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Understanding young people's perception toward forestation as a strategy to mitigate climate change in a post-conflict developing country

Osman M. Jama[1,2,3] · **Abdishakur W. Diriye**[2,3,5] · **Abdulhakim M. Abdi**[4]

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Abstract
Understanding the perceptions of young people is a critical issue in the formulation and implementation of climate change mitigation strategies. Based on cognitive hierarchy theory, the present study aims to investigate the factors that motivate or hinder young people's perception of forestation as a strategy to mitigate climate change in post-conflict Somalia. This study hypothesized a model in which climate change knowledge, risk perception and forest value orientations (anthropocentric/biocentric) influence attitude toward forestation and attitude, in turn, predicts behavioral intentions. We randomly surveyed students from three universities in three different regions of Somalia and collected 434 structured survey questionnaires. Using structural equation modeling, the results showed that climate change knowledge is a significant predictor of behavioral intention but not attitude toward forestation. The results also revealed that young people's perception toward forestation as a strategy to mitigate climate change is significantly influenced by biocentric value orientation both directly and indirectly through attitude toward forestation. Contrary to previous studies, our results indicate that attitude partially mediates the relationship between biocentric value orientation and behavioral intentions and fully mediates the relationship between anthropocentric value orientation, risk perception and behavioral intentions, while it did not show any mediation results between climate change knowledge and behavioral intention. We found that the young people's climate action or inaction is mainly shaped by climate change knowledge, biocentric value orientation, and attitude toward forestation. Finally, climate change mitigation efforts should avoid relying solely on attitude for behavioral decision-making formation and instead incorporate other factors into a more comprehensive framework.

Keywords Forestation · Afforestation · Reforestation · Cognitive hierarchy theory · Structural equation modeling · Somalia · Somaliland · Puntland

✉ Abdishakur W. Diriye
geesood08@mail.ustc.edu.cn

Extended author information available on the last page of the article

1 Introduction

Climate change is one of the twenty-first century's biggest global problems, and to effectively reduce atmospheric carbon dioxide (CO_2) levels, mitigation strategies require both source reductions in greenhouse gas emissions and a significant enhancement of the land sink of CO_2 through photosynthesis (Bastin et al., 2019; IPCC, 2021). In recent years, there has been growing attention to forests as an effective way to mitigate climate change as they store large quantities of carbon in vegetation and soil (Bastin et al., 2019). Governments, international organizations, and researchers are increasingly recognizing the importance of forestation (which comprises forest restoration, reforestation, and afforestation) as a feasible strategy to tackle climate change (Bastin et al., 2019; Peterson St-Laurent et al., 2018; Strange et al., 2019). The Kyoto Protocol in 1997 was one of the first efforts that underlined the need for forestation as an effective strategy to mitigate climate change. The Intergovernmental Panel on Climate Change reported that forest restoration efforts have a mitigation potential of 0.2–13.8 gigatonnes equivalent carbon dioxide per year (GtCO2e/year) by 2030 with a cost up of to US$100/tCO2e (Smith et al., 2014). However, as efforts to reduce global carbon footprints through forestation and forest management continue, understanding the perceptions of the target groups such as young people has become a critical issue in the formulation and implementation of such promising projections and policy options (Lee et al., 2020; Lin et al., 2012). Although public perception is not a prerequisite for far-reaching solutions to climatic or environmental problems, it has a substantial effect on policy implications that are essential to reduce climate change through carbon sequestration in forests or to increase forest resilience to climate change (Beiser-McGrath & Huber, 2018; Peterson St-Laurent et al., 2018). In general, the public perception toward specific policy propositions such as forestation and forest management can be measured by the people's attitudes and value orientations. Numerous studies have revealed that understanding people's attitudes and value orientation toward forest management has a favorable influence on the formulation and execution of forest policies that are intended to mitigate climate change (Meijer et al., 2015; Peterson St-Laurent et al., 2018; Petit et al., 2021; Strange et al., 2019). Such understanding of people's perceptions can serve to eliminate disputes between the public and policymakers, allowing the proposed policies to be executed effectively (Clement & Cheng, 2011). Aside from people's attitudes and values orientations, other factors such as factual knowledge and risk perception are also considered as essential components that determine policy perceptions (Choon et al., 2019; Lee et al., 2015; O'Connor et al. 1999). Other factors, such as socio-demographics including gender, age and, individual amenities, (e.g., education, employment, wealth, and political inclination) are also found to explain environmental and climate-related behaviors (Beiser-McGrath & Huber, 2018; Hornsey et al., 2016; Lee et al., 2015; Vaske et al., 2001), and educated younger people, who are financially better positioned and politically lean to the left have more environmental and climate change concerns (Vaske et al., 2001). However, research focusing on students and young people's perception is limited in countries that are socially conservative with low per capita incomes and education. This paper aims to fill this knowledge gap by studying the factors that motivate or hinder the perception of young people (between 18 and 35 years of age) on forestation as a strategy to mitigate climate change in Somalia, a socially conservative, less-developed, post-conflict country. Specifically, this study attempts to shed light on (1) whether climate change knowledge, risk perception, and forest value orientations predict attitudes for specific climate change management intervention (forestation) and attitude in turn predicts the behavioral intentions to adapt forestation

as a strategy to mitigate climate change, (2) whether attitude toward forestation mediates the relationship between the higher-order cognition variables and behavioral intentions in the cognitive hierarchy theory. We are interested in investigating this age-group because the majority of available studies on young people's perceptions of climate change are primarily from the developed world and to the best of our knowledge there are no studies in post-conflict settings such as Somalia. It is not clear whether the factors that explain climate- and environmental-related attitudes of young people from post-conflict developing countries such as Somalia are consistent with those of developed countries. As such, assessing such different socioeconomic and cultural contexts would help both researchers and practitioners better understand and compare perceptions to policy interventions in different scenarios.

The remainder of this article is organized as follows: In the second section, we elaborate on the conceptual framework and derive from a set of hypotheses. In the third section, we describe the materials and methods including data collection, survey structure and statistical modeling. In the fourth section, the results are presented. In the fifth section, the results are discussed in relation to previous studies followed by theoretical and practical implications. In the final section, conclusions and limitations are presented.

2 Theoretical framework and hypotheses

2.1 Cognitive hierarchy theory

The cognitive hierarchy theory posits that the individual assessment of the surrounding environment is controlled by a set of linear structure concepts of value patterns, specific beliefs, attitudes, norms and behavioral intentions or actual behaviors (Homer & Kahle, 1988). Figure 1 provides a theoretical illustration of the underlying logic of the cognitive hierarchy model. Multiple cognitive levels are depicted, with base values serving as the groundwork for higher-level attitudes and behaviors (Brown & Reed, 2000). The base values are described as being small in size, commonly held in society, and surpass the unique circumstances and experiences, so metaphorically they are often inadequate in explaining the specific attitudes and behaviors (Homer & Kahle, 1988; McFarlane & Boxall, 2000, 2003). In this respect, the cognitive hierarchy portrays the function of values in shaping behavior via a sequence of higher-order mediating procedures such as general beliefs (Vaske & Donnelly, 1999). General beliefs regulate specific attitudes, which in turn influence actual behaviors. The next sections discuss the variables in the cognitive hierarchy such as forest value orientations, knowledge, attitude and behavioral intention.

