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1 **Living under extreme conditions: how African communities are coping with a**
2 **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.

Keywords: climate change, adaptation, extremes, wild plant, community

1. Climate Change and Extreme Events in Africa

Climate change has triggered a serious environmental crisis (IPCC, 2021; IPCC, 2022) 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 2⁰C (Nangombe *et al.*, 2018; Levine *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, Olaniyan and Nagle, 2022).

66 The depletion of water and agro-pastoral resources is also associated with a variety
 67 of violent conflicts among local people in some countries (Ayal, Desta & Robinson,
 68 2019; Laremont, 2021; Brottem, 2020). As a result of the influence of various factors,
 69 which include poor governance, conflicts and economic hardships -which were
 70 intensified by the COVID-19 pandemic- and climate change (Leal-Filho, Nagy & Ayal,
 71 2020), which converts to a stage of food insecurity, it is estimated that Africa will be
 72 home to over 433.2 million malnourished people by 2030, as opposed to the current
 73 figure of 250.3 million people (CSIS, 2021).

74

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

79

80 **2. Living under Extreme Conditions: some adaptation strategies**

81 African communities adopt different responses to climate stresses in order to buffer
 82 their adverse impacts. The nature of the responses depends on various factors,
 83 including the severity and length of the climate risks and their adaptive capacity.
 84 Often, the rich pool of local and traditional knowledge is put to use (Leal Filho *et al.*,
 85 2021b).

86

87 Under extreme conditions, local communities usually adopt various measures, so as
 88 to cope with their impacts (Debela *et al.*, 2019). These may include income
 89 diversification by growing different cash and food crops, feeding animals with crop
 90 residues and tree branches, utilization of hay for animals feed, and the gathering and
 91 consumption of wild fruits and vegetables as food items (Coppock, 1994; Abdulla,
 92 2013; Birhanu *et al.*, 2017; Melaku and Ebrahim, 2021). Table 1 outlines some
 93 examples of plants being used in various ways, as part of the adaptation strategies
 94 implemented by various communities in an attempt to cope with extreme events.

95

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

Coping strategy	Major plant types (Scientific names)	Community, Country	References
Human food			
Fruits and leaves	<i>Grewiavillosa</i>	Borana, Guji	Coppock, 1994,

	<i>Grewiabicolor</i> <i>Acacia negrii</i> <i>Boswelliamicrophylla</i>	and Afar Ethiopia	Riché <i>et al.</i> , 2009; Beche <i>et al.</i> , 2016)
Fruits and seeds	<i>Doberaglabra</i> <i>Grewiaerythrea</i> <i>Salvadorapersica</i> <i>Cordiaghara</i> <i>Ziziphus spina-christi</i> <i>Grewiaferruginea</i>	Afar, Ethiopia	Tsegaye <i>et al.</i> , 2007
	<i>Uapacakirkiana</i>	Zimbabwe	Armistice <i>et al.</i> , 2020
Green leaf, flower buds and blossoms, seed	<i>Moringa stenopetala</i>	Maasai in Tanzania Turkanas in Kenya	Kumssa <i>et al.</i> , 2017; Kebede <i>et al.</i> , 2018
	<i>Tamarindus indica</i> L.	Wanyiramba in Tanzania Karamajong in Uganda	Fandohan, and Vitoekpon. 2021
Bark and leaves, flowers, buds, and young shoots	<i>Grewia mollis</i>	Sukuma in Tanzania	Brink, 2007 IUCN, 2020
Fruit	<i>Rubus petalus</i>	Tanzania, Ethiopia, South Africa, Botswana, Kenya, Uganda	Munyali <i>et al.</i> , 2020
Animal feed			
Crop residues, tree branches, leaves and fruits	<i>Balanites aegyptica</i> <i>Olea afficana</i> <i>Pappea capensis</i> <i>Rhus natalensis</i> <i>Balanitiesaegyptiaca</i> , <i>Ziziphus spina-christi</i> <i>Ximeniaamericana</i> <i>Grewiavillosa</i> <i>Boswelliamicrophylla</i>	Borana, Guji, Afar Ethiopia	Riché <i>et al.</i> , 2009, Beche <i>et al.</i> , 2016)
Branches that make excellent mulch and animal fodder during the dry season	<i>Moringa stenopetala</i> (moringa tree)	Maasai in Tanzania Turkanas in Kenya	Kumssa <i>et al.</i> , 2017; Kebede <i>et al.</i> , 2018
Source of income to purchase food			
Charcoal and firewood	<i>Acacia busse</i> <i>Acacia tortilis</i> <i>Acacia etbaica</i> <i>Acacia nilotica</i>	Borana and Guji, Ethiopia	Birhanu <i>et al.</i> , 2017; Roba 2021
Charcoal and honey production	<i>Apodytesdimidiata</i> <i>Rostrariacristata</i> <i>Prosopisjuliflora</i> <i>Rostrariacristata</i>	Afar, Ethiopia	Beche <i>et al.</i> , 2016
Plants used as traditional medicines			
Roots, fruits, stem, barks	<i>Acacia nilotica</i>	Afar, Ethiopia	Giday, and

