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Impacts of environmental education on perceptions of climate change risks in rural and township communities in Limpopo Province, South Africa

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Abstract

Climate change impacts are affecting communities in the Limpopo Province, South Africa. However, only limited evidence exists about awareness level of local communities about climate change impacts. In this paper we investigate influence of environmental education programs, currently being implemented by different NGOs, on the level of awareness about climate change impacts among young people in two communities of the Limpopo province. We collect empirical data during two focus groups discussions in a rural and a township community in the Limpopo province. During these focus group discussions we apply different participation tools to facilitate the discussion and to collect the participants' views.

Acknowledgments

About the Authors

Mr Elvis Modikela Nkoana is a former student leader who completed his undergraduate and postgraduate studies in South Africa and Europe. He is currently pursuing doctoral studies in the Antwerp University in Belgium. His doctorate is focused on participation components of climate change adaptation tools as they are applied in sub-Saharan African communities. His other research interests include systems analysis methodologies, particularly the application of multi criteria analysis techniques on stakeholder views and opinions on utility scale renewable energy deployment in South Africa. He participated in the South Africa Young Scientists Summer Program (SA-YSSP) hosted by International Institute for Applied Systems Analysis (IIASA), the National Research Foundation (NRF), Department of Science and Technology (DST), University of the Free State, and the Stellenbosch University. Mr Nkoana is employed as a lecturer by the University of South Africa in Pretoria.

Dr Nadejda Komendantova is a coordinator of the research theme "Governance in transition" within the Risk and Resilience Program. Her research interests include participatory and multi-risk governance of climate change mitigation and adaptation, based on the understanding of views and risk perceptions of involved stakeholders, of governance structures, market and civil society as well as social institutions and political processes towards more adaptive and inclusive governance approach, which is central to the science-policy interface.

1 Introduction

Climate change is one of the biggest challenges of the 21st century (IPCC, 2014). Climate change impacts threaten the resilience of natural, economic, political, and social systems. Recognizing this challenge, several countries adopted climate change mitigation and adaptation targets and measures for their implementation. Human-decision making processes, including awareness about climate change impacts, are essential for implementation of these measures. Awareness about climate change impacts is also a critical determinant of human response and adaptation, as communities first have to be aware about the impacts of climate change to be able to adapt. The level of awareness influences communities' ability to adapt to climate change. The lack of climate change awareness can lead to complacency increasing people's vulnerability to climate change and climate variability in the near and far future.

Environmental education is an important tool to raise communities' awareness about climate change. Currently, the South African government and NGOs are implementing several environmental education programmes, most of them are focused on persistent problems of droughts and flooding. However, despite popularity of these programmes, only few studies in South Africa investigate the relationship between environmental education and awareness about climate change impacts. Only few studies exist with the focus on the Limpopo river region. These studies show that inhabitants of the region lack awareness of climate change impacts posed by flooding from the Limpopo river (Maponya et al., 2003; Patt and Schroeter 2008). In our paper we investigate if and how environmental programs implemented in two communities, rural and township, influenced the level of awareness about climate change impacts. We collect our data during focus group discussions and with the help of implementation of participatory tools among students.

Therefore, the major research question of this work is about how environmental education impacts the level of awareness about climate change impacts among inhabitants of the Limpopo province.

2 Background

2.1. Environmental education and level of awareness about climate change impacts

Climate change awareness is a precursor of climate change adaptation and local communities should be aware of climate change in order to adapt to it (Adger et al., 2008). However, local communities' priorities in the Limpopo province are livelihoods activities and not climate change adaptation (van Aalst et al., 2008). Everyday struggles coupled with 'silent' hazards such as occasional flash floods and surreptitious droughts can create an environmental of complacency towards climate change adaptation.

The level of awareness about climate change impacts is influenced by psychological (socio-cognitive factors, heuristics and biases), social (socio-economic, socio-physical, demographic, and economic factors), moral (individual and societal values), institutional (trust of public opinion and risk communication), and cultural (religious beliefs and local customs) factors (Adger et al. 2008; Dessai et al. 2004; Grothmann & Patt 2005; Frank et al. 2005; Patt & Schoter 2008; Wiid & Ziervogel 2012; Marx et al. 2007, Perry et al. 2008; Paton et al. 2008; Gaillard 2008; and Schumuck 2000).

All these factors grouped into internal and external factors. The internal factors include values (trust of public opinion), beliefs (myths), experience (personal and/or vicarious), and knowledge (local knowledge and/or scientific data) about climate change and variability (Dessai et al., 2004). External factors can be institutional and societal factors (Komendantova et al. 2012; Scolobig et al., 2014). Often these factors are identified in technical and experts reports and shape individual, organizational and societal level of awareness about climate change impacts through risk communication processes (table 1).

`Table 1: Factors influencing level of awareness about climate change impacts

Factors			References
Psychological (Dessai et al. 2004)	Socio-cognitive (Personal/Vicarious experience & Behaviour)	Heuristics	Marx et al. 2007; Grothmann & Patt 2005; Patt and Schoter 2008; Frank et al. 2005; Wiid & Ziervogel 2012; Adger et al. 2008; Paton et al. 2008; Paton 2001
		Biases	
	Knowledge	Local Knowledge	Adger et al. 2008
		Scientific Knowledge	
Social (Dessai et al. 2004)	Socio-economic	Household structure	Frank et al. 2010; Grothmann & Patt 2005
	Economic	Private property ownership	Grothmann & Patt, 2005; Perry & Lindell 2008

