frontiers in Climate

ORIGINAL RESEARCH
published: 03 January 2022
doi: 10.3389/fclim.2021.753888

Water and Emotion: Testing a New Approach for Monitoring Water Security Among Afar Pastoralists in Ethiopia

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OPEN ACCESS

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Specialty section:
This article was submitted to Climate Risk Management, a section of the journal Frontiers in Climate

Received: *05 August 2021*
Accepted: *30 November 2021*
Published: *03 January 2022*

Citation:
Hutchings P, Cooper S, Butterworth J, Joseph S, Kebede A, Parker A, Terefe B and Van Koppen B (2022) Water and Emotion: Testing a New Approach for Monitoring Water Security Among Afar Pastoralists in Ethiopia. Front. Clim. 3:753888. doi: 10.3389/fclim.2021.753888

Ethiopia has over 12 million pastoralists that raise livestock and move their herds in search of fresh pasture and water. This way of life is especially vulnerable to climate change as drought and shifts in seasonal rainfall patterns are changing the distribution and availability of these resources in pastoralist regions. The dynamic use of water within these settings is also not well-understood or captured by conventional water sector monitoring systems, which prevents appropriate supportive interventions and policies to be delivered. This paper presents results from a study into a new approach to measuring water security that focuses on assessing the emotional response of pastoralist populations to their water security situation. Formative research involving focus groups and interviews was followed by a survey of 148 pastoralists to assess their emotional response to different water security dimensions. The results indicate that emotional response can be used to elicit valuable insights into water security and provide a powerful complement to conventional water security monitoring techniques. Using the approach, we show a strong relationship between variation in seasonal water access and reported emotional response. Negative emotions also strongly associate with the most laborious methods of collecting water such as scoop holes and hand dug wells, whereas positive emotions were associated with access to higher quantities of water. Access to equines for carrying water was associated with more positive emotional well-being indicating a route to water security improvement in this context could be through the provision of donkeys and mules for water carrying. The paper discusses the value of using an emotion-based approach to capture experiences of water security alongside more conventional objective measures, especially among populations with water use patterns that continue to be poorly understood.

Keywords: water security, emotion, well-being, pastoralists, Ethiopia, environmental change

INTRODUCTION

Research on the assessment of water security have pointed to the value of psychosocial approaches to account for the complexity and dynamism of water use at an individual level (Jepson et al., 2017; Wutich et al., 2017). Subbaraman et al. (2015) highlights how water security in India can be linked to women's distress over the inability to finish chores, strained relationships with relatives, domestic conflicts over water, compromised community cohesion, and resentment against water vendors and government officials. Similarly, Workman and Ureksoy (2017) directly link water access, usage and cleanliness to psycho-emotional distress of women in Lesotho. The first cross cultural and ecological household water security index includes 12 measures three of which are connexion to emotional issues of anger, worry and shame (Young et al., 2018, 2019). Recent research has shown the influence of household water insecurity on mental disorders, such as depression and anxiety (Brewis et al., 2019; Miller et al., 2021).

In this paper we present an approach of using emotional response to track water security and assess its links to the well-being of pastoralists in the Afar Region of Ethiopia. We start from the premise that emotional well-being is a status that reflects that the experience of different emotions enrich or worsen our lives (Kahneman and Deaton, 2010). For example, experiencing positive emotions can inspire hope, optimism and creativity which can have advantageous repercussions for health, social relationships and livelihoods. Conversely, negative emotions such as sadness, anxiety and grief can present serious implications for emotional well-being and broader welfare (Frederickson and Joiner, 2002).

The persistent experiencing of negative emotions has been linked to increased incidences of mental health issues such as anxiety and depression which in turn impact on an individual's resilience and ability to cope with everyday life (Frederickson and Joiner, 2002; Hershfield et al., 2013; Yoo and Miyamoto, 2018). This makes emotional well-being an important marker of an individual's welfare but we also believe that emotion provides an underexplored means to assess a community's experience of water and the environment (Cooper et al., 2019). Emotions are subjective with interpretation and experience of them shaped by previous experiences, belief systems and personality types (Lazarus, 1991; Diener and Ryan, 2009; White, 2009; Leersnyder et al., 2013). Yet they also have intersubjective meaning with establish norms about appropriate emotional response and meaning, which hold within specific socio-cultural settings (Hochschild, 1979; Lutz and White, 1986). It is this very tension between relatively recognisable rules and language for emotional response within a given group, and the subjective expression of emotion, which shape the rationale for using emotions to examine experiences of water and the environment as employed in this paper.

The application of such thinking is especially considered to hold promise for understanding water experiences in settings whereby there are complex and poorly understood water use patterns. Standardised parameters such as measuring access to an improved or unimproved water source or associated service level assessments (as defined by the WHO-UNICEF Joint Monitoring Progam, 2018) have significant value in providing measures that the sector can use to track progress toward targets such as the Sustainable Development Goals (Schouten and Smits, 2015). However, the standardisation of these parameters can raise challenges in settings with unconventional water supply arrangements (Giné Garriga and Pérez Foguet, 2013) both in terms of alignment with community water needs and in terms of the collection and processing of the necessary data to make assessments.

We believe that this is the case for many of the nearly 200 million pastoralists worldwide that raise livestock, and move their herds in search of fresh pasture and water supplies. These populations often use multiple water sources spread over large range lands and that change seasonally making the collection of conventional indicators extremely challenging (Whitley et al., 2019). Poor understanding of water use can lead to water programmes and policies that can exacerbate rather than improve the resilience of pastoralists to deal with water security risks. For example, the provision of a new water source can have maladaptive impacts if it leads to the overcrowding of populations in places and although this will lead to improvements in access and quantity of water available, it may lead to overall negative impacts on welfare (Nassef and Belayhun, 2012). In response to such problems, we believe the use of emotional response to assess personalised views of water security can help provide a more contextual, sensitive and authentic assessment of whether an individual considers their needs met by their water supply arrangements.

