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Baobabs as symbols of resilience

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ARISING FROM A. Patrut *Nature Plants* https://doi.org/10.1038/s41477-018-0170-5 (2018)

In 2018, Patrut et al. published a paper in *Nature Plants* entitled 'The demise of the largest and oldest African baobabs' and reported that ten of the 15 trees they examined had recently died or collapsed[1]. The authors characterized this mortality as 'most unexpected', although they did not provide demographic data of entire baobab populations to illustrate what might be expected. In addition, in the penultimate sentence they proposed that 'the demise of monumental baobabs may be associated at least in part with significant modifications of climate conditions that affect southern Africa in particular', despite not mentioning climate effects previously. Although the authors then clearly stated that 'further research is necessary to support or refute this supposition', the suggestion that recent failure of some of the largest, most ancient baobabs may have been due to climate change caught the media's attention and went viral. A fleeting speculation became exaggerated and cast as an enduring fact: climate change is killing Africa's baobabs. In contrast, we provide evidence that most baobab (*Adansonia digitata*) populations found on mainland Africa are healthy, and the cohort of the oldest and largest African baobabs is enduring. We discuss the longevity of baobabs and speculate on what may have caused the collapse and death of some of these giants. We also give a brief overview of other threats and provide a summary.

Climate fluctuations are not new for millennial trees

Baobabs reach extraordinarily old ages. Radio-carbon dating has identified many baobabs well over 1,000 years old, with the oldest reaching 2,500 years of age[1]. During these life spans, elder baobabs have survived erratic climate conditions, including decadal and centennial droughts and floods. For example, the carbon isotope composition of the pith of nine baobabs revealed extensive rainfall variation during the past 1,000 years, with numerous droughts including the most severe in AD 1840, which was one of the driest periods in the 1,000 years preceding 2014[2]. Severe growing conditions are clearly not new to baobabs.

Threats to baobabs

Only five of the 15 trees featured in Patrut et al.'s paper[1] have died; the remainder have been regrowing from the remaining live portions of the fallen stems and branches (Table 1). An additional 13 venerable trees were assessed and found to be in good health without any signs of decay, such as crown loss or stem decay (Table 1).

Trees that grow too big typically struggle with hydraulic failure, leading to crown dieback and death. The most likely explanation for the collapse and death of these venerable trees is that they exceeded the structural strength of their low-density wood and collapsed. Baobab populations generally have fewer large trees than medium-sized trees[3]. Given this pattern, the relatively high frequency of collapse and death observed by Patrut et al.[1] for the largest baobabs is unsurprising.

Too much water appears to be a greater threat than too little. Of the venerable trees considered by Patrut et al.[1], only one died during a drought period; the others died or collapsed during years with expected levels of rainfall (Fig. 1b) and two collapsed from too much water due to artificial watering (Fig. 1a and Table 1). Baobabs are vulnerable to excess water during the dry season (winter) when they are leafless, as leaf transpiration is needed to pump water from the roots[4]. Without leaves, baobabs cannot get rid of excess water, resulting in widespread root and stem rot and possibly collapse or death. This problem may explain why baobabs in high rainfall areas live shorter lives than those in dryer areas[5].

Apart from this, baobabs face several threats, the most devastating of which is herbivory. Studies across Africa have shown that browsing by domestic animals and wildlife kills many young baobabs[6]. Venter and Witkowski[7] reported 90% mortality of one- to three-year-old baobabs in communal grazing land. Poor rainfall, habitat destruction, grazing and trampling by large herbivores and soil erosion are severe bottlenecks to baobab recruitment across many parts of Africa[6,7]. Adult baobabs are relatively immune to browsing; however, they are vulnerable to bark stripping by elephants. Our 2023 assessment found numerous large trees with severe elephant damage (Table 1). These animals were responsible for the near extirpation of baobabs in Tsavo East National Park (Kenya) during the 1970s[8]. Elephants also imposed 8% annual mortality on baobabs in Mapungubwe National Park (South Africa) between 2009 and 2019[9]. This rapid loss of adult trees is especially alarming as baobabs rely on a storage effect for episodic recruitment[7]. Without adult trees, these areas will not be repopulated easily.

