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ORIGINAL RESEARCH

Prunus Africana Under Stress: Adaptation Strategies of Indigenous Communities to Climate Change at Mount Cameroon

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Abstract

Prunus africana is a "flagship" medicinal plant species in Africa. However, its dynamics and sensitivity to climate change remain unclear. This study explores the perceived dynamics of *P. africana* in relation to climate change and indigenous adaptation strategies based on local knowledge of forest-dependent communities around Mount Cameroon. To achieve this objective, empirical data was collected in four villages by conducting group discussions, interviews, transect walks and observations. The study reveals that *P. africana* at lower forest altitudes is highly susceptible to weather anomalies and climate change, expressed by increases in pest and disease infections, decreasing area distribution, changes in growth and vitality and decelerated recovery after harvesting. Due to its importance for medicinal purposes, local farmers plant *P. africana* on farmlands, practice agroforestry and create nurseries. This study aims to provide insights for integrated conservation and development projects adapting to climate change, fostering medicinal plant conservation and sustainable livelihoods.

Keywords Local knowledge · Medicinal plants · Climate change · Adaptation · Cameroon

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Introduction

Climate change is affecting plant species and other animate components of the biosphere across the world (IPBES 2019). This also applies to plant species important for the health and survival of Indigenous communities living in areas where conventional medical treatment is inaccessible. In Tropical Africa, medicinal plants are used by about 80% of the population for natural remedies and traditional medicine, mainly because of their accessibility and affordability (Ntie-Kang et al. 2013; Tsobou et al. 2016). In contrast, access to Western medicine is low and unequal between rich and poor households. The population grapples with diseases such as tuberculosis, cancer, malaria, diabetes, HIV and cardiovascular diseases. Adequate treatment for ailments is challenging for many reasons, including shortage of healthcare professionals, high costs for drugs and poor infrastructure (Cumber et al. 2017), thereby indicating that the traditional healthcare system remains the major source of remedy for health challenges in remote rural communities.

The most significant medicinal plant in the mountainous areas of Cameroon, the exploitation of which commenced in 1972, is *Prunus africana*, also known as African cherry, *Pygeum africanum* and red stinkwood (Rubegeta et al. 2023). It is an indigenous tree species of the Afromontane forests (Dzokou et al. 2020), and of the more than 200 types in the *Prunus* genus, it is found exclusively in Africa (Amougou et al. 2011). In the region of Mount Cameroon, almost 30% of all *P. africana* trees are infected by borer and ants (Eben Ebai 2015), while Vinceti et al. (2013) predict that a high percentage of the present range of *P. africana* will be unsuitable by the year 2050 as a result of climate change. Therefore, documenting the dynamics of *P. africana* and adaptation strategies employed by Indigenous people to boost its resilience and their livelihoods is vital in view of increasing climatic threats.

Prunus africana grows in natural forests and is also planted on farms. It is found at elevations between 800 and 3400 m above sea level, with a mean yearly precipitation of 890 to 2600 mm and temperatures between 18 and 26 °C (Komakech et al. 2017). At lower altitudes below 800 m, it may mature faster, but it is more prone to diseases, pests and fire (Ntoko 2020). *P. africana* is threatened by increasing human pressure, agricultural expansion, unsustainable harvesting, fragmentation, mountain forest degradation, logging, increased demand and poor management, infrastructural development and loss of natural vegetation exacerbated by climate change (Das et al. 2016; Njoh and Wanie 2018; Ntoko 2020).

The plant's bark, seeds, leaves and roots are enormously important to forest-dependent communities in terms of medicinal treatments, food security, ecological stability, income generation, employment and cultural values (Njoh and Wanie 2018; Dzokou et al. 2020; Ntoko 2020), as summarised in Table 1 (see Appendix). The many medicinal uses of *P. africana* are connected to the several constituent phytochemicals it contains (Nyamai et al. 2016; Rubegeta et al. 2023), albeit these have led to overexploitation of its bark for local and global markets (Cunningham et al. 2016). About 3000 tons per annum are exported from Africa to Europe, with Cameroon contributing almost 62% of the continent's total bark export (Jimu 2011). This increasing demand, aligned with anthropogenic features, compounds with climate change to

produce enormous stress on the tree's health and distribution range, occasioning a significant decrease in its population (Vinceti et al. 2013; Giliba and Yengoh 2020).