2.1.1 Behavioral intention to adapt forestation as a strategy to mitigate climate change

Behavioral intention in the cognitive hierarchy theory is predicted by an additive amalgamation of higher-order attitudes toward the behavior and social norms about specific attitudes or behaviors that are direct precursors to behavioral intention. This study tested behavioral intention to adapt forestation because of the complexity in identifying behaviors linked to climate change which are generally applicable and contextually relevant. Prior studies show that behavioral intentions are closely associated with actual behavior (Ajzen, 1991; Kollmuss & Agyeman, 2002), and as such the actual behavior would presumably

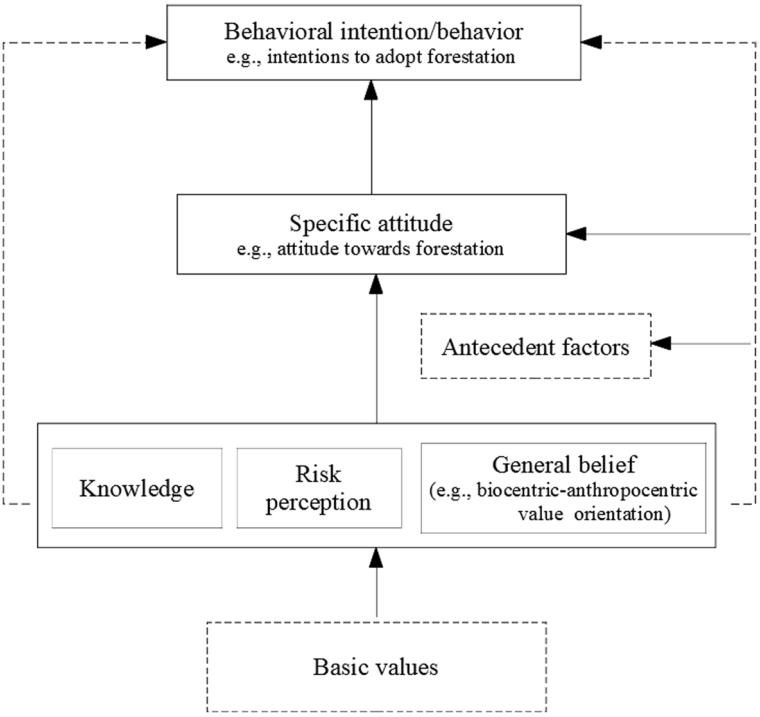

Fig. 1 Conceptual representation of a cognitive hierarchy theory of human behavior. Boxes with dashed lines were not included in the analysis. Solid arrows denote the hypothesized paths; dashed paths denote that were not hypothesized. In our model, knowledge, risk perception and value orientations (anthropocentric–biocentric) provide the foundation for higher-order attitudes and behaviors. Adopted from (McFarlane & Boxall, 2000)

be achieved once the determinants to perform the intentions are identified (Ajzen, 1991). Previous studies on public perception have extensively used intentions to reforestation (tree planting) as a climate change mitigation strategy. For instance, Curry et al. (2005) analyzed the public perception of British people and concluded that 76% of those polled think that planting trees would lower the amount of carbon dioxide. In the USA, Leiserowitz (2006) found that 49% would adopt afforestation as a strategy to combat global warming. Reiner et al. (2006) carried out a study in four nations, the UK, Japan, the USA and Sweden, to determine the proportion of individuals who could employ carbon sequestration (i.e., afforestation), and the findings revealed that people in Japan had the greatest percentage. Overall, behavioral intentions toward afforestation as a strategy to mitigate climate change are influenced by the resources people have to participate in tree planting and their attitudes toward forestation (Lin et al., 2012).

2.1.2 Attitude toward forestation

Attitude is more specific in the cognitive hierarchy theory and is defined as an individual's negative or positive cognitive evaluations, emotional experience or behavioral patterns that are regularly present in specific circumstances (Ajzen, 1991). The hypothesis in the cognitive hierarchy theory suggests that specific attitudes affect behaviors, and other factors

such as knowledge and value orientations have their effect on behaviors indirectly through specific attitudes (McFarlane & Boxall, 2000, 2003; Vaske & Donnelly, 1999). There is a significant difference in the public's attitude on tree planting for general and specific issues. For example, Karppinen (2005) investigated the attitudes of forest managers in Sweden and showed a positive attitude toward natural reforestation. Kazana et al. (2015) discovered relatively positive attitudes toward genetically engineered tree plantations among students in predominantly European nations. Nonić et al., (2015) used identical procedures and obtained comparable findings. Hajjar and Kozak (2015) revealed that almost half of Western Canadian citizens agreed to plant more trees with features introduced through biotechnology to address climate change. However, in the same region, just 25% of the population backed reforestation using genetically engineered technology to adapt to climate change (Peterson St-Laurent et al., 2018). Overall, a positive attitude toward forestations as a strategy to mitigate climate change can enhance people's behavioral intention to participate in tree planting, but actual involvement is still influenced by other variables such as climate change knowledge, risk perception and value orientation (Lin et al., 2012).

2.1.3 Climate change knowledge

Knowledge is defined as an individual's ability to distinguish the facts, concepts and relationships between behaviors and environmental protection (Fryxell & Lo, 2003). Early models of environmental communication posited that there are knowledge gaps between the general public and climate change experts, and as a remedy for this gap, climate communicators proposed a deficit model, which is a linear model where information flows from experts to the general public in an attempt to change individuals' attitudes, beliefs and behavioral decision-making (Suldovsky, 2017). These models contended that the awareness of environmental problems would provoke concern for the environment, which in response inspires people to participate in pro-environmental behaviors (Kollmuss & Agyeman, 2002). However, such models were identified as being overly simplistic, inconsistent, and labeled as information deficit models (Suldovsky, 2017). Thus, further determinants to explain behavioral intentions or actual behaviors are needed, particularly, climate change which is a prime example of a politically polarized issue (Kollmuss & Agyeman, 2002). Although it has been theoretically argued that knowledge accounts for a substantial part of pro-environmental behaviors (Amoah & Addoah, 2021), most studies have reported that knowledge is not a powerful predictor in explaining actual behavior and they suggested that the influence of knowledge on behavior can be mediated by other higher-order cognitions or beliefs (Kollmuss & Agyeman, 2002; Peterson St-Laurent et al., 2018). Applying this assumption, both older and more recent studies have reported that individual knowledge of the causes and consequences of climate change plays a significant role in developing intentions to address climate change, but it is still not established if the influence is direct or indirect through risk perception and beliefs or attitudes toward specific behaviors (Kwon et al., 2019; O'Connor et al., 1999).

2.1.4 Risk perception

Risk perception is an important predictor of the public's attitudes toward climate change (Leiserowitz, 2006; Spence et al., 2011). A significant argument in the literature on human behavior has focused on risk perceptions as one of the main factors affecting people's willingness to support forest conservation as a strategy to mitigate climate change (O'Connor

et al. 1999; Peterson St-Laurent et al., 2018). The core of this argument states that people who perceive negative environmental effects as threats will be more prepared to take mitigation and adaptation actions as there are favorable positive associations between risk perception and attitude toward climate change (O'Connor et al. 1999, Kwon et al., 2019). However, risk perceptions might differ substantially between the general public and various interest groups. Scientists, for example, frequently estimate risks based on real probabilities, but members of the general public frequently evaluate risks based on more personal and emotional responses (Leiserowitz, 2006; Spence et al., 2011), that said, experiences of climate-related natural hazards can cause an increase in the probability of climate change being perceived as a severe risk (Broomell et al., 2015; Spence et al., 2011).

