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Climate Change Perceptions and Attitudes to Smallholder Adaptation in Northwestern Nigerian Drylands

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Abstract: As climate change is projected to increase in vulnerable areas of the world, we examined farmers' perceptions of this change and their attitudes to adaptation in two communities (Zango and Kofa) in northwestern Nigeria. A total of 220 arable farming households completed a livelihoods survey preplanting. The perceptions survey was followed by a survey of 154 households post-harvest for the attitudes questions based on the theory of planned behaviour (TPB). In addition to the positive responses from the farmers towards climate change perceptions, TPB findings reveal that such perceptions could lead to intentions to adapt as determinants of attitude were significant. Subjective norm was a significant predictor of adaptation intention in Kofa, but not in Zango. Perceived behavioural control, though useful, was not a determinant of climate change adaptation intention. Most importantly, principal component analysis (PCA) of climate change perception variables allowed us to discriminate smallholder farming households and can be used as a tool for segmentation into climate change-perceiving and nonperceiving farming households. Efforts towards improving the determinants of behavioural intention for the poorly perceiving group could lead to better decisions to adapt to climate change and provide more targeted extension support in the future.

Keywords: climate change perceptions; adaptation intentions; smallholders; decision-making; principal component analysis

1. Introduction

Climate change is projected to have the greatest impact on agricultural production and food security in the developing world, where communities are dependent on the environment for their livelihoods (Neil et al. 2003; Alliance for a Green Revolution in Africa 2014; Dang et al. 2014a). This is especially true in drylands of Africa, where up to 250 million people will be exposed to water stresses by 2020 (IPCC 2007).

Furthermore, variability and change in rainfall patterns affect investment for agricultural productivity enhancement as well as natural resources conservation (Mortimore 2000; Stringer et al. 2009). In Africa, higher temperatures and drought conditions are likely to increase, particularly in the Nigerian drylands. If not urgently addressed, these will impact negatively on the environment and result in a loss of about 11% of Nigeria's GDP by 2020 (Federal Ministry of Environment Climate Change Department 2011). Hence, Northern Nigerian dryland farmers need to adopt suitable adaptation strategies.

No consensus exists on the temporal implications of adaptation strategies. Short-term strategies are argued to be enough to cushion the effects of climate change. However, short-term responses could

lead to prolonged vulnerability to future climate effects (Burton 1997; Smithers and Smit 1997). Given that dryland smallholders in northwestern Nigeria have survived for long periods, it is reasonable to assume that they have developed adaptive strategies to weather patterns they have frequently encountered (Stringer et al. 2009). Although, these are likely to be insufficient amidst new climatic change events in the future, not least because the smallholders are expected to be subjected to weather conditions not previously experienced (IPCC 2007).

Adaptation is either autonomous or planned (Bryant et al. 2000). Autonomous adaptation displayed involves coping strategies by farmers and other community members in an agricultural setting. Such strategies include diversification, irrigation, change in planting date, crop and livestock insurance and using tolerant varieties of crops which are location-specific (Dang et al. 2014b). In contrast, planned adaptation strategies include government intervention and public policy geared towards managing climate change impacts, such as investment in infrastructure, subsidies, research, innovation and tax regimes (Bryant et al. 2000).

Climate change is considered a significant risk due to uncertainties around crop and livestock performance (Hardaker et al. 2004). Therefore, risk perception is significant in decision-making because decisions need to anticipate all possible consequences so as to tackle them holistically (Maye et al. 2012; Hardaker et al. 2015). Several factors affect adaptation decisions, for example, socioeconomic, technical and institutional determinants such as the ownership of assets and land (Scoones 2009; Hisali et al. 2011), access to credit and extension information (Deressa et al. 2009; Hisali et al. 2011; Fosu-Mensah et al. 2012) and investments in rain-fed agriculture and efficient rainfall utilization (Wani et al. 2009). These factors are important because certain adaptation actions require physical assets that may need to be acquired or previously owned.

Most previous studies ignored perception of risk as a key determinant of adaptation to environmental shocks and stresses (Bandura 1977; Stehr and Storch 1995; Weber 1997); rather, they rely on resource considerations alone (Patt and Gwata 2002; Grothmann and Patt 2005; Deressa et al. 2011; Jones and Boyd 2011). Neglecting the role of perception in the adaptive decisions of those affected by climate change is likely to be counterproductive because integrating human perceptions to the adaptation process could address the shortfalls of the socioeconomic, technical and institutional determinants (Grothmann and Patt 2005). Therefore, before adaptation can take place, climate change must be perceived to be happening; hence, the role of perception as a precursor to adaptation cannot be overemphasized (Maddison 2007; Bryan et al. 2009; Mertz et al. 2009; Deressa et al. 2011; Tambo and Abdoulaye 2013).

This paper utilized the theory of planned behaviour (TPB) to explore the perception and adaptation responses in two communities in northwestern Nigerian drylands to determine the influence of perception on attitude towards adaptation behaviour for future climatic challenges. In addition to the TPB, the paper applied principal component analysis to differentiate the contributions of perceptive from nonperceptive farming households so that extension on adaptation can be appropriately targeted.

2. Theory of Planned Behaviour (TPB)

The theory of planned behaviour (TPB) (Ajzen 1988, 1991, 2001) has wide application as a conceptual framework in the study of human action (Ajzen 1988, 1991, 2001). It has been applied successfully in different fields, such as food consumption and health-related behaviour (Fishbein and Ajzen 2010; Ajzen 2015; Conner and Sparks 1996). To date, to the best of our knowledge, only a few studies have applied the theory to climate change adaptation (e.g., Lin 2013; Masud et al. 2016), with almost no application in the context of Nigerian drylands.

The role of intention and behavioural control in influencing behaviour has been previously studied (Ajzen 1991). Three factors make up TPB: behavioural beliefs (attitude towards behaviour), normative beliefs (subjective norms) and control beliefs (behavioural control). These were applied in this study in the context of climate change. Ajzen (2002) suggested that behavioural beliefs lead to an unfavourable

or favourable attitude concerning behaviour. Normative beliefs lead to subjective norms or perceived social pressure to accomplish behaviour. Control beliefs result in perceived behavioural control that is the perceived difficulty or ease of performing the behaviour (Ajzen 2002). These three factors, when combined, give rise to behavioural intention. Perceived behavioural control is linked to the theory of 'self-efficacy' (Bandura 1977, 1982), and like subjective norm and attitude, self-efficacy is measured by directly probing the capability to perform a behaviour or indirectly based on beliefs about the ability to deal with specific inhibiting or facilitating factors (Ajzen 2002, p. 668).