	Socio-physical	Hazard environment (hazard proximity, frequency, magnitude)	Perry & Lindell 2008; Paton et al. 2008; Gaillard 2008; Adger et al. 2008; Frank et al. 2010; Grothmann & Patt, 2005; Wiid & Ziervogel 2012
	Demographic	Age, Gender, Household structure, Education level	Frank et al. 2010
Moral (Dessai et al. 2004)	Values	Culture (hierarchical, individualistic, egalitarian, fatalism, & hermitic)	Wiid & Ziervogel 2012; Leiserowitz, 2006; Weber and Hsee, 1998; Weber 2006
Institutional (Dessai et al. 2004)	Trust deficit	Trust of public opinion	Wiid & Ziervogel 2012; Paton et al. 2008
	Participation	Community participation in risk management	Paton et al. 2008; Grothmann & Patt 2005; Gaillard 2008; Paton et al. 2008
	Risk management	Risk communication (information)	Perry & Lindell 2008; Grothmann & Patt, 2005: 209; Paton et al. 2008
Cultural (Dessai et al. 2004)	Religious beliefs	Natural disasters are acts of gods and ancestors	Schumuck 2000; Grothmann & Patt 2005, Gaillard 2008
	Local customs	Environmental cues or signs used for traditional predictions and climate forecasts	Marx et al. 2007

The level of awareness about climate change impacts can be also influenced by public education, which can play an important role in risk perception amplification in the absence of personal (direct) experience (Paton et al. 2008; Sharma et al., 2013; Striessnig et al., 2013). Education can be formal, non-formal, and informal. Formal education refers to "purposive and structural learning leading to recognized certificates and diplomas". Non-formal education means "any educational activity taking place outside the formal 'education' system". Informal education is "unplanned learning that goes on in daily life" (Sharma et al., 2013).

Studies on climate change impacts have increased attention to the need of environmental education as an important factor in determining the coping and adaptive capacity. Evidence exists that "formal education is negatively correlated with deaths or other forms of loss from disasters and the correlation seems to be particularly strong for developing countries" (Sharma et al., 2013). This is mainly due to poor access and low quality of formal education in rural areas of developing countries. More evidence suggests that formal education leads to the adoption of improved strategies for coping with and adaptation to climate change in the agricultural sector, which is the economic mainstay of most rural communities in developing countries. Therefore, "farmers with higher levels of education are more likely to better adapt to climate change" (Sharma et al. 2013).

For example, in their study, Maponya et al. (2013) report that there is a direct correlation between educational level and climate change awareness amongst farmers in Limpopo Province.

In contrary, better education does not necessarily correlate with reduced vulnerability and greater adaptation. Sharma et al., (2013) indicate that this contradiction stems from different methodological approaches to studying the correlation of formal education and climate change adaptation and, particularly, response to natural hazards early warming messages. However, there is a positive, albeit little, correlation between formal education and climate change adaptation, including the level of awareness about climate change impacts. In fact, Sharma et al., (2013) indicate that higher educated community members do understand better early warming messages but they might not necessarily evacuate in a cyclone situation due to the "false sense of safety" from better housing quality.

Both non-formal and informal education finds expression through traditional knowledge systems. Traditional knowledge plays a crucial role in climate change awareness among rural communities of developing countries, because, rural communities possess traditional knowledge that is hazard-specific, gained from non-formal sources. For example, Sharma et al. (2013) observed traditional knowledge (using environmental cues) of fishermen who could predict cyclones before they occurred with remarkable accuracy. Local residents possessed traditional knowledge how to cope and adapte to climate change and climate variability (cyclone extremes). Their level of awareness was higher than of people with formal education. Traditional knowledge plays an important role in rural areas of developing countries and might lead to better decision-making outcomes regarding climate change adaptation, disaster risk reduction, and early warming-response and evacuation.

2.2. Environmental education program in the Limpopo province

The subjects of our study are two communities in the Limpopo province and the object is impacts of eco-schools environmental education program on the level of awareness about climate change impacts. The Eco-Schools Programme is an international programme of the Foundation for Environmental Education (FEE) and is active in 54 countries around the world. The South African chapter of the Eco-Schools programme was initiated in 2003 with the Wildlife and Environment Society of South Africa (WESSA) as the implementing agent (WESSA, 2014).

Eco-schools programme is aimed at creating awareness and action around environmental sustainability in schools and their surrounding communities as well as supporting ESD (Education for Sustainable Development) in the national curriculum. There are over 1,200 schools which implements this programme. The themes of the programme include: Water, Waste, Energy, Nature and Biodiversity, Lifestyle and Healthy living, Transportation, Climate change, and the Local agenda XXI (Foundation for Environmental Education, 2014)

The two cases of this study are RALEMA Villages and Mankweng Township situated in the Polokwane region of Limpopo Province, South Africa. Polokwane region shares its name with Polokwane city, which is the largest metropolitan area in the Limpopo Province, and a major economic center. The Polokwane region serves as a corridor to neighboring countries such as Botswana, Zimbabwe, Mozambique and Swaziland. It has a very high unemployment rate of 32%, thee youth unemployment is 42%. The biggest part of population are black Africans (93%) with 41% of them being in the age between 15 and 24. The significant share of population (43%) is agricultural households (Statistics of South Africa, 2012).