P. africana is collected from community-owned forests and individual farms, while the bulk of the exported bark is collected in natural forests (Cunningham et al. 2016). Cultivation on farms is done in mixed agroforestry plots and meant to ensure the viable supply of bark (Ingram et al. 2015). To control harvesting and commercialisation, given the large volumes involved, the Cameroon government instituted a "National Management Plan for *Prunus Africana*", which sustained larger endeavours towards diminishing pressure on wild species with locally cultivated species (Ingram et al. 2015). In general, *P. africana*'s existence and health depend on weather conditions, forest undergrowth, soil nutrients, harvest season, the intervals between harvests and the quantity of bark harvested (Awono et al. 2015; Nkeng et al. 2009).

Despite measures put in place to treat *P. africana* in a sustainable way, wild populations remain endangered. For example, the Mount Cameroon Prunus Management Organisation (MOCAP), the epitome of the decentralised management of natural resources to local communities (Ntoko 2020), unfortunately has not ensured sustainable management or equity in benefit sharing, due to elite capture, market control and subsidised management systems (Cunningham et al. 2016). Table 2 (see Appendix) indicates how climate and environmental changes affect *P. africana*.

Several studies on *P. africana* have focused on bark domestication, commercialisation, poor governance, habitat loss, unsustainable harvesting and conservation (Cunningham et al. 2016; Komakech and Kang 2019; Dzokou et al. 2020). The Cameroon National Plan for *Prunus africana* places more emphasis on harvesting and capitalisation. Despite numerous studies and projects, the plant is on the decline, threatened and risks extinction (Cunningham et al. 2016). With a focus on local Indigenous communities at Mount Cameroon and their perceptions of current climatic changes, this study aims to enhance knowledge about the recent dynamics of *P. africana* due to climate change and the adaptation strategies of the affected population. Thus, it will contribute to the fight against biodiversity loss, in order to support traditional healthcare systems and enhance the livelihoods of forest-dependent communities. Our study addresses the following objectives: (1) an exploration of the perceived susceptibility of *P. africana* to climate change and (2) an examination of adaptation strategies taken by Indigenous communities to secure livelihoods and ecosystems. The paper is organised as follows: Sect. "Materials and Methods" explicates the study site and methodology, while Sect. "Results" focuses on the perception of *P. africana* dynamics in relation to climate change and on local adaptation strategies. The findings are discussed in Sect. "Discussion", which is followed by a conclusion.

Materials and Methods

Study Site

Mount Cameroon is located near the Gulf of Guinea coast in the south-western region of Cameroon (Fig. 1) and is part of one of the most diverse large tropical rain forest areas in the world. The mean temperature at the foot of Mount Cameroon is about