2.1.5 Value orientations

Values orientations are most central beliefs concerning general objects and provide meaning to abstract values (Bright et al., 2010; Manfredo et al., 2009). It is a lasting belief in first-order cognitions that form the basis for specific attitudes toward a topic, such as forestation in the cognitive hierarchy framework (McFarlane & Boxall, 2000). Value orientation in the context of natural resources is possible along a gradient from anthropocentric to biocentric value orientation continuum (Vaske & Donnelly, 1999; Vaske et al., 2001). Anthropocentric value orientation signifies the viewpoint of the biosphere centered around humans. This is the traditional notion of natural resource management which bases policies on a utilitarian concept. It is the idea that the primary aim of environment is to provide the people benefits such as timber, food and recreation (Bright et al., 2010). In contrast, biocentric value orientation emphasizes environmental preservation and ecosystem maintenance and is focused on nature (Vaske & Donnelly, 1999; Vaske et al., 2001). Here, the human values of natural resources, ecosystems and species are at the core and continue to be significant but are seen from a broader perspective (Fulton et al., 1996). They typically predict attitudes and preferences of specific issues, and specific attitudes in turn predict behavioral intentions or behaviors. For example, value orientations provide essential and accurate measures of whether proposed forest policies or national forestry plan would be acceptable to the public (Clement & Cheng, 2011; Fulton et al., 1996; Vaske et al., 2001). Values orientations have been investigated in relation to forest planning and management (Brown & Reed, 2000; Clement & Cheng, 2011), wildlife planning and conservation (Bright et al., 2010), biodiversity protection (Matzek & Wilson, 2021) and forests as a climate change mitigation/adaptation strategy (Hajjar & Kozak, 2015; Peterson St-Laurent et al., 2018). Studies on people's attitudes about forests as a climate change mitigation strategy revealed that anthropocentric value orientations have less influence on attitude and biocentric orientations have a stronger influence on attitude (Peterson St-Laurent et al., 2018). Other studies have indicated that biocentric orientations have a major impact on attitude toward forest conservation (Vaske & Donnelly, 1999), while it has a weak influence on people's attitudes toward forests as an adaptation strategy to climate change (Hajjar & Kozak, 2015).

2.2 Hypothesis

This study is grounded on previous studies related to specific natural resource management interventions and proposes six hypotheses based on the principle of cognitive hierarchy model:

H1 Attitude toward forestation positively influences behavioral intentions to adapt forestations as a strategy to mitigate climate change.

H2 Climate change knowledge positively influences the attitudes toward forestation.

H3 Risk perception positively influences the attitudes toward forestation.

H4 Anthropocentric value orientation positively influences the attitude toward forestation.

H5 Biocentric value orientation positively influences the attitude toward forestation.

H6 Attitude toward forestation mediates the relationship between climate change knowledge, risk perception, value orientations and behavioral intention to adapt forestation as a strategy to mitigate climate change.

3 Materials and methods

3.1 Study area and context

Somalia is located in the Horn of Africa between the latitudes of 2° S and 12° N and longitudes of 41° E and 51° E with a landmass of 636,240 km^2 (Fig. 2). The ecosystems of Somalia are part of the arid and semiarid belt that stretches across Africa comprising of trees that provide fuelwood and animal fodder and are dependent on the availability of water (Abdi et al., 2017). It is a type of dryland with low seasonal average rainfall (approximately 282 mm) where droughts occur every 2–3 years and are regularly followed by seasonal floods in the dry river valleys. Somalia is among the world's most climate-vulnerable countries, and climate projections suggest more frequent extreme climatic events (Busby et al., 2014), while the mitigation of, and adaptation to, climatic extremes are poorly integrated into the national adaptation and mitigation framework due to the absence of a functioning state for nearly three decades (Federal Republic of Somalia, 2013).

The forest cover in Somalia has considerably declined over the past three decades from 9,050,000 ha in 1980 to 6,363,501 ha in 2015 (FAO, 2014) (see example in Supplementary Fig. 1). Deforestation due to burning trees and unsustainable land use practices are some of the factors that negatively affect the composition of tree species and the density of the forest cover (Achu et al., 2021; Oduori et al., 2011; Diriye et al., 2022). This is in part due to the overexploitation of woody resources for charcoal and fuelwood which ultimately contributes to environmental degradation (Oduori et al., 2011). Furthermore, lawlessness in some parts of the country also contributes to the reduction in woody cover and the subsequent degradation of ecosystems (FAO, 2014). Tensions over natural resource control and use have further aggravated internal tensions and mass migration over time as natural resources have become increasingly scarce (Dehéz, 2009). For example, Somalia has witnessed significant deforestation for charcoal production due to weak forest regulations (Oduori et al., 2011). These destructive behaviors lead to conflicts between groups who advocate the availability of trees as an important fodder for their livestock and groups who trade in timber and perceive forests as lucrative businesses (Jama et al., 2020).

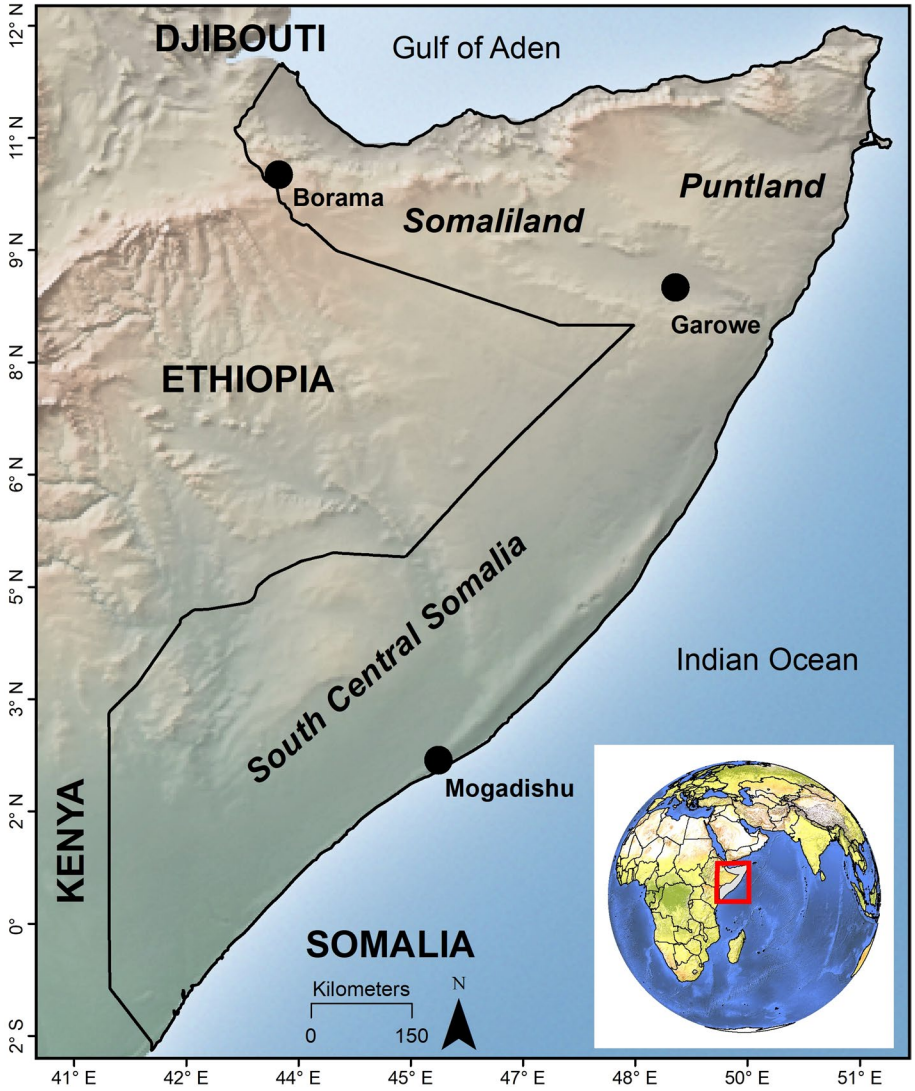

Fig. 2 Overview of Somalia's map relative to its neighbors and the African continent in the inset. Study sites include: Borama (Somaliland), Garowe (Puntland), Mogadishu (South central Somalia). The internal borders of the semi-/autonomous regions of Puntland and Somaliland are constantly changing and have thus been intentionally excluded from this map. The data source for these maps is Natural Earth Data (www.naturalearthdata.com)