This is especially important in the context of climate adaptation plans to support resilience among pastoralist communities. Afar and the Horn of Africa more broadly has a high degree of vulnerability to climate change hazards, especially droughts, flash floods and changes in rainfall patterns (FDR of Ethiopia, 2019). In 2018, the Government of Ethiopia launched the Climate Resilient Water, Sanitation and Hygiene policy (CR-WASH) dedicated to improve water security in semi-arid and arid regions where most of Ethiopia's pastoralists live (FDRE, 2018). This initiative follows a series of failures in water policy and provision which did not take into account the pastoralist's mobility, multiple uses of water and traditional customary governance resulting in environmental degradation and conflict (Nassef and Belayhun, 2012). Poor policy alignment in this area reflected what many view as a general hostile environment created by government to the pastoralist way of life. This view is now beginning to shift, with the recognition of the value of pastoralism as a sustainable livelihood, which is well-adapted to the impact of droughts and desertification compared to other economic activities (Gardelle, 2011; Notenbaert et al., 2012). The pastoralists' resilience and adaptive capacity is now viewed as valuable in the face of climate change (Ericksen et al., 2013). Against this backdrop, through exploring pastoralist's emotional connexions to water we hope to provide a more in-depth explanation of how water interacts with the everyday hopes and fears of an often marginalised community and test

whether emotion can be useful in tracking water security within such communities.

MATERIALS AND METHODS

The study was conducted in Afar, Ethiopia, which is a state of 1.4 million with 87% of the population living in rural areas, where pastoralism and agro-pastoralism are the dominant livelihood practise (Tsegaye et al., 2013). The pastoralist population of the semi-arid region is reliant on seasonal rainfall with two short rainy seasons between June and September and March and April, and much, longer dry periods throughout the rest of the year. The pastoralism in this areas is transhumance in character with people and livestock navigating between a main village and seasonal water sources around the year. Therefore, a diversity of seasonally changing water sources—both formally engineered boreholes but also seasonal ponds and natural sources—are used for human and animal consumption. Livestock, primarily camels, cattle and goats, are fundamental to material and subject well-being (Tilahun et al., 2016) and so water for animals is widely considered as important as that for human consumption.

A specific study location was selected within Dullassa Woreda within Administrative Zone 3 of the State in partnership with NGOs and with permission of local government. The original sampling logic was to select three villages with different levels of water supply access, with one having access to an improved water source (borehole with a solar powered pump) and one completely reliant on unimproved sources (surface water and unimproved wells), with the third village set geographically between these and having rights to access the improved water source. At the time of the main survey study, the borehole had failed and therefore the three villages had similar water supply arrangements. The villages also had similar characteristics with populations homogenously following a pastoralist livelihood, members of the same clan and with similar levels of material wealth.

The study design involved a two-stage formative study period followed by a quantitative survey, with fieldwork between December 2017 and July 2018. In total, the formative stage involved focus groups ($n = 12$) and interviews ($n = 36$) with community members. The first set discussed natural resources and public services and notions of positive and negative well-being for pastoralists, and the emotions they would associate with each state. From this a list of emotional words was developed in the local language of Afarigna and refined before the second-stage of formative fieldwork when it was validated via further focus groups and interviews. In that second round, particular attention was also placed on understanding the key dimensions of water security from the population using participatory ranking techniques. Socio-economic and environmental context of the results is informed by the formative study, but a more detailed description of the formative methods and results are presented in Cooper et al. (2019).

A final list of validated 12 emotion response words were then organised into four categories around a circumplex (see the framework in **Figure 1**). Each quadrant reflects different high-level emotional states distinguishable by two dimensions. The first is the valance of the emotion which reflects its positivity or negativity. The second is the arousal of the emotion that reflects the physiological excitation from passive to active. For example, "anger" is categorised as negative-active due to its negativity and the high levels of excitation felt when experiencing this emotion, as compared to "grief" which is negative but passive. This organising framework was used to provide 12 possible emotional response categories that were linked to nine statements about water supply. Those statements being gleaned from the participatory ranking exercises around important water supply issues in the area. In the survey, which is the focus of the result water security coverage and emotional response and discrete emotions and different aspects of water security in this paper, respondents were read statements and then asked to select which emotions (up to three in total) they would use to describe their emotional response to it. Alongside this emotional-response section, the survey included questions needed to calculate conventional indicators for water quantity, accessibility and access to water source [in terms of improved and unimproved category used as defined by the WHO-UNICEF Joint Monitoring Progam (2018)]. Respondents were asked to give answers for both the rainy and dry seasons, with what constitutes the rainy or dry seasons based on the respondents interpretation of these terms (e.g., we did not provide a technical definition of the rainy or dry season with particular date ranges). In June 2018 when the survey was conducted the rains had still not come so it was the end of the dry season and hence the rainy season questions are based on recall. The study was reviewed, and ethical approval was obtained from Cranfield University Ethical Review Systems [CURES/3724/2018]. Permission to conduct surveys in the communities was obtained from Dulassa Woreda (district) government office and respective individuals being questioned.