Critics of TPB have argued that it is limited in its ability to determine intention because it does not determine a certain association between intentions and behaviour to understand how attitude can impact goal attainment (Conner and Armitage 1998). Similarly, TPB is argued to be concerned about the salience of individuals' beliefs, which may not align with the researcher's beliefs (Conner and Armitage 1998). Further, Bonnes et al. (2003) assert that TPB is limited by its inability to address the societal predicament; that is, collective outcomes are affected by a person's behavioural feat (Serenari et al. 2012). Despite perceptions of TPB as being oversimplistic, the present paper utilized it in the analysis due to its wide application in predicting human behaviour in different fields (Ajzen 1991, 2011). It is at the perception stage that the unique factors that influence one person to carry out a behaviour of interest and the other to act differently can be learned (Ajzen 1991).

3. Materials and Methods

3.1. Research Location, Sampling and Data Collection

This study was carried out in northwestern Nigeria (Figure 1), recording baseline climate change perceptions and adaptive strategies of 220 farming households with a specific survey built around TPB with 154 of the farming households to explore attitudes towards adaptation behaviour to climate change. TPB is useful in assessing whether many factors affect intended versus actual adoption of climate change adaptation behaviours among farmers (Niles et al. 2016).

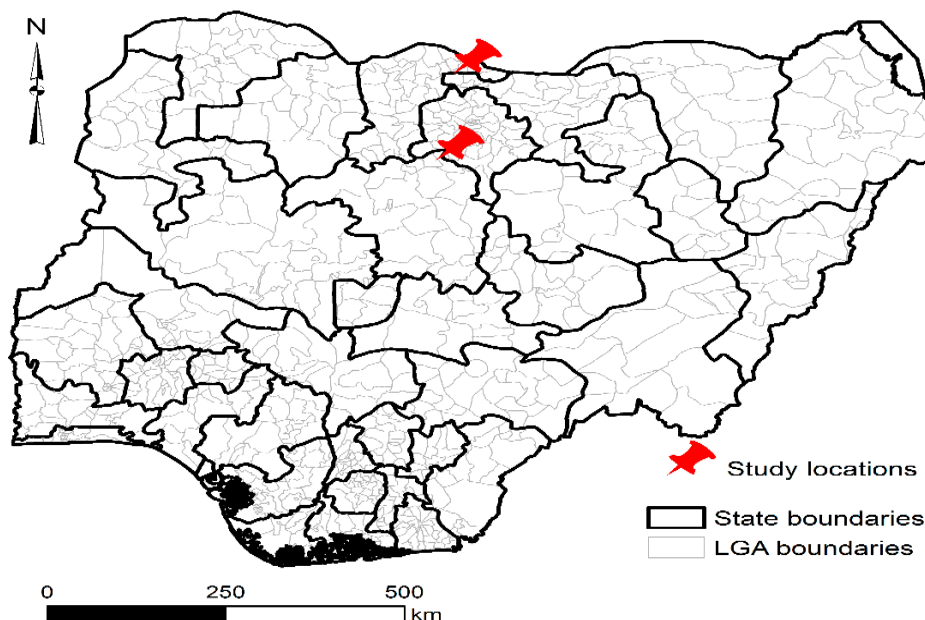


Figure 1. Map of Nigeria showing the two study communities, Zango (Katsina State) and Kofa (Kano State). Zango is situated at latitude 13°03'19.0" North and longitude 8°29'17.2" East while Kofa lies on latitude 9°41'14.6" North and longitude 7°41'12.4" East.

Two communities, Zango and Kofa, were purposely selected with the aim of studying the agricultural practices of areas affected by rainfall shortages (drought) and land degradation.

The communities provided more rationale to study the perceptions and responses of the dryland smallholders to drought and other environmental challenges, so that improvements in practices can be made where necessary. Communities without such experiences may not have knowledge of environmental and climate change, thereby making it difficult to explore these issues in those areas. As seen in the baseline data, there is indication that Zango is experiencing changes in climatic variables. Zango is ideal for exploring vulnerability to drought as previous studies have found the area to be adversely affected by the increasing climate events ([Abiodun et al. 2011](#)). Kofa, however, was chosen to compare practices and results in terms of farming systems and farm characteristics which are beneficial according to comparative studies ([Fisher 2012](#)). Total annual rainfall in Zango is approximately 591 mm, which supports the production of cereal and legume crops. Cereals farmed include sorghum (*Sorghum bicolor*) and pearl millet (*Pennisetum glaucum*), while legume crops include cowpea (*Vigna unguiculata*), soybean (*Glycine max*) and groundnuts (*Arachis hypogaea*). Irrigation agriculture, being a ready source of food and important for managing short-term stresses in drylands, is not practiced in Zango. Kofa, on the other hand, lies between the semiarid and Sudan Savannah agroecological zones south of Zango, with an annual rainfall average of 835 mm. Baseline study of the Kofa community shows that farmers were involved mainly in cereal (maize (*Zea mays*), sorghum (*Sorghum bicolor*) and millet (*Pennisetum glaucum*)), legume (cowpea (*Vigna unguiculata*), soybean (*Glycine max*) and groundnuts (*Arachis hypogaea*)) and some vegetables (onions (*Allium cepa*), tomato (*Solanum lycopersicum*) and garlic (*Allium sativum*)) production. Inhabitants of both Zango and Kofa are mostly farmers and practice Islamic religion.

A nonprobability sampling technique was employed based on the willingness of the farming household's head to participate in the study. Sampled households were not necessarily representative of the population at large, but are indicative of the two communities farming under slightly different dry conditions. An aspect of snowball sampling with the Centre for Dryland Agriculture, Kano, provided links to the field officers working in the study communities. To ensure no nonresponse bias, characteristics of respondents (farmers) in the two communities were checked and found to be typical of communities in the Living Standard Measurement Study (LSMS) ([Nigerian Bureau of Statistics et al. 2014](#)).

