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Climate change awareness among the livestock rearers of east coast of India

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ABSTRACT

The phenomenon of global climate change is directly affecting the livestock production system world overall. Therefore, understanding the changing climatic scenario by the millions of resource poor livestock rearers across the east coast of India found to be imperative to get information for strategic planning to improve the livelihoods of rural people. But, systematic methodology to assess climatic change awareness among the livestock rearers is currently not available. Therefore, a psychometric scale entitled "Climate Change Awareness Scale" was developed and applied among the randomly selected 480 livestock rearers of eastern coastal region of India. Results reflected majority of the population exhibit their strong level of awareness towards changing climatic scenario in general and particularly towards broad spectrum of climate change like causes, features, effects and impacts. It was also found that 37.188% of livestock rearers of coastal region were having higher level of awareness followed by 31.973% and 30.839% were having lower and medium level of awareness. Comparisons of state of awareness with the factual climatic data validated farmers' claim and established the authenticity of the psychometric tool. Hence, this study will provide a significant tool for researchers and policy makers to assess state of climate change awareness among the end users and to develop appropriate adaptation strategies to minimize the risk of livestock sector to climate change.

Key words: Climate change awareness scale, East coast of India, Livestock rearers, Psychometric assessment

Since the widespread recognition of anthropogenic climate change as a serious concern, in the 1980s, scientists from many disciplines have undertaken research and assessment of the likely impacts. Scientists also engaged in estimation of the probability and intensity of higher temperatures, sea level rise, weather extremes, the breakdown of the thermohaline circulation, the effect on biodiversity, and the loss of property and lives because of these changes (McCarthy *et al*. 2001). After contributing to climate change impact assessments, the social sciences' contribution centred on the topic of mitigation, adaptation and vulnerability assessment. By making certain assumptions about how people and societies will respond to climate change, and incorporating these responses in the assessment of damages, economists could more accurately compare the costs and benefits of particular mitigation policies (Fankhauser 1996, Pittock and Jones 2000, Smit *et al.* 1999, Tol *et al*. 1998, UNEP 1991, Yohe *et al.* 1996). Geographers and anthropologists identified many ways in which traditional practices allow for greater adaptive capacity, and how a disruption of social cohesion reduces people's adaptive capacity, making them less resilient to environmental stress (Adger 2000, Adger *et al*. 2003, Scoones *et al*. 1996). Likewise, scholars of international relations and institutions have identified appropriate funding and incentive building mechanisms (Klein 2002). Economists developed indicators for adaptive capacity (Yohe and Tol 2002).

Climate change described by farmers as temporal displacement of weather cycle reflecting in change in crop enterprise and livelihood options. Farmers of river basin and coastal region were aware of climate change like increasing temperature during summer, prolonged summer, delayed onset of monsoon, uneven distribution of monsoon, delayed onset of winter, short winter period, temperature above normal during winter, occurrence of cold and heat waves, heavy fog, frequent cyclone etc. (Angels *et al*. 2011, Acquah-de Graft and Onumah 2011, Deressa *et al*. 2011, Mandleni and Anim 2011, Acquah-de Graft 2011, Nyanga *et al*. 2011, Sofoluwe *et al*. 2011, Mengistu 2011, Gandure *et al*. 2012).

The most common approach to study the awareness and/or perception of farmers to climate change is based on comparing farm survey or farm group discussion results with data records from meteorological stations (Orderud and Kelman 2011, Mtambanengwe *et al*. 2012, Falaki *et al*. 2013, Lieske *et al*. 2014). Although informative in terms

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of validating farmers' claims of perceptions of change against meteorological data, these approaches do not explicitly identify the state awareness *vis-à-vis* climate change and factors influencing awareness of climate change. Even also, generated information does not ruled out subjectivity and did not cover all the aspects of climate change and livestock rearing. More than 100 million families engaged livestock rearing in India. Then, it is essential to know how these farm families perceivechanging climatic scenario. In this context, understanding the changing climate scenario by the millions of livestock rearers found to be imperative to get information for strategic planning to improve the livelihoods of rural people.

MATERIALS AND METHODS

Sampling plan: Length of coastline of India including the coastline of Andaman and Nicobar Islands in the Bay of Bengal and Lakshadweep Islands in the Arabian Sea is 7,517 km. In mainland, length of coastline is 6,100 km. and divided into east coast and west coast. Eastern coastal region lies between Eastern Ghats and Bay of Bengal, stretching from Tamil Nadu in the south to West Bengal in the east. There are 4 states in eastern coastal region of India namely West Bengal, Odisha, Andhra Pradesh and Tamil Nadu. Among these 4 states, two states i.e. Odisha and West Bengal were selected randomly. There are 6 districts in coastal region of Odisha namely Balasore, Bhadrak, Kendrapara, Jagatsighpur, Puri and Ganjam. In West Bengal, 3 districts namely South 24 Parganas, North 24 Parganas and Purba Medinipur lies in its coastal region. Two districts i.e. Ganjam and Bhadrak were selected randomly among 6 districts of coastal Odisha. From West Bengal, Purba Medinipur and South 24 Parganas were selected randomly. Thus, total 4 districts were selected randomly for the present study.

Three blocks namely Rangeilunda, Ganjam, and Chhtrapur were selected randomly from the coastal blocks of Ganjam district of Odisha. Basudevpur, Tihidi and Chandbali block were selected randomly from the coastal blocks of Bhadrak districts of Odisha. Deshapran (Contai-II), Ramnagar-I and II blocks of Purba Medinipur district of West Bengal were selected randomly from its coastal blocks. In South 24 Parganas, three blocks i.e. Gosaba, Basanti and Namkhana were selected randomly from its coastal blocks. Thus, the present study was confined in 12 blocks of 4 selected coastal districts. A block wise list of villages, where few livestock depended households were existing, were prepared in consultation with the block level veterinary officers. Subsequently, total 24 villages were selected randomly by selecting 2 villages from each selected block.

A livestock-rearer who has more than 30 years of experience in livestock rearing of at least one species among cattle, buffalo, goat, sheep and pig, and having main income from livestock was considered as respondents for the present study. Village wise lists of livestock depended households were prepared with the help of livestock enumerator of that respective villages. Household head was considered as respondents for the present study. Subsequently, 20 respondents from each village were selected randomly. Thus, a total sample size of the present study was 480.

