statements

(a) F1 factor array for four factor analysis

Q sort	Weight	Loading
H4	10.0000	0.8457
B6	7.41564	0.7984
H2	5.86757	0.7534
K3	5.80322	0.7511
B4	-	0.7508
H5	4.5496	0.6962
BB2	-	0.6695
BB3	3.33682	0.6155

(b) F1 Q sort weights and loadings for four factor analysis[a]

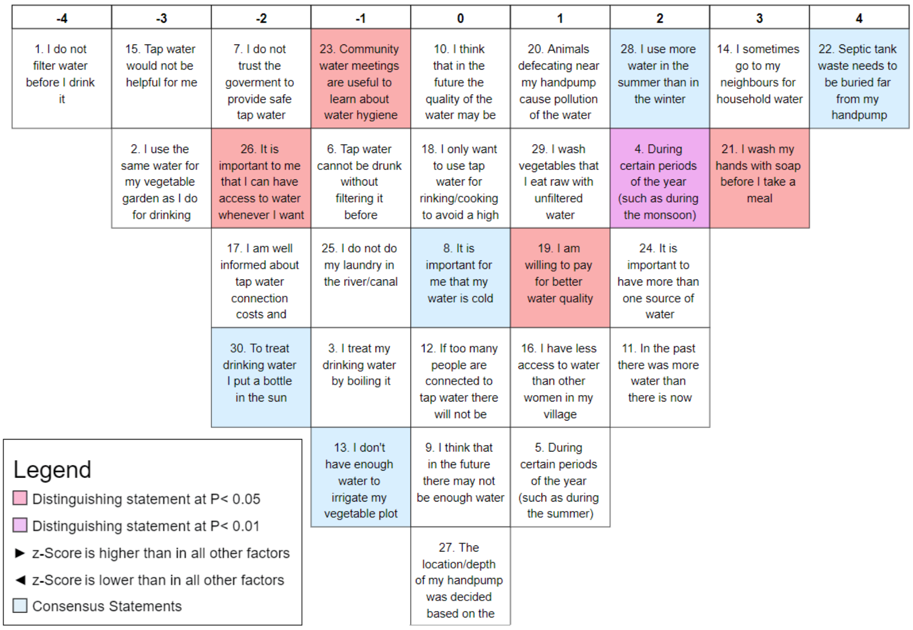
[a]The weight is the Q-sort's weight for calculating z-scores. Light green shading indicates flagged Q sorts.

Figure M.1: F1 Factor array and Q sort weights and loadings for four factor analysis

#	Statements	F1	F2	F3	F4
Highest ranked statements					
S21	I wash my hands with soap before I take a meal	4	3	4	1
S22	Septic tank waste needs to be buried far from my hand pump	3	4	2	3
S23	Community water meetings are useful to learn about water hygiene	3	-1	1	1
Statements ranked higher in F1 array than in other factor arrays					
S26	It is important to me that I can have access to water whenever I want	2	-2	0	2
S10	I think that in the future the quality of the water may be worse	2	0	-2	1
S15	Tap water would not be helpful for me	1	-3	-4	-2
S25	I do not do my laundry in the river/canal	1	-1	0	0
S06	Tap water cannot be drunk without filtering it before	1	-1	-1	0
S27	The location/depth of my hand pump was decided based on the water quality	1	0	0	1
S07	I do not trust the government to provide safe tap water	0	-2	-2	-1
S12	If too many people are connected to tap water there will not be enough water for everyone	0	0	-3	-2
S08	It is important for me that my water is cold	0	0	-1	-1
Statements ranked lower in F1 array than in other factor arrays					
S24	It is important to have more than one source of water	1	2	3	3
S11	In the past there was more water than there is now	0	2	1	0
S09	I think that in the future there may not be enough water	0	0	1	0
S29	I wash vegetables that I eat raw with unfiltered water	-1	1	1	2
S04	During certain periods of the year (such as during the monsoon) the quality of my water is worse	-1	2	1	-1
S05	During certain periods of the year (such as during the summer) there is less water available	-1	1	0	1
S13	I don't have enough water to irrigate my vegetable plot when needed	-2	-1	-1	-1
Lowest ranked statements					
S14	I sometimes go to my neighbors for household water	-3	3	-3	2
S16	I have less access to water than other women in my village	-3	1	-1	0
S01	I do not filter water before I drink it	-4	-4	0	-3

Table M.1: Crib sheet for F1 for four factor analysis

M.2 F2 factor characteristics



(a) F2 factor array for four factor analysis

Q sort	Weight	Loading
P1	6.46776	0.773
H6	6.35007	0.7694
P7	5.99112	0.7577
P6	5.42774	0.7368
H3	4.05575	0.6676
P2	3.30928	0.6132

(b) F2 Q sort weights and loadings for four factor analysis[a]