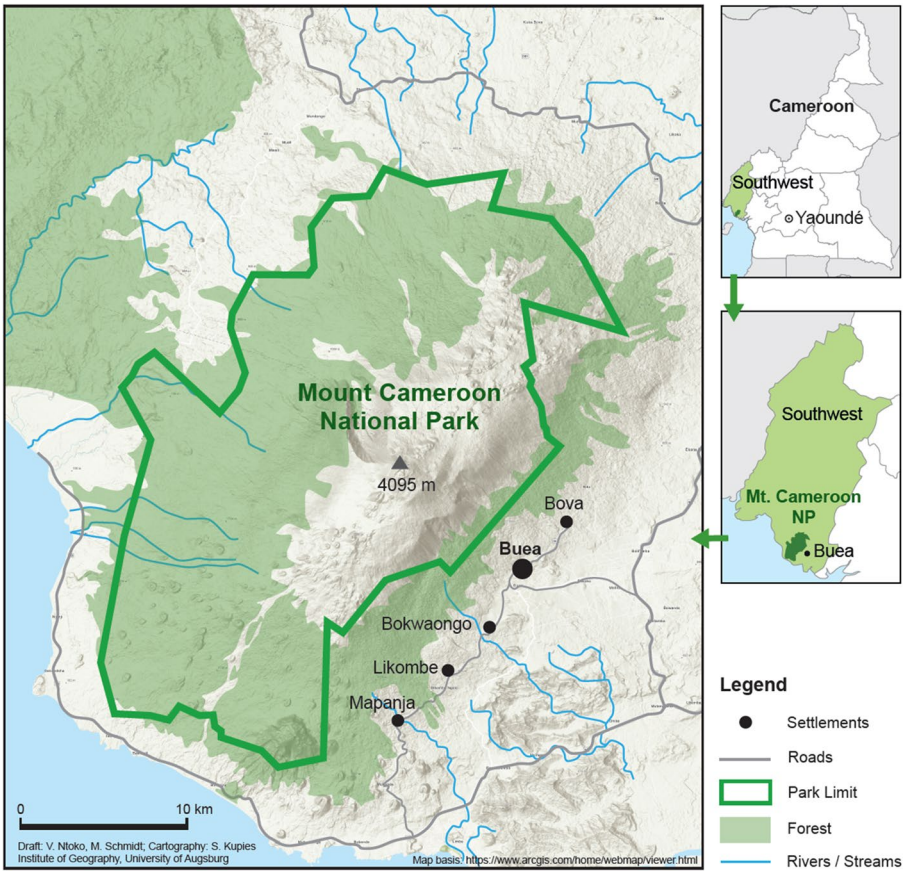


Fig. 1 Mount Cameroon region and location of the study villages

23 °C and at the summit around 4 °C in rainy and 8 °C in dry seasons (Ministry of Forestry and Wildlife 2014). The dry season reaches its peak between February and April, while the rainy period extends from April to November and reaches its peak from July to October (Molua 2002). Annual rainfall fluctuates from 12,000 mm in the south-west of the core massive to 2,000 mm in the north-east (Forboseh et al. 2011). The Mount Cameroon National Park (MCNP) was created in 2009 and is home to important fauna and flora species and encompasses the greatest and most diverse ecology in Cameroon, with around 2,435 flora species, of which 49 plant taxa are threatened, while around 50 are at risk (Tchouto 1996; Cheek 1998). The Mount Cameroon region has a population of about 450,000 people; the Indigenous people include Bakweri, Isabu, Wovea, Bomboko, Bakolle and Balong (Ministry of Forestry and Wildlife 2014). Non-timber forest products collected from the forest and montane grasslands are important for the local economy and welfare due to their productive, consumptive and non-consumptive use (Ntoko 2020; Ntoko and Schmidt 2021).

The high biodiversity of the park is exposed to multiple challenges, including illegal logging, climate change, land-grabbing, large-scale agro-industries, popula-

tion growth and the spread of farmlands (Taylor 2015). These features result in species loss, decreasing genetic diversity and increasing risks of diseases and arbitrary population fluctuations. The MCNP is divided into six cluster conservation villages to ensure efficient management. In order to enhance local well-being and to sustainably manage natural resources, park management and NGOs have urged communities to adopt agroforestry practices. Multipurpose nurseries have been created and tree-planting promoted. Also, several villages are involved in cassava and plantain projects (Degrande et al. 2017).

Methods and Data Analysis

This study is based on empirical field research that was conducted in 2018. Data collection and analysis are based on the "Community-based Risk Screening Tool—Adaptation and Livelihoods" (CRiSTAL) (IISD 2013), to better understand the interrelationships between climate change, livelihoods, vulnerability and adaptation. It depends on local knowledge and uses participatory methods for data collection.

The perceptions of the local population of ecological changes are part of and reflected by their Indigenous knowledge systems (Ntoko and Schmidt 2021). Indigenous knowledge is the foundation of forest and natural resources management (Mazzocchi 2020) and jointly employed by local populations to manage and direct traditional ways of living, and to ensure communal livelihoods (Kaunga 2017). Indigenous knowledge holders are unique sources of biological and socio-ecological information for plants and animal species (Wong 2016). The convergence of Indigenous knowledge and climate change remains under-researched (Ntoko and Schmidt 2021), partly because the former has been seen as less relevant and valid than scientific knowledge, even though it continuously shapes local livelihoods. But Indigenous knowledge is vital to understanding forest-dependent communities' vulnerability to climate-linked threats and natural resources insufficiencies, particularly in areas where scientific data is missing (Pearse 2016; Wong 2016).