Operationalization and quantification of climate change awareness: Climate change in Inter-governmental Panel on Climate Change (IPCC) usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and /or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any changes in climate over time, whether due to natural variability or as a result of human activity. Awareness regarding climate change was operationalized as the conscious feeling of livestock rearers regarding the changing climatic scenario. At first, the respondents was directly asked whether they feel any change in climate over the past 30 years on the binary response 'YES' or 'NO'.

The livestock rearers, who recognised changing climatic scenario, were again interviewed to know the level of awareness and determinants of their different level of awareness. Therefore, in order to measure the differential levels of awareness regarding climate change and its variability among the livestock-rearers, an exclusive 'Climate Change Awareness Scale (CCAS)' was developed for the present study.

Construction of the climate change awareness scale (CCAS)

Collection of climate change awareness statements: An exhaustive list of climate change facts and figure was collated covering all aspects of climate change on agriculture as well as livestock production from published literatures, reports etc, and informal discussion with the climate change, livestock researchers relevant professionals and farmers. Then, all the collected climate change facts and figures were written in sentence form and these sentences were considered as 'statements' for the present study. After preparation of statements, each and every statement were checked and edited to reduce ambiguity. After editing and checking, 41 statements were retained for the development of climate change awareness scale.

Relevancy test of the selected statements: Statements, selected in previous step, were administered to a group of 210 subject matter expert thorough personal contact, email and surface post worldwide. Subject matter specialists were requested to check each and every statement w.r.t. its relevancy on dichotomous response viz. 'Relevant' or 'Irrelevant' to measure awareness of livestock–rearers to climate change and its variability. Total 130 subjects matter specialists returned the duly filled questionnaire with in enhanced (two months) time schedule. Then, relevancy weightage of each statement (Annexure 1) was calculated as per Kumar and Popat (2009). From the set of statements, 2 statement (serial no 13 and 36) were dropped as their relevancy weightage (RW) were below the cut-off (0.80).

Item analysis: Items, selected in relevancy test, were modified and rewritten as per suggestion made by the subject matter experts. Then, modified and rewritten items or statements were administered to 120 livestock rearers of coastal region. These 120 livestock rearers were selected randomly from the non-sample village(s) of the blocks under study (total 12 blocks were under study and from each block 10 livestock rearers were selected randomly). Respondents were requested to give their response on a 4 point continuum from 'fully aware' to 'not aware at all' with a score of 3, 2, 1 and 0, respectively, in a personal interview by the researcher at their door step.

After completion of personal interview, each and every completed interview schedule was thoroughly checked. Response of 11 livestock rearers were rejected due to their irrational responses. Then, responses of remaining 109 livestock-rearers were tabulated. After completion of the tabulation work, data were subject to Principal Component Analysis (PCA) for final selection of statements as well as to get their scale values. The response on a 4 point continuum was purely an ordinal type of response. Therefore, PCA was run by using Polychoric Correlation Coefficient (Annexure 2) as data input instead of direct using the data set.

After first run of factor analysis by using principal component analysis, 4 statements (serial no 1, 4, 30 and 37) were dropped for further analysis from the list of 39 relevancy test passed statements as their communality values were below the cut-off (0.80) point. Again PCA was run (second run of PCA) with the remaining 35 statements and it was found that communalities values of all the 35 statements were greater than equal to 0.80 (the cut off point) (Annexure 3). Therefore, all the 35 statements were retained for further analysis i.e. calculation of scale values.

Calculation of scale values of selected statements: After selection of statements in item analysis, again PCA was run to obtain factor loading and eigen values. Kaiser normalization was used to identify the initial eigen values greater than 1. It was found that there were 8 eigen values greater than 1 in the data set. According to the number of eigen values, the same numbers of components were extracted by using Varimax rotational method for each statement as shown in rotational component matrix.

Then, the extracted rotational component matrix was multiplied by the eigen values, i.e., the first eigen value was multiplied with the first extracted component column and second eigen value was multiplied with the second extracted component column, considering only absolute values and so on.

The values obtained were added in case of each statement to get scale values for that particular statement. Similarly, scale values obtained for other statements, too.

Final selection of statements: During the preparation of interview schedule for item analysis, 6 statements (serial no 5&6, 11&12, 20&21, 22&23, 24&25 and 29&41) same categories of statements were incorporated in the interview schedule to check the consistency of the response of the livestock rearers. These same categories of the statements were found till the steps to calculate scale values. Statement with higher scale value was selected for final scale. Thus, 29 statements were selected for final scale and these statements with their scale values are presented in the Table 1.

Table 1. Statements meant for 'Climate change awareness scale' for coastal region with their scale value

St no.	Statement	value Scale
2	'Climate Change' is happening due to excessive burning of fossil fuels such as oil, coal and natural gas etc.	11.99
3	Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have led to a rise in the emission of carbon dioxide, which finally leads to 'Climate Change'.	12.47
6	Increasing temperature during summers	6.61
7	Prolonged summer	6.13
8	Delayed onset of winter	8.22
9	Short winter periods	3.50
10	Occurrence of heavy fog during winter season	4.76
12	Unpredictable rainfalls	4.91
14	Precipitation has declined.	9.49
15	Long dry spells and increased rate of drought	8.74
16	Change in the season cycle during the last 10–15 years	8.12
17	Increased rate of heat and cold waves	9.37
18	The type, frequency and intensity of extreme climatic events are expected to rise even with a slight change in the climate.	6.63
19	Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding.	6.90
21	Reduced soil moisture and evapotranspiration may increase land degradation and desertification.	5.85
23	'Water stress' for the human-beings and or livestock due to decrease of freshwater availability in river basins during summer months due to glaciers retreat	10.39
24	The key 'climate- related risks' in the coastal zone include tropical cyclones, sea level rise and changes in temperature and precipitation.	13.57
26	Coastal zones will be more sensitive to erosion, flooding, submergence and deterioration of Coastal ecosystems such as mangroves and salinization.	13.48
27	Damage to coastal infrastructure, aquaculture and coastal tourism, due to the erosion of sandy beaches is also likely.	13.88
28	Both the coastal and alpine ecosystems will be adversely affected, thereby causing the extinction of 15 to 40 % of species due to in rise by temperature 2°C.	13.07
29	Increase in endemic morbidity and mortality due to vector borne diseases like malaria, cholera	12.68

Table 1...