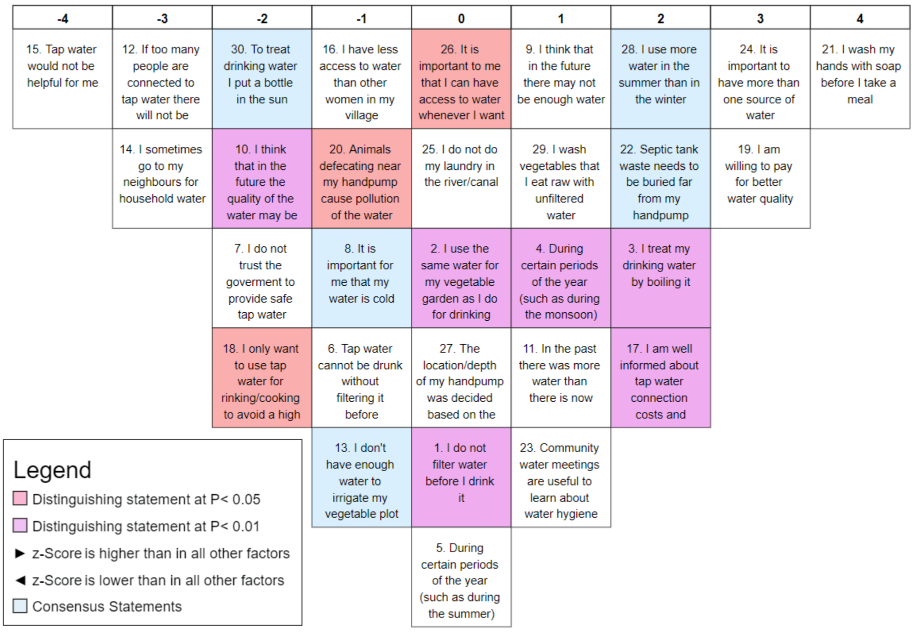
[a]The weight is the Q-sort's weight for calculating z-scores. Light green shading indicates flagged Q sorts.

Figure M.2: F2 factor array and Q sort weights and loadings for four factor analysis

#	Statement	F2	F1	F3	F4
Highest ranked statements					
S22	Septic tank waste needs to be buried far from my hand pump	4	3	2	3
S14	I sometimes go to my neighbors for household water	3	-3	-3	2
S21	I wash my hands with soap before I take a meal	3	4	4	1
Statements ranked higher in F2 array than in other factor arrays					
S04	During certain periods of the year (such as during the monsoon) the quality of my water is worse	2	-1	1	-1
S11	In the past there was more water than there is now	2	0	1	0
S20	Animals defecating near my hand pump cause pollution of the water	1	1	-1	-4
S16	I have less access to water than other women in my village	1	-3	-1	0
S05	During certain periods of the year (such as during the summer) there is less water available	1	-1	0	1
S18	I only want to use tap water for drinking/cooking to avoid a high water bill	0	0	-2	0
S08	It is important for me that my water is cold	0	-1	-1	-1
S12	If too many people are connected to tap water there will not be enough water for everyone	0	0	-3	-2
S13	I don't have enough water to irrigate my vegetable plot when needed	-1	-2	-1	-1
Statements ranked lower in F2 array than in other factor arrays					
S24	It is important to have more than one source of water	2	2	3	3
S19	I am willing to pay for better water quality	1	2	3	4
S09	I think that in the future there may not be enough water	0	0	1	0
S27	The location/depth of my hand pump was decided based on the water quality	0	1	0	1
S23	Community water meetings are useful to learn about water hygiene	-1	2	1	1
S06	Tap water cannot be drunk without filtering it before	-1	1	-1	0
S25	I do not do my laundry in the river/canal	-1	1	0	0
S07	I do not trust the government to provide safe tap water	-2	0	-2	-1
S26	It is important to me that I can have access to water whenever I want	-2	1	0	2
S17	I am well informed about tap water connection costs and planning	-2	-1	2	-1
Lowest ranked statements					
S15	Tap water would not be helpful for me	-3	0	-4	-2
S02	I use the same water for my vegetable garden as I do for drinking	-3	-2	0	-2
S01	I do not filter water before I drink it	-4	-4	0	-3

Table M.2: Crib sheet for F2 for four factor analysis

M.3 F3 factor characteristics



(a) F3 factor array for four factor analysis

Q sort	Weight	Loading
K2	4.92608	0.715
P5	4.27484	0.6809
BB5	4.1955	0.6762
B3	3.39774	0.6205

(b) F3 Q sort weights and loadings for four factor analysis[a]