3.2 Survey structure and measures

The survey questionnaire was structured into three sections. The first section introduces the research purpose and procedure of filling the questionnaires. The second section gathered demographic information and a basic understanding of the relationship between climate change and forest management. The third section was used to understand the respondent's

perception toward forestation as a strategy to mitigate climate change using the psychological factors of climate change knowledge, risk perception, value orientation (anthropocentric and biocentric), attitude toward forestation and behavioral intention. An initial list of measured items was drawn from an extensive literature review of previous studies in applied socio-psychological theories and slightly modified based on the context. A pretest was conducted on a small group of the target respondents ($n=30$) before the actual survey was distributed to ensure that the survey questions addressed the specific objectives of the study and to enhance the validity and reliability of the survey. The questionnaires were then slightly modified according to the expert suggestions.

We used existing measures with widely accepted validity to quantify the values and attitudes of our participants. Regarding the climate change knowledge variable, we adapted instruments from Peterson St-Laurent et al. (2018). The instruments comprised four statements that assessed the participant's knowledge of the links between climate change and forests, potential consequences of burning forests, strategies for forest management and their effect on climate change, and their knowledge of deforestation as one of the causes of climate change. Risk perception was measured using four instruments adapted from Leiserowitz (2006). The instruments focused on the risks associated with climate change impacts. This included experience of serious threat posed by climate change sometime during the lifetime of the participant, negative consequences of climate change and harmful long-term impacts of climate change on society. Forest value orientations (anthropocentric and biocentric) were measured with four instruments for each value orientation continuum that were adapted from Vaske and Donnelly (1999) and Vaske et al. (2001). The instruments of the attitude variable were adapted from Lin et al. (2012) and measured with four instruments assessing the respondent's attitude toward the potential of forestation to provide shade on hot days, reduce the temperature, sequester CO_2 and increase the availability of firewood. Finally, behavioral intention measurements were adapted from Lin et al. (2012) and the instruments focused on the intentions to contribute money to forest conservation, support stricter forest regulation, campaign for pro-environmental candidates and participate in a campaign against tree cutting for charcoal. All the constructs in the current study were latent variables and measured with multiple five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree).

3.3 Participants and data collection

The data used in this study are a self-administered, closed-ended survey questionnaire with organized sections deployed to a sample of three major universities in Somalia. Eight undergraduate students with prior survey experience were recruited as interviewers and trained in the survey procedure. Participants were selected using a random sampling technique from *Mogadishu University* in Mogadishu, South Central Somalia, *Puntland State University* in Garowe, Puntland, and *Amoud University* in Borama, Somaliland (Fig. 2). We purposively selected these universities as it is relatively safe to collect data, and their student bodies are representatives of the entire country as students move from their home regions to these cities where the universities are located. The cities where the universities are located are also sufficiently far apart to reduce subcultural similarities. According to the United Nations, 75% of the Somali population is under the age of 30 and is projected to continue growing, which encouraged us to target young Somalis for this study (Supplementary Fig. 2) (UNFPA, 2014). Before we collected the data, we calculated the sample size by applying a formula proposed by Tabachnick et al. (2007) that takes into consideration the

number of predictor variables that are used: $N > 50 + 8$ m (where the N = number of sample size m stands for the number of predictor variables). In this case, we have five predictors in our model which makes our sample size $N > 90$ respondents, but to get more accurate picture of the target population and to increase the reliability and validity of our study we increased the sample size to 500 participants.

The survey was administered between March and May 2019 during which a total of 500 questionnaires were circulated and 457 of them were returned. After cross-checking, unanswered and unengaged responses were discarded. A total of 434 (86.8%) valid responses, of which 157 were from Somaliland, 145 from Puntland and 132 from South Central Somalia, were prepared for further analysis. Since the data were collected from different regions, we checked whether there are significant differences in gender, awareness of climate change, perception of the importance of forest management, and willingness to participate in forestation campaigns. The datasets of the three samples were then merged into one dataset to avoid selection bias due to no significant differences. The chi-square ranged from 0.076 to 11.796; and the p value ranged from 0.161 to 0.963 (Supplementary Table 1).

3.4 Statistical analysis

Exploratory factor analysis was first performed using SPSS version 23 to identify factor loadings with maximum likelihood and varimax rotation as the extraction methods. Structural equation modeling was performed using AMOS version 24. The present study applied the two-stage testing approach suggested by Anderson and Gerbing (1988). In the first stage, confirmatory factor analysis (CFA) was used to estimate the reliability and validity of the measurement model. In the second stage, a structural (path) model was used to test the hypotheses of the latent variables (Anderson & Gerbing, 1988). However, we examined the measurement model goodness of fit before establishing the validity and reliability of the constructs.

As suggested by Hu and Bentler (1999), goodness of fit for the predicted model should be evaluated using chi-square $\chi^2/\mathrm{df} < 3$), root-mean-square error of approximation (RMSEA), comparative fit index (CFI), standardized root-mean-square residual (SRMR) and the Tucker–Lewis index (TLI). It is further recommended that CFI and TLI scores are satisfactory at a level higher than 0.9 (and preferably greater than 0.95), SRMR scores below 0.06 and RMSEA scores below 0.08 denote a good model fit (Table 4).

Before performing the CFA, data were screened for possible violations of the underlying assumptions of normality, skewness and bias and no statistical violations were found (see Supplementary Tables 3, 4, 5 and Fig. 4). Skewness/kurtosis scores ranged within the required ± 1 and ± 3 except three skewness items, which according to Bagozzi and Yi (2012) is not a concern for extreme non-normality. Furthermore, collinearity statistics (tolerance/variance inflation factor) and multivariate normality and outliers were all within acceptable ranges (Bagozzi & Yi, 2012). Additionally, we tested the common method bias using Harman's single-factor test. The highest variance explained by a single factor was 17.56%, which is considerably less than the threshold of 50%, indicating that our data do not contain common method bias. Equally, we ran specific bias tests to determine whether the dataset had zero bias and equal bias. The chi-square test for zero constrained ($\chi^2 = 86.114$, $\mathrm{df} = 24$, $p < 0.0$) and equally constrained ($\chi^2 = 86.114$, $\mathrm{df} = 23$, $p < 0.0$) models was significant. This means that the test of equal specific bias showed unevenly distributed

bias, which according to Pallant (2013) should not cause a problem if the simple size was greater than 40.