A section on livelihood survey with 36 questions gathered data on household demographics: food security indicators, assets, labour availability, land size, water sources, crop input requirements and extension support. A further 29 questions covered farmer enterprises; perceptions, causes and effects of climate and environmental challenges; sources and accessibility of climate information; the language of communicating climate information and level of satisfaction with information received; and autonomous adaptation strategies. A second round of questionnaires based on TPB were developed from the themes emerging after the initial interviews and explored subjective norms, perceived behavioural control (PBC), and attitudes and behavioural intention for climate change adaptation. PBC was measured based on the ease or difficulty of carrying out the adaptation practices as influenced by internal and external controls (Table 1).

The baseline survey was undertaken between June and July 2015 in the two communities. Staff were recruited to help with data collection after intensive training on interviewing skills and correct questionnaire interpretation. The surveys were carried out in all the villages that make up the communities to ensure an even spread of views. The respondents included the heads of the farming households, or the spouse or older son/daughter in the absence of the farming household's head. To be qualified as a respondent, they must have been involved in farming for at least 5 years under their parents or on their own. It took between 45 to 60 min to administer a questionnaire; therefore, each interviewer was expected to interview a maximum of 3 household heads per day to ensure the quality of responses. The researcher checked the questionnaires for missing sections every day after data collection, and where data were missing, the person responsible was requested to revisit the household and complete the missing sections.

Climate change perception variables were selected based on a review of the literature (Table 2).

Table 1. Variables measured for attitude, subjective norm, perceived behavioural control and intention to adapt to climate change according to the theory of planned behaviour.

Items	Scale *
Direct attitude	
For me, climate change adaptation is	(very irrelevant–very important)
Climate change adaptation on my farm is	(very difficult–very practical)
Adaptation to climate change for me is	(very inconvenient–very convenient)
Subjective norm	
I feel under pressure from extension agents to integrate adaptation to climate change in my farming	(strongly disagree–strongly agree)
People whom I respect (e.g., community head) will disapprove if I do not integrate adaptation in my farming	(strongly disagree–strongly agree)
It is expected of me to integrate adaptation to climate change in my farming since others are doing it	(strongly disagree–strongly agree)
Perceived behavioural control	
If I wanted to, it is easy to integrate adaptation in my farming	(strongly disagree–strongly agree)
Not having enough resources makes it difficult to adapt to climate change	(strongly disagree–strongly agree)
Whether I integrate adaptation into my farming is entirely up to me	(strongly disagree–strongly agree)
Behavioural intention	
I intend to integrate adaptation in my farming	(very unlikely–very likely)

* Variables measured against a four-point Likert scale and bipolar adjectives.

Table 2. Climate change perception variables selected for principal component analysis (PCA) based on literature review.

Perception Variable	Reference
Poor fertility of most soils	Swe et al. (2015)
Decrease in arable yield	Ndamani and Watanabe (2015)
Increased drought	Smit et al. (1996) ; Okonya et al. (2013)
Change in rainfall pattern	Smit and Skinner (2002) ; Okonya et al. (2013)
Poor humidity/dryness	Okonya et al. (2013)
Increase in temperature/hot	Smit and Skinner (2002) ; Okonya et al. (2013)
High sunshine intensity	Mehar et al. (2016)
Increased rate of erosion	Nearing et al. (2004)
Flooding	Okonya et al. (2013)
Pests and diseases	Bryant et al. (2000) ; Brklacich et al. (2000) ; Swe et al. (2015)

3.2. Statistics

Data were analysed using SPSS version 22 statistical software with descriptive statistics to profile the baseline conditions before applying principal component analysis (PCA) ([Morgan et al. 2007](#); [Pallant 2013](#)). This was done to determine the extent of similarities among variables and to reduce the data to a manageable size while retaining much of the characteristics of the original variables ([Jolliffe 2002](#)). All statistical criteria for the PCA were satisfied before the test was carried out, namely scree plot test, Bartlett's test of sphericity, and correlation and parallel analysis. Multiple regression was employed to forecast adaptation intention along with Cronbach's alpha coefficient for measuring internal consistency and the reliability of the TPB questions. Significance levels were set at 0.05.

4. Results

Two sets of results are presented. The first focuses on the communities' baseline conditions, while the second focuses on the application of the theory of planned behaviour (TPB).

4.1. Community Livelihoods and Perceptions of Climate Change

4.1.1. Community Baseline Conditions

Respondents from the two communities comprised different age groups, gender, marital status, family size and educational qualifications. These are summarized in Table 3.

Other livelihood conditions surveyed included roof types of houses. In Zango, 57.5% of roofs were zinc, while 93.0% were zinc in Kofa. From the demographics in the two study communities, women involved in farming mostly farmed plots in backyards, while the men managed plots in more distant places.

Table 3. Demographic characteristics of Zango and Kofa communities.

Demographic Characteristics	Zango (%) n = 120	Kofa (%) n = 100
Age (years)		
21–40	32.5	55.0
41–60	64.2	37.0
≥61	3.3	8.0
Gender		
Male	83.3	87.0
Female	16.7	13.0
Marital status		
Single	1.7	6.0
Married	95.0	93.0
Widowed	3.3	1.0

Table 3. Cont.

Demographic Characteristics	Zango (%) n = 120	Kofa (%) n = 100
No. of children		
0	0.8	9.0
1–5	31.1	48.0
6–10	44.5	26.0
11–15	21.0	10.0
≥16	2.5	7.0
Highest education		
No education	32.5	33.0
Primary	19.2	35.0
Secondary	30.0	13.0
Tertiary	18.3	19.0

4.1.2. Source of Climate Information

The radio was ranked as the most important source of climate information in the two study communities. Eighty percent of respondents in Kofa and all respondents in Zango reported the radio as being the major source of climate information. Research institutes and internet sites were ranked as the least important sources of climate information in both communities. Television was recorded as an important source of information in Kofa, but not in Zango. Access to climate information through modern means of communication such as television, internet and from research institutes did not indicate any gender sensitivity, but was low overall (Figure 2).

