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ORIGINAL ARTICLE

Resilience of the poorest: coping strategies and indigenous knowledge of living with the floods in Northern Namibia

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Abstract In Northern Namibia, the climate is highly polarised between dry and wet seasons, and local communities have lived with these varying weather extremes for centuries. However, the recent changes in socio-environmental dynamics—associated with urbanisation, inappropriate spatial planning, and population growth—have disturbed the river system in the area. These changes, together with torrential seasonal rains, have aggravated the social impacts of the flood events. By using various qualitative and quantitative data sources, and comparative analyses between the flood dynamics in urban and rural environments, this research studies local residents' coping strategies to endure the irregular flood events from the perspective of socio-ecological resilience. Particular interest is placed on the learning processes that enhance the residents' capability to cope and the role of indigenous knowledge. Indigenous knowledge (IK) has been emphasised as a source of resilience in both theory and practice, as it is built upon learning from past experiences of natural hazards. The findings reveal that the floods are a result of complex and relational development without the necessary linear relationship between the causes and effects. The abrupt socio-ecological changes, together with the multiple stressors related to poverty, have made residents more vulnerable to the flood events and attenuated the communities' coping strategies based on IK. Instead of focusing on the communities' capacity to self-organise, the focus of resilience building needs to be directed to emphasising the broader socio-political processes, which are making the communities vulnerable in the first place.

Keywords Resilience · Disaster risk reduction · Indigenous knowledge · Flood · Namibia

Introduction

> "In the past the rainy season brought water for the plants and animals and fish for us but nowadays it is coming all the way to our houses destroying everything" (Household interview 118, 26 October 2012).

Various socio-ecological changes—such as anthropogenic climate change and population growth—have increased the risk of climate-related disasters globally. Several researchers have demonstrated how climate hazards will become more prominent and unpredictable in the future (Christensen et al. 2007). Some of the most vulnerable regions for future changes are located in developing countries and particularly in sub-Saharan Africa (Mertz et al. 2009). Due to the growing uncertainty concerning global environmental changes, there is a need to look for new ways to increase the capacity of communities and individuals to cope with these changes.

Resilience has become one of the major conceptual frameworks to address this socio-environmental change (Berkes and Folke 1998; Adger 2000; Folke 2006; Christopherson et al. 2010; Kaul and Thornton 2014). The popularity of the concept is based on its malleability and holistic perspective, and how it places emphasis on complexity and dynamic change across the multiple spatial and temporal scales (Cote and Nightingale 2012). The

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interdisciplinary studies of resilience have been interested in how to mitigate threats, cope with changing conditions, and increase the communities' ability to bounce back and to recover from disturbances with little or no external assistance (Carpenter et al. 2001). One central presumption has been that communities and individuals are capable of learning from uncertainty and change by building upon memory from the past, and using their previous experiences in the coping process to face anticipatory disturbances in the future (Berkes et al. 2003).

Regardless of its many advantages, resilience has recently been challenged by several authors in social science (Swanstrom 2008; Hassink 2010; Walker and Cooper 2011; Weichselgartner and Kelman 2014; Brown 2014). The main critique considers that resilience is incapable of properly addressing and reflecting social dynamics in general and of contemplating the questions of power and agency (Béné et al. 2014). Furthermore, the case studies regarding developing countries have been criticised for approaching resilience too descriptively. The descriptive interpretation of resilience measures it with quantitative methodology, assessing the different attributes that increase communities' capacity to self-organise and cope when facing various disturbances (Brand and Jax 2007). The limited analyses of the quantitative approach create a danger of overemphasising the capacity of the communities and individuals to cope, and shift the attention away from the social–political relationships behind the actual disasters, which are making the communities vulnerable in the first place (Bunce et al. 2010). Furthermore, different coping measures—like reducing daily meals or emergency relocation—might also have negative trade-offs for the overall well-being of the communities (Béné et al. 2014).

In this research, I study the theory of socio-ecological resilience with a case study from Namibia, where, since 2008, floods have become a frequent but unpredictable phenomenon, causing extensive inconvenience and destruction for local communities. The floods have particularly affected the most disfranchised members of the local communities. The reasons behind the suddenly occurring floods are torrential seasonal rains combined with various anthropogenic changes in the socio-ecological dynamics, which have interfered with the fragile natural water system, and directed the seasonal rainwater to the settlement areas (see "The floods in Northern Namibia" section). Annually, close to 700,000 people are affected. Around 50,000 people need immediate relocation, and 100 people have lost their lives (Government of Namibia 2010). The water stays in the settlement areas from 1 to 3 months causing serious disturbance to livelihood activities, agriculture, businesses, and the industry of local residents. As the floods have become recurrent phenomena, the main research questions addressed in this paper are as follows: *What kind of coping measures do local communities apply to cope with the floods and what have they learned, if anything, from the previous floods? Can the acquired knowledge and applied coping measures be used to build resilience for the anticipatory flood events in the future?* To answer these questions, I will analyse the different coping measures, the communities' capacity to self-organise, and the knowledge used in order to reflect these measures onto the broader socio-ecological changes in the area. In addition, as the dynamics of flooding varies between urban and rural areas, I will focus on comparative analyses between these two different environments.