Mediation analysis was carried out using the nonparametric multivariate bootstrapping method developed by Preacher and Hayes (2008). In this study, 2000 bootstrap samples from the original data were used. Bootstrapping samples the original data with replacement and calculates the standard error of the indirect effects in each sample (Preacher & Hayes, 2008). This is a well-established approach used in mediation research to analyze both the total effect and indirect effects of the antecedent factors while controlling for other factors (Preacher & Hayes, 2008). The purpose of the mediation analysis was to determine whether attitude toward forestation fully or partially mediated the relationships between climate change knowledge, risk perception, value orientation (anthropocentric/biocentric) and behavioral intention.

4 Results

4.1 Survey demographics

Of the 434 valid responses, males comprised 64.5% ($n=280$) and females comprised 35.5% ($n=154$). The oldest respondent was 30 years old, the youngest was 19 years old, and the mean age was 26 years (Table 1). The majority of the respondents were either moderately aware 46.5% ($n=202$) or somewhat aware 31.1% ($n=135$) of climate change (see Fig. 3). Similarly, the majority of the respondents reported the importance of forest management as either important (20.3%, $n=88$) or very important (61.5%, $n=267$) (Fig. 4). Finally, 77.2% of respondents were either somewhat willing (38.5%, $n=167$) or very willing (38.7%, $n=168$) to participate in forestation campaigns (Fig. 5).

4.2 Measurement model

4.2.1 Confirmatory factor analysis

Stage one of the Anderson and Gerbing (1988) two-way approach was conducted to establish the validity and reliability of the latent variables underlying each measurement item. The results of the measurement model goodness of fit indicated that the model fit indices were satisfactory ($\chi^2=558.618$, $P<0.0$, df $=237$, $\chi^2/\text{df}=2.357$, SRMR $=0.045$,

Table 1 Demographics of the survey participants

Variable	Category	$N=434$	Percentage (%)
Gender	Male	280	64.5
	Female	154	35.5
Age	Average	26	–
	Maximum	30	–
	Minimum	19	–
Regions	Somaliland	157	36.2
	Puntland	145	33.4
	South central Somalia	132	30.4
Total		434	100

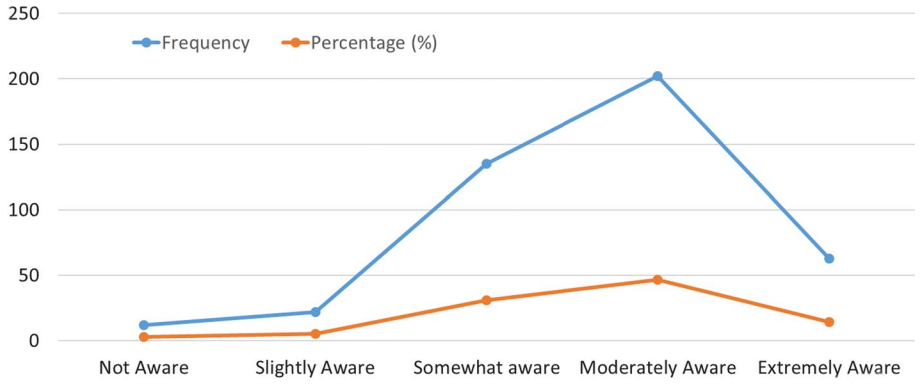

Fig. 3 Climate change awareness of survey respondents. These figures show a largely moderate awareness of the climate change

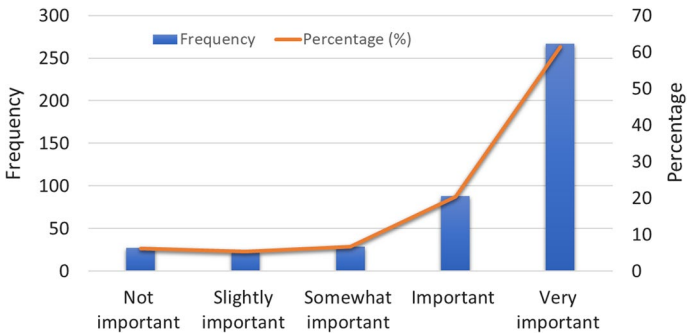

Fig. 4 Respondent perception toward their importance of forest management. The majority responded that forest management is very important to them

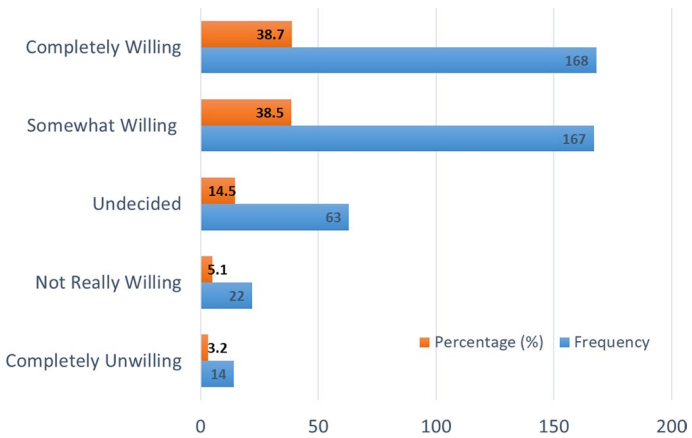

Fig. 5 Respondent willingness to participation forestation campaigns. Majority of the respondents were either somewhat willing or completely willing to participate the forestation campaigns

RMSEA = 0.056, CFI = 0.964) and acceptable according to Hu and Bentler (1999). However, a number of modification indices were suggested by the AMOS module as possible improvements to the model. After adding two covariance modifications to the error components of the measurement indices for attitude and behavioral intention, the goodness-of-fit indices were substantially improved ($\chi^2 = 413.342$, $p < 0.000$, df = 235, χ^2/df = 1.759, SRMR = 0.043, RMSEA = 0.042, CFI = 0.98, TLI = 0.976). All the scores met the cutoff criteria suggested in the literature (Anderson & Gerbing, 1988; Hair Jr et al. 2014; Hu & Bentler, 1999) except the *P* value which is sensitive to sample size greater than 200 (Schermelleh-Engel et al., 2003).

4.2.2 Validity and reliability test

Cronbach's alpha value was higher than the minimum threshold standard of 0.7 (Table 2), indicating internal consistency of the entire scale with no less than 70% of variability in measurement captured by the construct variance (Nunnally & Bernstein, 1994). The standardized factor loadings of the measurement items were above acceptable value of 0.7. Similarly, the composite reliability (CR) and average variance extracted (AVE) were above the lowest level of 0.6 and 0.5, respectively, indicating satisfactory convergent validity for the structural model (Hair Jr et al. 2014). Overall, Table 2 provides a strong indication of construct validity in relation to the reliability of unidimensionality and convergent validity. Moreover, we adapted the recently developed discriminant validity of the heterotrait–monotrait ratio of correlations (HTMT) matrix which has a superior performance in estimating the discriminant validity (Henseler et al., 2014) (see Table 3).