Access to direct extension information is expected from extension services; however, the proportion of males (81% for Zango and 63% for Kofa) who had access to extension was significantly higher than that of females (15% for Zango and 4% for Kofa) in the two communities (Chi-square test (with Yates continuity correction); χ^2 (1, n = 220) = 5.75, p = 0.017, ϕ = −0.18).

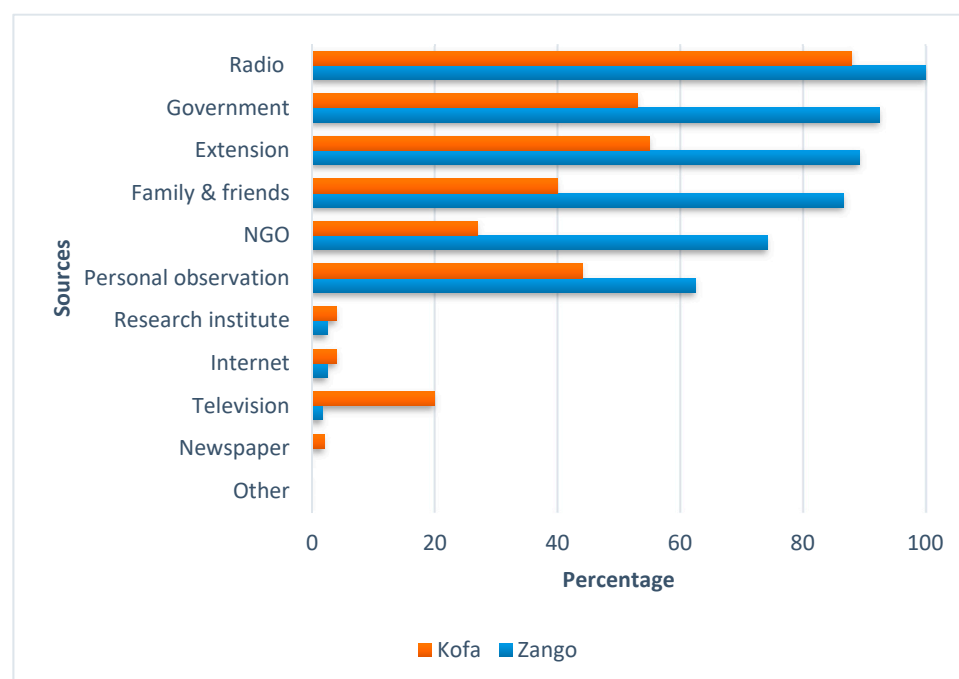


Figure 2. Sources of climate information in Zango (n = 120) and Kofa (n = 100) in terms of the most utilized sources. NGO—Non-Governmental Organisation.

4.1.3. Perceptions on Environment and Climate Change Awareness

Principal component analysis (PCA) was used to explore perceptions of climate and environmental change awareness. Extraction of factors and oblique factor rotation was performed using the Oblimin method (Pallant 2013). Ten items on the environmental change perception scales (Table 2) were subjected to PCA. Data suitability for factor analysis was verified before conducting the PCA. The correlation matrix showed that many coefficients were 0.3 and above (Appendix A). The Kaiser–Meyer–Olkin value was 0.61, which is slightly above the recommended value of 0.6, while Bartlett’s test of sphericity attained statistical significance ($p < 0.05$); random figures from parallel analysis showed that figures for only the first two cases were less than the eigenvalues for the extracted factors, which makes PCA appropriate (Pallant 2013).

The results of pattern matrix further supported this decision, which showed two components with 3 items each having 0.3 or more loading on each component. The top two components explained 40% of the total variance, with component 1 contributing 24.1% and component 2 contributing 15.9%. The various variables (Figure 3) were loaded on each component. Oblimin rotation was carried out (Pallant 2013), revealing the presence of a simple structure (Thurstone 1947), with both components showing some strong loadings.

The perception factors were illustrated (Figure 4) against their percentage of variance contributed. In addition, correlations between the environmental change awareness indices and loadings of the environmental change parameters are presented (Appendix A) along with pattern and structure matrix loadings on the two components, together with their communalities (Appendix B).

The factor scores of the households from the two communities were analysed together but plotted separately on scatter plots (Figures 5 and 6), representing the scores of each household on each of the perception variables; this is presented in order to visualize and assess the perceptions of environmental change awareness in the two communities and their loadings on the two components.

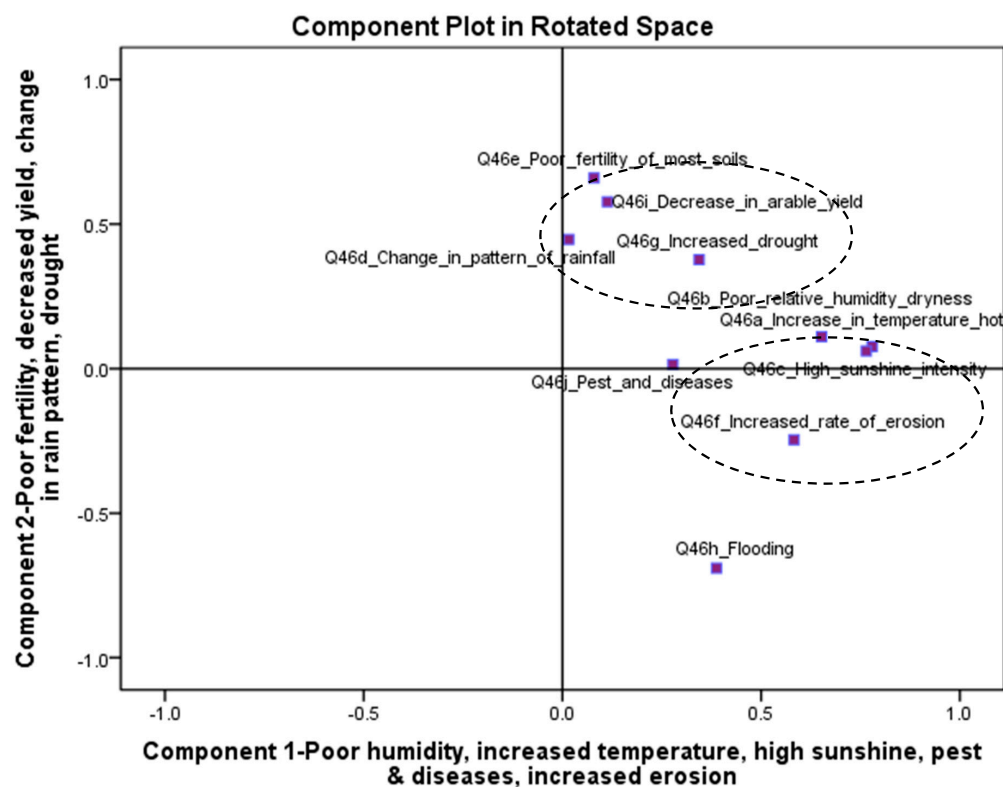


Figure 3. Component plot in rotated space of perception variables for both communities.