Recent academic discussion and activities embarked on by various national governments and international organisations emphasise the role of knowledge integration in the resilience-building processes. However, Weichselgartner and Kasperson (2010) have argued that resilience continues to be externally defined and the role of expertise knowledge is overemphasised. They denote (2010, 267) that disaster professionals undertake many of the resilience-building activities without sufficient understanding about the local circumstances or engagement of the local stakeholders or residents and their local knowledge. In the context of developing countries, an essential source of local knowledge is indigenous knowledge (IK) (Sillitoe 1998). IK has been regarded as important for community resilience as it is based on previous experiences and centuries of learning and adaptation to changing conditions (Nyong et al. 2007). Application of IK may empower communities and individuals to become active participants in their own resilience building and thus work as a bridging concept to build partnerships between different actors (Bohensky and Maru 2011). Hence, related to the communities' learning and coping measures, I also address the study question: *What kind of flood-related IK exists in the study area and what kind of role does it have, if any, in the local communities' learning and coping measures in order to increase the resilience of these communities regarding the challenges caused by flooding?*

I begin by presenting a literature review of the socio-ecological concept of resilience, from the social theory perspective, and illuminating the role of indigenous knowledge in developing countries' disaster studies. The subsequent section explains the applied methodology and research data in detail. Then, I address the characteristics of the flood events in Northern Namibia and the main resilience-building processes applied by the communities. To do so, I first scrutinise the ability of, and mechanism used by, communities and individuals to cope with the disturbance caused by floods. Thereafter, I concentrate particularly on IK and its role in learning, coping, and the building of resilience in these communities. I conclude by discussing the limitations of the resilience approach,

whether it concerns the larger socio-political processes related to socio-environmental disturbances, and the significance of IK for flood-related policy initiatives and future development.

Socio-ecological resilience from a social studies perspective

Contemporary studies of socio-ecological processes have claimed that comprehensive analyses of the dynamics and complexity of these processes require more integrated and interdisciplinary approaches (Turner 2010). Resilience has been seen as a bridging concept to bring environmental and social disciplines together with a common interest to address environmental change characterised by unknowable risks and future surprises (Tompkins and Adger 2004). Generally, resilience in disaster studies is defined from the equilibrium perspective developed in the field of ecology. The equilibrium approach means either engineering or ecological resilience (Holling 1973; Folke 2006). Engineering resilience is defined as the ability and the time it takes for a system to return to equilibrium after a disturbance or shock (Holling 1973). Here, a disturbance refers to anything from an environmental hazard and social turmoil to economic crises, and resilience is measured by the time it takes for the system to recover to its pre-disturbed state. Ecological resilience is defined as the capacity of the ecosystem, organisation, individual, or material to cope with disruption and stress, retaining or subsequently regaining its functional capacity and form (Berkes and Folke 1998). Compared with the single-equilibrium approach of the engineering resilience, the ecological resilience definition assumes that there can be multiple equilibria, and after a shock, the system can either return to the pre-shock state or move on to another state or regime (Adger 2000).

Several authors in social studies have been critical towards the ambiguity of the equilibrium approach of resilience arguing that societies are hardly ever in equilibrium (Simmie and Martin 2010). One of the challenges has been the idea of bouncing back to normal without questioning what that normality is. Resilience has been considered to reinforce the existing status quo, and thereby, it may promote inequity and undermine sustainability (Brown 2014). For example, in the context of global poor, the idea of bouncing back would mean return to the previous poverty after facing another shock. Similarly, in disaster studies, bouncing back is often associated with returning to a dysfunctional state, which may have incubated the conditions that contributed to the origin of the disaster in the first place (Leitch and Bohensky 2014).

Alternatively, in social studies, societies have been conceived to be more of a constantly evolving non-equilibrium process where the only certain process is change (Pike et al. 2010). Moreover, disturbance can be a result of linear or proportional cause and effect or there may not be any clear linear relationship between the cause and its effect (Davoudi 2012). Sometimes a small shift can cause a major change, while some larger shifts do not necessarily have any relevance. Socio-ecological resilience is not simply about resistance to change or maintaining existing structures but also about the adaptive capacity to manage, adjust, learn, and cope with different changes (Bohensky et al. 2010). Folke (2006) emphasises the role of learning, the combination of different knowledge and capacity for renewal, innovation, and re-organisation as important dimensions of adaptive capacity and resilience. One important attribute of adaptive capacity is the ability for self-organisation, which is described as the community's or individual's own capacity to respond or recover from the disaster rather than depend on external assistance or aid (Etkin and Dore 2003).

It is important to notice that there are still open questions and weaknesses in the conceptualisation of resilience from the social studies perspective. Cote and Nightingale (2012) argue that questions such as "resilience for what and for whom?" have not yet been adequately addressed, and what might look like resilience for some actors or elements may, on some scale, increase the vulnerability of others elsewhere. Thus, resilience involves a number of political and normative questions, which need to be studied more accurately. For example, how does resilience recognise and treat power (Hassink 2010)? One of the most criticised aspects of the resilience theory concerns the framework's presumption of self-organisation. When self-organisation is interpreted in a social context, it easily becomes highly ideological with an emphasis on the "self-reliance" and the individualistic "adaptive" subject of neoliberalism (Walker and Cooper 2011). Swanstrom (2008) has claimed that stressing self-reliance overemphasises the ability of individuals and communities to lift themselves out of difficulty or reinvent themselves when facing external shock. Thus, the capacity of re-organisation, renewal, learning, and innovation in the resilience approach should also concern those socio-political processes that are constricting the agency (Obrist et al. 2010).

Notwithstanding this critique, many authors have seen resilience as a principle for local level solutions making, and compared to the conventional sustainable development, it has been considered to be forward-looking towards deliberative transformation (Brown 2014). The application of resilience has a tendency to bridge the gap between science and policymaking and recognise the importance of engaging and involving the local stakeholders, residents, and their knowledge (Berkes and Jolly 2002). In developing countries, the question of resilience and local level

governance has been allied with the discussion on IK, which I will elaborate in the next section.

