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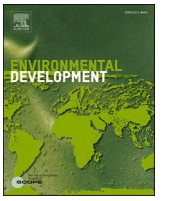

Living under extreme conditions: How African communities are coping with a changing climate

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ABSTRACT

This Commentary reports on the pressures posed by climate change to the living habits of some African communities and outlines some of the adaptation strategies currently deployed. It also describes how resources such as plants, leaves and roots are used in inhospitable environments, as responses to the changing climate conditions.

1. Climate change and extreme events in Africa

Climate change has triggered a serious environmental crisis (IPCC) and Africa is the most vulnerable continent, as millions are already exposed to severe climate hazards including heat waves, droughts, extreme precipitation or periodical flooding (IUCN, 2015; Eberle et al., 2020; ICP, 2021; Laremont, 2021). Climate change is also associated with an increased incidence of secondary disasters such as wildfires, vector-borne diseases, and a spread of insects (IPCC, 2022; Godde et al., 2021; CSIS, 2021). For instance, armyworm and desert locust were the two main destructive pests in Africa in the last decade, whose levels of incidence are intrinsically linked to climate change. The combined pressures have resulted in resource scarcity (especially water), conflicts, disrupted livelihoods, and an increase in food insecurity (ICP, 2021). Extreme climatic events in Africa have become very common, and their impacts are likely to be exacerbated by the expected rises in the global annual mean temperature by more than 2 °C (Nangombe et al., 2018; Levin et al., 2021). The current climatic conditions are responsible for environmental and intergenerational inequities (Thiery et al., 2021).

Millions of Africans are likely to migrate to urban centers, neighboring countries and to Europe in search for better opportunities (ICP, 2021). Estimates reveal that about 86 million people would be forced to suffer internal displacement while tens of millions would cross international boundaries (ICP, 2021). Many sub-Saharan countries are already experiencing high levels of human migration (Leal Filho et al., 2022).

The depletion of water and agro-pastoral resources is also associated with a variety of violent conflicts among local people in some countries (Ayal, Desta & Robinson, 2019; Laremont, 2021; Brottem, 2020). As a result of the influence of various factors, which include poor governance, conflicts and economic hardships -which were intensified by the COVID-19 pandemic- and climate change (Leal--Filho, Nagy & Ayal, 2020), which converts to a stage of food insecurity, it is estimated that Africa will be home to over 433.2 million malnourished people by 2030, as opposed to the current figure of 250.3 million people (CSIS, 2021).

The novelty of this paper resides in the fact that it provides an indication of how African communities are managing to cope with the extreme living conditions. In commenting on their coping strategies, it provides a description of such conditions in Section 2 and then explores future trends in Section 3.

2. Living under extreme conditions: some adaptation strategies

African communities adopt different responses to climate stresses in order to buffer their adverse impacts. The nature of the responses depends on various factors, including the severity and length of the climate risks and their adaptive capacity. Often, the rich pool of local and traditional knowledge is put to use (Leal Filho et al., 2021a, 2021b).

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Under extreme conditions, local communities usually adopt various measures, so as to cope with their impacts (Debela et al., 2019). These may include income diversification by growing different cash and food crops, feeding animals with crop residues and tree branches, utilization of hay for animals feed, and the gathering and consumption of wild fruits and vegetables as food items (CSIS, 2021; Abdulla, 2013; Birhanu et al., 2017; Melaku and Ebrahim, 2021). Table 1 outlines some examples of plants being used in various ways, as part of the adaptation strategies implemented by various communities in an attempt to cope with extreme events.

As specific responses to food insecurity, many communities are using entomophagy and consuming wild foods (Armistice et al., 2020; CSIS, 2021), despite the fact that they cannot be expected to replace conventional agriculture. Wild edible plants, as the name suggests, are neither planted nor domesticated, but available in a wild natural habitat and are being used as a source of food as an attempt to complement the dietary needs of some sectors of the population.