Most of Africa's adult baobab populations are flourishing

More generally, adult baobab populations are healthy and stable, with low levels of mortality except for those in areas with abundant elephant

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Table 1 | Current (2023) state of venerable baobab trees in southern Africa

Baobab tree	Location	Date of collapse or death	Climate conditions preceding and during collapse or death	Girth (m)	Height (m)	Calculated age in years[a]	Current (2023) condition
Panke tree[b]	Matabeleland, Zimbabwe	2010	2008/2009 was a very good season across most of Zimbabwe; no drought was recorded for the area near the Panke tree, nor in the preceding 3 years	25.5	15.5	2,500	Dead
Dorslandboom[b]	Nyae Nyae Conservancy, Namibia	2006	Drought not known preceding this period, with 2004 and 2006 being wet years in the area	30	14.3	2,100	Collapsed stem regrowing; tree leafing and flowering
Glencoe tree[b]	Hoedspruit, South Africa	2009	Surrounded by an irrigated field, with period not known to have been preceded by drought	30	16	2,000	Collapsed stem regrowing; tree leafing and flowering
Holboom[b]	Nyae Nyae Conservancy, Namibia	2012	Drought not known preceding this period, with 2009–2012 being wetter years in the area	35.1	30.2	1,800	Dead
Mukuri Leboom[b]	Nyae Nyae Conservancy, Namibia	2005	Drought not known in the preceding 3 years, with 2004 a wet year in the area	34.2	14.5	1,800	Collapsed stem regrowing; tree leafing and flowering; severe elephant damage starting in 2023
Grootboom[b]	Nyae Nyae Conservancy, Namibia	2004	Drought not known in the preceding 3 years, with 2004 a wet year in the area	30.6	32	1,600	Dead
Lundu tree[b]	South Luangwa, Zambia	2014	Drought not known preceding this period, with average rainfall in the preceeding years	26.01	24.6	1,250	Not assessed in 2023; collapsed stem regrowing in 2018*
Chapman's baobab[b]	Central, Botswana	2016	2014/2015/2016 drought, with very high temperatures and very late rains in the 2015/2016 rainy season	25.9	22.6	1,400	Dead
Platland tree (CT)[b]	Modjadjiskloof, South Africa	2016	Surrounded by a watered lawn	34.11	18.9	1,100	Collapsed stem regrowing; tree leafing and flowering
Makulu Makete[b]	Alldays, South Africa	2008	No drought recorded in the preceding years and no drought recorded in the year of collapse	22.25	23	1,250	Dead
Sagole tree (CT)	Tshipise, South Africa			34.35	20.3	850	Leafing and flowering; no branch or stem dieback
King of Ga-Ratjeke (CT)	Ga-Ratjeke, South Africa			25	23	Unknown	Leafing and flowering; no branch or stem dieback
Swartwater Giant (CT)	Swartwater, South Africa			24.2	22	Unknown	Leafing and flowering; no branch or stem dieback
Honnet Giant (CT)	Honnet Nature Reserve, South Africa			22.14	15	Unknown	Leafing and flowering; no branch or stem dieback
Luna tree	Venetia Mine, South Africa			26.01	24.6	1,250	Leafing and flowering; no branch or stem dieback
Leydsdorp tree	Gravelotte, South Africa			19.67	26	990	Leafing and flowering; no branch or stem dieback; termites around base of tree

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Table 1 (continued) | Current (2023) state of venerable baobab trees in southern Africa

Baobab tree	Location	Date of collapse or death	Climate conditions preceding and during collapse or death	Girth (m)	Height (m)	Calculated age in years[a]	Current (2023) condition
Kremetart tree	Alldays, South Africa			21.1	15.6	Unknown	Leafing and flowering; some branch dieback
Holboom Campsite tree	Nyae Nyae Conservancy, Namibia			15.4	15	Unknown	Leafing and flowering; no branch or stem dieback; attempt to protect from elephants
Makuri Campsite tree	Nyae Nyae Conservancy, Namibia			23.05	14.8	Unknown	Leafing and flowering; no branch or stem dieback
Green's baobab	Central, Botswana			16.06	9.9	Unknown	Leafing and flowering; no branch or stem dieback; elephant damage started in 2023
Honeymoon tree	Mapungubwe National Park, South Africa			17	10	Unknown	Leafing and flowering; severe elephant damage
Sentinel Giant	Sentinel Ranch, Zimbabwe			21	10	Unknown	Leafing and flowering; severe elephant damage
Tshanda Tsha Mutu tree	Sentinel Ranch, Zimbabwe			19	14	Unknown	Leafing and flowering; severe elephant damage

[a]Calculated age in years. [b]The ten trees from the Patrut et al. study[1] that died or collapsed in the period 2005–2016. The current (2023) condition of each tree is indicated, along with the climate conditions preceding and during the collapse or death of each tree. Assessment outcomes for an additional 13 venerable baobabs are included. CT, champion trees. These are officially the largest trees of their kind in South Africa, selected because of their height, size or importance. South Africa has six designated baobabs on this list, as administered by the Department of Forestry, Fisheries and the Environment. The giant trees in this table are well known and regularly visited by tourists.