In our study, we used participatory rural appraisal techniques, including random transect and observation walks, group discussions and qualitative interviews with key informants and experts. Participatory methods enabled local people to share knowledge, identify and assess their needs and shed light on their livelihoods and living conditions. For the village selection, we consulted unpublished secondary data from the MCNP office in Buea, which enabled the identification of stakeholders engaged in forest use—and particularly *P. africana*. This led to the selection of two clusters, namely Buea 1 (eight villages) and Buea 2 (five villages). Village selection was based on the following criteria: distance from the park, climate, community and ethnic composition, economic activities, population, involvement in forest management and *P. africana* activities. We selected two villages from each cluster as follows: Bova and Bokwaongo (Buea 1), and Mapanja and Likombe (Buea 2). With the help of secondary data and cluster facilitators, we identified 13 groups in the four villages.

Formal groups known by the government and involved in forest management included MOCAP, village forest management committees (VFMCs) and traditional councils. Informal groups, mainly women's groups, recognised by the locals and park management consisted of Hands on the Ground, Ifose and solidarity women's

groups. A total of 58 men and 38 women were involved in the group discussions, which enabled the gathering, interpretation, triangulation and comprehension of the dynamics of *P. africana* in relation to climate change and adaptation strategies employed by individuals and groups.

Twenty key informant interviews were held with male farmers chosen based on their agency in terms of *P. africana* cultivation and management. We used interview guides targeting local experiences and perspectives on the dynamics of *P. africana* in relation to seasonal changes and their connections to area diversity, distribution and growth. Also, transect walks carried out in Bokwaongo village provided an opportunity for further discussions, as well as the observation and identification of *P. africana* plants in their natural environment. The transect team consisted of the researcher and two village resource persons, selected on the basis of their long experience and knowledge of *P. africana* and the forest environment. During the walk, farmers were asked to identify *P. africana* plants and provide information on the effects of climate change on quality, productivity, growth, area diversity, timing and species loss. Farmers also provided information on the different adaptation strategies employed due to the deteriorating state of *P. africana*. Overall, about 116 persons participated in the study, namely 78 men and 38 women.

In addition to the analysis of secondary data, this study is based almost exclusively on qualitative data that was processed and analyzed using the MAXQDA software. The assessments and answers of the interviewees were first sorted by topic and then classified according to frequency and trends and critically reflected on for plausibility. The frequency of occurrence and mention revealed the importance of the topics, phenomena and concerns of the interviewees being investigated. Particularly impressive and plausible statements in the overall context were highlighted. Some of these are reproduced verbatim in the following presentation of the results. Statements from the interviews were triangulated with other statements, our own observations and the results of other studies and checked for plausibility. The extensive and detailed statements of the interviewed persons together with our own observations thus provided a comprehensive picture of the utilisation forms and relevance of *P. africana*, the threat it faces from various uses and climate change, its impact on local livelihoods and recent adaptation strategies.

Results

Local Perceptions of *Prunus africana* Dynamics in Relation to Climate Change

The empirical data provides an insight into farmers' experiences of *P. africana* dynamics as the consequences of changes in weather trends. In the following, farmer's agencies of climate change influences on *P. africana* in the MCNP region are expounded.

Perceived Changes in Temperature and Rainfall

When questioned about weather changes in the region, all respondents expressed that rainfalls have reduced and temperatures increased, both with negative effects on biodiversity. In particular, MOCAP provided insights into the susceptibility of *P. africana* to climatic factors, mainly as a consequence of reduced precipitation and increases in temperature over the last 20 years. Farmers expressed that 20 years ago, when they debarked *P. africana*, water oozed out of its bark. Currently, very little water leaks out, due to reduced water intake linked to warmer temperatures and decreased rainfall. A member of the MOCAP in Mapanja expressed this view as follows:

> In the past, the forest was thick, the clouds were dark regularly and the rainy season lasted longer than the dry season in the Buea area. Wotango [*P. africana*] had excess water. If we took off its bark, the basket or bag in which we put the tree bark would be wet. Also, our head or back on which we carried it would be soaked with water. Today, water coming out of the tree bark has greatly reduced.