Sampling for the survey was intended to follow random sampling techniques but moved to a purposive model in the field. As it was still dry season during the survey process, many male pastoralists were ∼one hour's walk from their main settlement which challenged the original sampling plan. These are typical circumstances when studying nomadic communities as their mobility precludes standard randomised sampling techniques. Each survey was completed by both the female and male primary adult of the household so to assess gendered differences. In either case, if the head was unavailable, the next available adult from that household would be interviewed. In total, 148 individuals were interviewed. Thirty-eight individuals were interviewed in Adkonta (village 1), 56 individuals from Ege (village 2) and 54 individuals from Tirtira (village 3). Based on estimates taken from locally sourced data there was a range of 50–80 households per village; therefore the total survey sample is estimated to be representative of the household population of the villages at a confidence level of 95% and confidence interval of 7% using basic power calculation techniques.

The survey data was processed to allow analysis of a selection of standardised indicators against the emotional-response data. At the population level three conventional coverage statistics were calculated based on international and government norms: (1) percentage of household population having access to an improved water source as a primary

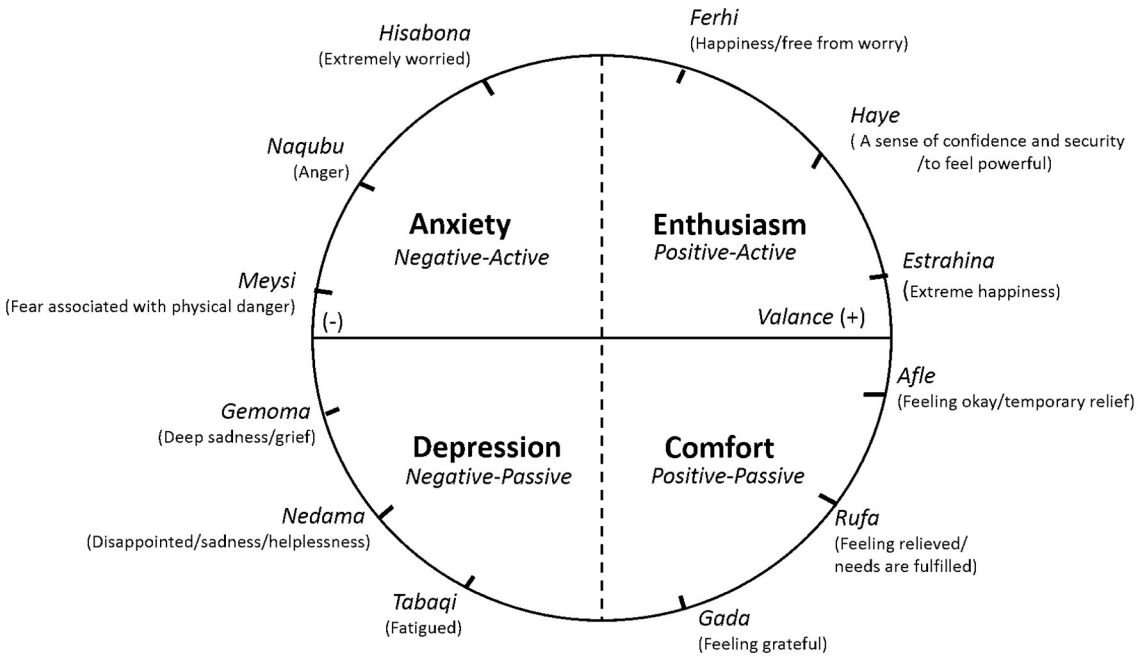

FIGURE 1 | Framework of Afar words for emotion used in the emotion indicator and their meaning [first published by authorship team in Cooper et al. (2019)].

or secondary water source; (2) percentage of household population reporting collecting a quantity of water collected at 25 L per capita or above; (3) percentage of household population reporting accessibility to a water source involving a collection time per day of 30 min or less (see **Table 1** for further details on indicators within the study). To assess the usefulness of the emotional response approach as a monitoring tool, this data was compared against a binary emotional response variable at the population level. For this purpose, the emotional response data was aggregated into positive and negative response categories and calculated to give a binary "positive" or "negative" emotional response for each category. However, we also sought to unpack the broader analytical capacity of the approach, by analysing the full set of 12 discrete emotional responses against the conventional coverage statistics and socio-demographic variables. For example, seasonal, gender and village differences were assessed within the analysis using basic inferential tests (Chi-square Test, Kruskall-Wallis, Mann-Whitney) on IBM SPSS Statistics for Windows (Version 25). Material wealth was not directly assessed within the study because the communities are subsistent and live largely beyond the cash economy, which precludes income based measures. However we analysed emotional response in relation to livestock numbers which is considered a useful proxy for wealth among pastoralists' communities.

The logic of the two-tiered analytical approach is that it provides both a "simplistic" positive/negative binary variable, which may be useful for high-level monitoring of an intervention, and the disaggregated emotional response parameters that could be useful for detailed needs assessments or research. Finally, in commenting on the methods, we note that whilst access, quantity and accessibility parameters are household-level measures, the emotional response data is an individual level measure which reduces direct comparability. However, part of the logic of using emotional response is that it enables analysis of intra-household differences so to assess whether men and women experience the same water supply arrangements differently and so we analyse the data at an individual level for all parameters to allow us to make these comparisons.

RESULTS

The results are split into three sections. The first provides a more in-depth description of the study area as informed by the formative study which helps to explain important characteristics of daily life and water use in the villages. The second section based on the survey study presents results from the analysis of the conventional indicators and the emotional response data that is processed into a positive and negative aggregate measure of emotional response. The third section also based on the survey study covers the patterns of discrete emotional responses and how they relate to other variables.

Socio-Economic and Environmental Context

During the formative research, the pastoralist communities gave a general account of their daily lives and what was important to their well-being. As with other pastoralist communities, livestock were central to survival providing milk, butter and meat as their

TABLE 1 | Water supply monitoring indicators and key characteristics.