St no.	Statement	value Scale
	and diarrhea	
31	Agriculture is extremely vulnerable to 'Climate Change'.	8.18
32	Higher temperatures eventually reduce yields of desirable crops, while encouraging weed and pest proliferation.	6.70
33	Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines.	7.57
34	Rising temperatures will be the cause of shifts in crop growing seasons	9.16
35	Productivity of rain-fed crops will be adversely affected due to increased rate of drought.	10.89
38	Heat stress may reduce the fertility of livestock.	7.54
39	Increase in temperature and humidity is the cause behind declined milk production of dairy bovine.	7.47
40	Heat stress may cause the reduced feed intake of the livestock.	7.56

Administration and scoring of the statements: Finally selected statements of the scale were incorporated in the final format of the interview schedule. Each of the statement was provided with 4 point continuum, from 'fully aware' to 'not aware at all' with a score of 3, 2, 1 and 0, respectively. Then, respondents were requested put their response by a tick or cross mark in the appropriate box representing 4 categories. These responses were multiplied by the scale value of that particular statement. In this way, exact score of each statement was calculated and summation of all these score reflected a livestock-rearer's awareness score.

Reliability of the developed scale: The Ordinal alpha as suggested by Gadermann *et al*. (2012) used for calculating the reliability of scale developed to measure awareness regarding climate change among the livestock rearers of coastal and alpine region. Scale was administered to randomly selected 90 livestock rearers of coastal region. This sample was drawn from the non-sample villages of the studied blocks. Calculated ordinal alpha were found to be 0.90 for the developed scale.

Typically, the psychometric literature (Nunnally 1978) recommends that alpha for a scale should not be smaller than 0.70 when used for research purposes, at least 0.80 for applied settings, and greater than 0.90 or even 0.95 for high-stake, individual-based educational, diagnostic, or clinical purposes. Here, the scale had crossed the cut-off marks (0.70) successfully. Therefore, it may be concluded that the reliability and internal consistency of the both scales were confirmed.

Validity of the scale: The contents of the developed awareness scale were derived through opinions of concerned subject matter specialists, extension professionals, and all the scale construction steps were taken carefully. Thus, it may be concluded that the developed awareness scales were able to measure what it intended to measure.

Differential level of awareness among the livestock rearers: The livestock rearers were categorised in to 3 different levels of awareness groups on the basis of obtained score by the respective livestock-rearers. Cumulative square root frequency method was used to categories livestock-rearers into 3 categories as follows:

Category	Score for differential level of awareness
Having lower level of awareness (low)	149.620 - 367.420
Having medium level of awareness (medium)	367.421 – 559.796
Having higher level of awareness (high)	559.797 – 743.030

RESULTS AND DISCUSSION

Climate change awareness among the livestock rearers of coastal region: The results revealed that 85 and 99.170 % of the livestock rearers of Ganjam district and Bhadrak district, respectively, were aware regarding the changing climatic scenario (Table 2). Super cyclone hit on coastal Odisha during 1999. Not only super cyclone, other extreme climatic events like flood, drought etc used happened in coastal Odisha. Therefore, most the livestock rearers of coastal Odisha were aware regarding changing climatic scenario. It was also found from the same table that 83.333 and 100% of the livestock rearers of Purba Medinipur district and South 24 Parganas district, respectively, were aware regarding the changing climatic scenario. During last 3 to 4 years, there were tropical cyclones namely *Aila, Laila, Mahasen* hit on coastal West Bengal mainly in coastal South 24 Parganas. Hence, all the studied livestock rearers of the coastal South 24 Parganas were aware regarding changing climatic scenario. But, Sarkar and Padaria (2010) studied farmers' awareness and risk perception about climate change in coastal West Bengal. They observed that nearly 38 % of the respondents had heard about climate change. Whereas, Maddison (2006) studied farmers' awareness and adaptation to climate change in Africa and concluded that farmers of 10 countries believed average temperatures had increased, rainfall level had decreased. A similar study conducted by Semenza *et al*. (2008) in the USA on public perceptions of climate change, also indicated that a vast majority (92 %) was aware of climate change. Gbetibbou (2009) studied farmers' awareness and/or perception about climate change and variability in the Limpoo River basin and found that about 91 % of the farmers surveyed perceived an increase in temperature and 81 % of respondents reported a decrease in rainfall over the past 20 years. This perception was confirmed by statistical record between 1960 and 2003. Case study was conducted by Tripathi (2010) in the Indo-Gangetic region to investigate perceptions of the local people on climate change. Almost 100 % of the respondents perceived the changes in winter. In African countries, climate change also perceived by many smallholder crops

Table 2. Climate awareness among the livestock rearers of coastal region

Study area	Climate change awareness	
	Aware	Not aware
Odisha		
Ganjam (n=120)	18 (15.000)	102 (85.000)
Bhadrak (n=120)	119 (99.170)	01 (00.830)
West Bengal		
Purba Medinipur (n=120)	100 (83.333)	20 (16.667)
South 24 Parganas (n =120)	120 (100)	0 (0.00)

Values in parenthesis indicate percentage.

and livestock farmers. A study conducted by Mubaya *et al*. (2010), in Zambia and Zimbabwe, indicated that 80 % of famers perceived a change in climate as they had noticed droughts and excessive rains in the past 5 years. Deressa *et. al* (2011) studied perception of and adaptation to climate change by the farmers in the Nile Basin of Ethiopia. They concluded that 51 % of the surveyed farmers were aware about increasing temperature, and 53 % regarding decreasing rainfall over past 20 years. Sofoluwe *et al*. (2011) analysed farmers' perception to climate change in Osun state of Nigeria. They reported that most the farmers (75%) in the study were aware on increase in temperature and decline in rainfall. Their perception on precipitation shows that majority of them (42.3%) perceived a decline in the level of precipitation. Mandleni and Anim (2011) investigated the extent of awareness of climate change by livestock farmers in the Eastern Cape Province of South Africa. They reported that 57 % of the livestock rearers were aware of climate change.

Differential level of awareness among the livestock rearers of coastal region: By using the developed psychometric tool, the possible range of awareness score was 0 to 767.49. But, in the present study range of awareness score was 149.620 to 743.030. Therefore, it may be concluded that livestock rearers coastal region were having differential level of awareness. For more precise interpretation, all the livestock rearers of coastal region those who were aware categorised into 3 differential level of awareness i.e. low, medium, and high on the basis of obtained score by the respective livestock rearers. Cumulative square root frequency method was used to categories livestock rearers into 3 categories (Table 3).

Almost half (49.020%) of the livestock rearers who were aware regarding changing climatic scenario of Ganjam district were having lower level of awareness (Table 3) followed by 45.098 and 05.882 % were having higher as well as medium level of awareness, respectively. Whereas 36.134 % of livestock rearers of Bhadrak district were having higher level of awareness followed by 34.454 and 29.412 % were having medium and lower level of awareness, respectively.