4.3 Structural path model

Stage two of the Anderson and Gerbing (1988) two-way approach yielded satisfactory goodness of fit ($\chi^2 = 471.718$, $P < 0.0$, df = 239, χ^2/df = 1.974, RMSEA = 0. 047, SRMR = 0.077, CFI = 0.974, TLI = 0.97) that is in line with earlier research (Hair Jr et al. 2014; Hu & Bentler, 1999). Unexpectedly, the suggestions of the modification indices from AMOS indicated potential improvements to the model. If we add two additional paths from climate change knowledge and biocentric value orientation to behavioral intentions, the goodness of fit of the indices improved substantially with minimal effect on the hypothesized model ($\chi^2 = 416.202$, $p < 0.0$, df = 237, χ^2/df = 1.756, RMSEA = 0.042, SRMR = 0.046, CFI = 0.98, TLI = 0.976). Therefore, we maintained the adjusted structural model (χ^2/df = 1.756) as the final model because it exhibited a superior fit than the hypothesized model (χ^2/df = 1.974). The results of the chi-square difference showed that the two models differed significantly ($\Delta\chi^2 = 55.516$, $P < 0.0$, Δdf = 2). Equally, while a low *R*-Square is common in socio-psychological studies as these fields try to predict human behaviors which can always bring a random measurement errors (Cohen, 1988), the *R*-square in our final model ($R^2 = 0.227$) indicated a higher ability to explain the variance in behavioral intentions than the hypothesized model ($R^2 = 0.11$). This means that our model explains 22% of the variance in behavioral intentions to adapt forestation as a strategy to mitigate climate change. The remaining 78% might be attributed to additional factors not included in our research. Table 4 summarizes the comparison between the models.

Table 2 Questionnaire items used in the survey, reliability and validity analysis: α = Cronbach's alpha; AVE = average variances extracted; CR = composite reliability

	Factor loadings	α	CR	AVE
Climate change knowledge (CCK)		0.902	0.906	0.712
Forests regulate climate by capturing greenhouse gas emissions and increasing carbon removals from the atmosphere	0.868			
Burning forests as charcoal have a potential consequence on climate change in Somalia	0.896			
Strategies for forest management (i.e., forestation) can mitigate climate change	0.918			
Increase in the climate change impacts is partly caused by deforestation	0.648			
Risk perception (RP)		0.920	0.922	0.747
I am concerned about the impacts of climate change in my area	0.789			
I have experienced sometime during my life a serious threat posed by climate change (e.g., pollution, floods, droughts)	0.926			
I am frequently worried about the potential negative consequences of climate change	0.871			
In my opinion, climate change would have a very harmful long-term impact in our society	0.841			
Anthropocentric value orientation (ACV)		0.939	0.940	0.795
Forests should be managed to meet the needs of as many people as possible;	0.901			
The primary use of forests should be for products that are useful to humans;	0.866			
Forests that are not used for the benefit of humans are a waste of our natural resources;	0.916			
Forests are valuable only if they produce jobs and income for people	0.874			
Biocentric value orientation (BCV)		0.917	0.919	0.740
Forests give us a sense of peace and well-being;	0.907			
Whether or not I get to visit forests as much as I like, it is important for me to know that forests exist in Somalia	0.893			
Forests have a right to exist for their own sake, regardless of human concerns and uses;	0.834			
Humans should have more love, respect and admiration for forests	0.734			
Attitude toward forestation (ATT)		0.913	0.906	0.708
I think forestation (tree planting) will provide shading on hot days	0.864			
I think forestation (tree planting) will reduce the temperature and hotness	0.834			
I think forestation (tree planting) can sequester carbon dioxide, mitigating greenhouse effect	0.891			
I think forestation (tree planting) can give me and my family a comfortable environment	0.761			

Table 2 (continued)

	Factor loadings	α	CR	AVE
Behavioral intention (BI) to adopt forestation		0.941	0.934	0.782
I intend to contribute money to an environmental organization that advocate forestation (tree planting)	0.942			
I intend to sign a petition in support of stricter and tougher forest protection policies	0.922			
I intend to encourage others to participate forestation (tree planting) for reduction in carbon emissions	0.801			
I intend to participate in campaigns and demonstration against the companies and persons cutting forests	0.750			

Table 3 Heterotrait–monotrait ratio of the correlation analysis

	1	2	3	4	5	6
Climate change knowledge	–					
Risk perception	0.069	–				
Anthropocentric orientation	0.088	0.015	–			
Biocentric orientation	0.111	0.127	0.073	–		
Attitude toward forestation	0.082	0.150	0.104	0.138	–	
Behavioral intention	0.136	0.188	0.013	0.357	0.318	–

Table 4 Comparisons of fit indices of the measurement model, hypothesized model and the final model

Goodness of fit	Measurement model	Hypothesized model	Final model	Threshold
CMIN	413.342***	471.718***	416.202***	–
DF	235	239	237	–
CMIN/DF	1.759	1.974	1.756	Between 1 and 3
CFI	0.980	0.974	0.980	> 0.95
SRMR	0.043	0.047	0.046	< 0.08
RMSEA	0.042	0.042	0.043	< 0.06
TLI	0.976	0.970	0.976	> 0.900
R^2		0.110	0.227	

CMIN chi-square, *DF* degrees of freedom, *CFI* comparative fit index, *SRMR* standardized root-mean-square residual, *RMSEA* root-mean-square error of approximation, *TLI* Tucker–Lewis index

*** = $p < 0.001$

4.4 Hypothesis testing

The final model based on the cognitive hierarchy model is shown in Fig. 6. The influence of the hypothesized constructs was tested, including the two additional paths revealed by the structural path model. The hypothesis testing of the final model indicates that three of our proposed hypotheses were supported, one hypothesis was partially supported and two were rejected. Similarly, the two discovered paths after modifications of the original model were also supported. Regarding the first hypothesis, H1, we found that attitude toward forestation positively influences behavioral intentions to mitigate climate change (H1: $\beta = 0.262$, $t = 5.635$, $p < 0.0$). The second and fourth hypotheses, H2 and H4, stated that climate change knowledge and anthropocentric value orientation positively influence attitude toward forestation, and both these hypotheses were rejected (H2: $\beta = 0.085$, $t = 1.652$, $p > 0.05$; H4: $\beta = 0.099$, $t = 1.949$, $p > 0.05$). The third and fifth hypotheses, H3 and H5, hypothesized that risk perception and biocentric value orientation have a significant positive influence on attitude toward forestation and both hypotheses were supported (H3: $\beta = 0.140$, $t = 2.690$, $p < 0.01$), (H5: $\beta = 0.138$, $t = 2.677$, $p < 0.001$). The two additional paths revealed interesting links to behavioral intentions. Path D1 showed that biocentric value orientation has a direct and significant positive influence on behavioral intention (D1: $\beta = 0.318$, $t = 6.872$, $p < 0.00$), and path D2 revealed that climate change knowledge has a direct and significant positive influence on behavioral intention (D2: $\beta = 0.119$, $t = 2.614$,

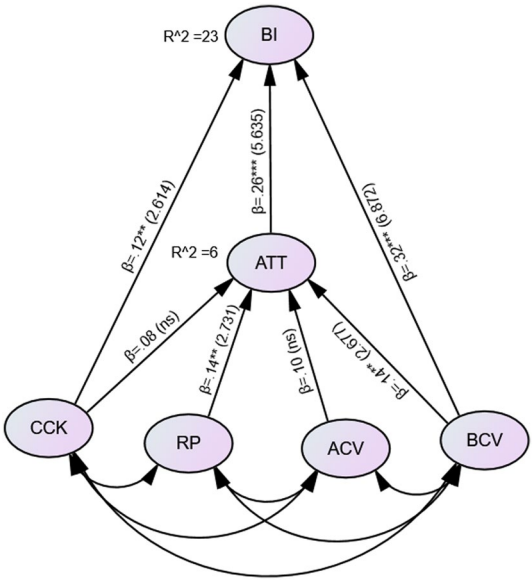

Fig. 6 Final proposed model based on cognitive hierarchy model. The basic logic of the model denotes several layers where knowledge and risk perception and value orientations (anthropocentric–biocentric) were hypothesized as predictors of specific attitude and behaviors. Causal relationships among latent variables, represented by single-headed arrows and covariances among several of the residuals by dual-headed arrows. β = standard regression weight, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, t values are in the parenthesis, ns = "not significant." CCK = climate change knowledge; RP = risk perception; ACV = anthropocentric value orientation; BCV = biocentric value orientation; ATT = attitude; BI = behavioral intention to adopt forestation. ($\chi^2 = 416.202$, $p < 0.0$, df = 237, χ^2/df = 1.756, RMSEA = 0.042, SRMR = 0.046, CFI = 0.98)

$p < 0.001$). These two additional paths were retained in the final model. Table 5 summarizes the results of the hypothesis testing.