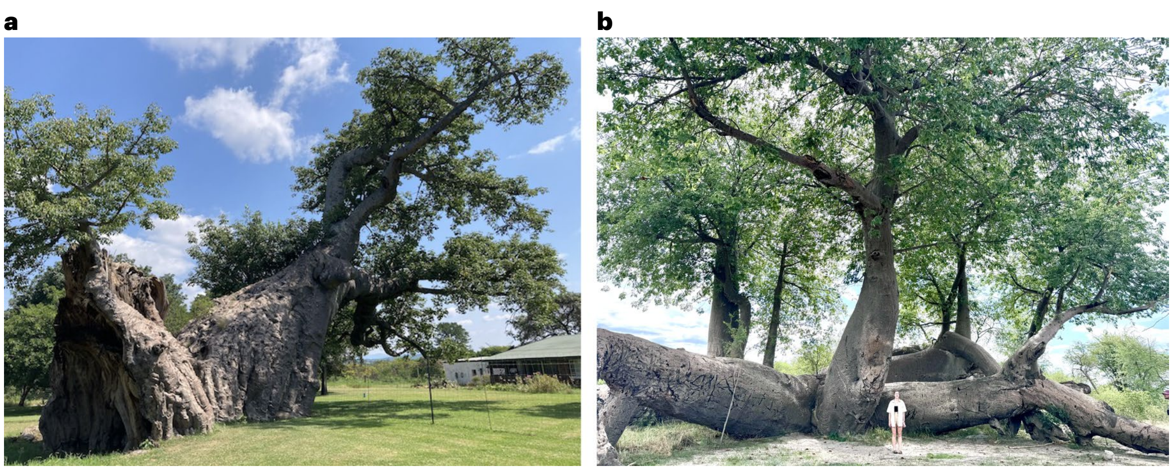

Fig. 1 | Examples of collapsed trees. Shown are images of two of the trees mentioned by Patrut et al.[1]. **a**, The Platland tree developed a fungal disease from excess watering of the surrounding lawn. Two-thirds of it collapsed (fell) and a portion of it died in 2016. **b**, Dorslandboom has collapsed (branches fallen) numerous times in the past and continues to flourish. Photos taken in April 2023 (**a**) and December 2023 (**b**).

populations[10]. It is estimated that there are up to four million baobab trees in Zimbabwe alone[11], and this only represents a fraction of Africa's population. In November 2023, we revisited 106 previously measured baobabs[3] located in South Africa and found that only one tree had died in the past 17 years. Another study in Musina Nature Reserve, South Africa tracked the growth and survival of 116 adult trees and found that in 25 years (1998–2023) no adult trees died despite recurring droughts in the area[12].

The future of baobabs

Predicting the fate of baobabs under climate change scenarios is not straightforward. Sanchez et al.[13] predicted that the distribution of baobabs across Africa would decline by between 31 and 95% when modelled for two climate change scenarios. However, Sanchez et al.[13] also detected probable increases in suitable baobab habitats in many other parts of Africa where baobabs are not currently found. Thus, as climate change shrinks the existing habitat, baobab populations may slowly colonize new areas. But, for this to happen, saplings need an environment protected from habitat destruction and high browser numbers. As Africa comes under increasing pressure from growing human populations[14], this seems unlikely without targeted interventions. Furthermore, seed production and dispersal may also be a limitation in many regions, particularly where baobab foliage is harvested for food, which limits or even prevents seed production altogether[15].

Conclusion

Contrary to reports in the popular media, adult baobabs do not appear to be dying at an accelerated rate because of climate change. In particular, the cohort of very large and old trees continues to endure as icons of resilience rather than victims of climate change. However, for these trees not to be the last survivors of the species, research on population viability based on demographic rate estimates and conservation efforts that mitigate recruitment threats is urgently required.

Data availability

Data not included in this manuscript are available via Dryad at https://doi.org/10.5061/dryad.sj3tx96bp (ref. 16).

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Author contributions

S.M.V. did field work, collected and analysed data, produced figures and tables, and wrote the paper. E.T.F.W contributed to editing and writing the paper.

Competing interests

The authors declare no competing interests.

Additional information

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