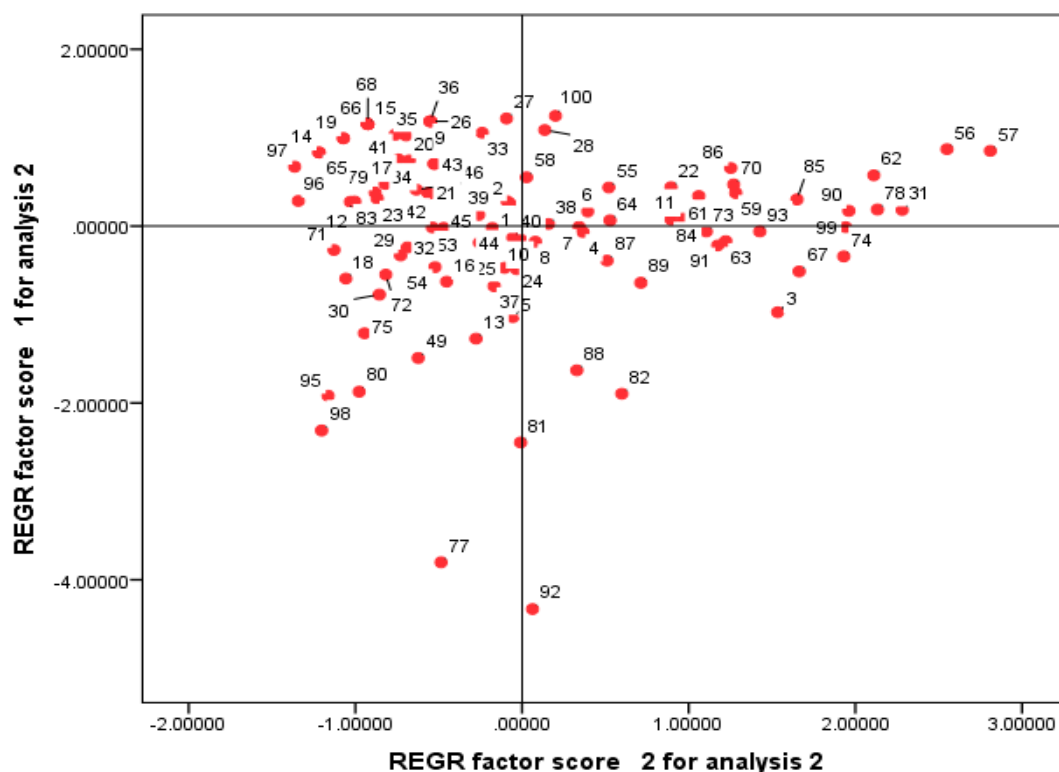


Figure 6. Scatter plot of regression factor score of households in Kofa from the two PCA factors.

4.1.4. Gender Difference

Mann–Whitney U tests showed significant difference between the genders in terms of climate change perception, where male respondents were more informed about change in climate compared to the female respondents. This was articulated in Zango as three variables: increased rate of erosion ($U = 235.0, p < 0.05$), flooding ($U = 753.0, p < 0.05$) and pests and diseases ($U = 334.5, p < 0.05$), while in Kofa, one variable—high sunshine intensity ($U = 385.0, p < 0.05$)—was the main variable.

4.1.5. Age and Education Differences

No significant difference was recorded on any of the perception variables based on age and the highest level of educational attainment of respondents in the two communities.

4.1.6. Climate Change Adaptation Practices

Good practices such as mulching for water and fertility management, rehabilitating problems of soil sealing and compaction (Kidane 2010) were poorly adopted, as indicated in the baseline survey. Similarly, a few households had adopted irrigation in Kofa, compared to no uptake in Zango. Most respondents in Kofa and all respondents in the Zango community adopted agroforestry and improved varieties of crops due to access to improved seeds from ICRISAT. Uptake of intercropping was 93% and of crop rotation was 80% in Zango, compared to 67% and 44%, respectively, in the Kofa community (Figure 7). This negates the argument that despite the viability of these practices in soil and water management, only a few farmers in this part of Nigeria are engaged in the uptake of these practices (Akande and Ogundele 2009).