Figure 1: Limpopo Province with Polokwane region highlighted
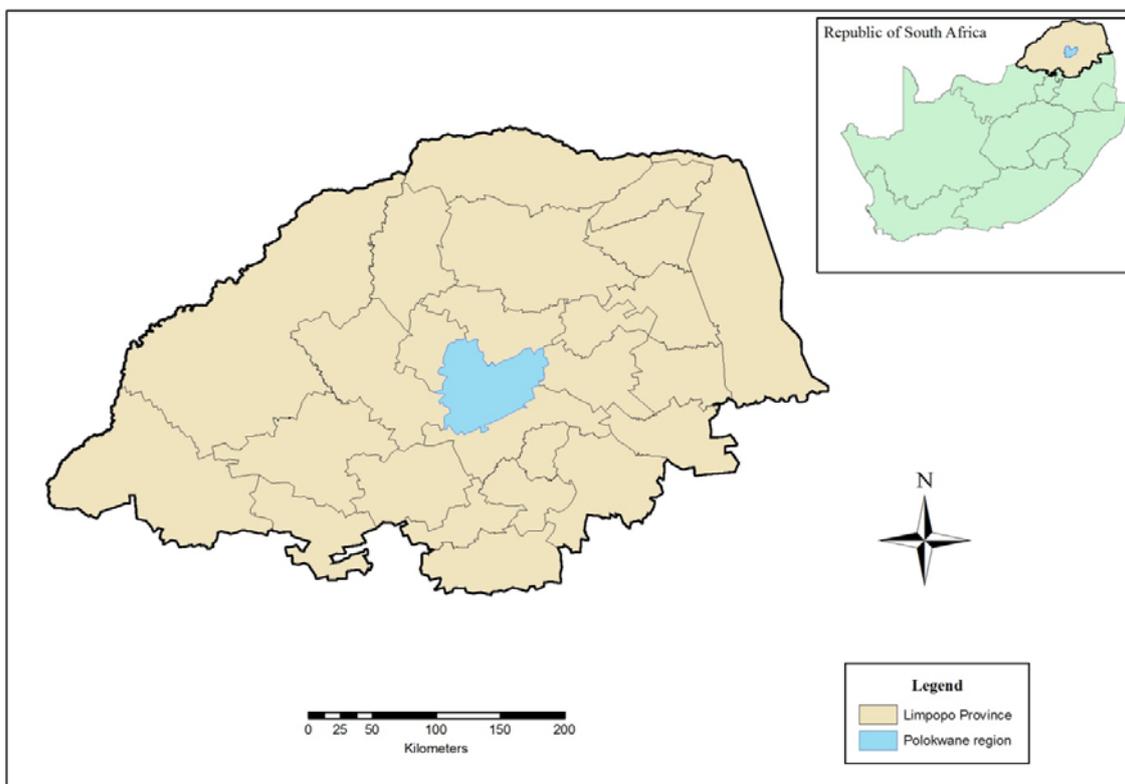
Source: Researcher's own using SANSA Fundisa data.

The RALEMA (RAmphele, LEgodi, and MAbotsa) village forms part of the Moletjie chieftaincy. Moletjie chieftaincy is a region constituted by various villages divided between Polokwane and Aganang local municipalities. Moletjie occupies an area to the North-West of Polokwane city. Moletjie region is predominantly rural and subsistence agriculture is common. Moletjie residents commute to Polokwane city for work, leisure, and shopping. Residents of these villages are entirely dependent on urban infrastructure for work, leisure and household errands. Elderly residents cultivate maize, water melons, pumpkins, sugar beans, and sorghum in their backyards and in the veld. Moletjie water supply is erratic and unreliable and most household might not afford boreholes (Polokwane Municipality, 2014; Statistics of South Africa, 2012).

The Mankweng region is located 30 kilometers East of the Polokwane city. The University of Limpopo, major shopping areas, commercial banks, a major hospital, and two churches form core economic activities of the Mankweng region. The Polokwane municipality planners regard Mankweng region as a provincial economic growth node alongside mining towns and the provincial capital city. The Mankweng region is a township area with formal dwellings, major road networks, a decent water supply, and high-density dwellings. Availability of economic infrastructure means that Mankweng residents are independent of Polokwane city for work, leisure, and shopping. Mankweng residents do not engage in subsistence farming due to unavailability of land.

3. Methodology

A collective case study approach was chosen for this study. Case study research involves the study of an issue explored through one or more cases within a bounded system (i.e., a setting, a context). Cases studies can be intrinsic, instrumental, or collective (Approaches, 2006; Baxter, 2008). A collective case study approach was relevant in order to compare or contrast recipients of environmental education with those that did not receive it. These two groups also reside in different socio-economic and cultural conditions (i.e. village and township settings).

Indeed, statistical analysis is often applied to studies with similar subject. However, we apply here the qualitative methods of case study analysis in accordance to definition developed by Yin (2009). We also argue that case study

allows holistic analysis of events, decisions, projects, policies, institutions, or other systems (Thomas, 2011). That is why the method is gaining popularity recently when testing hypotheses and researching questions which are difficult to answer with existing statistical methods. As opposed to quantitative methods of research, which are often used for statistical analysis, cases are selected based on information-oriented sampling. We argue here that a case study approach can create additional benefits through detailed and more in-depth evaluation of the case. This research method also allows in-depth examination of a subject of study and its related contextual conditions.

In RALEMA villages we selected eleven (11) students from the Josephate Hendrik Moloto secondary school to form a focus group. The students belong to the BaPedi ethnic group and are 13-15 years old. They were in Grade Eight (8) which is the first year of secondary school. We choose four (4) 'average' achievers, four (4) 'top' achievers, three (3) 'bottom' achievers. They were five (5) male learners and six (6) female learners. Three (3) students resides in RAmphele village, four (4) students came from LEgodi village, and four (4) from MAbotsa village. These are three (3) areas of RALEMA villages. All selected students have never participated in environmental education initiatives.

In the Mankweng region we selected the zone A as a case study, which includes The University of Limpopo, Mankweng shopping complex, and Mankweng hospital and the Pula-Madibogo primary school. We selected twelve (12) students from the Pula-Madibogo primary school to form a focus group. The students also belong to the BaPedi ethnic group and are 13015 years old. They were in Grade Seven (7) which is the last year of primary school. We choose four (4) 'average' achievers, four (4) 'top' achievers, four (4) 'bottom' achievers. They were six (6) male students and six (6) female students. All the students resided in the Mankweng area. These students participated in environmental education initiative through the Eco-schools programme that completed projects at their school.

To collect empirical data on the level of awareness we conducted focus group discussions with selected students in both communities. Focus group is a qualitative research method where a moderator (facilitator) who guides a group of five to twelve participants through a series of questions or exercises related to a particular topic in a non-threatening environment (For & Groups, 1997; Mackey et al., 2014; Permanent, 1995; Trigg & Roy, 2007). Unlike group interviews that are often used as a quick and convenient way to collect data from several people

simultaneously, focus groups explicitly use group interaction as a part of data collection method (Mackey et al., 2014). The moderator encourages participants to talk to each other by asking questions, exchanging anecdotes and commenting on each others' experiences and points of view (Permanent, 1995). We selected mixed (age, gender, academic achievement) focus groups through a non-probability sampling technique. Their selection was based on participation in Eco-School projects.