This statement illustrates that changes in precipitation and warmer temperatures have affected water availability for *P. africana*. Moreover, the respondents expressed that the debarking of the plant during the dry season renders it more susceptible, since it requires a good deal of water to recover, but warmer temperatures, late rains and extended dry periods provide less water to sustain its growth. *P. africana* debarked in the dry season has fewer chances of surviving than those debarked during the rainy season. Some farmers revealed that climate change linked to changes in forest cover has affected the availability of dew, which would otherwise provide water and "freshness" to the plants. This observation is reflected in a statement made by an elderly man from Likombe village:

> The "black bush" is not as thick as it was before. We see more sunlight in the black bush now than in the past. Wotango does not take in enough water. Dew around the village in the morning has greatly reduced, especially during the dry season. If there is no moisture, then wotango trees too cannot have water.

The farmer's observations disclose that the reduced density of bushes and shrubs have exposed *P. africana* to more sunlight. Also increasing temperatures have affected the availability of dew and, consequently, water availability for tree species.

Pest Influence on *Prunus africana*

The empirical data also provided insights into the respondents' perceptions of the exposure of *P. africana* to vector diseases induced by warmer temperatures and reduced rainfall. The degree of pest infection seems to be a function of altitude, vegetation cover, temperature and seasonality. When asked about the alterations in weather conditions and how these have influenced *P. africana*, all farmers expressed

that the warmer temperatures experienced in the region have increased the plant's susceptibility to pest infection. Moreover, *P. africana* grows well under cooler conditions at higher altitudes (more than 1500 m), while hotter temperatures at lower altitudes negatively influence its occurrence and the likelihood being affected by the borer disease (insect vector). During transect and observational walks around the Bokwaongo neighbourhood, farmers showed *P. africana* trees disturbed by borer disease and invaded by powdery mildew on their bark (Fig. 2).

Borer disease affects vitality as well as productivity of the trees, since most of the infected trees die or their growth is retarded. Trees affected by borer are unsuitable for traditional medicines and thus cut down for fuel wood. This in turn reduces local revenues and the capacity to support family needs. A farmer in Bova, involved in large scale *P. africana* farming and its commercialisation, mentioned:

> The disease which kills wotango is a huge trouble to me. I see ants and dust on the skin of wotango. Most of the wotango in my farmland have ants and dust. I cannot use it for traditional medicines, so I fell it for firewood. I realise that my friends who have wotango on farms closer to the mountain do not actually face this problem.

MOCAP members from Mapanja and Bokwaongo said that buds and fresh leaves produced by the plant are malformed because of the borer disease. The infected trees lose their leaves, especially in the dry season, when the borer insects are numerous and very little water is available for the plant. When rainfall is heavy and continuous, however, the farmers expressed that the trees suffer less from borer infection by washing the insects away and thus reducing their population. An elderly man in Mapanja said:

> The heavy rainfall reduces the insect population and takes the insects off the plant. It also affects their reproduction, since it might wash away freshly laid eggs, thus preventing further propagation. During years of prolonged rainfall, the effect of borer disease decreases.



Fig. 2 *P. africana* affected by stem borer and an invasion of powdery mildew (Photo: Ntoko, 2018)

The farmers expressed that some 20 years back, when the "black bush" was thick and temperatures were lower, *P. africana* did not suffer from disease infection. According to some elderly people in Bokwaongo village, formerly, between the months of March and June they had cloud cover, and in August the nimbus cloud was very thick, and it rained nearly daily. Under such weather conditions, *P. africana* trees were not affected by insects. The heavy rains created harsh survival conditions for insects and stopped them from settling on the tree. In all study villages, farmers indicated that since 2010, prolonged dry seasons have led to a reduction in *P. africana* around homes and farmlands, since they are more exposed to the borer disease.

Prunus africana Growth and Seed Productivity

Climate change, in the form of both alterations in precipitation and dry periods, also influences *P. africana*'s development and flowering period. The following factors emerged: a reduction in tree size and height, poor health and changed sprouting periods. Local farmers expressed that, currently, most of the trees are not "big" or "huge," unlike in the past. This view was highlighted by the Likombe VFMC members:

> Formerly, we could tell when the seasons were coming. The rainy period was long and the weather chilly. As a consequence, wotango had enough water, and it was very large and tall. Now, most wotango, especially those on farmlands, are thin in size.