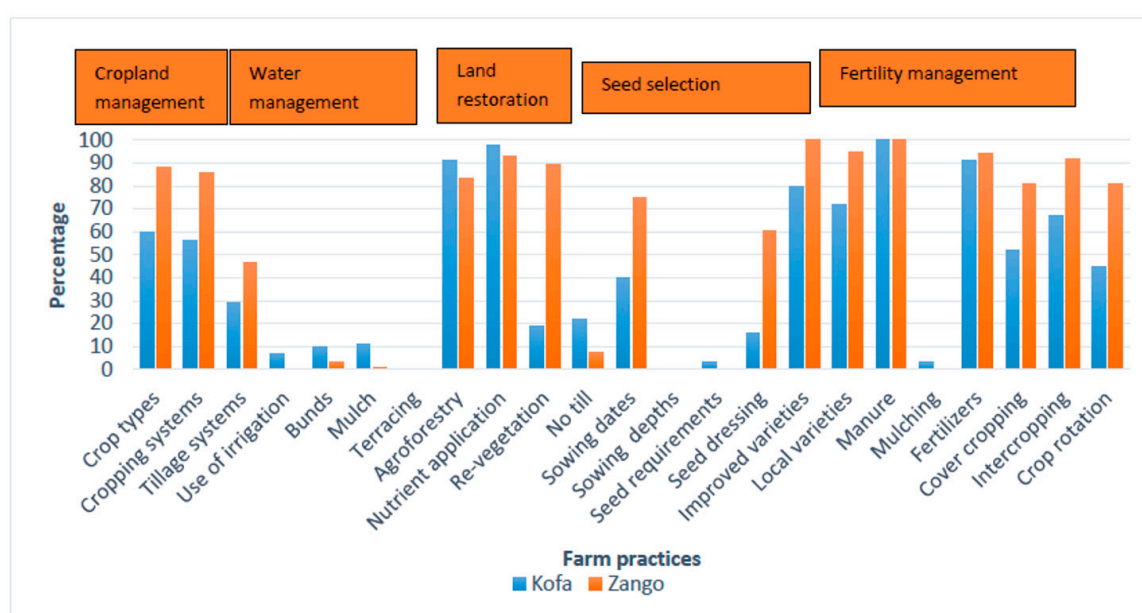


Figure 7. Current farm practices employed in Zango (n = 120) and Kofa (n = 100) based on a baseline study.

4.2. Climate Change and the Theory of Planned Behaviour

4.2.1. Variability of Determinants across Climate Change Adaptation Behaviour

The descriptive statistics of the theory of planned behaviour model of climate change adaptation practices are listed in Table 4.

Table 4. Descriptive statistics of TPB components for climate change adaptation behaviour (Zango—n = 86; Kofa—n = 68).

TPB * Variables	Item's Composition	Mean		SD		Cronbach's Alpha	
		Zango	Kofa	Zango	Kofa	Zango	Kofa
Attitudes	Mean of 3 items	7.91	7.51	2.04	2.26	0.80	0.81
Subjective norms	Mean of 3 items	7.37	7.06	2.00	2.27	0.47	0.57
Perceived behavioural control	Mean of 3 items	5.93	6.21	1.49	1.98	0.34	0.43
Behavioural intention		2.76	2.87	1.07	1.01		

TPB—theory of planned behaviour; SD—standard deviation. * The attitudes, subjective norms, perceived behavioural control and intention measures were rated on Likert and bipolar adjectives scales from one to four. Higher figures indicate more positive responses.

4.2.2. Multiple Regression Analysis of Climate Change Adaptation Intention

A multiple linear regression was employed to assess the TPB model for climate change adaptation behaviour to predict the main determinant of climate change adaptation from attitude, subjective norms and perceived behavioural control, and also to test whether climate change perception predicts adaptation behaviour. The reliability of the TPB questions was verified using Cronbach's alpha coefficient. Significance level was set at 0.05.

The intention of households to adapt in the two communities was predicted from direct attitudes, subjective norms and perceived behavioural control. The regression model explained approximately 61% and 55% of the variance of the intention to adapt in Zango and Kofa, respectively (Table 5).

When analysing more specifically, one predictor (attitude towards behaviour) contributed significantly towards the prediction of adaptation intention to climate change in the two communities

(0.9 and 0.8 for Zango and Kofa, respectively), while subjective norm also contributed significantly to adaptation intention in Kofa (0.6), but not in Zango (Figures 8 and 9).

Table 5. Regression model for Zango and Kofa communities for climate change adaptation intention.

Community	R ²	Adjusted R ²	MS Residual *	F (Significantly Different from Zero)
Zango	0.65	0.61	0.452	(3, 82) = 40.73
Kofa	0.61	0.55	0.452	(3, 64) = 29.38

* $p < 0.05$. MS-Mean Square.

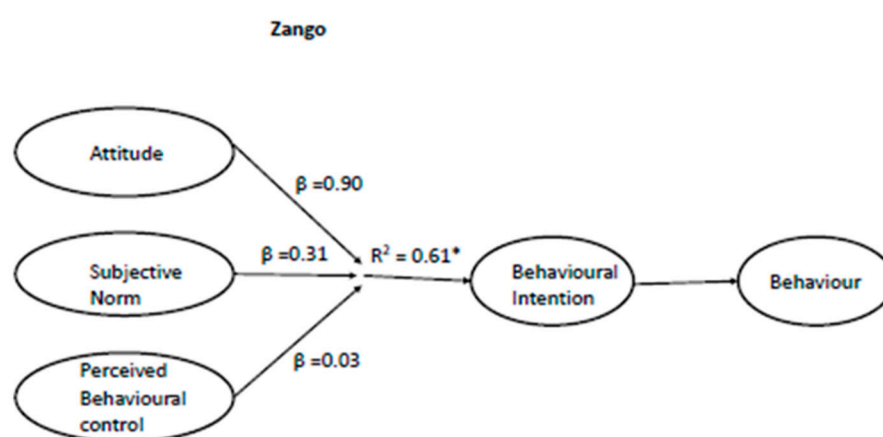


Figure 8. Theory of planned behaviour model for climate change adaptation determinants for the Zango community (* $p < 0.05$).

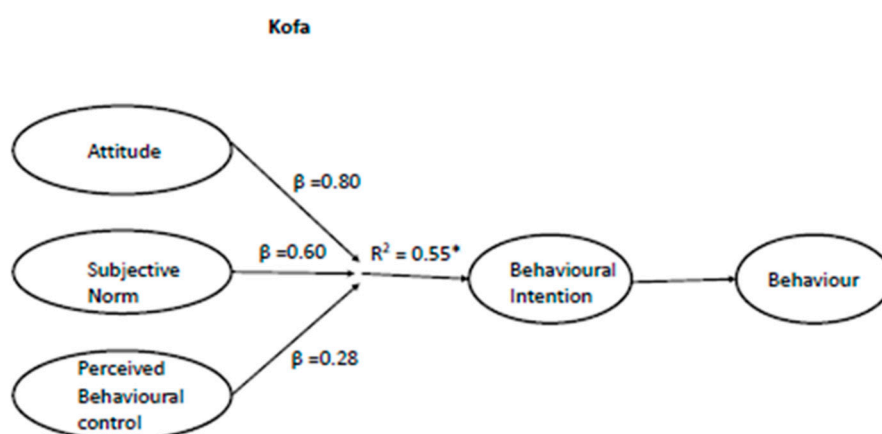


Figure 9. Theory of planned behaviour model for climate change adaptation determinants for the Kofa community (* $p < 0.05$).