Indigenous knowledge contributing to socio-ecological resilience

There are a growing number of studies demonstrating how IK and understanding the local environment, and its disturbance, should be an inherent part of any resilience-building process (Berkes et al. 2003; Dekens 2007; Bohensky and Maru 2011; Weichselgartner and Kelman 2014). IK is a heterogeneous combination of different knowledge and it varies between different localities. IK is accumulated from the observations, experimentation, beliefs, behaviours, and the holistic worldviews of local people (Escobar 1995; Briggs and Sharp 2004; Subba Rao 2006; Domfeh 2007). IK has been rooted in local habits, institutions, practises, communication channels, and rites. It is most commonly transmitted orally or through demonstration and imitation from earlier eras, and it is generally learnt by repetition (Ellen and Harris 1996). Repetition also helps in the reinforcement and retention of this knowledge (Sen 2005). IK is not static but a constantly evolving dynamic process. Although localities are subject to constant change, IK never disappears but changes its form when it is influenced by internal creativity and experimentation and intertwined with external knowledge (Flavier et al. 1995). Thus, IK is a dynamic mix of past traditional knowledge and present innovation (Bertelsen and Müller 2003).

From a resilience perspective, IK has been seen as an opportunity, as it is embedded in local circumstances and it is based on the knowledge of local residents (Bohensky and Maru 2011). Through the recognition of their IK, local people can gain the ownership of the development process in which they are involved (Briggs and Sharp 2004). As IK is based on centuries of learning, experience, and intergenerational transmission, it has proved to have the ability to address uncertainty and complexity, and thus be an integral coping mechanism in communities (Boillat and Berkes 2013). It is very difficult or even impossible to find sustainable solutions to local socio-ecological challenges without the comprehensive participation of local stakeholders and residents (Nyong et al. 2007; Fortmann 2009).

However, too often, indigenous knowledge sources are considered in isolation from other types of knowledge without acknowledging their mutual benefits. Agrawal (1995) argues that there is a need to go beyond the artificial dichotomy between different types of knowledge and look for new integrated approaches between them. Often, the most resilient solutions to local socio-environmental challenges are based on the latest external knowledge, which has been adjusted to local circumstances through IK (Weichselgartner and Kelman 2014). Although such integration has been discussed for several decades, its practical application has been challenging with cooperation between different stakeholders representing different knowledge has often failing (Dekens 2007). Wohling (2009) denotes that one challenge of knowledge integration is scale, as it is difficult to utilise local level IK for the management of broader scale changes in society. According to Gaillard and Mercer (2013), the integration has failed because of the uneven power relationship, the lack of mutual trust or political will, and the space for a dialogue between different stakeholders.

Research data and methodology

The research material was collected between May and November 2012. The field studies included a household survey with 282 residents, semi-structured interviews with four traditional authorities,[1] and four focus group meetings, in which 38 members of the societies participated. The exact study areas, their location, and the research methods applied in each study site are presented in Fig. 1. To be able to perform comparative analyses between urban and rural environments, two of the four focus group meetings and 160 household interviews were conducted in the two most flooded informal urban settlement areas in the town of Oshakati. Similarly, 122 household interviews and two focus group meetings were conducted in five rural villages.

The household survey was done door to door using random sampling procedures, and the structured survey included both open- and close-ended questions. The mean duration of one household survey was 46 min. The focus group meetings followed a similar semi-structured agenda in different locations, but there was also time to discuss local issues specific to each study site. The meetings lasted from two to three and a half hours. Four semi-structural interviews conducted face to face with traditional authorities lasted from 35 to 50 min. The governing regions of the traditional authorities were Oukwanyama, Ondonga and Ombandja and Uukwambi.

The questions in the different research materials had some deliberate overlapping to ensure the triangulation of the findings, and reduce the potential bias that any single method could have had (Chambers 2008). The themes were related to basic demographical and household information, overviews of the flood events, IK and strategies to predict,

[1] Traditional authorities (*Omukwaniilwa,*' the King') have predominantly control over the rural population in Ovamboland (Keulder 2000). Their selection process follows old customs and can be considered as undemocratic. Officially, their activities are regulated by *the Traditional Authorities Act* (No. 17 of 1995), but local practices rather follow the traditional customs.