We are well aware that the number of participants in these focus group discussions is not significant. Therefore, we tried to address the possible bias in the results by applying different methods and tools of data collection on their level of awareness about risks affecting their communities, including climate change related impacts. We applied the following participatory tools in frames of focus group discussions: Social Network Analysis tool, Historical Timeline and Trend-line, Seasonal Calendar, Problem Tree, Future Backward Scenarios Analysis tool, Hazard, Vulnerability, and Impact matrix (table 2).

Table 2: Data collection tools

	RALEMA Villages		Mankweng Township			
No. of Focus Group	1st	2nd	1st	2nd	3rd	4th
Dates	07th /04/2013	15th /04/2013	20th /09/2013	22nd /09/ 2013	29th /09/ 2013	06th /10/2013
Participation time	105 min.	97 min.	80 min.	36 min.	62 min.	42 min.
Participation topic	'Not prompted'	Climate change	'Not prompted'	'Not prompted'	Climate change	Climate change
Participation tools	Social Network Analysis tool, Future-Backward Scenarios Analysis tool, Historical Timeline, Trend-line , & Seasonal Calendar, Problem Tree, and Hazard, Impact & Vulnerability matrix.	Future-Backward Scenarios Analysis tool, Historical Timeline, Trend-line & Seasonal Calendar, Problem Tree, and Hazard, Impact & Vulnerability matrix.	Social Network, Venn Diagram, Future-Backward, Historical Timeline, Trend-line & Seasonal Calendar,	Problem Tree, and Hazard, Impact & Vulnerability matrix.	Social Network, Future-Backward, Historical Timeline, Trend-line & Seasonal Calendar,	Problem Tree, and Hazard, Impact & Vulnerability matrix.

Social Network Analysis is a social structure made up of individuals (or organizations) called "nodes", which are tied (connected) by one or more specific types of interdependency, such as friendship, kinship, common interest, financial exchange, dislike, sexual relationships, or relationships of beliefs, knowledge or prestige (Scott, 2013). Social network is useful with determining the social capital (or lack thereof) in a local community. This is useful for vulnerability and capacity assessment. We applied a social network analysis exercise through two focus group discussions with middle school learners in rural and township communities. We began by requesting focus group participants to list the various organizations in their communities. Then the participants had to indicate the relationship between their school and the community organization they mentioned. The relationship could be defined as one-way or a two-way/ mutually beneficial. The flow/direction of the relationship is indicated by an arrow pointing to the recipient/beneficiary in the relationship.

Seasonal Calendar records the annual cycle of economic and social activities, their connections with climate events (i.e. monsoon, rainy and dry seasons) and seasonal hazards (including diseases and pests). Seasonal calendar may reveal valuable qualitative information about climate trends that are unknown to outsiders and hidden from national-level data or histories (Scott, 2013). This tool helps community members to identify the relationship between socio-economic activities and seasonal variations. It also assists them in pointing out their economic capacities (or lack thereof). We requested focus group participants in the rural and township areas to list household and community livelihood activities on a seasonal calendar. They listed the livelihood activities on a monthly timeline. These enabled us to discover the similarities and differences in economic activities of the selected rural and township communities.

Historical timeline and trend-line enables local residents to diagnose climate hazards, their impacts and their trends. These tools are useful with soliciting local knowledge about climate change and climate variability and for communicating local knowledge about climate change to 'outsiders' (Scott, 2013). The rural and township participants were instructed to complete a historical timeline and historical trend-line. Historical timeline records the natural hazards that participants remember. In this case, rural and township participants recorded natural hazards that occurred in their community on a monthly and yearly timeline. The historical timeline and hazard ranking were implemented simultaneously by focus group participants. The participants were introduced to the hazard ranking tool which has a positive scale (+1 to +10) which indicates

that the weather event had a positive impact in the rural and/or township community. +1 indicates that the weather event had least benefits and +10 indicate more benefits for the community. The hazard ranking tools also has a negative scale (-1 to -10) that indicate the severity of the natural hazard, -1 been the least severe, and -10 been the most severe, or having devastating impact on the rural and/or township community. We could deduce the historical trends of the natural hazards from the historical timeline thereby eliminating the need for the rural and township participants to complete the historical trend-line exercise.

Problem Tree assists local residents to identify the problem (trunk), causes (roots), and impacts (branches). Problem tree is based on causality (the relationship between cause and effects) theory (Scott, 2013). Problem tree exercise has the potential of taking the community members on a learning experience through the single loop, double-loop, and triple loop learning. Single-loop is learning about consequences of specific actions (i.e. instrumental learning-cognitive knowledge that include declarative, procedural, and effectiveness knowledge) (Garmendia & Stagl, 2010). Double-loop learning is reflecting on the assumptions, beliefs, culture, norms, practices, and traditions which underlie our actions (i.e. transformative learning). Triple-loop learning challenges the assumptions, beliefs, culture, norms, practices, traditions, values and higher order thinking processes that underpin assumptions and actions (i.e. social learning-transformative learning that becomes embedded in wider social networks). This tool might be used for communicating to outsides (i.e. local knowledge), vulnerability assessment, and impact assessment. The focus group participants from the rural and township communities were introduced to the concept of the problem tree through an example. They were subsequently requested to complete the problem tree exercise by identifying the problems in their respective communities. They then diagnosed the root causes of their community problem and the impacts these problems are having on their communities.