In overall Odisha, 40.271 % of livestock rearers were having higher level of awareness followed by 38.462 and 21.267 % were having lower and medium level of

Table 3. Level of awareness regarding awareness among those who were aware in coastal region

Study area	Low (149.620 - 367.420)	High (367.421 – 559.796) #	Medium (559.797 – 743.030) #
Odisha			
Ganjam (n=102)	50 (49.020)	6 (05.882)	46 (45.098)
Bhadrak (n=119)	35 (29.412)	41 (34.454)	43 (36.134)
Odisha Overall (n=221)	85 (38.462)	47 (21.267)	89 (40.271)
West Bengal			
Purba Medinipur (n=100)	6 (6.000)	66 (66.000)	28 (28.000)
South 24 Parganas (n=120)	50 (41.667)	23 (19.167)	47 (39.167)
West Bengal Overall (n=220)	56 (25.455)	89 (40.455)	75 (34.091)
Coastal region Overall (n=441)	141 (31.973)	136 (30.839)	164 (37.188)

score for level of classification. (Remaining) values in parenthesis indicate percentage.

awareness, respectively. Nearly two third (66%) of livestock rearers of Purba Medinipur district were having medium level of awareness, but, 41.667 % of livestock rearers of coastal South 24 Parganas were having lower level of awareness. In overall coastal West Bengal, 40.455 % of livestock rearers were having medium level of awareness. As far as overall costal region was concerned, it was found that 37.188 % of livestock rearers who were aware regarding changing climatic scenario were having higher level of awareness followed by 31.973 and 30.839 % were having lower and medium level of awareness.

Comparative evaluation of awareness towards climate change and its different dimensions in coastal region: Those who were aware subsequently administered with developed Climate change awareness scale to explore their awareness in different dimensions of climate change like climate change and its causes, features of climate change, general effect & impact of climate change, impact on agriculture & livestock as well as overall awareness regarding climate change.

Duncun's Multiple Range Test (DMRT) was applied for comparative evaluation of different dimensions of climate change awareness at district level (Table 4). Livestock rearers of Bhadrak district were more aware regarding the climate change and its causes with value of 59.596±1.596 and mean awareness score among the livestock rearers of coastal region were 49.126±0.930. There was a significant ($P<0.05$) differentiation between the livestock rearers of Ganjam and Bhadrak district in terms of their awareness regarding climate change & its causes. The same trend was

also observed between the coastal districts of West Bengal. Whereas, the same table also stated that there was no differentiation between the livestock rearers of Bhadrak and Purba Medinipur district. This trend was also observed between Ganjam and South 24 Parganas district.

Livestock rearers of South 24 Parganas were more aware regarding the features of climate change than their counter parts of the other studied districts. Coastal South 24 Parganas district is situated in the Sunderban area of southern West Bengal. It is well recognised that the Sunderban will be severely affected due to changing climatic scenario. Therefore, many public as well as private organisations were deeply involved in the coastal South Parganas to make aware local people regarding the changing climatic scenario. Hence, this may be reason of higher awareness of livestock rearers of South 24 Pargans regarding the features of climate change. There was no significant differentiation among the livestock rearers of South 24 Parganas, Purba Medinipur and Bhadrak district regarding features of climate change.

Not only features of climate change, due to the above discussed reason, livestock rearers of coastal South 24 Parganas were also more aware regarding impact on agriculture and livestock production. Table 4 also stated that there was a significant (P<0.05) differentiation between the livestock rearers of two coastal districts of West Bengal regarding awareness towards impact on agriculture and livestock production. The same trend was also observed between the two districts of Odisha.

As far as awareness of general effect and impact of climate change and overall awareness of climate change was concerned, livestock rearers of Purba Medinipur district were more aware to both dimension of climate change than the livestock rearers of other districts. Literacy rate of Purba Medinipur is much higher than the other studied districts. Therefore, livestock rearers of Purba Medinipur district were more aware in both general effect and impact of climate change and overall awareness of climate change. From the same table it was also found that there was no significant differentiation among the livestock rearers of Purba Medinipur, Bhadrak and Ganjam district regarding awareness of general effect and impact of climate change. Whereas, livestock rearers of South 24 Parganas district had differential significant (P<0.05) awareness with the livestock rearers of Purba Medinipur, Bhadrak and Ganjam district. In overall awareness regarding climate change, it was found that there was significant (P<0.05) differentiation between the livestock rearers of two districts of coastal

Table 4. Average value and comparative evaluation of awareness towards climate change and its different dimensions in coastal region (mean±SE)

Study area	Climate change and its causes	Features of climate change	General effect and impact of climate change	Impact on agriculture and livestock production	Overall awareness regarding climate change
Odisha					
Ganjam (n=102)	38.199± 1.529^{b} (85.850)	137.162± 6.358^{b} (162.840)	154.971± 8.204 ^{a} (215.500)	77.530± 1.596 ^{c} (101.620)	407.861± 17.038^{c} (418.250)
Bhadrak (n=119)	59.596± 1.596 ^{a} (73.380)	141.428± 5.031 $^{a\,b}$ (170.510)	161.437± 8.468 ^{a} (275.780)	132.470± 4.426 ^{b} (160.060)	494.932± 17.570 ^{ab} (567.31)
Odisha overall (n=221)	49.721± 1.322 (85.850)	139.459± 3.987 (170.510)	158.453± 5.918 (275.800)	107.113± 3.099 (180.090)	454.745± 12.619 (567.310)
West Bengal					
Purba Medinipur (n=100)	55.457± 1.248 ^{a} (106.88)	150.160 ±2.658 $^{a\,b}$ (106.880)	169.781± 3.060 ^{a} (268.570)	131.067± 3.366 ^{b} (132.780)	506.465± 7.776 ^{a} (338.340)
South 24 Parganas (n=120)	42.753± 2.020^{b} (73.380)	151.540± 3.939^{a} (150.380)	122.120± 7.301 ^{b} (268.570)	143.217± 4.208 ^{a} (157.660)	459.630± 15.744 ^{b} (582.81)
West Bengal Overall (n=220)	48.528± 1.308 (73.380)	150.913± 2.460 (150.38)	143.784± 4.505 (268.570)	137.694± 2.783 (157.660)	480.919± 9.401 (582.810)
Man Whitney U statistics (Odisha Vs West Bengal)	24007 (p = 0.817)$^{\#}$	22425 (p = 0.158) $^{\#}$	20916.5000** (p = 0.011) $^{\#}$	14879.500* (p = 0.000) $^{\#}$	22179 (p = 0.111) $^{\#}$
Coastal region overall (n=441)	49.126± 0.930 (85.850)	145.173± 2.358 (170.510)	151.135± 3.733 (275.800)	122.369 ±2.205 (180.090)	467.802± 7.889 (593.410)

Means at district level with different superscript in a column differ significantly at 5 % level of significance, in a 2 tail test. Multiple comparisons are based on DMRT post hoc test. $^{\#}$ P value. * significant at 1 % level of significance, in a two tail test. ** significant at 51 % level of significance, in a 2 tail test. Values in parenthesis indicate range.