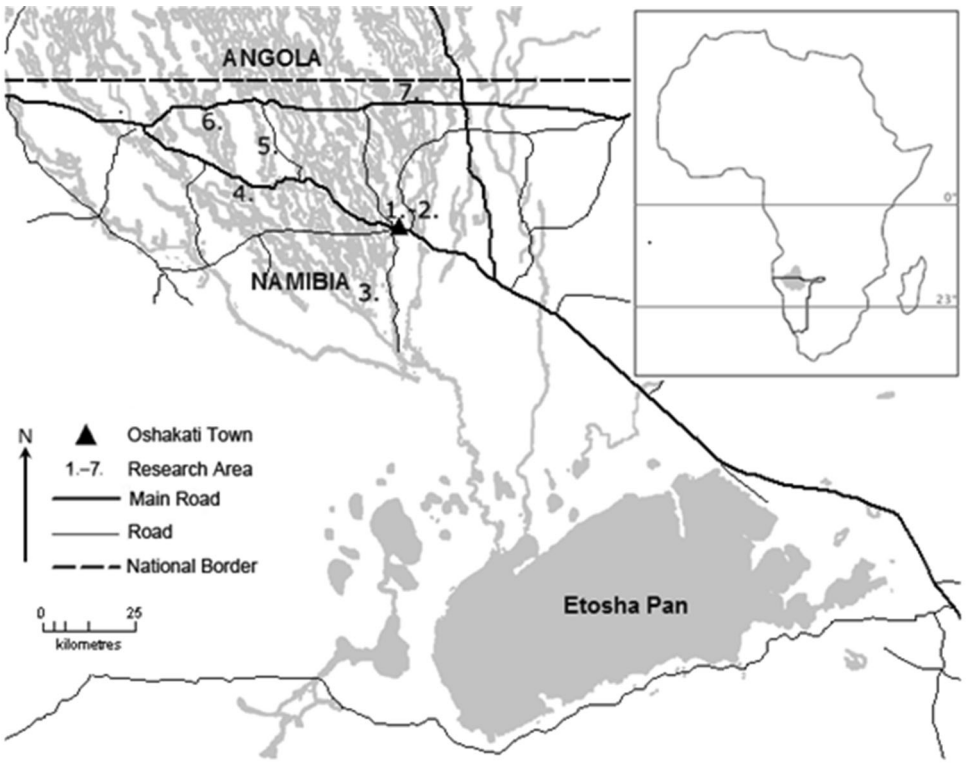

Fig. 1 Cuvelai-Etosha River basin (*grey*) originates in Angola and spreads across the flat plains in Namibia finally draining to the Etosha pan. Research was done in two informal settlement areas in Oshakati town, plus in five rural villages

No.	Study District/Village	Urban / Rural	Household Survey (N =)	Focus Group Female (F) / Male (M)
1.	Uupindi	Urban	84	8 F
2.	Oshoopala	Urban	76	4 F / 5M
3.	Ompundja	Rural	18	N/A
4.	Olumpumbu	Rural	19	5 F / 4 M
5.	Oshitutuma	Rural	33	N/A
6.	Epoko	Rural	24	8 M
7.	Omuloka	Rural	28	N/A

mitigate, cope with, and learn from the event. The main research unit was a household, described as a group of people living in the same compound and who contribute to the food or income of the dwelling unit (Osbahr et al. 2010). The field studies were conducted together with four local university graduates who were experienced research assistants. The main language of the research was Oshivambo, but as English is the official language in Namibia it was also generally used. The focus group meetings and semi-structured interviews were recorded, transcribed verbatim, and later, together with the research assistants, translated into English.

The closed answers in the household questionnaire were analysed using standard statistical tests suitable for non-parametric survey analyses (De Vaus 2002). The parameters included variances and means, but also some cross-tabulations. The open-ended answers of the household questionnaire, focus group meetings, and traditional authority interviews were analysed applying qualitative content analysis. For structuring the data, the content was systematically coded into themes and patterns that were significant for the study questions. Triangulation of different data sources is important to gain deeper understanding about the reliability and the validity of the quantitative analyses and to generalise the subjectivity of the qualitative analyses (Philip 1998).

Study area

The population of Namibia is just over two million, and it is one of the most sparsely populated countries in the world. Economically, it is among the wealthiest countries in Southern Africa. However, the social divide between the rich and poor is one of the most extreme in the world, as 29 % of the population lives under the poverty line (Namibia Statistical Agency 2012). The study area in North-Central Namibia consists of four administrative

regions (Ohangwena, Omusati, Oshana, and Oshikoto) located within the Cuvelai-Etosha River basin (see Fig. 1). The area is one of the most densely populated areas in the country, as well as one of the poorest. The overall population of these four regions is over 847,000 inhabitants living in approximately 150,000 households (Namibia Statistical Agency 2011). More than 93 % of the households in the area are Oshivambo speaking, and most of the population are Ovambo by ethnicity. The population has grown rather rapidly, by 13 % between the years 2001 and 2011. Although most of the people still live in rural areas, the urban population has more than doubled during the last decade, now being 17 % (ibid). Migration from the rural villages is predominantly directed to the urban informal settlement areas, which are uncontrollably expanding to the marginal outskirts and wastelands of the urban centres. Many of these areas are extremely flood-prone and have not been planned for housing.

Two urban informal settlement areas of this study, Oshoopala and Uupindi, are situated in the northern part of the Oshakati town, approximately one to three kilometres from the town centre. Oshakati is the most important commercial centre in Northern Namibia but also very vulnerable to floods. The dwellings of these areas are mainly constructed from corrugated iron sheets and lack proper sanitation, waste management, municipal engineering, or proper roads. Only a few houses on the edge of the study area had ERF numbers indicating formal municipal recognition. Less than a quarter of the respondents (23 %) in the urban area had access to private or shared piped water and only 18 % had electricity. Oshoopala's estimated population is around 3500, and Uupindi has over 10,000 inhabitants.[2] However, due to the informal nature of the settlement areas and the rapid migration, the exact population of these locations are unknown. Oshoopala is the most densely build informal settlement area in Oshakati, and the residents are some of the most disfranchised members of society. Uupindi is the largest informal settlement area in the town in terms of both its geographical size and its population. People in the urban areas mostly derive their income from small and often informal businesses, industrial activities, and employment in the service sector—however, the unemployment rate is high.

The other half of the research was conducted in five rural villages (Fig. 1). The size of the villages varies from relatively large, approximately 200 households in Ombundja to Omuloka with less than 80 households.[3] In addition to the size, the villages differ in terms of road connections and access to different services. While some of the villages are connected with relatively good gravel roads and have their own schools and some other basic services, other remoter villages are lacking any maintained roads and basic services. Due to the agricultural activities, the villages are large and scattered without proper road connections between the homesteads. Thus, the access and connections also vary within the villages. The majority of the interviewed households were traditional homesteads consisting of mud huts covered with straw roofs and surrounded by pearl millet sorghum (called *omahangu*). More than every fourth (28 %) of the households had access to private or shared piped water and 8 % had electricity. The livelihood of the population is still strongly dependent on agriculture and subsistence farming.[4] Most of the households also had small herds of cattle, poultry, and goats. The agriculture-based activities generating incomes are particularly vulnerable to different weather extremes.