This excerpt reveals that *P. africana* tree growth, volume and vitality are dependent on water availability and stable seasons. According to members of MOCAP-Mapanja, *P. africana* trees cannot absorb enough water from the soil, since the rains are not regular. Also, trees affected by the borer disease have stunted growth and appear to be in poor health. Moreover, some farmers, such as an elderly member of MOCAP-Bokwaongo, expressed that climate change has influenced and confounded seed productivity and the flowering period. Normally, during the wet period, it does not bud seeds. Previously, it produced seeds around the months of March and April, but this now happens between November and January.

Adaptation Strategies to Secure Livelihoods and Ecosystems

The perceived and observed climate change and its supposed, and in their consequence actual, consequences for the vitality and occurrence of *P. africana* force the local population to develop adaptation strategies. This is because the forests, and in particular *P. africana*, are of essential importance for their livelihoods. The measures and activities developed and modified by the local population are presented below.

Prunus africana Tree Planting

The empirical data expresses that *P. africana* has become scarce due to climate change and deforestation. Planting trees and caring for and protecting *P. africana* on one's own farmland or in natural forests is seen as imperative by most members of

the communities. To support tree growth and to enhance its occurrence, for example, some ecotourism guides indicated that whenever they come across a *P. africana* tree in the forest, they clear the ground around it so that nearby plants and weeds do not obstruct its growth. They also plant young saplings found on ecotourism trails in comfortable environments, in order to protect them from harm and destruction, since they know about its importance for the local population. This view was also shared by farmers who protect naturally grown *P. Africana* trees on their farmland by taking care of their surroundings or replanting them if not situated in a secure area. Some farmers expressed that due to climate change effects, they have adopted new planting techniques. Formerly, they would space the trees about five metres apart, but currently this is more like ten metres or more, depending on the space availability, to improve growth conditions. Local farmers plant *P. africana* mainly for economic reasons, but also to protect the soil and shade crops and dwellings from too much sunlight. Furthermore, in order to increase its availability and profitability, some farmers have created individual nurseries. A couple in Bova village, for instance, had about 4000 *P. africana* plantlets in their nursery and had 300 planted on their farmland. The plantlets are sold to farmers and the revenue is used for their children's education. Other farmers in Bova and Bowaongo had planted between 55 and 200 trees, with many practicing agroforestry by planting *P. africana* alongside food crops, on the same piece of land and as a boundary fence.

Changes in the Debarking Period

Local farmers formerly followed a rotatory system, according to which *P. africana* was harvested every five years. However, they realised more recently that the bark was not recovering quickly, due to increasing temperatures and reduced rainfall. The harvesting period since has been extended by MINFOF from five to eight years, to provide the tree bark ample time to recover. The farmers alluded that despite these changes in the harvesting period, *P. africana* still struggles to recover sufficiently. Thus, longer dry periods may have drastic consequences and lead to extending the harvesting period to about ten years. Although the bark recovering has indeed been decelerated, some farmers assess individually if the plant has fully recovered from previous debarking. Some elderly farmers said they collect a very small portion of the tree bark, weigh it with their hands and use their eyes to judge whether any further debarking will harm the tree or not.

Fight Against Pests and Diseases

The well-being of *P. africana* is determined by care given to the surroundings in which it is located. To reduce borer disease propagation and impacts, local farmers use wood ash against infections by scattering it at the bottom of *P. africana* trees found around their homes and farmlands. During the transect walk, some farmers stated that this method is not very efficient, but it does diminish the degree of infection. In addition, farmers take care of young trees by cleaning their surroundings. Also, household waste used as manure is either spread around the plant or put in the soil before tree-planting. This organic manure is made up of plantains and cocoyam

pilings, and the respondents perceived that it enriches the soil and protects it from infectious diseases harmful to plants. These practices support growth and vitality of *P. africana* trees, albeit with limited effectiveness.

Stakeholder and Group Initiatives

In the study villages, some groups carry out alternative activities to build socio-economic resilience against the impacts of climate change. The Ifose women's group in Bokwaongo, for example, promotes tree planting activities; varieties planted include *Cedrela odorata*, *Voacanga africana* and *P. africana.* Tree planting was introduced by the government and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) to reduce dependence on the natural forest. An elderly woman from the women's group stated:

> Planting *P. africana* reduces how often and how far we have to go to the forest in search of fuel wood, thus fighting against deforestation and temperature increase. Wotango gives fresh air to the village.