Indicator Name	Description	Application within study	Service level benchmarks
Improved Water Source	An improved water source is a term used to categorise drinking water sources within monitoring frameworks, such as those associated with the Millennium Development Goals (MDGs) and the Sustainable Development Goals. Improved drinking water sources are those that have the potential to deliver safe water by nature of their design and construction, and include: piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered water. Unimproved water sources are other types of sources, such as unprotected dug wells and in this study also include surface water such as ponds.	The WHO-UNICEF Joint Monitoring Progam (2018) core questions: W1: Main drinking water source and W2: Secondary water source survey, were used in the study. We used data from the individual survey to present proportion of population that report access to improved or unimproved water sources.	As a binary indicator the minimal service level benchmark is having an improved water source. However, the measure focuses on primary water sources so a household may access water from a "safe" improved water source but also from one or more other unimproved "secondary" water sources, yet the household still counts as being served by an improved water source. This is a particular weakness of the measure in communities that regularly use multiple water points.
Water Quantity	Water quantity is a measure of how much water a respondent reports is used by a household in a day for domestic purposes. It is measured in Litres Per Capita Per Day (LPCD).	To calculate LPCD within a setting whereby people collect water, we followed the approached set out within the Indikit database of humanitarian and development indicators People in Need, 2021. This includes survey questions on number of people living in a household, the volume in litres of water containers, and an estimated number of containers that are used in each day. Using the answers to these questions we can calculate an estimate for lpcd.	Various service benchmarks exist for lpcd with the latest WHO guidance stating that optimal access for health is above 100 lpcd Howard et al., 2020. However, in Ethiopia at the time of the study, the quantity standard set by government in the Growth and Transformation Plan 2 (GTP 2) for rural areas was 25 lpcd and hence this was used as a service benchmark within the study.
Accessibility	Accessibility is a measure of how long it takes a household to collect drinking water. It is measured either by time (minutes) or distance (metres).	To estimate accessibility we used the WHO-UNICEF Joint Monitoring Progam (2018) core questions on time to collect water and multiplied that by the total number of trips a day.	Within the SDGs water supply monitoring framework, a basic water service has a collection time not more than 30 min for a roundtrip including queuing. This definition is also found in the GTP-2 standards. We used this as a service benchmark for total water collection time.
Water-related emotional response	Water-related emotional response is the new measure designed within the study. It is a direct measure of reported emotional response to different water supply characteristics.	Water-related emotional response derives from survey questions that contain water security statement (e.g., "Your ability to cope in times of drought") and eight possible emotions that cover key emotional states. Respondents have to select three emotions per statement.	As a new measure there is no established benchmarks, although we present data in a positive/negative binary model and also at the discrete emotion level. We do not anticipate a water-related emotional response service benchmark at the household level, but we believe benchmarks could be designed at a population level (e.g., No more than 10% of population reporting negative water-related emotional response).

primary food source. Income was also generated by women through the sale of livestock at the market located in Dullassa, the closest woreda town located ∼ six hours walk away from the villages. The recently constructed railway connecting the north of Ethiopia with the Addis Ababa to Djibouti line was the only infrastructure present, other services such as roads and electricity were lacking. Children travelled to the next kebele to access school. In the local area, a school building had been supplied through a national NGO, however it was unused reportedly due to the inability to employ a teacher due to the lack of formal water supply and other services.

The climate of Dullassa Woreda is hot and semi-arid and Afar has one of the lowest rainfall levels of any Ethiopian state. The rainfall is concentrated in June to September in what is known as the Karma season although even these rains can be unpredictable and fail leading to severe drought (World Bank, 2021). Seasonality in rainfall is therefore a significant force shaping the communities' way of life and well-being, particularly their mobility and settlement patterns. Both men and women reported the migration of men with livestock to look for new pasture and fresh water in the dry season. Women, children and elders generally remained in the village, however observations during data collection recorded the migration of these community members too when the borehole failed in one of the villages and hence long distances were travelled by both men and women to find water and pasture. Water collection

TABLE 2 | Percentage of sample that reports meeting standards for conventional domestic water.

Measure	Season	Population reaching standard
Access to an Improved Water Source[a] as Primary Source	Dry	4%
	Rainy	27%
Accessing >25 L per capita per day (quantity)	Dry	48%
	Rainy	49%
Total collection time is not more than 30 min for a roundtrip including queuing (accessibility)	Dry	1%
	Rainy	38%

[a]*Improved drinking water sources are those that have the potential to deliver safe water by nature of their design and construction, and include: piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered water.*

is highly gendered in that women and girls collect water for domestic use (drinking, cooking, personal and home hygiene) and animals that remain close to the homestead. This includes kid goats and equines. Men travel with livestock to water sources with their animals and will consume water from these water sources themselves whilst travelling.

All villages accessed the seasonal river known locally as Kolkata about 2–4 h walk away, with villages also accessing other tributaries of the Awash River. Pasture land known as Henellita was located beyond the Kolkata and used by all the villages, with each village travelling long distances to other areas of pasture. The traditional governance and customary rights of natural resources permitted equal access to all the same clan members. "There are no restrictions as they are a gift from Allah" as stated by women in one village indicating a commonly shared normative position on resource sharing and management within the clan system. However, it was reported that when men from the area crossed the locally recognised tribal border to where Argoba or Amhara people lived they reported conflict occasionally ensued.