Annexure 1: Relevancy weightage (RW) of each statement of climate change awareness scale

St No	Statements	RW
'Climate Change' and its causes		
1	'Climate Change' is the change in the average weather of a given area or region, albeit it is concerned with the universe as a whole.	0.88
2	'Climate Change' happens due to excessive burning of fossil fuels such as oil, coal and natural gas supply etc.	0.88
3	Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have led to a rise in the emission of carbon dioxide, which finally leads to 'Climate Change'.	0.96
4	Emission of greenhouse gases is the main cause of temperature rise.	0.96
Features of 'Climate Change'		
5	Increase in mean temperature throughout the year	0.84
6	Increasing temperature during summers	0.84
7	Prolonged summer	0.96
8	Delayed onset of winter	0.88
9	Short winter periods	0.84
10	Occurrence of heavy fog during winter season	0.80
11	Delayed onset of monsoon; uneven distribution and early withdrawal of monsoon	0.92
12	Unpredictable rainfalls	0.84
13	Span of rainfall has been reduced but there is tendency of heavy downpour during monsoons as compared to constant low-intensity rainfall in the past	0.60*
14	Precipitation has declined.	0.80
15	Long dry spells and increased rate of drought	0.88
16	Change in the season cycle during the last 10 – 15 years	0.80
17	Increased rate of heat and cold waves	0.92
Effect and impact of '*Climate Change*'		
18	The type, frequency and intensity of extreme climatic events are expected to rise even with a slight change in the climate.	0.84
19	Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding.	0.92
20	'Climate Change', leading to warming and 'water stress' could further exacerbate land degradation, further leading to desertification.	0.92
21	Reduced soil moisture and evapotranspiration may increase land degradation and desertification.	0.92
22	Increase in the number and severity of glacial melt-related floods, slope destabilization, followed by decrease in river flows as glaciers disappear.	0.92
23	'Water stress' for the human-beings and or livestock due to decrease of freshwater availability in river basins during summer months due to glaciers retreat	1.00
24	The key 'climate- related risks' in the coastal zone include tropical cyclones, sea level rise and changes in temperature and precipitation.	0.96
25	Increasing sea levels means greater risk of storm surge, inundation and wave damage to coastlines.	0.96
26	Coastal zones will be more sensitive to erosion, flooding, submergence and deterioration of Coastal ecosystems such as mangroves and salinization.	0.96
27	Damage to coastal infrastructure, aquaculture and coastal tourism, due to the erosion of sandy beaches is also likely.	0.96
28	Both the coastal and alpine ecosystems will be adversely affected, thereby causing the extinction of 15 to 40 percent of species due to in rise by temperature 2^0C.	0.88
29	Increase in endemic morbidity and mortality due to vector borne diseases like malaria, cholera and diarrhea	0.84
30	Increased risk of extinction for many species due to the synergistic effects of 'Climate Change' and habitat fragmentation	0.92
Effect on agriculture and livestock production		
31	Agriculture is extremely vulnerable to 'Climate Change'.	1.00
32	Higher temperatures eventually reduce yields of desirable crops, while encouraging weed and pest proliferation.	0.92
33	Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines.	0.92
34	Rising temperatures will be the cause of shifts in crop growing seasons	0.96
35	Productivity of rain-fed crops will be adversely affected due to increased rate of drought.	0.92
36	There will be gains in some crops in some regions of the world.	0.76*
37	Crop cultivation may be expanded in the alpine region due to increased temperature.	0.84
38	Heat stress may reduce the fertility of livestock.	0.88
39	Increase in temperature and humidity is the cause behind declined milk production of dairy bovine.	0.8
40	Heat stress may cause the reduced feed intake of the livestock.	1.00
41	'Climate Change' is the cause of increased rate of 'temperature-related illness and vector borne diseases' among livestock.	0.96

*Statements are dropped for scale construction as their Relevancy weighage are below the cut-off (0.80).

Annexure 2: Polychoric correlation co-efficient of selected statement for climate change awareness scale