This quote indicates that tree planting is also considered a measure to mitigate increasing temperatures. Furthermore, the Ifose women's group is also involved in collective beekeeping, introduced by the Forestry, Agriculture, Animal and Fishery Network. In Mapanja village, the Hands on the Ground Women promote cassava and maize farming, introduced by GIZ. Their objective is to reduce food shortages, increase income and alleviate poverty, as well as to reduce forest dependence. Governmental institutions and GIZ provide training and awareness courses on regeneration techniques for *P. africana* and have also introduced alternative income generating activities, such as the ex-situ conservation of non-timber forest products, environmentally friendly ecotourism and training on improved varieties of yams and plantains.

Discussion

Prunus africana provides ecological, material and non-material benefits to local populations and governments in Tropical Africa. It's population and occurence over the past few years, however, have come under threat from human pressure and environmental changes (Giliba and Yengo 2020; Ntoko 2020; Galabuzi et al. 2021). Increasing temperatures and reduced rainfall influence *P. africana* and the livelihoods of Indigenous communities in the Mount Cameroon region alike. Susceptibility, especially at lower sections of the forest, is associated with and heightened by climatic and non-climatic factors such as seasonal alterations, warmer temperatures, unsustainable harvesting, deforestation and soil degradation, all of which reduce resilience and adaptive fitness of the trees. This study confirms other research, that the propagation of infectious diseases and pests consequently affects the growth, development and area distribution of *P. africana*. The presence of borer insects on trees weakens their resilience, increases the death rate and, ultimately, threatens extinction (Eben Ebai 2015). Moreover, warmer temperatures provide a favourable breeding ground

for infectious diseases and pests and induce changes in the flowering period of *P. africana*. In Cameroon, no monetary appraisals of the impacts of climate change on *P. africana* in relation to national and local economies exist. This lacuna in research onto this important area reveals that conservation policies on flagship medicinal plant species are not built on solid data (Awono et al. 2016). Indigenous agency is therefore important, since Indigenous people are able to diagnose the effects of climate change on *P. africana* on the basis of their knowledge, experience and daily interactions and observations.

The vulnerability of forest-dependent populations is reliant on the availability of and their capacity to use pharmaceutical plants such as *P. africana* which form an important part of the traditional healthcare regime. The inability to find quality *P. africana* bark suitable for traditional treatments affects the well-being of Indigenous communities, since very few people can afford the high costs associated with modern treatments. Therefore, changes in access, availability and utilisation damage the function of medicinal plants as safety nets, while reduced quantities of *P. africana* bark for commercialisation influence and threaten local livelihoods. In the MCNP region, farmers adopt different coping practices and agency in order to ameliorate their livelihoods and to protect the environment. All farmers in the study area complained of both environmental influences and a feeling of helplessness, since no effective measures or solutions exist. Adaptation strategies are influenced by water scarcity, the reduced availability of natural resources, distances to foraging sites, increased diseases and pests and costs of living. To mitigate the impacts of climate change, farmers practice agroforestry, introduce new varieties, use wood ash to combat vector disease infection, plant and protect trees and create tree nurseries. These practices sustain soil fertility, enhance crop productivity, increase revenue and reduce the dependence on the natural forest (cf. Ndoh et al. 2016). *P. africana* is planted alongside food crops, either as a boundary tree or to create shade. These diverse practices and activities employed by farmers enable them to diversify their survival strategies in a dynamic environment.

Social capital is vital for the livelihoods of forest-dependent communities. Women's groups play an important role in promoting adaptation, and they act as agents of change and players in multifaceted systems (Tschakert and Machado 2012). Groups in the study area mobilise their capabilities to boost resilience through collective activities such as cassava farming and beekeeping, both of which have been introduced by park management and NGOs. These activities reduce the burden of coping with poor farm yields as well as vulnerability to the effects of climate change and enhance environmental protection. The Programme for the Sustainable Management of Natural Resources (Eben Ebai 2015) corroborates that women's groups income-generating activities are vital social as sets and a form of economic empowerment vital to community resilience to climate change. Governments and NGOs augment the realisation of climate adaptation strategies among forest-dependent communities by promoting capacity-building, supporting apiculture and encouraging tree planting in the villages. The support provided by external institutions—usually in the form of training, awareness raising and participatory forest management—could sustain new threats modelled by climate change, if local knowledge and grassroots communal capabilities are also developed.