Water Security Coverage and Emotional Response

Table 2 presents results from the survey study in terms of the coverage of the population against the three standards for access, quantity and accessibility. Around three quarters of the population report not having access to an improved water source as a primary source (73%; $n = 148$), whilst the remaining nearly one quarter report having access to an improved water source via a protected borehole (23%; $n = 148$). Primary water sources were either the borehole with a solar powered pump or local surface water sources such as ponds and rivers. However, on average, the population accesses four different water sources in total to fulfil the full spectrum of water needs (domestic and livestock) and, in this context, nearly all respondents report accessing unimproved water sources for secondary sources. Unimproved sources include "scoop holes" that are dug into seasonal river beds, hand dug wells, as well as direct collection from ponds and rivers. Access to an improved water source for domestic uses drops from 27 to 4% from the rainy to dry season which highlights the extremely strong seasonal changes in water access among these populations. This manifests most strongly when comparing the accessibility indicator that is the percentage of respondents taking 30 min or less per day to collect water; this drops from 38% in in the rainy season, to just 1% in the dry season. The number of respondents report that they collect 25 lpcd or more in both seasons is similar across seasons and in many ways surprisingly high. Comparing male and female responses, we found similar response patterns for all categories with no statistical difference in response by gender ($p \geq 0.05$) indicating that both genders answers questions related to these conventional parameters in a consistent manner. We also analysed differences by villages which found no statistical differences across these conventional indicators ($p \geq 0.05$).

Figure 2 presents survey results for the emotional response questions in relation to different water security statements. The results here for each respondent are processed into simple positive or negative responses. They show that overall survey respondents associate negative emotional words to describe their overall water situation and their ability to cope (90% negative). There were only marginal differences between genders which are not statistically significant ($p \geq 0.05$) however there were significant differences between villages with Adkonta reporting no positive emotions compared to Ege and Tirtira ($p =< 0.05$) where respondents occasionally did report positive emotions to describe the water security situation. Seasonality manifests even more strongly with positive emotional responses associated with the rainy season (92 and 90%) when asked about their feeling toward the amount of water for both human and livestock consumption. Negative emotions were strongly associated with quantity of water in the dry season (99% for both human and livestock) despite the quantity data reported in **Figure 2** showing only a marginal difference in the litres collected per capita between the seasons. Emotional response to accessibility issues is also seasonal with 73% using positive emotions to describe accessibility issues in the rainy season compared to 1% in the dry season. Fewer negative emotions were expressed for accessibility issues in the rainy season in Ege than the other two villages ($<p = 0.001$).

Discrete Emotions and Different Aspects of Water Security

During formative research the sourcing of water and accessing good pasture during the dry season was mentioned as the most stressful aspect of the pastoralist's livelihoods and this is reflected in the survey data on discrete emotional response. When asked to select emotions to describe their overall water security situation 79% of respondents selected Tabaqi (fatigued), 70% selected Hisabona (extremely worried), 48% Meysi (fear) and 37% Gemoma (grief). Conversely, in the cases where positive emotional responses were selected these were underpinned by the emotions: Rufa (contentment), Afle (temporary relief) and Gada

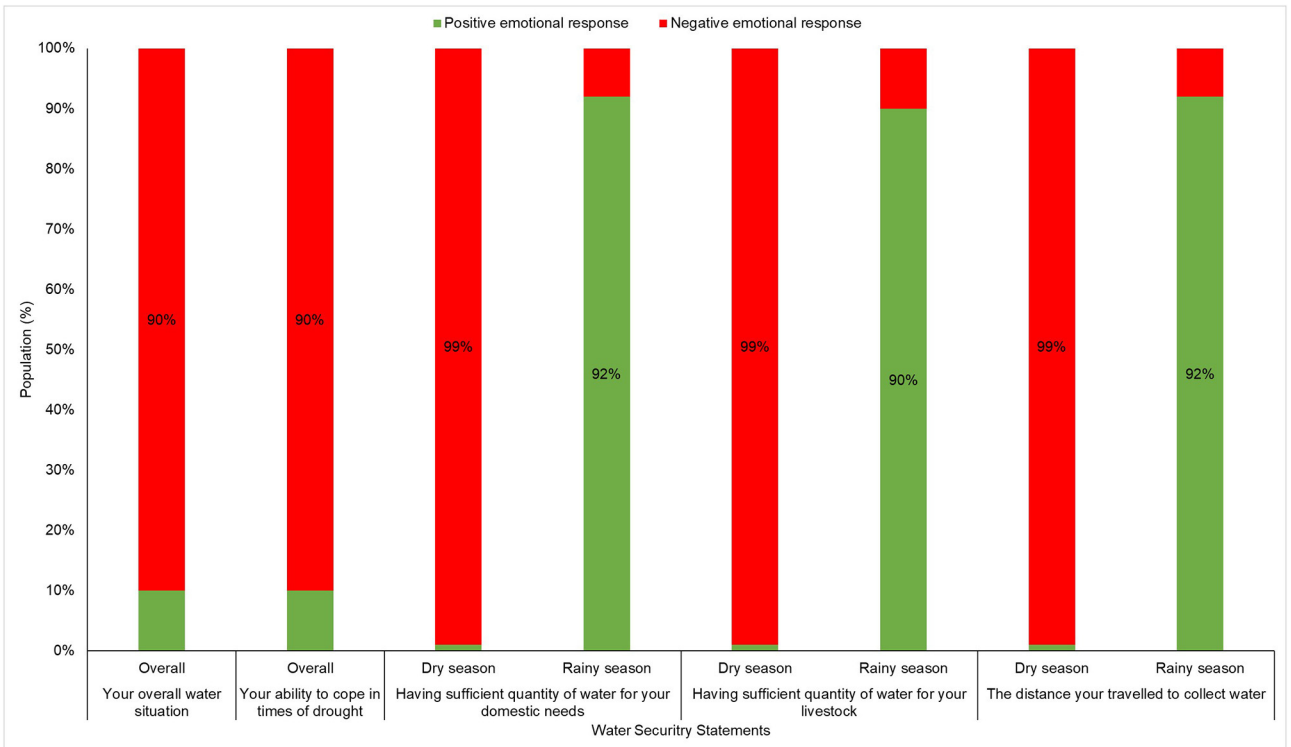

FIGURE 2 | Percentage of sample reporting positive or negative emotions to water security statements.