5. Discussion

Roof types of houses are important indicators for livelihoods in this region, as investments in zinc roofing are indicative of improved disposable income compared to thatching with local materials. Such roofs are also more efficient in harvesting water for domestic uses and potentially for vegetable garden production as an adaptation strategy. Despite the presence of irrigation facilities in the outskirts of the Zango community, the type of agriculture practiced was 100% rainfed; this was also the dominant practice in Kofa, though 7% of respondents also used irrigation. The responses from the survey clearly indicate that extension communication channels need improvement to enable households to access

up-to-date information, early warnings and new drylands technology to help in their decision-making for adaptation.

In agrarian economies dependent on natural resources, roles, responsibilities and assets are often differentiated by gender. The farming household heads, who were mostly men or widows, controlled land, meaning that those women who controlled both nearby and distant areas of land were from female-headed households. The dominance of male respondents in the practice of agriculture in the study areas is likely due to religious barriers that limit female participation in northern Nigeria and a limited number of female extension agents that will interface with the women (De Schutter 2013). The Zango community has more access to extension than that in Kofa. Although gender can determine the coping strategies adopted under a climate change scenario (Mehar et al. 2016), female-headed households were too few in this study to accurately determine this phenomenon.

Addressing environmental challenges of farming in the drylands of northwestern Nigeria will require an understanding of current practices of farming households. Despite not being exhaustive, current adaptation practices uptake in the two study communities shows some good ongoing practices. We noted that adaptation practices important for dryland resilience were visibly absent in both communities (Figure 7). Hence, updating farming households' knowledge and improving all the three determinants of adaptation behaviour would be a valuable part of future extension. The results from the TPB survey suggest that attitudes towards behaviour and subjective norms were the most important determinants of intention to adapt to climate change in Kofa, while only attitude was important in Zango. Thus, households were more likely to integrate adaptation into their farming practices when they perceive climate change to be happening.

The significance of perception has been demonstrated in other climate change adaptation studies (e.g., Weber 1997; Grothmann and Patt 2005). Subjective norms (Masud et al. 2016) and perceived behavioural control (Lin 2013; Masud et al. 2016) were argued to be the significant determinants of adaptation to climate change in other studies. Although the subjective norms and perceived behavioural control were skewed positively in this study (Table 4), only the subjective norms aspect was significant in determining intention in Kofa, while both factors were not considered significant determinants of climate change adaptation in Zango. Findings also suggest that for climate change adaptation behaviour, intention may not be considered completely within households' attitudes alone and that a lack of available and up-to-date extension information could contribute to poor awareness, which in turn could limit adaptation to climate change. Hence, it could be argued that more emphasis on the modern means of information dissemination, such as information communication technology (ICT), internet, and the print and electronic media, which was found to be poorly utilized in this study, could improve adaptation intention and subsequently behaviour.

This paper tested the usefulness of the TPB in prompting climate change adaptation intention against the backdrop of climate change perception by Zango and Kofa smallholders. As anticipated, the TPB model accounted for a substantial variance in the association amongst subjective norms, attitude and perceived behavioural control and intention. The mean responses for all the variables were positively scaled. This suggests that most farming households have positive attitudes and intentions and received social pressures to adapt to environmental challenges. Cronbach's alpha coefficients showed the level of internal reliability in the responses to questions. An alpha coefficient greater than 0.7 was considered suitable (DeVellis 2012). Only attitudes towards behaviour had a Cronbach's alpha coefficient >0.7 in the two communities, which suggests that the households responded and ranked the questions related to attitude consistently.

The level of trust in one's effectiveness will affect the intention to cope with a given circumstance. While people tend to avoid or fear unfavourable events that they perceive to exceed their adaptive capacities, they often engage and have confidence in activities they feel competent about handling, even if they are potentially threatening (Bandura 1977). High perception of climate change risks could lead to interest in adaptation or mitigation, as an understanding of the benefits of such action is necessary for a behavioural change (Burch and Robinson 2007). This is exemplified in the findings of

this study, as the respondents considered climate change perception as an important driver of adaptive behaviour in the two communities. Similarly, intentions are to a reasonable extent expected to result in the performance of a behaviour, as [Ajzen \(2015\)](#) asserted that a person is likely to have an intention to carry out a specific behaviour if an intention to perform the behaviour exists. This aligns with results from this study, which show positive values for intention to carry out the adaptation behaviour. However, available evidence across a range of disciplines show that mere intention to act does not always translate into action ([Niles et al. 2016](#)). In the same vein, other studies for sub-Saharan Africa (e.g., [Bryan et al. 2009](#)) found that though respondents perceived climate change to be happening, perception did not lead to adaptation. This was argued to be due to certain barriers such as lack of access to credit and land. Respondents in the Zango community, being the drier community, perceived higher sunlight intensity to be increasing, while Kofa, which experiences relatively more rainfall, perceived rainfall to be decreasing. Previous climate change perception studies for the Nigerian Savanna ([Tambo and Abdoulaye 2013](#)) show similar trends, where the perception of rainfall and temperature differed according to agroecological zones (AEZ). It is noteworthy that the average annual rainfall in Africa as a continent is 655 mm ([World Bank 2019](#)). Therefore, the rainfall average in Kofa is 180 mm higher than the average for Africa, while in Zango, it is 64 mm below the average for Africa (see Section 3.1).

PCA showed four components with eigenvalues more than 1, which explained 24.1%, 15.9%, 12.8% and 11.7% of the variance, respectively. The scree plot showed a significant break after the fourth component, and using the [Catell \(1966\)](#) criteria scree test, two components were retained for further analysis. The result suggests that component 1 comprised variables that portray temperature and heat-related signs of the environment changing, while component 2 showed variables related to changes in rainfall (Figure 3); these informed the choice of sustainable practices for training as part of the research intervention. These practices included reduced tillage, cover cropping (mulching) and crop rotations.