People consume the leaves, stems, fruits, flowers, tubers, bark, seeds and roots of wild plants at different levels. The intensity of their use is directly related to the extent to which they are exposed to food insecurity (Bell, 1995; Lulekal et al., 2011). For instance, the Sukuma community of Tanzania uses the bark and leaves in soups (Brink, 2007; IUCN, 2020). The seed and fruit parts of trees such as Doberaglabra and Grewiaery Threa have become alternative food sources. The Borana (in Ethiopia) consume parts of wild trees such as Grewiavillosa and Grewiabicolor in times of food shortage (Riché et al., 2019).

Many people also utilize crop residues and tree branches as alternative sources of feed for their livestock. Hay is often collected from distant and remote areas and brought home to feed their livestock (Debela et al., 2019). This hay is frequently obtained by purchases made by senior members of the community. Alternatively, hay could be obtained from emergency responses. Tree branches and herbaceous species are also used as important animal fodder by the Maasai in Tanzania and Turkanas in Kenya (Kidane and Kejela, 2021) and by the Borana and Afar communities in Ethiopia (Beche et al., 2016; Treydte et al., 2017). Moreover, selling honey is an important source of income in order to purchase food during drought periods (Abdulla, 2013). All these elements are part of a larger adaptation framework, some of the components of which are outlined in Fig. 1.

During droughts, communities sometimes engage in firewood and charcoal production for sale. It helps them earn cash needed for basic needs and to support health care (e.g., purchase of medicines). However, this non-regulated fuel wood production undermines the local ecosystems and rangeland productivity (Birhanu et al., 2017). Besides, excess harvesting of trees undermines rangeland productivity and the long-term resilience capacity of the sites (Debela et al., 2019).

Different plant species have crucial medicinal contributions. More than 14% of plant species are sources of traditional medicines in Ethiopia (Duguma, 2020). Drought tolerant plant species serve as traditional medicines for humans and livestock (Tsegaye et al., 2007; Giday and Teklehaymanot, 2013). The Afar and Borana communities use plants to prepare traditional medicines, to treat ailments such as swelling on legs and hands, stomach problems, camel eye disease, bone breakage, etc. (Tsegaye et al., 2007; Ayal et al., 2018). They also use specific plants to treat wounds, bleeding, and blotting. The Nyambo and Hehe communities of Tanzania utilize *Agathosma-betulina* species to treat antispasmodic, antipyretic, kidney and urinary tract infections, and cholera diseases. The Herero communities of Namibia, and the Nyakyusa of Tanzania, use *Harpagophytum procumbens* **(devil's claw)** to treat rheumatism, diabetes, gastrointestinal problems, headaches, some heart conditions, and gout (Stewart and Cole, 2005). In Zimbabwe, many households rely on wild fruits as a source of food for nearly a quarter of the dry seasons (Kidane and Kejela, 2021). This is similar to trends seen in Ethiopia, where wild fruits are consumed to withstand seasonal shortage of food (Melaku and Ebrahim, 2021). In contrast to this, in Uganda most wild fruits are gathered during the rainy season (Nyero et al., 2021).

3. Future trends

Climate change affects virtually all sectors of the rural economy and has substantial implication for national economies. Apart from its global impacts - which may influence worldwide trends at different scales and related to items such as desertification, sea-level rise or increases in the frequency of extreme events - there are climate change impacts which are felt at the local level (e.g., reductions in agriculture yields), often negatively influencing the livelihoods of many communities (IPCC et al., 2019).