The average age of the respondent in the household survey in the urban areas was 35 years and in the rural areas 51 years. The rapid urbanisation also became evident from the empirical findings, as most of the urban respondents (63 %) had lived in their household less than 10 years, and 78 % of them had migrated there from the rural areas. Migration is especially common among the young people from the age at which they become independent. The most common reason for urban migration was the hope of attaining a better living standard. Many had considered it as their only choice when the rural home could not offer livelihood opportunities for the rapidly expanding young generation.

The floods in Northern Namibia

The climate in North-Central Namibia is semi-arid, and the weather in the region varies seasonally between extreme droughts and floods. The rainfall being highly variable both in amount and in timing with an annual precipitation that may differ from 900 mm to as little as 200 mm (Mendelsohn et al. 2009). Generally, the majority of the rain falls between January and March, but there have been remarkable annual differences. The flat relief and easily mobilised sandy soils have created the Cuvelai-Etosha River basin (see Fig. 1), which encloses an extensive and complex seasonal river network covering an area of about 7,000 km^2. The river network carries the rainwater from southern Angola towards Northern Namibia, ending in a vast inland lake—the Etosha pan. The channels in the river network are characterised by shallow and wide ephemeral

[2] Based on the Oshakati town council official's oral estimation.

[3] Based on the calculations from the satellite image, the average size of a household in the research area is five people per household (Namibia Statistical Agency 2011).

[4] For example *omahangu*, beans, peanuts, sorghum flour, and *ekaka* (traditional dried spinach).

watercourses (the singular channel is called *oshana*, and the plural *ishana*), which fill up with surface water during the rainy season (ibid).

Historically, the seasonal floods (called *efundja*) have been vital for the rural majority whose livelihood depends on agricultural activities, as they have renewed pastures, recharged ground water supplies, and provided fishing grounds. However, during the last decade, rapid changes in the socio-ecological dynamics have disturbed this extremely fragile river network and the floods have turned into major social disasters. The population growth and urbanisation have increased the pressure to constantly inhabit more flood-prone zones and even riverbeds (NRFRMP 2011). Some of the informal settlements have literally been built at the bottom of the water channel. Population growth has also caused vegetation destruction, leading to accelerated erosion and thereby affecting the run-off. Hundreds of kilometres of road and railway network have been constructed in the area, mainly across the water channels (see Fig. 1), with insufficient or non-existent culverts and bridges. Generally, the building of new infrastructure, for example large shopping complexes, has been done without adequate environmental impact assessment or consultation with the local experts who possess knowledge concerning the water channels and topography in the area (ibid). Furthermore, the master plans of the urban areas have been non-existent or insufficient, with the storm water drainage systems being particularly inadequate (Government of Namibia 2010).

The impacts of the floods

The first serious flood disaster occurred in 2008. According to the household survey, the flood took most of the residents by complete surprise. Although small-scale annual flooding has been frequent, the previous major flood event, causing larger social disturbance, occurred some time ago in the 1970s (Government of Namibia 2010). Since 2008, however, the destructive floods have become an almost annual event, and depending on the location, the respondents had experienced three to five floods between the years 2008 and 2012. The floods have become so regular that the households have hardly recovered from the previous one before they have to face the next event. Moreover, the participants of the focus groups organised in rural areas, especially emphasised that the flood-related challenges have been severally exacerbated by extensive droughts in between the flood events.

The household survey revealed the different consequences caused by the floods. For almost a fifth of all respondents (20 % of urban and 15 % rural respondent), the floods have caused the death of a close relative or friend. Almost half of the urban (49 %) and a third of the rural (30 %) respondents reported that flooding had caused an injury or illness for them. These physical injuries were mainly the result of the underwater flooding objects, fragile building materials, and snakebites. Lack of proper sanitation, the collapse of the sewage water system, together with domestic animal waste, and mosquitoes breeding in the floodwater have increased the risk of different epidemics and diseases (diarrhoea, infections, malaria, and cholera)—particularly in densely built informal urban settlements. Water has damaged individual households and possessions, for example, twisting and rusting the corrugated iron sheets of the settlements in urban areas, and collapsing the mud huts in rural areas, which for many are their only possessions. Destroyed and impenetrable road connections have restricted access to education, work, and health care for several months. While human injuries were more common in the urban environment, the impacts on livelihood have been more severe in the rural areas. For example, the floodwater has washed away fields and domestic animals' feeding grounds. Almost all of the rural respondents had lost crops (95 %) and livestock (85 %). The uncertainties concerning the weather events have led to miscalculations over whether to cultivate or not. This has also jeopardised the urban food security, where many are dependent on the agricultural products of their social networks in rural villages. The floods have also increased stress and trauma symptoms in households who already live with multiple stressors connected with poverty.

Household coping strategies regarding the floods

Almost all of the respondents in the household survey (94 %) had applied at least some coping strategies to increase their resilience towards the floods, when asked the question: *What kind of coping measures, if any, has your household undertaken to protect the household from the floods*? The most frequently applied measures and the divergence of their utilisation in urban and rural areas are presented in Fig. 2. These coping measures included both long-term proactive anticipatory measures preventing and preparing the households for the floods, and more direct response measures, i.e. short-term actions, to cope with the immediate threat or in reaction to the already existing floods (López-Marrero 2010). Furthermore, the different coping strategies can be classified into structural and more functional non-structural measures. The structural coping measures refer to the engineering interventions, like building a floodwall; the functional non-structural methods are the long- and short-term strategies and practises, like improved land-use practices or warning systems (Few 2003). Generally, the households used different measures simultaneously. The most commonly applied measures were short-term and more functional, such as placing