While previous studies have suggested that perception determines intention to adapt to climate change ([Burch and Robinson 2007](#); [Dang et al. 2014b](#)), this study has further explored how PCA can segment perceiving from nonperceiving households. Results from the scatter plots show outlier households away from the groupings, such as respondents ID 3, ID 4, ID 5, ID 32, ID 58, ID 109, and ID 112 for Zango (Figure 4) and ID 77, ID 81, ID 92 and ID 98 for Kofa (Figure 6). This suggests that such analysis can identify nonperceiving households who have been left behind in the perception of environmental change and adoption of good farming practices, as indicated by few assets and livestock, few crops, small land sizes and lack of access to extension for most of these groups. Similarly, households represented at the forefront of the groupings (top of Figures 5 and 6) are demonstrating that they are sensitized to climate change and are adapting more successfully, as indicated by their higher assets (ID 116, ID 117, ID 113, ID 106, ID 102, ID 54, and ID 11 and ID 100, ID 97, ID 96, ID 68, ID 43 and ID 39 for Zango and Kofa, respectively); these households may contain perceptive lead farmers for improved farmer-to-farmer extension or community self-help. However, in stating these observations, this paper did not find these characteristics to be exclusive to these groups and the available data did not sufficiently validate these findings. In addition, our further probing of the available data did not show any unique features that could describe the outlier group, which may be serendipitous.

Perceived behavioural control is achieved when there is a complete belief that the required resources and privileges to carry out an action is possessed ([Ajzen 1985](#)). This implies that the more the person perceives control over a certain behaviour, the greater the motivation they have to perform that action ([Ajzen 1985](#); [Madden et al. 1992](#)). Poor perceived behavioural control recorded in this study may signal limited motivation to carry out the adaptation behaviour. Contrarily, when intentions are held constant, it is more likely to perform a behaviour as PBC increases ([Conner and Armitage 1998](#)). It is highly likely that intention, when strong, indicates willingness to make effort to perform a behaviour; that is, the stronger the intention, the more likely it is to perform the behaviour ([Ajzen 1991](#); [Dang et al. 2014b](#)). Hence, it could

be argued that if smallholders believe they have the capacity to carry out adaptation behaviour, they will likely carry it out.

It can reasonably be suggested that climate change perception, the presence of PBC and attitude towards behaviour can lead to adaptation behaviours. However, [Conner and Armitage \(1998\)](#) argue that the link between behaviour and PBC is not a straightforward one, as there is a likelihood to engage in desirable behaviours that one has control over, while one is unable to carry out a behaviour that one has no control over. Contrary to findings from previous psychological studies that suggested that attitude does not influence people's behaviour (Wicker 1969, cited in [Terry et al. 1999](#)), this study found attitude to be a key determinant of behaviour.

6. Conclusions

This paper demonstrated that while socioeconomic factors (capital and assets such as land) are important determinants of climate change adaptation, other key determinants exist, such as perception, which can cover the shortcomings of capital and assets. Evidence from farmer responses and field observations indicate that the climatic variables have been fluctuating, suggesting signs of the climate changing. However, a review of current practices embarked upon by the farming households indicate some ongoing good adaptation practices, although some key dryland adaptation actions were scantily practiced. PCA has allowed us to segment climate change-perceiving from -nonperceiving farming households. However, additional research is required to verify this. The theory of planned behaviour has also predicted the role of perception as a determinant of adaptation to climate change, although intention alone is insufficient to influence a behaviour in the absence of the ability to execute that intention. Finding means of improving the three behavioural determinants would be useful. The multiple regression model explained (for Zango = 0.61; for Kofa = 0.55) the level of significance of the variance in climate change adaptation intention ($p < 0.05$). Although mean values for subjective norms and perceived behavioural control were positively skewed, the subjective norm was a significant predictor of intention in Kofa, but not Zango, while perceived behavioural control was not a significant predictor of intention to adapt to climate change in either of these communities. The findings from this paper have implications for both policy and practice. The findings will support policymakers to design programmes and extension strategies that will influence the decision to adapt, thus reducing the impact of climate change and degradation to farming household livelihoods. For practitioners, extension should focus on improving farmer knowledge of ongoing climatic changes and on the need to adopt sustainable adaptation practices suitable for managing dryland conditions.

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Appendix A

Table A1. Correlations matrix between perception variables.

	Increased Temperature/Hot	Poor Humidity/Dryness	High Sunshine	Change in Rainfall Pattern	Poor Fertility of Soils	Increased Erosion	Increased Drought	Flooding	Decreased Arable Yield	Pests and Diseases
Increased temperature/Hot	1.000	0.483	0.630	0.150	0.057	0.212	0.123	0.085	0.150	0.125
Poor humidity/Dryness		1.000	0.399	0.034	−0.002	0.162	0.274	−0.004	0.127	0.047
High sunshine			1.000	0.108	0.068	0.202	0.198	0.084	0.091	0.157
Change in rainfall pattern				1.000	0.128	−0.078	0.048	−0.155	0.094	−0.009
Poor fertility of soils					1.000	0.197	0.322	−0.216	0.301	0.087
Increased erosion						1.000	0.249	0.363	−0.043	0.143
Increased drought							1.000	−0.059	0.112	−0.078
Flooding								1.000	−0.126	0.096
Decreased arable yield									1.000	0.213
Pests and diseases										1.000

Appendix B

Table A2. Pattern and structure matrix for PCA with Oblimin rotation of a two-factor solution of perception elements.

Item	Pattern Coefficients		Structure Coefficients		Communalities
	Component 1	Component 2	Component 1	Component 2	
Increased temperature	0.779	0.076	0.788	0.165	0.626
High sunshine intensity	0.765	0.061	0.772	0.149	0.599
Poor humidity/dryness	0.652	0.111	0.665	0.185	0.454
Increased erosion	0.583	−0.246	0.555	−0.179	0.367
Pest and diseases	0.278	0.015	0.280	0.046	0.078
Flooding	0.388	−0.693	0.309	−0.648	0.569
Poor fertility of soils	0.080	0.659	0.115	0.669	0.453
Decreased yields	0.113	0.577	0.179	0.590	0.361
Change in rainfall pattern	0.016	0.447	0.067	0.449	0.202
Increased drought	0.344	0.377	0.387	0.416	0.290

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