St No	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	37	38	39	40	41
1	1.00																																						
2	0.36	1.00																																					
3	0.11	0.82	1.00																																				
4	0.44	0.20	0.26	1.00																																			
5	0.07	0.31	0.17	0.23	1.00																																		
6	0.02	0.30	0.17	0.41	0.73	1.00																																	
7	0.03	0.24	0.18	0.18	0.44	0.60	1.00																																
8	0.02	0.38	0.37	0.14	0.06	0.29	0.50	1.00																															
9	0.03	0.21	0.16	-0.02	0.24	0.06	0.30	0.54	1.00																														
10	-0.14	0.13	0.22	0.09	0.09	0.13	0.21	0.44	0.45	1.00																													
11	0.22	0.17	0.13	0.09	0.28	0.11	0.14	0.09	0.41	0.51	1.00																												
12	0.22	0.10	0.06	0.20	0.40	0.31	0.21	0.21	0.31	0.48	0.61	1.00																											
14	0.32	0.25	0.14	0.30	0.29	0.38	0.36	0.23	0.29	0.27	0.46	0.33	1.00																										
15	0.04	0.30	0.10	0.21	0.52	0.42	0.37	0.15	0.15	0.21	0.31	0.29	0.71	1.00																									
16	-0.02	0.25	-0.01	0.17	0.27	0.36	0.36	0.35	0.39	0.21	0.26	0.16	0.49	0.66	1.00																								
17	0.22	0.29	0.23	0.34	0.24	0.44	0.25	0.42	0.05	0.33	0.18	0.38	0.55	0.55	0.56	1.00																							
18	0.32	0.15	0.05	0.22	0.25	0.25	0.26	0.32	0.17	0.20	0.19	0.21	0.34	0.41	0.43	0.50	1.00																						
19	0.28	0.16	-0.07	0.12	0.31	0.25	0.38	0.23	0.14	0.16	0.19	0.28	0.37	0.37	0.34	0.53	0.71	1.00																					
20	0.31	0.14	0.08	-0.04	0.02	-0.05	0.12	0.05	0.10	-0.12	-0.02	0.06	0.11	0.00	0.16	0.08	0.07	0.14	1.00																				
21	0.23	0.13	0.27	0.16	-0.04	-0.10	0.10	0.14	0.10	-0.06	0.08	0.11	0.09	-0.03	-0.03	0.13	-0.02	0.10	0.68	1.00																			
22	0.15	0.09	0.18	0.13	-0.12	-0.11	0.03	0.01	-0.05	-0.02	0.08	0.12	0.01	-0.08	-0.05	0.05	-0.09	0.15	0.30	0.69	1.00																		
23	0.00	0.15	0.13	0.04	0.12	-0.06	0.00	0.14	0.04	0.03	0.24	0.15	-0.03	-0.07	0.01	0.01	0.06	0.03	-0.27	0.52	0.62	1.00																	
24	0.15	-0.14	-0.08	0.14	0.19	0.08	0.16	0.13	0.24	-0.01	0.22	0.30	-0.01	-0.09	-0.06	0.03	0.00	0.14	0.09	0.54	0.63	0.68	1.00																
25	0.02	-0.09	-0.02	0.16	-0.08	-0.09	0.11	0.12	0.26	0.17	0.15	0.17	-0.14	-0.16	-0.04	-0.14	-0.01	-0.05	0.01	0.33	0.43	0.49	0.74	1.00															
26	-0.08	-0.04	-0.05	0.21	0.01	-0.10	-0.12	-0.03	0.31	0.30	0.21	0.24	-0.03	0.01	0.03	-0.12	0.03	0.09	0.02	-0.01	0.33	0.29	0.52	0.68	1.00														
27	0.02	0.01	-0.04	0.24	0.02	0.18	0.00	0.19	0.22	0.24	0.19	0.23	0.09	0.07	0.15	0.11	0.20	0.14	0.10	0.16	0.30	0.46	0.62	0.68	0.68	1.00													
28	0.19	-0.14	-0.22	0.12	-0.08	-0.08	-0.10	-0.22	-0.14	-0.14	-0.11	-0.08	-0.09	-0.04	-0.07	-0.16	0.10	0.19	0.12	0.21	0.34	0.26	0.46	0.43	0.53	0.68	1.00												
29	0.20	-0.05	-0.13	0.11	-0.04	-0.13	-0.07	-0.04	0.10	-0.11	0.05	-0.01	-0.09	0.09	0.05	-0.05	0.07	0.08	0.25	0.08	0.18	0.03	0.22	0.44	0.50	0.45	0.63	1.00											
30	0.28	-0.07	0.01	0.24	-0.04	0.08	0.11	-0.03	0.09	0.03	0.18	0.22	0.10	0.09	0.07	0.16	0.18	0.22	0.30	0.27	0.17	-0.03	0.26	0.27	0.35	0.33	0.40	0.58	1.00										
31	0.17	0.06	-0.05	-0.01	0.18	-0.05	0.14	0.08	0.39	0.22	0.33	0.41	0.10	0.30	0.33	0.09	0.23	0.22	0.37	0.06	0.07	0.01	0.23	0.22	0.47	0.33	0.30	0.45	0.52	1.00									
32	0.16	0.14	-0.06	0.05	0.20	-0.03	0.01	0.15	0.45	0.21	0.27	0.24	0.24	0.28	0.40	0.22	0.33	0.29	0.34	-0.05	-0.02	-0.08	0.02	0.08	0.43	0.09	0.09	0.35	0.26	0.71	1.00								
33	0.23	0.25	-0.08	-0.06	0.27	0.16	0.19	0.11	0.21	0.05	0.20	0.25	0.17	0.29	0.30	0.29	0.27	0.33	0.31	0.04	0.14	-0.11	0.09	0.03	0.11	0.00	0.01	0.13	0.33	0.55	0.55	1.00							
34	0.03	0.09	-0.04	0.00	0.01	0.00	0.03	0.15	0.24	0.29	0.13	0.14	0.17	0.16	0.23	0.24	0.03	0.01	0.21	0.17	0.02	-0.11	-0.02	-0.06	0.01	-0.12	-0.25	-0.15	0.15	0.38	0.37	0.56	1.00						
35	-0.01	0.36	0.26	-0.04	0.16	0.32	0.18	0.24	0.02	0.10	0.08	0.00	0.15	0.19	0.15	0.19	0.04	-0.02	0.14	-0.11	-0.11	-0.11	-0.09	-0.09	0.04	0.03	-0.07	0.04	0.21	0.23	0.24	0.61	0.51	1.00					
37	0.24	0.28	0.27	0.08	-0.11	-0.04	-0.05	0.09	-0.02	-0.05	-0.03	0.05	0.23	0.19	-0.02	0.15	0.23	0.10	-0.19	0.06	0.20	0.11	0.15	0.18	0.10	0.22	0.22	0.08	0.28	0.12	0.04	0.17	-0.06	0.12	1.00				
38	0.02	0.17	-0.04	-0.11	-0.08	-0.04	0.11	0.14	0.15	0.17	0.28	0.07	0.32	0.23	0.28	0.07	0.08	0.17	0.20	0.09	0.17	0.02	-0.01	0.13	-0.03	-0.03	-0.15	-0.06	-0.03	0.14	0.35	0.44	0.51	0.27	-0.07	1.00			
39	-0.17	0.23	0.11	0.11	0.03	0.14	0.06	0.24	0.06	0.27	0.00	-0.05	0.16	0.12	0.38	0.10	-0.10	-0.13	0.02	0.05	0.27	0.18	0.13	0.10	0.10	0.09	-0.10	-0.16	-0.07	0.08	0.12	0.19	0.41	0.33	-0.01	0.61	1.00		
40	0.07	0.35	0.24	0.21	0.14	0.26	0.36	0.48	0.24	0.18	0.10	0.09	0.31	0.33	0.30	0.18	0.23	0.13	0.25	0.16	0.10	0.03	0.22	0.22	0.17	0.26	0.02	-0.05	0.25	0.37	0.38	0.37	0.58	0.49	0.13	0.70	0.77	1.00	
41	-0.03	0.34	0.25	0.02	0.23	0.32	0.15	0.36	0.07	0.06	0.14	0.07	0.18	0.41	0.41	0.22	0.11	-0.02	0.13	-0.05	-0.03	0.03	0.08	0.06	0.00	0.10	-0.06	-0.10	0.12	0.28	0.26	0.50	0.43	0.72	0.06	0.69	0.77	0.94	1.00