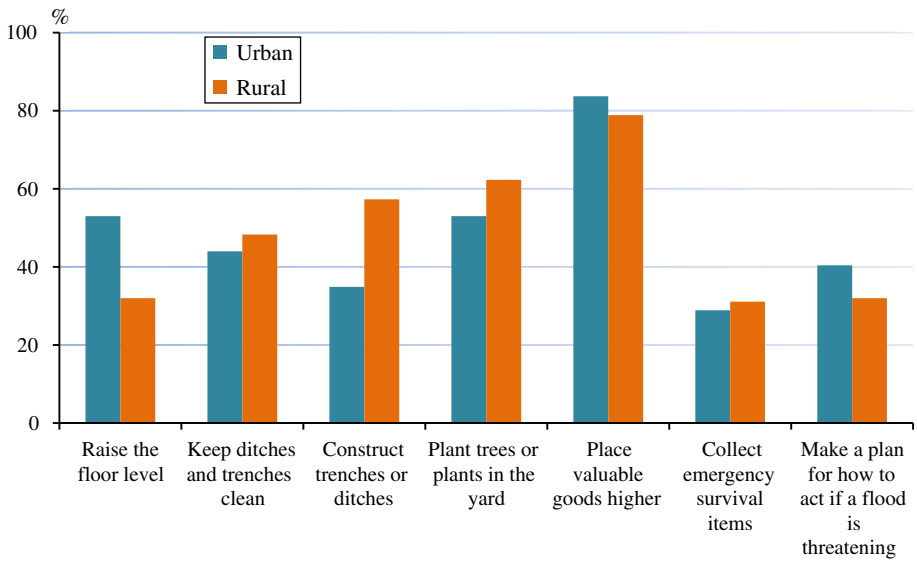

Fig. 2 Most frequently applied coping measures among the interviewed households ($n = 282$)

valuables higher in the house, gathering emergency survival items, making a plan for what to do when the flood becomes threatening, and emergency relocation when the flood occurs.

The most common proactive measures to increase resilience, expressed by over half of the respondents (58 %), were structural, such as planting trees in the yard but also, especially in urban areas, collecting sand and stones to raise the household's floor level. Other structural proactive measures included building bridges from bricks for walking on, and digging or clearing ditches and trenches around the house. In rural areas, the most severely affected households had relocated their settlements to higher ground, if there was sufficient land available. Those who only took reactive measures and did not do any structural measures, and those who did nothing at all, explained that all the proactive measures were to no avail, as the flooding was perceived uncontrollable. Other main explanations for not undertaking any coping measures were that the residents did not know what to do or they did not have sufficient tools to implement the planned measures.

During the floods, the only possible way of coping for many was temporary relocation, which can be considered as a functional and reactive coping measure. In urban areas, almost all of the respondents (90 %) had been relocated at least once and most of them (67 %) between two and five times. With a few exceptions, the urban residents relocated to the governments' relocation camp set up in the highlands a few kilometres from the town. Most of the urban households, who did not need to relocate, were situated on the edge of the study area. Their houses were built of bricks with a proper cement floor, and they had municipal ERF numbers. On average, relocation lasted between 2 and 3 months. However, in rural areas, the relocation to governments' relocation camps was less frequent (19 %). The main reasons for this were that many of the traditional homesteads in rural villages have been built on higher lands or have already been relocated there when the flood events became more frequent. Furthermore, as the government relocation camps were far from the villages and domestic animals demand constant tending, relocation to a relocation camp was considered very challenging. Instead, many relocated to their neighbours' households or set up a private tent in the nearby higher lands. According to the focus group discussions, although the temporal relocation as a coping strategy improved households' immediate resilience to cope with the floods, the overall impact of this strategy on the households' well-being was mainly negative. Relocation has, for example, disturbed livelihood strategies, through such occurrences as the vending of home-made food and alcohol, an increased danger of sexual harassment in the camps where the tents have been shared with several families, and an increase in the incidents of theft at the camps and in empty settlement areas.

Despite the above-mentioned prevention measures, only a quarter (25 %) of the respondents answered positively to question: *Do you think you are better prepared for the possible flood than you were before the last flood event?* Those who regarded themselves as better prepared explained that this was because they now have experience and have learned what the floods are like. If a flood occurs in the future, they will know what to do—almost without exception, this means relocation. In addition, they considered that some other important actors, like the municipality, meteorological institute, aid suppliers (Red Cross), and village headmen, were also more prepared for recurrent flood events. They reported, for example, receiving more accurate and detailed flood warnings as the

flood-prone areas are better recorded and relocation camps can be organised more systematically. Furthermore, building in flood-prone areas has become more restricted and controlled, and the government has made some small improvements to the infrastructure in order to obstruct the water and a few larger dykes have been constructed. However, most of the residents (74 %) did not think that their household is better prepared, and half (52 %) of all the respondents reported that they are not prepared at all for the anticipated future floods. One member in discussion with the Oshoopala focus group illuminated this (un)preparedness as follows:

> "Although, we are not prepared for future floods, it does not mean that we do not do anything when the flood comes. We have tried our best but then it doesn't help at all. When we hear that the flood is coming, which in most cases is announced on the radio, we try to act as fast as possible. We mostly tie our things up on roofs to prevent them from being damaged by the water and then relocate".

The role of indigenous knowledge in resilience building

According to the interviews with the traditional authorities and participants in the focus group meetings, only a few decades ago, the communities' resilience towards different weather extremes was based solely on IK. Locals had limited access to any formal weather forecasting, and thus, the IK was used to predict the weather, which was the key element in the coping method of the communities. Local communities accumulated IK over generations, and their livelihood was reliant on their capacity to observe and interpret nature by following different events in their local living environment. This IK contained knowledge of how and when local weather extremes occurred, how to mitigate those extremes, and how to cope with the impacts. Village elders acted as meteorologists, and their knowledge was widely applied, for example, by tuning the seasonal weather calendars to local circumstances (see also Motsumi et al. 2012).