Table 5 Hypothesis testing

Hypothesis	Standardized path coefficient	Standard error	t value	Outcome
H1: Attitude → *Behavioral Intention*	0.262***	0.047	5.635	Supported
H2: Climate change knowledge → *Attitude*	0.085	0.043	1.652	Rejected
H3: Risk perception → *Attitude*	0.140**	0.053	2.731	Supported
H4: Anthropocentric value → *Attitude*	0.099	0.055	1.949	Rejected
H5: Biocentric value → *Attitude*	0.138**	0.06	2.677	Supported
D6: Biocentric value → *Behavioral Intention*	0.318***	0.055	6.872	Discovered
D7: Climate change Knowledge → *Behavioral Intention*	0.119**	0.038	2.614	Discovered

*** = $p < 0.001$; ** = $p < 0.01$

4.4.1 Mediation analysis

The results of the mediation analysis revealed evidence of mediation between all the above-mentioned predictors and behavioral intention, except climate change knowledge, supporting H6. Contrary to our expectations, the results show that the effect of climate change knowledge on behavioral intention to adapt forestation was not mediated through attitude toward forestation ($b = 0.021$, $p > 0.05$). Full mediation exists when the direct effect is not significantly different from zero. The results revealed that, although the total effects of risk perception and anthropocentric value orientation were weak (significantly and insignificantly, respectively), they showed full mediation ($\beta = 0.111$, $p < 0.05$, $\beta = 0.012$, $p > 0.05$) (Table 6). Furthermore, risk perception and biocentric value orientation had the largest statistically significant indirect effect on behavioral intention ($b = 0.035$, $p < 0.01$, $b = 0.035$, $p < 0.01$). An important observation, however, is that the total effect of biocentric value orientation on behavioral intention ($\beta = 0.345$, $p < 0.000$) was the largest and it mainly originated from the direct effect of biocentric value orientation on behavioral intention ($b = 0.310$, $p < 0.010$); thus, we can conclude that the attitude toward forestation partially mediated the relationship between biocentric value orientation and behavioral intention to adapt forestation as a strategy to mitigate climate change. In partial mediation, the effect of X on Y is not completely explained by the $X \rightarrow M \rightarrow Y$ sequence of events.

5 Discussion

This study empirically tests the deterministic factors that shape young people's perception to adapt forestation as a strategy to mitigate climate change. The results revealed that climate change knowledge did not have a significant influence on young people's attitude toward forestation. Contrary to our findings, previous studies have reported a limited influence of climate change knowledge on attitude (Kollmuss & Agyeman, 2002; McFarlane & Boxall, 2000). Remarkably, one of our key findings is the discovery of the first significant path (D1) that predicted climate change knowledge to have a direct and significant positive influence on intentions to adapt forestation as a strategy to mitigate climate change. This

Table 6 Mediation results and total standardized effects on intentions to adopt forestation as a strategy to mitigate climate change: The table shows total standardized effect on response variable (c), direct effects on response variable after controlling the mediator (c′), and the indirect effects (c–c′) which is equivalent to $a \times b$, where a is the effect of independent variable X on the mediator M and b is the effect of M on the dependent variable Y after controlling for X

Independent variables	Mediator (M)	Direct effects (c')	Indirect effects ($a \times b$)	Standardized effects (c)	Outcome
CCK	ATT	0.113*	0.021 (ns)	0.135**	no mediation
RP	ATT	0.076 (ns)	0.035**	0.111*	Full mediation
ACV	ATT	-0.013 (ns)	0.025*	0.012 (ns)	Full mediation
BCV	ATT	0.310**	0.035**	0.345***	Partial mediation

CCK climate change knowledge, *RP* risk perception, *ACV* anthropocentric value orientation, *BCV* biocentric value orientation, *ATT* attitude

*** = $p < 0.001$; ** = $p < 0.01$; * = $P < 0.05$; ns = "not significant";

significant direct influence could be due to the fact that we measured the climate change knowledge variable as an objective empirical fact about the causes and consequences of climate change rather than self-reported knowledge or belief-based knowledge, which in turn triggered the participants' knowledge of the unsustainable local practices such as burning trees for charcoal. These practices are common in Somalia and largely contribute to both deforestation and climate change. This means that climate change knowledge plays a pivotal role in the decisions to adapt forestation and forest management, because awareness of the causes of climate change may lead individuals to better understand the behaviors that are more impactful to the environment, which might make them more likely to participate in mitigating actions. This finding compliments previous studies that reported climate change knowledge plays a significant role in elucidating behavioral intentions to mitigate climate change (O'Connor et al., 1999).

Risk perception positively influences attitude toward forestation, which is in line with earlier studies (O'Connor et al. 1999; Kwon et al., 2019). This could be a result of personal climate change experience as previous studies have suggested that it plays a valuable role in individual decision-making (Broomell et al., 2015; Spence et al., 2011). This means risk perception is a critical driver of collective action against human-induced environmental problems. Studies in developing countries have indicated that people primarily perceive the risk of climate change more than those in developed countries (Kim & Wolinsky-Nahmias, 2014). In Somalia, climate-sensitive agricultural production and livestock herding has been particularly affected by recurrent extreme climate events. Thus, we assume that respondents who are concerned about the risks of climate change are more willing to endorse and accept potential forest management strategies such as forestation.

Consistent with previous studies (Matzek & Wilson, 2021; McFarlane & Boxall, 2000; Petit et al., 2021; Vaske & Donnelly, 1999), biocentric value orientation showed a significant positive influence on attitude toward forestation. Unexpectedly, another important finding is the discovery of the second significant path (D2) that predicted biocentric value orientation to have a direct and significant positive influence on young people's intentions to adapt forestation as a strategy to mitigate climate change. A possible explanation could be that we targeted younger educated individuals living in urban areas as previous studies have stated that these groups hold stronger biocentric values and eventually support sustainable natural resource management (McFarlane & Boxall, 2000).

Moreover, our results indicate that the participants who endorsed anthropocentric value orientation did not show a significant attitude toward the forestation. This is consistent with previous studies that reported people with anthropocentric value orientation were less likely to approve forest conservation as a strategy to mitigate climate (Peterson St-Laurent et al., 2018), validating the notion that such a value orientation is correlated with the tendency for natural resource exploitation rather than conservation (McFarlane & Boxall, 2003). This result also confirms prior studies that stated affluence is not always a predictor of environmental concern (Plombon, 2011), since Somalia is a low-income country with a high poverty ratio, and poverty is a primary determinant of vulnerability that leads people to be directly dependent on natural resources. Meanwhile, we find that anthropocentric value ordination has no significance on both attitude toward forestation and behavioral intention together with the favorable perception on the awareness of climate change, the importance of forest management and the willingness of our respondents to participate voluntarily in forestation campaigns. Conspicuously, these findings imply that when individuals experience competing values but have the awareness and the willingness to take mitigative actions on climate change, they will base their decision on the values that they deem most essential to them which practically means "doing the right thing."