are used to treat disease-related to livestock (Camel, goat, sheep and cattle)	<i>Balanitesrotudifolia</i> <i>Bosciacoriacea</i> <i>Bourreriaorbicularis</i> <i>Euphorbia sp.</i> <i>Kanahialaniflora</i> <i>Withaniasomnifera</i>		Teklehaymanot, 2013
Leaf used to treat <i>both human and animal disease (e.g. Swelling on legs and hands, stomach problems, camel eye disease, bone breakage, etc).</i>	<i>Doberaglabra</i>	Afar, Ethiopia	Tsegaye <i>et al.</i> 2007; Giday, and Teklehaymanot, 2013
<i>Fruits, leaves, stems, barks used to treat wounds (for calf, camel, and human) prevent bleeding and blotting and Malaria prevention</i>	<i>Acacia negrii</i> <i>Acacia senegal</i> <i>Tamarindusindica</i> <i>Rostrariacristata</i> <i>Boswelliamicrophylla</i> <i>Balanitesaegyptiaca</i>	Afar, Ethiopia	Beche <i>et al.</i> , 2016
Remedies such as for burns, insect bites, sores, arthritis, conjunctivitis, and toothaches, and stomach pains.	<i>Aloe ferox (Aloe Vera)</i>	Masaai, Nyiramba in Tanzania	Munyali, 2020
Antispasmodic, antipyretic, kidney and urinary tract infections, and cholera	Agathosmabetulina (Buchu)	Nyambo and Hehe of Tanzania	Ramana, <i>et al.</i> , 2015
Antispasmodic, antioxidant, anti-aging, and antieczema- caffein free	Aspalathus linearis (Fabaceae) Herbal tea, called rooibos	Zulu and Xhosa in South Africa	Stander, <i>et al.</i> , 2019
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

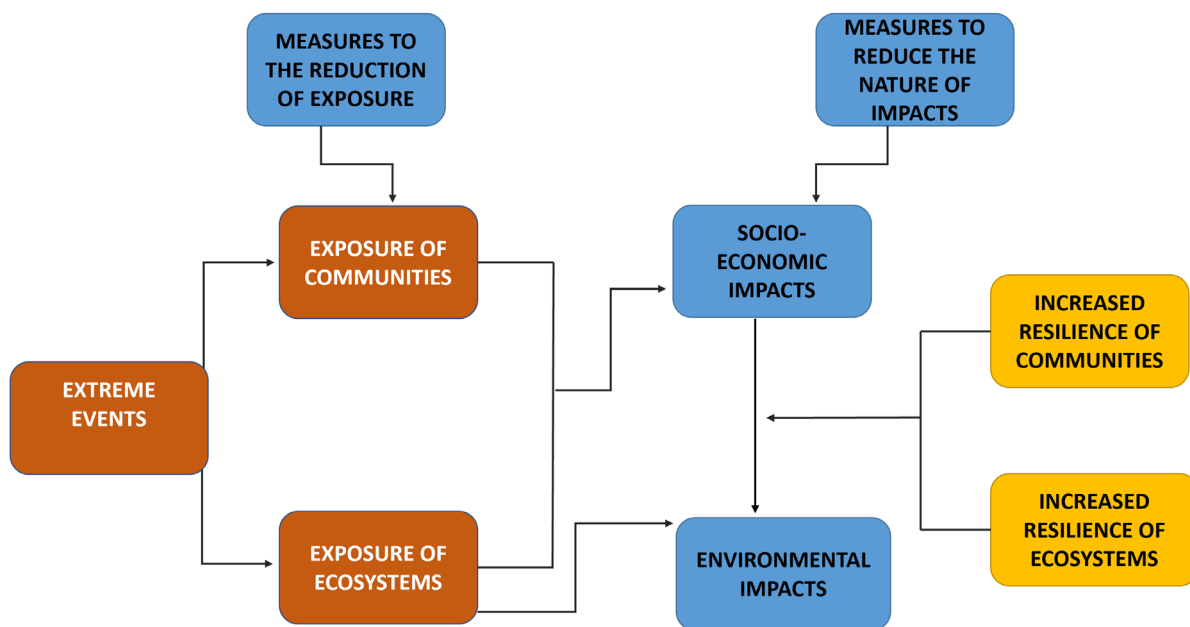
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As specific responses to food insecurity, many communities are using entomophagy and consuming wild foods (Armistice *et al.*, 2020; Carina *et al.*, 2021), despite the fact that they cannot be expected to replace conventional agriculture. Wild edible 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..