Annexure 3: Selection of statements for climate change awareness scale and their communalities value

St No	Statement for selected for scale construction in relevancy test	First run of Factor analysis Communalities		Second run of Factor analysis Communalities	
		Initial	Extraction	Initial	Extraction
'Climate Change' and its causes					
1	'Climate Change' is the change in the average weather of a given area or region, albeit it is concerned with the universe as a whole.	1.000	.767*		
2	'Climate Change' happens due to excessive burning of fossil fuels such as oil, coal and natural gas supply etc.	1.000	.846	1.000	.817
3	Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have led to a rise in the emission of carbon dioxide, which finally leads to 'Climate Change'.	1.000	.887	1.000	.875
4	Emission of greenhouse gases is the main cause of temperature rise.	1.000	.518*		
Features of 'Climate Change'					
5	Increase in mean temperature throughout the year	1.000	.866	1.000	.915
6	Increasing temperature during summers	1.000	.961	1.000	.957
7	Prolonged summer	1.000	.835	1.000	.890
8	Delayed onset of winter	1.000	.903	1.000	.938
9	Short winter periods	1.000	.888	1.000	.906
10	Occurrence of heavy fog during winter season	1.000	.845	1.000	.865
11	Delayed onset of monsoon; uneven distribution and early withdrawal of monsoon	1.000	.892	1.000	.887
12	Unpredictable rainfalls	1.000	.848	1.000	.883
14	Precipitation has declined.	1.000	.835	1.000	.830
15	Long dry spells and increased rate of drought	1.000	.860	1.000	.860
16	Change in the season cycle during the last 10 – 15 years	1.000	.836	1.000	.825
17	Increased rate of heat and cold waves	1.000	.842	1.000	.848
Effect and impact of 'Climate Change'					
18	The type, frequency and intensity of extreme climatic events are expected to rise even with a slight change in the climate.	1.000	.889	1.000	.861
19	Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding.	1.000	.868	1.000	.863
20	'Climate Change', leading to warming and 'water stress' could further exacerbate land degradation, further leading to desertification.	1.000	.887	1.000	.873
21	Reduced soil moisture and evapotranspiration may increase land degradation and desertification.	1.000	.925	1.000	.957
22	Increase in the number and severity of glacial melt-related floods, slope destabilization, followed by decrease in river flows as glaciers disappear.	1.000	.918	1.000	.924
23	'Water stress' for the human-beings and or livestock due to decrease of freshwater availability in river basins during summer months due to glaciers retreat	1.000	.847	1.000	.838
24	The key 'climate- related risks' in the coastal zone include tropical cyclones, sea level rise and changes in temperature and precipitation.	1.000	.892	1.000	.963
25	Increasing sea levels means greater risk of storm surge, inundation and wave damage to coastlines.	1.000	.930	1.000	.956
26	Coastal zones will be more sensitive to erosion, flooding, submergence and deterioration of Coastal ecosystems such as mangroves and salinization.	1.000	.929	1.000	.935
27	Damage to coastal infrastructure, aquaculture and coastal tourism, due to the erosion of sandy beaches is also likely.	1.000	.901	1.000	.910
28	Both the coastal and alpine ecosystems will be adversely affected, thereby causing the extinction of 15 to 40 percent of species due to in rise by temperature 2^0C.	1.000	.957	1.000	.957
29	Increase in endemic morbidity and mortality due to vector borne diseases like malaria, cholera and diarrhea	1.000	.915	1.000	.910

Annexure 3...

St No	Statement for selected for scale construction in relevancy test	First run of Factor analysis Communalities		Second run of Factor analysis Communalities	
		Initial	Extraction	Initial	Extraction
30	Increased risk of extinction for many species due to the synergistic effects of 'Climate Change' and habitat fragmentation	1.000	.743*		
Effect on agriculture and livestock production					
31	Agriculture is extremely vulnerable to 'Climate Change'.	1.000	.908	1.000	.917
32	Higher temperatures eventually reduce yields of desirable crops, while encouraging weed and pest proliferation.	1.000	.882	1.000	.908
33	Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines.	1.000	.830	1.000	.855
34	Rising temperatures will be the cause of shifts in crop growing seasons	1.000	.872	1.000	.895
35	Productivity of rain-fed crops will be adversely affected due to increased rate of drought.	1.000	.874	1.000	.876
37	Crop cultivation may be expanded in the alpine region due to increased temperature.	1.000	.758*		
38	Heat stress may reduce the fertility of livestock.	1.000	.913	1.000	.911
39	Increase in temperature and humidity is the cause behind declined milk production of dairy bovine.	1.000	.929	1.000	.947
40	Heat stress may cause the reduced feed intake of the livestock.	1.000	.864	1.000	.930
41	'Climate Change' is the cause of increased rate of 'temperature-related illness and vector borne diseases' among livestock.	1.000	.929	1.000	.951

Odisha. This trend was also observed between the livestock rearers of two coastal districts of West Bengal.

Man Whitney U statistics was also used to delineate the differentiation, if any, of different dimensions of climate change awareness as well as overall awareness regarding climate change at states level. Therefore, it was found that there was a significant differentiation between the livestock rearers of Odisha and West Bengal in awareness regarding general effect and impact of climate change and impact on agriculture and livestock production at 5 and 1 % level of significance, respectively. Whereas, in other two dimensions i.e. climate change and its causes and features of climate change as well as overall awareness regarding climate change, there was no differentiation between the livestock rearers of the two studied states.

This paper demonstrated the power of psychometric tool to assess the state of awareness among the livestock rearers. It has concentrated among the individual as well as district level on the different important aspects of climate change to determine the state of awareness among the livestock rearing community of the eastern coastal region of India. In general, majority of the population exhibit their strong level of awareness towards changing climatic scenario and particularly towards broad spectrum of climate change like causes, features, effects and impacts. Comparisons of state of awareness with the factual climatic data validated farmers' claim and established the authenticity of the psychometric tool. Hence, this psychometric tool will be key instrument for researchers and policy makers to assess state of climate change awareness among the end users and to develop appropriate adaptation strategies to minimize the risk of livestock sector to climate change.

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REFERENCES

Acquah-de Graft H. 2011. Farmers' perceptions and adaptation to climate change: a willingness to pay analysis. *Journal of Sustainable Development in Africa* **13**(5): 150–61.

Acquah-de Graft H and Onumah E. 2011. Farmers' perceptions and adaptations to climate change: An estimation of willingness to pay. *Agris* **3**(4): 31–39.