Future-Backward scenarios analysis tool aids community members to understand their past and present and the possibilities of their future. The facilitator prompts the community members for anecdotes about the 'current' situation, the 'worst future' situation (hell), and 'the best future' situation (heaven). The output of this exercise gives the 'outsiders' an insight about community members' concerns and aspirations. This can be regarded as an envisioning exercise. It also can assist back-casting and forecasting exercises. In contrast with Community mapping exercises, the Future-Backward tool is less time

consuming to implement and cannot be subjected to the 'Subjective Assessment of Group Analysis' (SAGA) indicators. SAGA indicators propose four elements of quality that have to be adhered to when conducting a community mapping exercise. These indicators include colour relevance, kinetic features, mood expression, and evidence for information (Bell and Morse, 2010). The Future-Backward exercise can be utilised for communication, identifying socio-political, economic, and ecological vulnerabilities, and adaptation assessment. Future Backward tool was used to assists participants in the rural village and township areas to envision different scenarios in their communities. These scenarios are 'best future scenario/situation', the 'current scenario/situation', and the 'worst future scenario/situation'. In the first instance, the focus group participants were encouraged to mention any community issue of their concern, and in the second instance, they were prompted to talk about climate change exclusively. Research participants were given 'post-it' notes on which to write their anecdotes (one or two words that describe their community). They were asked to write these anecdotes for 'best future scenario/situation', 'current situation/scenario', and 'worst future situation/scenario'. The results were recorded on the future backward scenarios analysis tool.

Hazard, Impact and Vulnerability matrix this tool enables the community members to pinpoint hazards, the impact of the hazards, their vulnerability to their hazards, and scoring these hazards in terms of the priority to community members. This can be used for vulnerability assessment, and adaptation assessment. The hazard ranking tool was utilized to help the rural and township participants to priorities the hazards that posed risks in their communities. The hazard with the highest score poses more risk and the hazard with the least score poses the least risk from the viewpoint of the community. In both focus groups the participants were given an equal amount of Lego building blocks (each participant was given 10 pieces). The participant had to decide on how to score (or not score) each hazard that was identified by the focus group participants. The individual scores (from each participant) were added together to represent a collective score (from all participants) for each community hazard. This ranking indicates which community hazards are priorities. In the case of climate change, this ranking indicates which climate change and climate variability hazards should be prioritized when drawing climate change adaptation plans.

4 Results and Discussion

Our findings from these exercises allow us to make three conclusions:

- Students were more aware and concerned about short-term risks than long-term risks,
- Students were not aware about linkages between different climatic and non-climatic risks, and
- Environmental education had an impact on the level of awareness about current and future climate risks.

4.1. Students were more aware about short-term risks than about long-term risks. These short-term risks included crime, lack of access to basic services (decent roads, drinking water, social security benefits etc.), and unemployment in their communities. Long-term community risks included climate change and climate variability. Participants in the rural community were more concerned about access to basic services and livelihoods opportunities. The township participants' concerns related to the high levels of crime and substance abuse in their community. Our results are consistent with van Aalst et al. (2008) findings that local people are more concerned about drinking water, crime and security, unemployment, poverty, and traffic accidents than natural hazards.

Table 3: People are concerned about short-term risks more than long-term risks

	Study area					
	Moletjie Villages		Mankweng Township			
	Not Prompted	Prompted (Climate change)	Not prompted	Prompted (Climate change)		
Best Future Situation	Decent Living conditions	Favourable weather conditions	Utopian Community	Favourable environmental conditions	Main Category	
	Community Infrastructure; Good Education; Social Security; Employment Opportunities;	Rainfall, Mild weather, Cold weather, Warm weather	Peace & security, Equity & fairness, Community cooperation, Healthy environment, Employment Opportunities	Absence of pollution; Healthy environment	Subcategory	Coding frame
Current Situation	Poor Living Conditions	Unfavourable weather conditions	Poor Living Conditions	Unfavourable environmental conditions	Main Category	

	No employment opportunities; Lack of Basic Services (roads, water, policing); Poor education	Rainfall, Cold weather	Pollution; Crime (theft, rape, murder); Traffic;	Pollution; Heavy rainfall; Heavy storms; Ozone layer depletion; Aeroplane emissions; Harsh weather	Subcategory
	Sense of Community		Lack of Community		
Worst Future Situation	Dysfunctional community	Catastrophic weather conditions	Dysfunctional Community	Catastrophic weather conditions	Main Category
	Crime, Teenage pregnancy, Incarceration, Lack of infrastructure, Taverns	Floods, Heavy rainfall, Cold weather	Crime (burglary, murder, kidnappings); Substance abuse (drugs, alcohol); Taverns	Heavy rainfall; Heavy storms; Variable weather; Tsunami; Droughts; Floods; Earthquakes	Subcategory

4.2. Students were not aware about linkages between different climatic and non-climatic risks affecting their communities (figure 2).

For example, students from both areas did not attribute a linkage between the weather extremes that they were experiencing, to climate change and climate variability. This might be an indication that the students were not aware of climate change impacts (van Aalst et al., 2008).

Figure 2: Awareness about climate change impacts perceptions of current and future climate risks within a community

	FUTURE BACKWARD SCENARIOS ANALYSIS TOOL								
	TOPIC: CLIMATE CHANGE								
BEST FUTURE SITUATION (HEAVEN)	Rain (Land cultivation)	Cold only	Cold	Mild weather (cool)	Sunny days	Rainfall	Hot (Warm)	Hot	Warm
CURRENT SITUATION	Cold	Rainy	No idea	No idea	Rainfall	No idea	Cold	No idea	No idea
WORST FUTURE SITUATION (HELL)	Floods	Floods	Rainfall and Floods	Cold	Floods	Heavy rainfall	Rainfall	Heavy rain	No idea

4.3. Impacts of environmental education on the level of awareness about current and future climate risks. Our results showed that the students from the township school, who enjoyed environmental education, were more aware of climate change related risks. The students were also able to see dependencies between current environmental problems and future risks for their community. The township group spoke generally about environmental issues whilst the rural group spoke exclusively about weather issues. This is also an indication that the township group participated in environmental education and rural group did not participate. Last, this implies that environmental awareness impacts perceptions of current and future climate risks in any community.