(gratitude) with a range of over 60% of pastoralists' selecting these emotions when referencing the situation in the rainy season.

There was a significant relationship between quantities of water collected in both seasons and the emotions experienced. Higher quantities of water collected in both seasons associated strongly with the intense positive-active emotions: Estrahina (extreme happiness) and Ferhi (free from worry). The seasonal differences in emotions experienced and the distances travelled to collect water are illustrated in **Figure 3**. The disparity between seasons is clearly visible with negative emotions being experienced more frequently in the dry season and positive emotions experienced in the rainy season. Tabaqi (fatigued) (86%) was the most frequently elicited emotion reflecting the fatigue and tiredness of travelling further to collect water. Feelings of Hisabona (extremely worry) (56%) was also common reflecting the anxiety over the uncertainty of finding enough water. Accompanied by feelings of Meysi (fear) (53%) and Gemoma (grief) (40%) indicating fear and sadness for the loss of livestock. The shorter distances which pastoralists travelled in the rainy season compared to the dry season is reflected by those pastoralists feeling Afle, Gada and Rufa (relief, gratefulness and fulfilment).

In the research we hypothesised emotional well-being would vary according to selected socio-demographic characteristics. Emotions experienced by men and women were expected to differ as a result of the patriarchal structure of their society and the strict divisional roles which men and women undertook in their everyday lives; however there were no significant differences detected between men and women. Analysis at the intra-household scale also indicated there was no significant difference between emotions selected between men and women from the same household. There was, however, a significant difference between the villages at the discrete emotional level, where pastoralists in Ege (village) were more likely to select the positive-passive emotions than the other two villages when perceiving their overall water situation. People in Adkonta (village) was the most likely to experience the negative-passive emotions in relation to their overall water situation more than the other two villages. People in Adkonta (village) collected comparatively less water in both seasons and walked further distances in the dry season, which may contribute to this result. People in Adkonta (village) were also more likely to feel Hisabona (extreme worry) and Tabaqi (fatigue) in the rainy season than the other villages.

There was also no significant association between emotions selected by the different age categories overall; however those aged between 40 and 45 years were more likely to select negative-active emotions, despite this age category collecting higher quantities of water in the dry season, than other age categories (with the exception of the younger age categories: 18–24 and 25–29 years). This age category was also most likely to select Tabaqi (fatigue) to describe the distance travelled in the rainy season. Those aged over 60 years were more likely to select negative-passive emotions. Overall there was no significant associations detected between emotions selected and vulnerable members

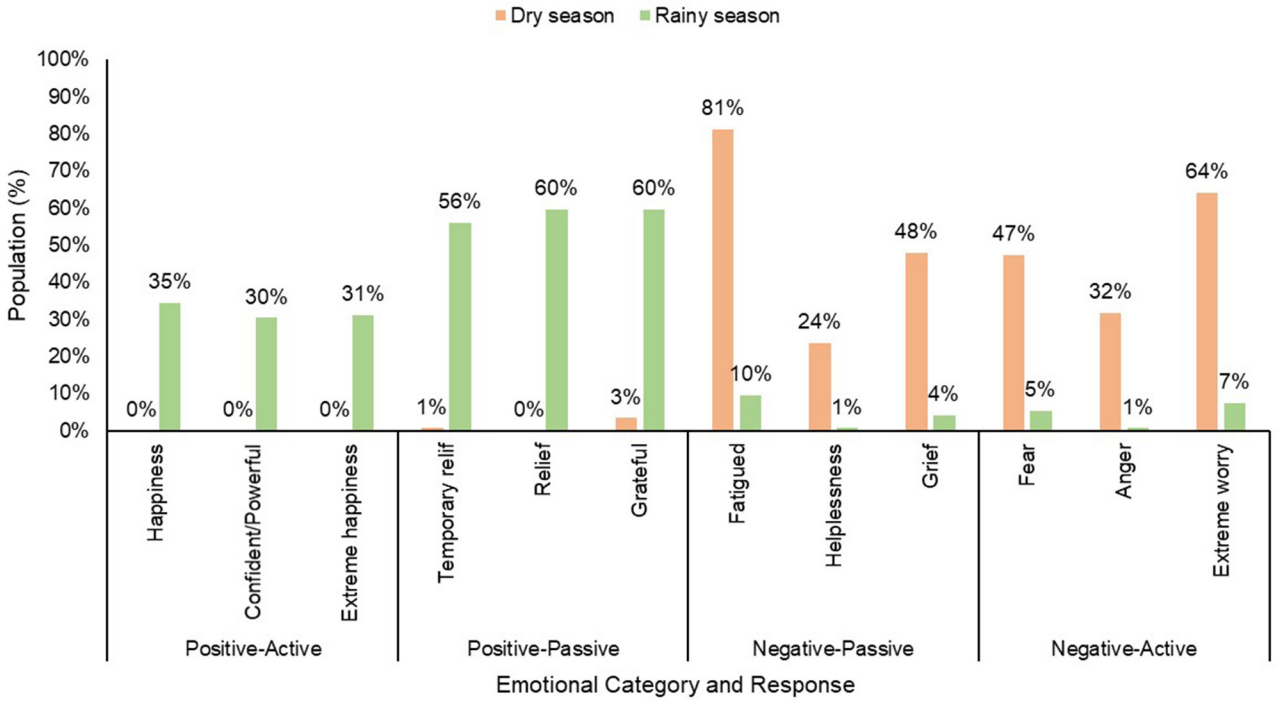

FIGURE 3 | Emotions experienced (%) by pastoralists in response to distance travelled to collect water by season in the Afar Region, Ethiopia.