Traditional authorities, whose power and legitimacy have always been built upon IK (Logan 2013), have still an important role in maintaining and transforming IK in the rural communities of the study region. For example, they have the right to allocate, measure, and sell the land in the area over which they have sovereignty, and thus, they maintain the IK-based land-use practices in villages, which are an important part of the local flood management. According to the traditional authorities, in some aspects, the deteriorated flood situation has even reinforced their role in land-use planning. Due to the previous failures in spatial planning that aggravated the flood situation, in 2010, the government made a decision that obligates the regional planners and constructors to consult traditional authorities in any significant public land-use practices executed in their villages. This is a significant change, as previously the traditional authorities did not have any official role in spatial planning. This change is important as building on this fragile landscape, characterised by the shallow *oshana* depressions, is extremely challenging without appropriate IK of the topography in the area.

Table 1 aggregates the most common IK across the study areas based on the household survey, focus group meetings, and the interviews with traditional authorities. Application of IK did not occur in isolation of the other forms of knowledge, but different knowledge was used simultaneously. A quarter (25 %) of the households in the survey responded in the affirmative to the question: *Have any of your ancestors (parents, grandparents, uncles, aunts or other community members) shared the ways in which they used to predict, prevent, prepare, or cope with the floods in the past?* The answers did not have any significant difference between urban (23 %) and rural (26 %) environments. To a certain extent, the respondents possessing IK were older than the respondent in general; in urban areas, their average age was 38 and in rural areas 55 years.[5] The majority of the IK mentioned (61 %) concerned methods of predicting weather events by observing the processes in the immediate natural environment. Most commonly, such methods concerned predictions from the local flora (trees and plants), which was mentioned by almost half (44 %) of the respondents who possessed IK. Such IK was described by one female participant in the Epoko focus group meeting:

> "I am saying that the flood situation is getting worse because in our home there is a Mopane tree that started bearing fruits since the floods started and this tree is still doing it. Therefore, I have reason to believe that floods are getting worse in the future".

Other IK was affiliated to different prevention methods (18 %), coping measures (12 %), and spiritual and mental preparations (9 %). From the prevention methods, the IK related to the local topography (see Table 1) was mentioned most often, as 16 % of all IK was related to it.

Despite the wide range of different IK related to the floods, the application of this knowledge in the coping processes was rather limited. Fourteen per cent of the respondents said they applied IK-based methods to anticipate the floods when they were asked: *Before the last flood even,*

[5] The average age in urban areas was 33 years and in rural areas 51 years.

Table 1 Most common flood-related IK in the study area

Purpose of the measure	Knowledge source	Knowledge
Prediction	Trees and plants	Looking at how different trees (*Mopane, Ebone, Omwandi,* and *Marula*) in the local living environment are producing fruits/flowers in that season
	Behaviour of livestock	Behaviour of domestic animals; for example, how cattle leave the kraal (fast/slow) in the morning, what they feed on during the day, and where, when, and how they sleep
	Astronomy	Interpreting the stars and moon
	Insects and animals	How insects and animals (ants, termites, lizard, frogs, birds, and millipedes) behave, when and where these insects and animals occur and how many there, and how the mammals mitigate
	Weather	Direction and type of rain and wind, form and colour of the clouds, the humidity of the air, thunder, lighting, the water flow, and colour of the water flooding in channels
Prevention	Topography	Where to build/not to build permanent houses or temporally relocate, where to prepare meals and take the domestic animals during the flood event
	Sand	Knowledge about the best type of sand to protect homesteads and assets. Places to collect it and how to use it for protection
	Building techniques	How to build, what materials to use to prevent water accessing the buildings, and how buildings can better withstand floods
Preparation	Belief systems	Spiritual sessions, rites, and prayers strengthening the unity of the community and mental preparation (see also Pratt 2002). May infuse the hazard with meaning
	Village elder	Dreams, rites, and other secret methods in order to prepare the community for weather extremes
Coping	Food security	What to eat and how and where to store the food. Eating wild berries, for example *eendago* and *eenyandi*. Where to get and how to store safe drinking water
	Agriculture techniques	Where, when, and how to cultivate or when to leave the field uncultivated when facing flood/drought
	Trading livestock/corps	The traditional institutions, structures, and rules of trading, exchanging, and borrowing livestock and grain during the crisis
	Fire making	Knowledge about where to make fire, the materials to use for making it and where to find those materials. Making a fire on top of *iikangwa* (a broken piece of clay pot)
	Social security	Storing food in common storage and during the disaster distributing it to those in need

did you somehow anticipate the coming of flood? Less than half of the respondents (40 %), who possessed IK, thought that it could be applied to cope with the recurrent floods. However, many of them added that although they think IK can be applied, it does not improve their coping capacity towards the recurrent floods. As one male respondent from Oshoopala explained:

> "My father told me how they predicted the weather from the Marula tree located in their yard, and also about the highlands, where they used to go during the rainy season. Although, I believe in that information, now it is difficult to apply, as the amount of water is uncontrollable and there is no highland in the urban settlement area" (Household interview 123, 30 October 2012).