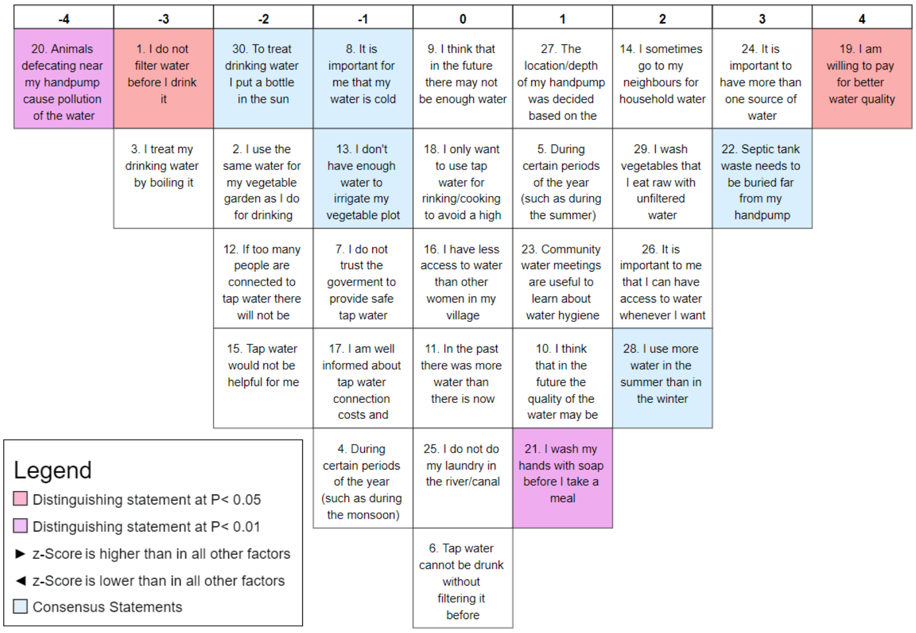
[a]The weight is the Q-sort's weight for calculating z-scores. Light green shading indicates flagged Q sorts.

Figure M.3: F3 Factor array and Q sort weights and loadings for four factor analysis

#	Statement	F3	F1	F2	F4
Highest ranked statements					
S21	I wash my hands with soap before I take a meal	4	4	3	1
S24	It is important to have more than one source of water	3	2	2	3
S19	I am willing to pay for better water quality	3	3	1	4
Statements ranked higher in F3 array than in other factor arrays					
S03	I treat my drinking water by boiling it	2	-1	-1	-3
S17	I am well informed about tap water connection costs and planning	2	-1	-2	-1
S09	I think that in the future there may not be enough water	1	0	0	0
S02	I use the same water for my vegetable garden as I do for drinking	0	-2	-3	-2
S01	I do not filter water before I drink it	0	-4	-4	-3
Statements ranked lower in F3 array than in other factor arrays					
S22	Septic tank waste needs to be buried far from my hand pump	2	3	4	3
S27	The location/depth of my hand pump was decided based on the water quality	0	1	0	1
S08	It is important for me that my water is cold	-1	-1	0	-1
S06	Tap water cannot be drunk without filtering it before	-1	1	-1	0
S10	I think that in the future the quality of the water may be worse	-2	3	0	1
S07	I do not trust the government to provide safe tap water	-2	0	-2	-1
S18	I only want to use tap water for drinking/cooking to avoid a high water bill	-2	0	0	0
S12	If too many people are connected to tap water there will not be enough water for everyone	-3	0	0	-2
Lowest ranked statements					
S14	I sometimes go to my neighbors for household water	-3	-3	3	2
S02	I use the same water for my vegetable garden as I do for drinking	-3	-2	0	-2
S15	Tap water would not be helpful for me	-4	0	-3	-2

Table M.3: Crib sheet for F3 for four factor analysis

M.4 F4 factor characteristics



(a) F4 factor array for four factor analysis

Q sort	Weight	Loading
P4	5.67791	0.7465
BB6	3.22388	0.6059
B1	2.57392	0.5408

(b) F4 Q sort weights and loadings for four factor analysis[a]

[a]The weight is the Q-sort's weight for calculating z-scores. Light green shading indicates flagged Q sorts.

Figure M.4: F4 factor array and Q sort weights and loadings for four factor analysis

#	Statement	F4	F1	F2	F3
Highest ranked statements					
S19	I am willing to pay for better water quality	4	2	1	3
S24	It is important to have more than one source of water	3	2	2	3
S22	Septic tank waste needs to be buried far from my hand pump	3	3	4	2
Statements ranked higher in Factor 4 array than in other factor arrays					
S29	I wash vegetables that I eat raw with unfiltered water	2	-2	1	1
S26	It is important to me that I can have access to water whenever I want	2	1	-2	0
S28	I use more water in the summer than in the winter	2	2	2	2
S27	The location/depth of my hand pump was decided based on the water quality	1	1	0	0
S05	During certain periods of the year (such as during the summer) there is less water available	1	-1	1	0
S18	I only want to use tap water for drinking/cooking to avoid a high water bill	0	0	0	-2
S13	I don't have enough water to irrigate my vegetable plot when needed	-1	-2	-1	-1
Statements ranked lower in Factor 4 array than in other factor arrays					
S21	I wash my hands with soap before I take a meal	1	4	3	4
S09	I think that in the future there may not be enough water	0	0	0	1
S11	In the past there was more water than there is now	0	0	2	1
S08	It is important for me that my water is cold	-1	-1	0	-1
S04	During certain periods of the year (such as during the monsoon) the quality of my water is worse	-1	-1	2	1
S30	To treat drinking water I put a bottle in the sun	-2	-2	-2	-2
Lowest ranked statements					
S14	I sometimes go to my neighbors for household water	-3	-3	3	2
S01	I do not filter water before I drink it	-3	-4	-4	0
S20	Animals defecating near my hand pump cause pollution of the water	-4	1	1	-1

Table M.4: Crib sheet for Factor 4 for four factor analysis