Recent climate change models and simulations indicate that the frequency of extreme events is bound to increase in the future (IPCC et al., 2022). Therefore, it is necessary to identify and implement climate change adaptation strategies (Godde et al., 2021), especially those compatible with local and indigenous knowledge and which also take into account their cultural profiles. Considering that even affluent countries have recognized the role of insects and worms as a fundamental source of human food in the future (Jansson and Berggren, 2015), it is necessary to sensitize Africans about the need to expand the range of dietary sources. Besides, being rich in high-quality nutrients, insect farming has been recognized as a climate change mitigation option (Jansson and Berggren, 2015). Therefore, one promising area that can ensure access to food in the future would be in fostering cultural changes and outlining the advantages of such practices. There is no evidence to consider that the resort to worms and insects as alternative sources of food constitutes an act of returning to an indigenous livelihood strategy long lost in the shrouded mystery of history. The bearings of consuming worms and insects on biodiversity can hypothetically be taken in a positive sense, especially if humans engage in the production of insects and worms rather than collecting them as wildlife food sources. This is because producing insects and worms on a given plot of land can yield more food than using the same plot of land for the production of cattle. Besides, the production of insects and worms causes no harm to soil fertility and land degradation, something that we observe is the case in the rearing of cattle. At any rate, it goes without saying that the survival of species consumed by humans appears to be more probable than those species regarded as 'unclean' to be a source of food. That is what researchers contend and that cannot be disputed FAO, 2013).

The evidence gathered in this study suggests that cultural change may play an important role as one of the means to foster climate change adaptation and as a tool to cope with food insecurity among communities across Africa.

Table 1
Plants used as sources of food, income and medicine by indigenous communities under extreme climatic conditions in different African countries.

Coping strategy	Major plant types (Scientific names)	Community, Country	References
Human food			
Fruits and leaves	*Grewiavillosa* *Grewiabicolor* *Acacia negrii* *Boswelliamicrophylla*	Borana, Guji and Afar Ethiopia	CSIS, 2021, Riché et al., 2019; Beche et al. (2016)
Fruits and seeds	*Doberaglabra* *Grewiaerythrea* *Salvadorapersica* *Cordiaghara* *Ziziphus spina-christi* *Grewiaferrugniea*	Afar, Ethiopia	Tsegaye et al. (2007)
	Uapacakirkiana	Zimbabwe	Armistice et al. (2020)
Green leaf, flower buds and blossoms, seed	*Moringa stenopetala*	Maasai in Tanzania Turkanas in Kenya	Kidane and Kejela, 2021; Kidane and Kejela, 2021
	Tamarindus indica L.	Wanyiramba in Tanzania Karamajong in Uganda	FAO, 2013
Bark and leaves, flowers, buds, and young shoots	*Grewia mollis*	Sukuma in Tanzania	Brink, 2007 IUCN, 2020
Fruit	*Rubus petalus*	Tanzania, Ethiopia, South Africa, Botswana, Kenya, Uganda	Melaku and Ebrahim, 2021
Animal feed			
Crop residues, tree branches, *leaves and fruits*	*Balanites aegyptica* *Olea afficana* *Pappea capensis* *Rhus natalensis* *Balanitiesaegyptiaca,* *Ziziphus spina-christi* *Ximeniaamericana* *Grewiavillosa* *Boswelliamicrophylla*	Borana, Guji, Afar Ethiopia	Riché et al., 2019, Beche et al. (2016)
Branches that make excellent mulch and animal fodder during the dry season	*Moringa stenopetala (*moringa tree*)*	Maasai in Tanzania Turkanas in Kenya	Kidane and Kejela, 2021; Kidane and Kejela, 2021
Source of income to purchase food			
Charcoal and firewood	*Acacia bussel* *Acacia tortilis* *Acacia etbaica* *Acacia nilotica*	Borana and Guji, Ethiopia	Birhanu et al., 2017; Riché et al., 2019
Charcoal and honey production	*Apodytesdimidiata* *Rostrariacristata* *Prosopisjuliflora* *Rostrariacristata*	Afar, Ethiopia	Beche et al. (2016)
Plants used as traditional medicines			
Roots, fruits, stem, barks are used to treat disease-related to livestock (Camel, goat, sheep and cattle)	*Acacia nilotica* *Balanitesrotudifolia* *Bosciacoriacea Bourreriaorbicularis* *Euphorbia* sp. *Kanahialaniflora* *Withaniasomnifera*	Afar, Ethiopia	Giday and Teklehaymanot, 2013
Leaf used to treat both human and animal disease (e.g. Swelling on legs and hands, stomach problems, camel eye disease, bone breakage, etc).	*Doberaglabra*	Afar, Ethiopia	Tsegaye et al., 2007; Giday and Teklehaymanot, 2013
*Fruits, leaves, stems, barks used to t*reat wounds (for calf, camel, and human)' prevent bleeding and blotting and Malaria prevention	*Acacia negrii* *Acacia senegal* *Tamarindusindica* *Rostrariacristata* *Boswelliamicrophylla* *Balanitesaegyptiaca*	Afar, Ethiopia	Beche et al. (2016)
Remedies such as for burns, insect bites, sores, arthritis, conjunctivitis, and toothaches, and stomach pains.	*Aloe ferox (Aloe Vera)*	Masaai, Nyiramba in Tanzania	Melaku and Ebrahim, 2021
Antispasmodic, antipyretic, kidney and urinary tract infections, and cholera	Agathosmabetulina (Buchu)	Nyambo and Hehe of Tanzania	Riché et al., 2019
Antispasmodic, antioxidant, anti-aging, and antieczema- caffein free	Aspalathus linearis (Fabaceae) Herbal tea, called rooibos	Zulu and Xhosa in South Africa	Stander et al., 2019