106 People consume the leaves, stems, fruits, flowers, tubers, bark, seeds and roots of
 107 wild plants at different levels. The intensity of their use is directly related to the extent
 108 to which they are exposed to food insecurity (Bell, 1995; Lulekal *et al.*, 2011). For
 109 instance, the Sukuma community of Tanzania uses the bark and leaves in soups
 110 (Brink, 2007, IUCN, 2020). The seed and fruit parts of trees such as *Doberaglabra*
 111 and *Grewiaery Threa* have become alternative food sources. The Borana (in
 112 Ethiopia) consume parts of wild trees such as *Grewiavillosa* and *Grewiabicolor* in
 113 times of food shortage (Riché *et al.*, 2009).

114
 115 Many people also utilize crop residues and tree branches as alternative sources of
 116 feed for their livestock. Hay is often collected from distant and remote areas and
 117 brought home to feed their livestock (Debela *et al.*, 2019). This hay is frequently
 118 obtained by purchases made by senior members of the community. Alternatively, hay
 119 could be obtained from emergency responses. Tree branches and herbaceous
 120 species are also used as important animal fodder by the Maasai in Tanzania and
 121 Turkanas in Kenya (Kumssa *et al.*, 2017) and by the Borana and Afar communities in
 122 Ethiopia (Beche *et al.*, 2016; Treydte, *et al.*, 2017). Moreover, selling honey is an
 123 important source of income in order to purchase food during drought periods
 124 (Abdulla, 2013). All these elements are part of a larger adaptation framework, some
 125 of the components of which are outlined in Figure 1.

126
 127 Figure 1- Components of an adaptation framework under an extreme events context
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 131 During droughts, communities sometimes engage in firewood and charcoal
 132 production for sale. It helps them earn cash needed for basic needs and to support
 133 health care (e.g., purchase of medicines). However, this non-regulated fuel wood
 134 production undermines the local ecosystems and rangeland productivity (Birhanu *et*

135 *al.*, 2016). Besides, excess harvesting of trees undermines rangeland productivity
136 and the long-term resilience capacity of the sites (Debela *et al.*, 2019).

137

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

156

157 **3. Future trends**

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

165

166 Recent climate change models and simulations indicate that the frequency of
167 extreme events is bound to increase in the future (IPCC, 2022). Therefore, it is
168 necessary to identify and implement climate change adaptation strategies (Godde *et al.*,
169 2021), especially those compatible with local and indigenous knowledge and
170 which also take into account their cultural profiles. Considering that even affluent
171 countries have recognized the role of insects and worms as a fundamental source of
172 human food in the future (Jansson and Berggren, 2015), it is necessary to sensitize
173 Africans about the need to expand the range of dietary sources. Besides, being rich
174 in high-quality nutrients, insect farming has been recognized as a climate change
175 mitigation option (Jansson and Berggren, 2015). Therefore, one promising area that
176 can ensure access to food in the future would be in fostering cultural changes and
177 outlining the advantages of such practices. There is no evidence to consider that the

178 resort to worms and insects as alternative sources of food constitutes an act of returning to
179 an indigenous livelihood strategy long lost in the shrouded mystery of history. The bearings
180 of consuming worms and insects on biodiversity can hypothetically be taken in a positive
181 sense, especially if humans engage in the production of insects and worms rather than
182 collecting them as wildlife food sources. This is because producing insects and worms on a
183 given plot of land can yield more food than using the same plot of land for the production of
184 cattle. Besides, the production of insects and worms causes no harm to soil fertility and land
185 degradation, something that we observe is the case in the rearing of cattle. At any rate, it
186 goes without saying that the survival of species consumed by humans appears to be more
187 probable than those species regarded as 'unclean' to be a source of food. That is what
188 researchers contend and that cannot be disputed (FAO, 2013).

189
190 The evidence gathered in this study suggests that cultural change may play an
191 important role as one of the means to foster climate change adaptation and as a tool
192 to cope with food insecurity among communities across Africa.

193
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