The main reasons why IK was not conceived as being applicable to the recurrent floods were related to the uncontrollability of the recent floods. This explains the 41 % of those who did not think or were not sure whether the IK they possessed could be applied to recurrent floods. Another common explanation, stated by almost a fifth (17 %) of the respondents who did not think or were not sure whether the IK they possessed can be applied, was that the recent changes in the socio-ecological dynamics related to the rapid urbanisation, population growth, and building of a new infrastructure had made their IK inappropriate. Some IK, once used in rural areas, was conceived to be ineffective in the urban environment. Population growth and new infrastructures have caused changes in the local environment, and thus, for example, familiar trees, anthills, or relocation places, on which IK had been based, may no longer exist or be distinctive in the urban environment. Moreover, different traditional practices concerning coping with floods have been forgotten during the last decades when major flood events did not occur. Likewise, due to globalisation, these societies have been in transition and are becoming more connected to and dependent on processes and knowledge outside of their local environment.

According to the focus group discussions, both urban and rural residents have had few opportunities to participate in the government's flood management or to integrate their knowledge into official resilience-building efforts. Apart from the relocation camps, the communities have not received any assistance from the government and the communication between them has been inadequate.

This poor co-operation was especially evident in the urban areas, where the municipality and residents have been in constant conflict over the building of informal settlements. The municipality generally considers the informal settlements illegal and has tried to restrict their expansion. Thus, any official co-operation with the residents of the informal settlements could be interpreted as a sign of legitimising their possession.

Conclusions and discussion

In this paper, I studied the coping measures and the communities' use of IK in Northern Namibia to cope with the aggravated social impacts of seasonal floods. Resilience was approached from the social studies perspective, perceiving it as a complex capacity to avoid, cope, adapt, reorganise, renew, and innovate in response to the changes and variability faced, rather than a capacity to return to a pre-existing normality. In this empirical study, first, I scrutinised the different coping measures that the communities employed in urban and rural environments, and their ability to learn from previous floods, and examined the impacts of these factors on the communities resilience to anticipated future flood events. Secondly, my particular focus was placed on IK, as the current research highlights it as a potential but underutilised and challenging source of local community resilience in sub-Saharan Africa.

The empirical findings revealed how the direct and indirect, predicted and unpredicted changes have reshaped the socio-ecological dynamics in Northern Namibia and aggravated the flood situation. Although the floodwater is a result of heavy seasonal rains, inappropriate building across the water channels together with population growth and urbanisation has disturbed the natural water systems and directed the water to settlement areas. The development process of the local infrastructure (roads, railways, buildings), which was aimed to increase the resilience of the communities, has in fact created new kinds of risks for the most marginalised members of the communities by directing the floodwater to the informal settlement areas and villages, and thus decreased their overall resilience.

Local communities, already living with multiple stress factors related to poverty, have only had limited opportunities to cope with and learn about these suddenly deteriorating circumstances. Generally, most of the coping measures have been reactive and functional. A few proactive measures have alleviated the negative impacts of the floods, but their effects on the long-term resilience of the communities have been only palliative. The social dynamics, the challenges related to the floods, and the coping mechanisms applied varied between the urban and rural environments. In urban areas, temporal relocation into government tents was the most effective coping measure increasing resilience towards immediate flooding; however, it had other important negative trade-offs for the overall well-being of the communities. In rural areas, the most workable coping measure has been to permanently relocate the homesteads to higher land, when suitable land has been available and affordable. The most important learning processes were related to the experiences gained in how to prepare and live with the floods. This knowledge included: what to do when a flood warning has been proclaimed, how to best protect personal assets by raising the floor level of the dwellings, securing personal belongings during an evacuation, when is the right time to evacuate, and what to expect of and how to manage in the relocation camps. The communities believed that as well as their own personal learning processes, other important institutions, stakeholders, and actors, such as the municipality, government, aid suppliers, and meteorological institutes are now better prepared to assist them in coping with future flood threats.

The study identified various types of IK related to prediction, prevention, and preparation concerning floods (see Table 1). Most of the IK was practical and emerged from normal events involving the natural local environment of the knowledge holders, although many of these events have recently disappeared due to rapid societal changes. However, IK has a role beyond its technical application. Applying and better understanding IK may embed explicit professional knowledge into local processes and emphasise the local communities' ways of observing, discussing, and interpreting the changes occurring (see also Boillat and Berkes 2013). Nevertheless, the study discovered that the local communities and their knowledge have not been actively engaged in the government's flood management activities. The government considers the residents of the informal settlements as illegal settlers rather than citizens who should be involved in the resilience-building activities. In fact, part of the reason for the aggravated flood situation in Northern Namibia has been the lack of consideration given to the available local topographical and socio-geographical details in the spatial planning process and infrastructure building in this fragile environment.

The result of the case study adds empirical evidence to the existing literature on the social theory of resilience (see example Davoudi 2012), arguing that the communities' capacity to learn from previous disasters and self-organisation may have some limited benefits to community resilience towards anticipatory natural hazards, such as flooding. However, many of the reasons for these hazards are beyond the control of local communities. Their reductive coping measures can only minimise the resultant consequences and will be unlikely to eliminate the fundamental reasons behind the disastrous events (Reid 2012). Thus, the role of the communities' capacity to cope, learn,

or self-organise must not be overemphasised. Instead, to increase the communities' resilience, the complex and long-term social and political conditions and processes behind the actual flood events need to be contemplated on various scales. In Northern Namibia, for example, there is a need to address the defects in spatial planning, land-use, and environmental resource management activities, mitigating uncontrolled urbanisation and population growth, and resolving the existing defects in the infrastructures that have been built. Above all, the flooding in Northern Namibia is primarily a disaster for the most disfranchised members of the communities. It is mostly the poorest, living in fragile settlements located in flood-prone areas, who bear the brunt of the flooding. Thus, it will be very difficult to build a resilient future without confronting the larger development issues related to poverty alleviation and a more equal distribution of resources.

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