(single-headed household, disabled and elderly) of the pastoralist community. However the individual emotion: Gada (grateful) was selected by disabled men when they were perceiving their ability to cope with their water security and receiving sufficient water for domestic use in the rainy season.

Livestock are the foundation of any pastoralist livelihood and donkeys or mules (equines) are especially important in terms of fetching water and carrying water containers when travelling to and from water sources. Gada (feeling grateful) was more likely to be experienced by those pastoralists who had two or more equines when pastoralists considered their ability to cope. Owning at least one equine also reduced the likelihood of feeling Tabaqi (fatigued) when pastoralists reflected on their ability to cope and also having sufficient water in the rainy season. Pastoralists with at least one equine were also less likely to feel Meysi (fear) about their overall water situation. Furthering this trend, pastoralists with no equines were more likely to feel Naqubu (anger) over getting sufficient water for both domestic and livestock in the dry season reflecting the difficulty in transporting water without an equine. They were also more likely to report Rufa (relief) when contemplating the shorter distances they travelled in the rain to collect water.

In terms of broader livestock, the numbers of livestock owned associated with certain patterns of experiencing emotions. Those with none or only one camel more likely to feel Nedama (hopelessness/sadness) about livestock needs in the dry season. But those with more than two camels were more likely to feel Meysi (fear), whereas those with higher numbers of camels (4 and 7 animals) were more likely to feel Naqubu (anger) when reflecting on their overall water situation and having sufficient water for livestock in the dry season. This may be tied to worries about losing livestock. Similar trends were observed with goat/sheep ownership when the pastoralist's focused on their ability to cope where those with a higher number (>7 animals) were least likely to feel Gemoma (grief), whereas those with fewer numbers (<2 animals) were more likely to experience Nedama (hopelessness/sadness).

DISCUSSION

The results present a snapshot into the water security of these communities and help to illuminate the close ties between water and emotional distress. Most notably is the dramatic shift from positive to negative emotions between the rainy season and the dry season. Considering how strong negative emotions are associated with mental health conditions such as depression (Yoo and Miyamoto, 2018) and how fundamental water access is to pastoralist livelihood (Nassef and Belayhun, 2012), we can deduce that the seasonal experience of such negative emotions is likely influencing the broader sense of well-being among the community. The conventional water indicators did partly detect these important seasonal changes as evidenced by the decrease in those meeting the accessibility target from 38% in the rainy season to just 1% in the dry season, although the water quantity data indicates that people access the same amount of water for

domestic use in each season. In contrast, the emotional-response data on water quantity shows dramatic, significant differences between seasons. In this case we believe that the sensitivity of the emotional indicator brings value in illuminating the importance of seasonality and this suggests promise as a complementary tool that can help us understand the dynamics of water use in a more sensitive way. We are aware broader trends in monitoring of water security are to move to remote sensors and other technologically driven approaches (e.g. Thomas and Godfrey, 2018), which are highly valuable and cost-effective. However, even with these new approaches, there is a need for more locally determined assessments that can better account for specific needs and it is in that space we believe that an emotional approach can be useful.

At a more specific level, the analysis reveals factors that determine an individual's experience of water security within these communities. Access to equines, especially donkeys or mules, which are used for fetching water were associated with more positive emotional responses. Although the labour-saving benefits of equines to poor rural communities has been documented (for example: Curtis, 1986) the impact on emotional well-being has not previously been discussed. In a separate paper, this research team analysed what steps could be taken to reduce faecal pathogen exposure within this setting without the provision of new water and sanitation infrastructure (Whitley et al., 2019). That paper concluded that improving water handling and storage practises could help reduce pathogen exposure but also argued that integrating water for livestock within interventions is the most likely route for engaging pastoralists within development projects. Building on that theme, the analysis presented in this paper indicates that there would be direct benefits in supporting equine numbers within pastoralist communities in terms of improving people's emotional experience of accessing water. Equines could even be considered to be of the water supply infrastructure and therefore supported as part of water security efforts by government and implementing agencies. The danger of maladaptation needs to be carefully considered however, as additional animals require feeding and watering, and in such stressed environments this may not always be possible.

The analysis found no statistical difference between male or female respondents despite that the formative research revealing that the water-labour (and broader livelihood patterns) in these villages is highly gender differentiated with women collecting water for domestic purposes and men focused on accessing water for livestock. In the context of broader research that show experiences of water security are often gendered (e.g. Wutich, 2009), this is a surprising finding. More research is required to understand what is going on but one explanation may be that a threshold effect is playing out with such gendered experiences. The situation in the Afar is so acute with such detrimental water security in the dry season that this manifests as universally negative emotion responses, such as fatigue and extreme worry, which is felt strongly by both men and women. Alternatively, the emotion-based indicator used may not have been sensitive enough to the more detailed aspects of the pastoralists' livelihoods and water security situation as the indicator statements used only covered very broad aspects of water security. It may be that a more accurate method of measuring emotion could help, such as a diary approach that involves documenting emotions at regular intervals (Lazarus, 1991; Scherer, 2005; Marcus et al., 2015). Recent research has demonstrated the value of community and individual diary methods for understanding belief systems around water in Malawi, Uganda and Ethiopia (Cleaver et al., 2021; Whaley et al., 2021).