Figure 3: Awareness about climate change impacts perceptions of synergies between climatic and non-climatic risks

PROBLEM TREE

Figure 3. Problem Tree
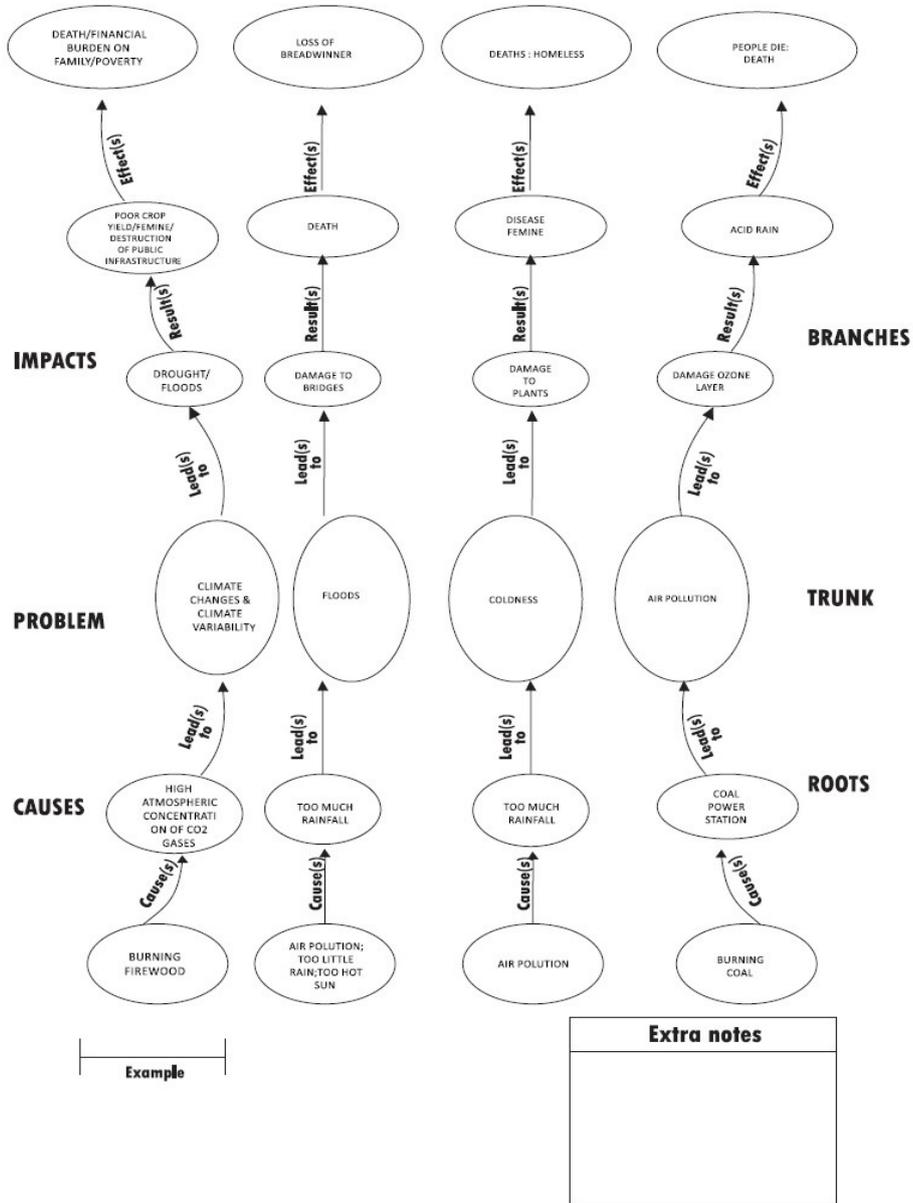
Both the rural and township groups completed a problem tree exercise (figure 3). The problem tree helped participants to investigate the cause-effect (causality) relationship of problem in their community. In terms of environmental change, both groups drew a clear connection between the lack of rainfall and persistent

drought resulting in poverty from loss of livestock and crops. In terms of natural disasters, they indicated that heavy rainfalls lead to flooding that damages community infrastructure resulting in deaths of breadwinners. The participants further indicated that the electricity they consume is generated from the coal fired power stations. These power stations emit greenhouse gases that generate air pollution problems resulting in acid rain that negatively affects their health.

In terms of social problems, participants discussed drugs and 'dangerous' taverns as the breeding grounds for criminal behavior in their communities. In their experience, rape and murder are common crimes committed in their community. In their opinion, these violent crimes are responsible for high HIV prevalence and unwanted pregnancies in their township community. A high HIV incidence results in loss of breadwinners, weak community networks, unemployment, and homelessness due to loss of parents to the endemic. This is not surprising as rape, murder, HIV, unwanted pregnancies, death, and homelessness are common features of township life in South Africa.

In both instances, the participants were able to establish relationships between causes, problems, and impacts of environmental and societal problems affecting their rural and township communities.

6 Conclusion

Our results lead us to five conclusions. First, the focus groups are more concerned about daily life and livelihoods than about natural hazard risks. Van Aalst et al. (2008) agree that local communities are more concerned about health problems, drinking water, crime and security, poverty, and traffic accidents than about natural hazard risks. This implies that climate change adaptation initiatives in developing countries should be framed within the context of socio-economic development.

Second, climate change is not a key concern for focus groups because they might not be aware of its occurrence (Maponya et al. 2003). It is important that "outsiders" work with local communities to increase their awareness of climate change and climate variability (Van Aalst et al. 2008). This assertion is confirmed by the high level of awareness and risk perception by the Township group that participated in the environmental education program. This is evidence that climate change awareness increases the risk perceptions of natural hazard among community members. In our study, we focused on the levels of awareness

among inhabitants which was acquired through environmental education. There is a link showing that environmental education increases climate change awareness and that subsequently heightens natural hazards risk perceptions.

Third, South Africa has predominantly young population (Statistics South Africa, 2012). Taken into reference the fact that young people will be the future decision makers, we thought it is important to address perceptions of this stakeholder group. Therefore, we selected middle school learners for our focus group discussions. In fact, demographers indicate that the population growth in Africa will continue to be dominated by young people into the foreseeable future. This growth shall be accompanied by massive enrolment in formal education and engagement in non-formal and informal education. In this context, environmental education should play a key role in climate change adaptation by raising awareness and heightening risk perception levels among the youth. The results of this scientific study unequivocally support this fact.