Conclusion

This study has explored the susceptibility of *Prunus africana* to climate change and various adaptation strategies by Indigenous communities in the Mount Cameroon region. The study reveals that *P. africana* is sensitive to unstable and extreme weather conditions. Warmer temperatures and changes in vegetation cover have affected its growth and health, confused flowering and harvesting periods, influenced area distribution and increased pest infection. Consequently, farmers' livelihoods have been rendered vulnerable since quantities available for traditional medicine and commercialisation have reduced. Moreover, farmers are desperately in need of solutions to eradicate—or at least mitigate—disease infection, since traditional methods such as the use of wood ash and organic manure are perceived as relatively ineffective. Furthermore, the effects of climate change on *P. africana* are manifold, and farmers are certainly not indifferent to these challenges, as they carry out individual and group actions to reduce vulnerability. In addition, they are frustrated by the fact that adaptation strategies do not help in fighting pest and disease propagation. Women's groups are a vital form of social capital to enhance resilience to climate change and promote adaptation actions. External institutions are instrumental in promoting climate change adaptation actions in local communities through capacity-building and the ex-situ conservation of forest products. This study points to the need for more research on the socio-economic effects of climate change on *P. africana* and suitable adaptation strategies to enhance its resilience against insects and diseases and to increase productivity. Thus, it is vital to consider Indigenous knowledge on climate change, since Indigenous communities recognise intersectionality between climate change, traditional healthcare and medicinal plants.

Appendix

See Tables 1 and 2.

Table 1 Functions and fields of application for *Prunus africana*

Theme	Functions and fields of application	Source of information
Pharmaceutical	Genito-urinary complaints, benign prostatic hypertrophy, malaria, hypertension, typhoid, stomach ache, fever, chest pain, gastrointestinal conditions, diabetes, obesity, infertility and kidney diseases	Cunningham et al. (2016), Njoh and Wanie (2018), Komakech and Kang (2019), Dzokou et al. (2020), Rubegeta et al. (2023)
Ecological	Diet (fruits) of birds, mammals (red and white colobus monkeys (*Colobus guereza*)) and rodents; pollen and nectar for bees	Fossey (1983), Chapman and Chapman (1999), Maisels and Forboseh (1999), Chapman et al. (2003), Fashing (2004)
Household use	Axe handles, poles, carving, fuelwood, infrastructure, charcoal, shade, windbreaks, ornamental tree, timber	Ingram et al. (2015), Cunningham et al. (2016), Dzokou et al. (2020), Giliba and Yengoh (2020)
Agroforestry	Erosion control, organic manure	Giliba and Yengoh (2020)

Source Own compilation

Table 2 Change factors and consequences for *Prunus africana*

Change factors	Consequences for *Prunus africana*
Bark regrowth	In dry areas and with warmer temperatures, *P. africana* bark hardly recovers. Bark recovery is retarded and large-scale debarking destroys the plant (Eben Ebai 2015; Ntoko 2020). Debarked trees suffer changes in tree crown size, linked to off-shoot and branch die-off due to disease and environmental disruption (Foaham et al. 2009; Eben Ebai 2015)
Pests and disease infection	In Cameroon, *P. africana* is threatened by sap-sucking pests such as *Cacopsylla* sp. and stem borers. Pests and disease collectively trigger the malformation of new leaves and buds, and the entire plant loses all its leaves (Eben Ebai 2015; Dzokou et al. 2020)
Heavy rainfall and warmer temperatures	*P. africana* is dominant in mountain regions with enough moisture supply for evaporation, but it is scarce in areas encountering reduced rainfall and prolonged dry periods (Mbatudde et al. 2012). It suffers from water stress due to reduced rainfall, 50% bark loss and root debarking (Ingram et al. 2015; Cunningham et al. 2016). Dzokou et al. (2020) establish a correlation between climate factors and pest variations; they document reduced larvae populations on *P. africana* due to heavy precipitation (occurred in September 2006 and 2007). Also, larvae at all development stages are washed away by heavy rains. The abundance of adult *Cacopsylla* sp. on the plant is due to reduced rainfall

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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