Adger W N. 2000. Institutional adaptation to environmental risk under transition in Vietnam. *Annals of the Association of American Geographers* **90** (4): 738–58.

Adger W N, Huq S, Brown K and Hulme M. 2003. Adaptation to climate change in the developing world. *Progress in Development Studies* **3**(3): 179–95.

Angles S, Chinnadurai M and Sundar A. 2011. Awareness on impact of climate change on dryland agriculture and coping mechanisms of dryland farmers. *Indian Journal of Agricultural Economics* **66**(3): 365–72.

Deressa T T, Hassan R M and Ringler C. 2011. Perception and adaptation to climate change by farmers in the Nile basin of Ethiopia. *Journal of Agricultural Science* **149**: 23–31.

Falaki A A, Akangbe J A and Ayinde O E. 2013. Analysis of Climate Change and Rural Farmers' Perception in North Central Nigeria. *Journal of Human Ecology* **43**(2): 133–40.

Fankhauser S. 1996. The potential costs of climate change adaptation. *Adapting to Climate Change: An International Perspective.* pp. 80–96. (Eds) Smith J, Bhatti N, Menzhulin G, Benioff R, Budyko MI, Campos M, Jallow B, Rijsberman F. Springer, New York,

Gadermann A M, Guhn M and Bruno D Z. 2012. Estimating ordinal reliability for Likert-type and ordinal item response data: A conceptual, empirical, and practical guide. *Practical Assessment, Research and Evaluation* **17**(3). Available online: http: //pareonline.net/ getvn.asp?v=17 &n=3 retrieved on July 29, 2013.

Gandure S, Walker S and Botha J J. 2012. Farmers' perceptions of adaptation to climate change and water in a South African rural community. *Environmental Development* **5**: 39–53. Doi: 10.1016/j.endev.2012.11.04.

Gbetibbou G A. 2009. Understanding farmers' perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa. IFPRI Discussion Paper No. 00849. Washington DC.

Klein R J T. 2002. Adaptation to climate variability and change: what is optimal and appropriate. *Climate change and the Mediterranean: Socio-Economics of Impacts, Vulnerability and Adaptation.* (Eds) Giupponi C and Schechter M. Edward Elgar, Cheltenham, UK.

Kumar G D S and Popat M N. 2009. Development of a scale to measure farmers' perception on quality groundnut. *Indian Research Journal of Extension Education* **9**(1): 11–13.

Lieske D J, Wade D and Roness L A. 2014. Climate change awareness and strategies for communicating the risk of coastalflooding: A Canadian Maritime case example. *Estuarine, Coastal and Shelf Science* **140**: 83–94.

Maddison D. 2006. The perception of and adaptation to climate change in Africa. CEEPA. Discussion Paper No. 10. Centre for Environmental Economics and Policy in Africa, University of Pretoria, Pretoria, South Africa.

Mandleni B and Anim F D K. 2011. Climate change awareness and decision on adaptation measures by livestock farmers in South Africa. *Journal of Agricultural Science* **3**(3): 258–68.

McCarthy J J, Canziani O F, Leary N A, Dokken D J and White K S. 2001. *Climate change 2001: Impacts, Adaptation and Vulnerability.* Cambridge University Press, Cambridge, UK.

Mengistu D K. 2011. Farmers' perception and knowledge of climate change and their coping strategies to the related hazards: Case study from Adiha, central Tigray, Ethiopia. *Agricultural Sciences* **2**(2): 138–45.

Mtambanengwe F, Mapfumo P, Chikowo R and Chamboko T. 2012. Climate change and variability: smallholder farming communities in Zimbabwe portray a varied understanding. *African Crop Science Journal* **20**: 227–41.

Nunnally J C. 1978. Psychometric theory (2nd ed.). New York, NY: McGraw-Hill.

Nyanga P, Johnsen F, Aune J and Kahinda T. 2011. Smallholder farmers' perceptions of climate change and conservation agriculture: evidence from Zambia. *Journal of Sustainable Development* **4**(4): 73–85. Doi: 10.5539/jsd.v4n4p73

Orderud G I and Kelman I. 2011. Norwegian mayoral awareness of and attitudes towards climate change. *International Journal of Environmental Studies* **68** (5): 667–86, DOI: 10.1080/ 00207233.2011.587648.

Pittock B and Jones R N. 2000. Adaptation to what and why? *Environmental Monitoring and Assessment* **61**(1): 9–35.

Sarkar S and Padaria N. 2010. Farmers' awareness and risk perception about climate change in coastal ecosystem of West Bengal. *Indian Research Journal of Extension Education* **10** (2): 32–38.

Scoones I, Chibudu C, Chikura S, Jeranyama P, Machaka D, Machanja W, Mavedzenge B, Mombeshora B, Mudhara M, Mudziwo C, Murimbarimba F and Za B. 1996. Hazards and Opportunities: Farming Livelihoods in Dryland Africa, Lessons from Zimbabwe. Zed Books Ltd, London.

Semenza J C, Hall D E, Wilson D J, Bontempo B D, Sailor D J and George L A. 2008. Public perception of climate change voluntary mitigation and barriers to behaviour change. *American Journal of Preventive Medicine* **35**: 479–87.

Smit B, Burton I, Klein R J T and Street R. 1999. The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change* **4**: 199–213.

Sofoluwe N, Tijani A and Baruwa O. 2011. Farmers' perception and adaptations to climate change in Osun Satte, Nigeria. *African Journal of Agricultural Research* **6**(20): 4789–94.

Tol R S J, Fankhauser S and Smith J B. 1998. The scope for adaptation to climate change: what can we learn from the impact literature? *Global Environmental Change* **8** (2): 109–23.

Tripathi A. 2010. People's perception on the effect of climate change - A case study of tribal district of Indo-Gangetic Region, Himalayas. Reflections of climate change leaders from the Himalayas, Leadership for Environment and Development (LEAD) report, India, New Delhi.

United Nations Environment Programme (UNEP). 1991. *Handbook on methods for climate impact assessment and adaptation strategies.* (Eds) Feenstra J, Burton I, Smith J and Tol R. United Nations Environment Program. Institute for Environmental Studies, Amsterdam, The Netherlands.

Yohe G, Neumann J, Marshall P and Ameden A. 1996. The economic costs of sea-level rise on developed property in the United States. *Climatic Change* **32**: 387–410.

Yohe G and Tol R S J. 2002. Indicators for social and economic coping capacity—moving toward a working definition of adaptive capacity. *Global Environmental Change* **12**: 25–40.