Fourth, in terms of social capital, we found that there are different risk sharing arrangements and resource pooling in rural and township communities. In the rural RALEMA, community risk sharing and resource pooling is done by community members via women savings groups. In the MANKWENG Township, community members are substituted by private stakeholders such as insurance companies.

Last, this study utilised two small focus groups to explore the impacts of environmental education on perceptions of climate change risks in rural and township communities in Limpopo Province of South Africa. This exploratory study illustrated the role that environmental education can potentially play in the perception of climate change risks at rural and townships levels. However, a confirmatory study is required using a large-scale survey in order to confirm these findings.

References

Adger W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D, R., Naess, L. O., Wolf, & J.,·Wreford, A. (2009). Are there social limits to adaptation to climate change? Climatic Change 93: 335–354. doi: 10.1007/s10584-008-9520-z.

Anik, S. I., & Khan, M. A. S. A. (2012).Climate change adaptation through local knowledge in the north eastern region of Bangladesh. Mitig Adapt Strateg Glob Change 17: 879–896. doi: 10.1007/s11027-011-9350-6.

Baiyegunhi, L. J. S. (2013). Rural households' social capital and welfare: A case study of Msinga, KwaZulu-Natal, South Africa. Journal of Agriculture and Rural Development in the Tropics and Subtropics 114 (2): 123–132.

Baxter, P., & Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers 13: 554-559.

Bofferding, L & Kloser, M. (2014): Middle and high school students' conceptions of climate change mitigation and adaptation strategies. Environmental Education Research. doi: 10.1080/13504622.2014.888401.

Brouwer, R. (2006). About bridges and bonds: community responses to the 2000 floods in Mabalane District, Mozambique. Disasters 30(2): 234−255.

Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: options and constraints. Environmental Science and Policy 12: 413-426.

Department of Environmental Affairs. (2011). South Africa's Second National Communication under the United Nations Framework Convention on Climate Change (pp: 1-288). Pretoria. Retrieved from http://unfccc.int/resource/docs/natc/zafnc02.pdf

Dessai, S, Adger W. N., Hulme, M, Turnpenny, J., Köhler, J., & Warren, R. (2004) Defining and Experiencing Dangerous Climate Change: An Editorial Essay. Climatic Change 64: 11–25.

Dulal, H. B., Brodnig, G.,, Thakur, H. K., & Charity Green-Onoriose, C. (2010).Do the poor have what they need to adapt to climate change? A case study of Nepal. Local Environment 15 (7) 621–635. doi: 10.1080/13549839.2010.498814.

Finnis, J., Sarkar, A., & Stoddart. M. C. J. (2015). Bridging science and community knowledge? The complicating role of natural variability in perceptions of climate change. Global Environmental Change 32: 1–10.

Frank, E., Eakin, H., & López-Carr, D. (2010). Risk Perception and Adaptation to Climate Risk in the Coffee Sector of Chiapas, Mexico. Conference on International Research on Food Security, Natural Resource Management and Rural Development: ETH Zurich, September 14 – 16.

Foundation for Environmental Education (FEE). (2014). Retrieved November 20th, 2014, from Eco-schools website: http://www.eco-schools.org/

Gaillard , J-C. (2008). Alternative paradigms of volcanic risk perception: The case of Mt. Pinatubo in the Philippines. Journal of Volcanology and Geothermal Research 172: 315–328.

Grothmann, T & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. Global Environmental Change 15: 199–213.

Hansen, J. W., Mason, S. J., Sun, L., & Tall, A. (2011). Review of Seasonal Climate Forecasting for Agriculture in Sub-Saharan Africa. Expl Agric 47 (2): 205–240. doi: 10.1017/S0014479710000876.

Khandlhela, M., & May, J. (2006). Poverty, vulnerability and the impact of flooding in the Limpopo Province, South Africa. Nat Hazards 39:275–287. doi: 10.1007/s11069-006-0028 4.

Komendantova N, Patt A, Barras L, Battaglini A (2012). Perception of risks in renewable energy projects: The case of concentrated solar power in North Africa. Energy Policy, 40:103-109.

Leiserowitz A. (2006). Climate Change Risk Perception and Policy Preferences: The Role of Affect, Imagery, and Values. Climatic Change 77: 45–72. doi: 10.1007/S10584-006-9059-9.

Mackey, S. et al. (2014). The learning experiences of senior student nurses who take on the role of standardised patient: A focus group study. Nurse Educ. Pract. 1-6. doi: 10.1016/j.nepr.2014.10.003.

Maponya, P., & Mpandeli, S. (2012). Climate Change and Agricultural Production in South Africa: Impacts and Adaptation options. Journal of Agricultural Science 4 (10). doi:10.5539/jas.v4n10p48.

Maponya, P., Mpandeli, S., & Oduniyi, S. (2013). Climate Change Awareness in Mpumalanga Province, South Africa. Journal of Agricultural Science 5 (10): 273-282. doi:10.5539/jas.v5n10p273.

Marx, S. M., Weber, E. U., Orlove, B. S., & Leiserowitz, A., Krantz, D. H., Roncoli, C., & Phillips, J. (2007). Communication and Mental Processes: Experiential and Analytic Processing of Uncertain Climate Information. Global Environmental Change 17: 47–58.

Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Farmers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahel. Environmental Management 43:804–816. doi: 10.1007/s00267-008-9197-0.

Mpandeli, S. (2014). Managing Climate Risks Using Seasonal Climate Forecast Information in Vhembe District in Limpopo Province, South Africa. Journal of Sustainable Development 7 (5). doi:10.5539/jsd.v7n5p68.

Mpandeli, S., & Maponya, P. (2014). Constraints and Challenges Facing the Small Scale Farmers in Limpopo Province, South Africa. Journal of Agricultural Science 6 (4). doi:10.5539/jas.v6n4p135.

Mpandeli, S., Nesamvuni, E., & Maponya, P (2015).Adapting to the Impacts of Drought by Smallholder Farmers in Sekhukhune District in Limpopo Province, South Africa. Journal of Agricultural Science 7 (2). doi:10.5539/jas.v7n2p115.