Beyond high-level monitoring needs, discrete emotions have potential to focus on specific sub-issues that we are currently poor at assessing. For example, the pastoralist lowlands of Ethiopia can be sites of tribal and clan-based violence that can erupt over resources, such as water (Chinasho, 2017). Inter-tribal conflict in the Afar Region is well-documented and the prevalence and intensity of emotions such as worry, fear and anger can only add to the perceived levels of threat and insecurity over highly-contested, increasingly scarce resources (Menbere, 2013). Unsurprisingly, these negative emotions were acutely more prominent among pastoralists who collected lower quantities of water, had further to travel to collect water and through the more laborious methods of obtaining water such as from scoop holes and hand dug wells in the dry season. Being able to recognise and predict which conditions are most likely to lead to conflict-associated emotions such as anger could be a valuable monitoring tool. We need to be careful overstepping our understanding here as resource scarcity leads to intra-community cooperation and sharing arrangements as well as violence (Gidey, 2017). Relatedly, violence in the region has been argued to be more driven by cultural and structural factors related to lineage and community narratives, rather than resource scarcity (Gidey, 2017). With this in mind, we do not have the data to make strong claims in this area but believe this could be an area for further exploration of such approaches, especially in conflict-risk areas such as many lowland areas in the Horn of Africa and the Sahel.

In assessing the methodological value of the work, it aligns closely with recent scholarship on household water insecurity which includes a variety of techniques and measures for assessing the links between water security and psychosocial distress (Workman and Ureksoy, 2017) and/or mental health (Brewis et al., 2019). Many of these studies adopt standardised diagnostic approaches for assessing mental health, such as The Hopkins Symptoms Checklist-25 for screening for anxiety and depression (Workman and Ureksoy, 2017), or attempt to develop new cross-culturally validated water-specific methods, such as the HWISE water security index (Young et al., 2018, 2019). These are valuable measures, however the use of emotional response within this project is considered to provide a locally adaptable tool for assessing experiences of water security. The water-security statements to assess can be adjusted to reflect local priorities and asking respondents for emotional responses allows them to offer direct responses based on their own interpretation of value. The use of the circumplex to organise emotions into four quadrants also enables nuanced analysis of emotional effects beyond simply a positive and negative impact. The survey tool is also relatively short and easy to administer. As an example, as applied in this study it involves nine questions, compared up to 29 questions

within the HWISE approach. This means it could be feasible to deploy in routine monitoring of water interventions.

Moving on to the limitations of the study, the findings are limited by the homogenous context in which the survey was undertaken. This means the study has not be able to verify whether individuals living with materially different water supply arrangements correlate with different patterns of emotional responses. Replicability is essential for monitoring and we believe the methodology and framework for developing the emotional-responses and associated statements to be replicable across different contexts. Here, we believe that the survey instrument we have developed to be re-deployable across the same linguistic contexts (Afarigna) but for new linguistic contexts an adapted circumplex would need to be developed. We are doubtful this could be achieved via simply translation but are unsure the extent to which the full extent of formative research would be required to deliver it. It would be beneficial for future work to examine the extent to which relevant emotional responses are cross-culturally and cross-linguistically valid.

In conclusion, many of the 200 million pastoralists worldwide face pressures in terms of water security and too often attempts to improve access to water in pastoralist regions have led to unintended consequences, such as overcrowding at water points and the degradation of grazing land. This implies a lack of understand of pastoralist water use and so we presented results from a study that sought to capture bottom-up experiences of water access and use in Afar pastoralist communities. This involved adopting an approach to assess the emotional response of pastoralists to different aspects of their water security. Seasonality was the determining factor governing emotional response: having enough water in the rainy season contributed to positive emotional well-being. The increased availability of water and reduced travelling times to collect water gave the pastoralists time to engage in social and cultural events. Emotional well-being also varied according to the quantity of water collected, distance travelled and the type of water sources they accessed. The most negative emotions were experienced by pastoralists collecting the least quantity of water, travelling over the longest distances and using the most laborious methods to source water. The analysis also implied additional determining factors for emotional response, with access to animals for fetching water associated with more positive emotional responses. This helps illuminate the complexity of water use in such communities and that access to conventional infrastructure in itself is not a sufficient measure for understanding what shapes individual-level experiences of water security. The use of emotional response, and other subjective measures, is considered to hold promise in terms of further exploration of water security experiences, especially among groups such as pastoralists with poorly understood water use practises. Further work would be needed to build the validity and test the analytical capacity of such approaches by assessing how durable and sensitive they are across different types of populations.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: Cranfield Online Research Data repository [https://doi.org/10.17862/cranfield.rd.9332279.v1].

ETHICS STATEMENT

The study was ethically reviewed, and ethical approval was obtained from Cranfield University Ethical Review Systems [CURES/3724/2018]. Permission to conduct research in the communities was obtained from Dulassa Woreda (district) government office and respective individuals being questioned.

AUTHOR CONTRIBUTIONS

PH designed the study and led the writing of themanuscript. PH, SC, JB, AK, AP, and BVK co-developed the field methodology. AK, BT, and SJ led the fieldwork teams. SC led the analysis, whilst the whole authorship team (PH, SC, JB, SJ, AK, AP, BT, and BVK) was involved in data interpretation and editing the final manuscript.

FUNDING

This research has been supported by the Economic and Social Research Council and Department for International Development through the Development Frontiers Research Fund (Grants: ES/ R001049/1; ES/T015977/1).

ACKNOWLEDGMENTS

The authors would like to thank the Friendship Support Association (FSA), Afar, an organisation focusing on education, water, health and livelihoods in the Afar. They facilitated the fieldwork and provide valuable insight into the project. The authors would also like to acknowledge the patience and time of research participants for answering questions and allowing us to learn about their way of life and household practices.

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