(*continued on next page*)

Table 1 (*continued*)

Coping strategy	Major plant types (Scientific names)	Community, Country	References
Rheumatism, diabetes, gastrointestinal, neuralgia, headache, heart, and gout	Harpagophytum procumbens (devil's claw)	Herero of Namibia; Nyakyusa of Tanzania	Stewart and Cole, 2005
Sprains and fractures, cancer tumors (cancerous), menstrual pains, infertility, Cardiac diseases, impotency, barrenness, cancer, headaches, immune booster, burns, and ulcers	Merwillanatalensis (Hyacinth)	Sukuma and Nyaturu in Tanzania	Van Jaarsveld,2018

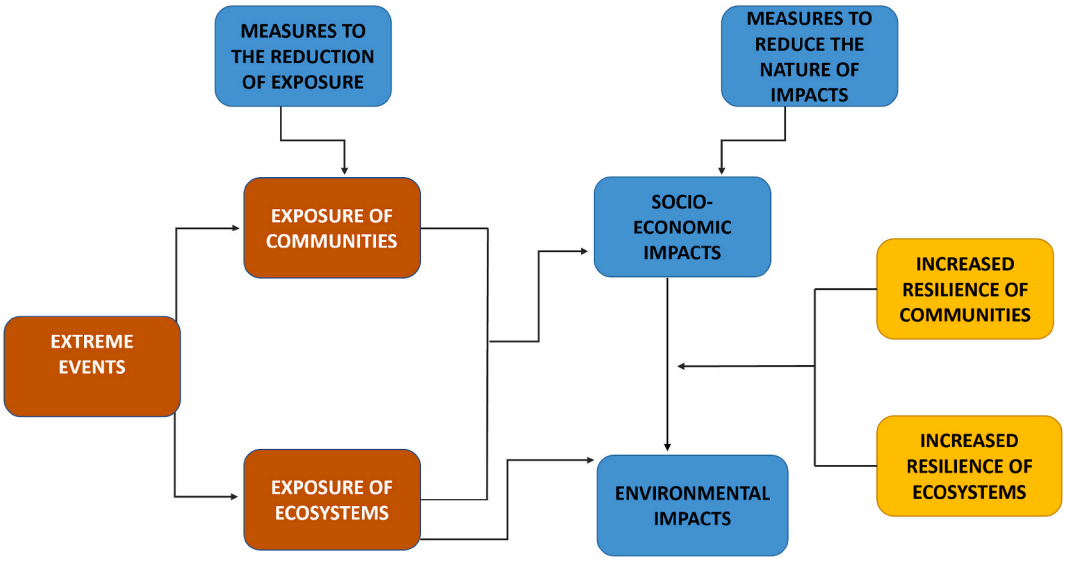

Fig. 1. Components of an adaptation framework under an extreme events context.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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