Municipal Demarcation Board. (2014). Polokwane Local Municipality Map. Retrieved at http://www.demarcation.org.za/index.php/ward-delimitation/2014-2015/limpopo/maps-3

Niang, I., O.C. Ruppel, M.A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart, (2014): Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199-1265.

O'Brien, K., Eriksen, S., Sygna, L & Naess, L. O. (2006). Questioning Complacency: Climate Change Impacts, Vulnerability, and Adaptation in Norway. Ambio 35 (2): 50-56.

Osbahr, H., Dorward, P., Stern, R., & Cooper, S. (2011). Supporting Agricultural Innovation in Uganda to Respond to Climate Risk: Linking Climate change and Variability with Farmer Perceptions. Expl Agric 47 (2): 293-316. doi: 10.1017/S0014479710000785.

Paton, D., Johnston, D. M., Beddington, M. S., Lai, C-D., & Houghton, B. F. (2001). Direct and Vicarious Experience of Volcanic Hazards: Implications for Risk Perception and Adjustment Adoption. Australian Journal of Emergency Management 58-63.

Paton, D., Smith, L., Daly, M., & Johnston, D. (2008). Risk perception and volcanic hazard mitigation: Individual and social perspectives. Journal of Volcanology and Geothermal Research 172: 179–188.

Patt, A. G., & Schroter, D. (2008). Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies. Global Environmental Change 18: 458– 467.

Pelling, M., & High, C. (2005).Understanding adaptation: What can social capital offer assessments of adaptive capacity? Global Environmental Change 15: 308–319.

Permanent, G. D. (1995). Introducing Focus Groups'. P. 311: 299-302.

Perry, R. W., & Lindell, M. K. (2008).Volcanic risk perception and adjustment in a multi-hazard environment. Journal of Volcanology and Geothermal Research 172: 170–178.

Polokwane Municipality. (2014). Integrated Development Plan 2014-2017 (pp. 1-187). Retrieved from

http://www.polokwane.gov.za/files/useruploads/user_1/files/2014 Final IDP part 1.pdf

Pula-Madibogo Primary School. (2011). Pula-Madidogo Primary School Achievements. Retrieved November 20th, 2014, from Pula-Madibogo Primary School website: http://www.pulamadibogoprimary.co.za/index.php?option=com_content&view=article&id=48&Itemid=54

Reid, P., & Vogel, C. (2006).Living and responding to multiple stressors in South Africa—Glimpses from KwaZulu-Natal. Global Environmental Change 16: 195–206.

Scolobig, A., Komendantova, N., Patt, A., Vichon C., Monfort, D., Begoubou-Valerius, M., Gasparini, P., Ruocco, A., (2014). Key characteristics of natural risk governance: comparative analysis of Gouadeloupe, France, and Napoli, Italy. Natural Hazards., http://dx.doi.org/10.1007/s11069-014-1152-1

Scott, J., (2013). The SAGE Handbook of Social Network Analysis, Sage, California

Sharma, U., & Patt, A. (2012). Disaster warning response: the effects of different types of personal experience. Nat Hazards 60:409–423. doi: 10.1007/s11069-011-0023-2.

Sharma, U., Patwardhan, A, & Patt, A. G. (2013).Education as a Determinant of Response to Cyclone Warnings: Evidence from Coastal Zones in India. Ecology and Society 18(2): 18. http://dx.doi.org/10.5751/ES-05439-180218

Smith, J. W., Anderson, D. H., & Moore, R. L. (2012).Social Capital, Place Meanings, and Perceived Resilience to Climate Change. Rural Sociology 77(3): 380–407. doi: 10.1111/j.1549-0831.2012.00082.x.

Statistics South Africa. (2012). Statistical Release (Revised) Census 2011. Statistical release (pp. 1-88). Pretoria. Doi: P0301.4

Striessnig, E., Lutz, W., & Patt, A.G. (2013). Effects of educational attainment on climate risk vulnerability. Ecology and Society 18(1): 16. http://dx.doi.org/10.5751/ES-05252-180116

Sunstein, C. R. (2006). The Availability Heuristic, Intuitive Cost-Benefit Analysis, and Climate Change. Climatic Change 77: 195–210. doi: 10.1007/s10584-006-9073-y.

Thomas, G. (2011). "sonia is typing..... A typology for the case study in social science following a review of definition, discourse and structure". Qualitative Inquiry 17 (6): 511–521.

Thomas, D. S. G., Twyman, C., Osbahr, H., & Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. Climatic Change 83:301–322. doi: 10.1007/s10584-006-9205-4.

Tjernström, E., & Tietenberg, T. (2008). Do differences in attitudes explain differences in national climate change policies? Ecological Economics 65: 315–324.

Trigg, S. N., & Roy, D. P. A. (2007). A Focus Group Study of Factors that Promote and Constrain the Use of Satellite-derived Fire Products by Resource Managers in Southern Africa. J. Environ. Manage. 82: 95-110.

Van Aalst M. K., Cannon, T., & Burton, I. (2008).Community level adaptation to climate change: The potential role of participatory community risk assessment. Global Environmental Change 18: 165–179.

Weber, E. U & Hsee, C. (1998). Cross-cultural Differences in Risk Perception, but Cross-cultural Similarities in Attitudes Towards Perceived Risk. Management Science 44 (9): 1205-1217.

Weber, E. U. (2006). Experience-based and Description-based Perceptions of Long-term Risk: Why Global Warming Does Not Scare Us (Yet). Climatic Change 77: 103–120. doi: 10.1007/s10584-006-9060-3.

Wiid, N., & Ziervogel, G. (2012). Adapting to climate change in South Africa: commercial farmers' perception of and response to changing climate. South African Geographical Journal 94 (2): 152–173.

Wildlife and Environment Society of South Africa (WESSA). (2014). About WESSA. Retrieved November 20th, 2014, from WESSA: http://www.wessa.org.za/who-we-are/about-wessa.htm

Yin, R., (2009). Case Study Research: Design and Methods. 4th Edition. Applied Social Research Methods Series, Volume 5.