There are ample socio-psychological models explaining that the relationship between higher-order cognition variables and behavioral intentions or behaviors is fully mediated by attitude (Homer & Kahle, 1988; Matzek & Wilson, 2021; McFarlane & Boxall, 2003; Vaske & Donnelly, 1999). Contrary to these studies, our results indicated that attitude partially mediated the relationship between biocentric value orientation and behavioral intentions and fully mediated the relationship between anthropocentric value orientation, risk perception and behavioral intentions. Our results are consistent with, among others, Hauser et al. (2013) who questioned the hierarchical structure of the values–attitudes–behavior chain. Our finding that attitude partially mediated the relationship between biocentric value orientation and behavioral intention suggests when individuals do not have a strong attitude toward the specific topic and forest value orientation is strong, it may not always influence behavioral intention or behavior through more cognitively accepted attitudes, but directly and significantly influences behavioral intention or actual behaviors (Hauser et al., 2013). Another explanation for this inconsistency could be what Maio and Olson (1998) called values as "cultural truisms—that is, beliefs that are widely shared and rarely questioned," which people normally approve without cognitive justification for them. Thus, the forest value orientation we tested in this study might follow the same scenario of "cultural truisms" where people may not be conscious of this mechanism but subconsciously influence behavioral intention.

Finally, in support of the cognitive hierarchy model, the findings indicated that young people's attitude toward forestation had a significant positive influence on behavioral intention to adapt forestation as a strategy to mitigate climate change. This finding is consistent with the existing literature which indicates that attitude toward specific forest management interventions has a significant positive influence on forest management intentions or actions (Brown & Reed, 2000; Laakkonen et al., 2018; Meijer et al., 2015; Petit et al., 2021). Although the prediction of behavioral intention is not strong in the present study, it still displayed a relatively high significance, which supports the widely accepted notion that attitude has a significant positive influence on behavioral intention or behavior. As evidenced by our results, even though young people's behavioral intentions to adapt forestation as a strategy to mitigate climate change was positively and significantly influenced by their attitude toward forestation, other factors such as climate change knowledge and biocentric value orientations played a significant role in their decision to adapt it. This could be the result of extreme climate vulnerability and deforestation that exist in Somalia as previous studies indicated that individuals in countries that are vulnerable to climate change express higher willingness to support and approve proactive climate change policies such as forestation (Kim & Wolinsky-Nahmias, 2014). However, research examining people's attitudes and intentions to approve forestation of trees that are not indigenous to East Africa's ecosystems are scant, but we expect negative views toward assisted migration of non-indigenous trees as these invasive species (e.g., Prosopis juliflora) as they largely colonized and disturbed the ecosystem balances when their exp2015ansion became out of control in arid and semiarid environments of East Africa such as Kenya, Ethiopia, and Somalia (Ayanu et al.,).

5.1 Theoretical and practical implications

Although our findings support the general consensus of the cognitive hierarchy theory, which states that higher-order variables in the theory predict specific attitudes, and attitudes, in turn, predict behavioral intention, our findings differ from this notion because

attitude is not fully mediated the relationship between higher-order cognition variables and behavioral intentions or behaviors, thus, we suggest that climate change mitigation efforts should avoid relying solely on attitude for behavioral decision-making formation and instead incorporate other factors into a more comprehensive framework.

One general implication for the biocentric–anthropocentric value orientation is that to understand public perception, it is imperative to not only focus on the specific attitudes related to the environment but also the underlying values and motives behind these attitudes. The reason is that understanding both attitudes and underlying value orientations will contribute to a greater understanding of the type of climate mitigation policies that are acceptable to the public (Diriye et al., 2021). As evidenced in our results, individuals with biocentric value orientation are more likely to behave pro-environmentally, which implies that future carbon trading forestry projects in low economy countries such as Somalia should not only focus on the handouts from carbon payments but should focus on communicating the environmental and social benefits of forestation such as unpriced recreational open spaces, carbon sequestration, prevention of soil erosion, and provision of ecosystem services as these were deemed most important to the people who hold biocentric value orientations. Finally, to improve public perception, this study commends younger people should be given specific consideration by enhancing their climate change awareness, attitudes and behaviors through novel risk communication strategies and environmental education, as they are the majority and the generation in which climate change will have a greater impact on their lives in Somalia and all other African countries.

6 Conclusion

Using cognitive hierarchy theory, this study examined the factors that influence young people's intentions to adapt forestation as a strategy to mitigate climate change from an applied perspective. Overall, the results indicate that the final model for young people's intentions to adapt forestation is favorable and the hypothesis testing fully supported three of the five proposed hypotheses (H1, H3, and H5), partially supported H6 and rejected two hypotheses (H2 and H4), and discovered two significant paths (D1 and D2). The results indicated that climate change knowledge is a significant predictor of young people's behavioral intention but not of their attitudes toward forestation. Similarly, this study revealed that biocentric value orientation and attitude toward forestation are the strongest predictors of young people's behavioral intention to adapt forestation as a strategy to mitigate climate change.

Although we believe the results of the present study will provide some guidance on public perceptions, there are some limitations that are worth mentioning. This study is based on questionnaire survey that is limited to students of three major universities from distinct regions in Somalia; thus, public perceptions may differ from our study respondents, and therefore, the results of this study should be interpreted as such. However, the results herein can serve as the foundation on which studies on perceptions of the general public in Somalia can be conducted. Similarly, the effect of demographic variables (e.g., gender, age, income, etc.) and other potential factors that might influence value orientations and attitudes, and behavioral intention was not considered in our cognitive hierarchy model. These are therefore worth investigating in future research.

Finally, the study sample leans toward younger and educated members of the Somali citizenry, which might reduce the generalizability of our findings. Nonetheless, we believe

that the cognitive hierarchy model we presented provides a suitable framework for understanding the determinants of the climate change perception as well as the decisions to mitigate climate change through forestation in Somalia and other African countries that face similar socioeconomic and environmental circumstances. Understanding young people's perception toward specific climate change mitigation strategies would help policymakers, forest managers and other stakeholders to gain in-depth knowledge about how climate change mitigation policies might be interpreted by this segment of society that comprises the majority of the population.

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Declarations

Conflict of interest The authors declare no conflict of interest.

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Authors and Affiliations

Osman M. Jama[1,2,3] · Abdishakur W. Diriye[2,3,5] · Abdulhakim M. Abdi[4]

Osman M. Jama
osmanjama@mail.ustc.edu.cn

Abdulhakim M. Abdi
hakim.abdi@cec.lu.se

1 Department of Science and Technology Communication and Policy, University of Science and Technology of China, Hefei, People's Republic of China

2 School of Public Affairs, University of Science and Technology of China, Hefei, People's Republic of China

3 Department of Public Administration, Faculty of Economics and Management Science, Mogadishu University, Mogadishu, Somalia

4 Centre for Environmental and Climate Science, Lund University, Lund, Sweden

5 School of Geographical Sciences, University of Bristol, Bristol, UK