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Vulnerability of nature-based tourism to climate variability and change: Case of Kariba resort town, Zimbabwe

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ABSTRACT

Nature tourism resorts are particularly sensitive to the impact of climate change and weather extremes, such as droughts, heatwaves, wildfires, extreme frost and flooding. While studies have been conducted to assess the implications of climate change on nature resorts in the global north, there is little understanding of how climate change will affect these resorts across Africa, where tourism is a significant contributor towards livelihood security for many. This study examined the evidence for and potential impacts of climate variability and change on nature-based tourism activities in the Kariba resort in Zimbabwe. A case study approach was used, with both primary and secondary data analysed using ArcGIS 10.3. Content and thematic analysis and Mann-Kendall trend analysis were also performed. The study revealed that nature-based tourism in Kariba is under threat from increased and intense droughts, likely resulting from climate change. Extreme temperatures and droughts are critical threats to biodiversity and water levels in Lake Kariba, and they undermine both certain tourist activities and destination attractiveness. Increased incidents of drought, among other factors, have likely led to a reduced hotel occupancy over the last two decades threatening tourism business viability. The paper recommends that the tourism industry in Kariba should streamline its operations, retrofit and invest in green buildings to adapt to climate change. Further studies are suggested to quantify the economic impacts of climate variability and change on flora and fauna. The results provide tourism players and other agencies with information that can support various management decisions and represent a benchmark for future monitoring of climate change in Kariba in line with the dictates of Sustainable Development Goal (SDG) 13 on climate action.

Management implications

Climate change-related extreme weather events have implications for nature-based tourism with far-reaching implications on policy and practice. The following aspects of nature tourism are being highlighted.

- Drought has negative implications on tourist arrivals in Kariba which calls for a strategic response to minimise the impacts on business profitability.
- Tourism is a victim of extreme weather events attributed to climate change and harms tourism as a whole. This underlines the need for robust climate change action by the tourism branch with regards to both mitigation and adaptation.
- Hydroelectricity is vulnerable to droughts in Kariba which underscores the demand to invest in other alternative sources of sustainable energy such as solar and gas to ensure tourism establishment sustainability.
- Water-based tourism in the Zambezi Basin is vulnerable to climate change. This buttresses the call for climate change action under the Paris Agreement and Agenda 2030 on Sustainable Development Goals.

1. Background and introduction

It is becoming increasingly evident that climate change is one of the greatest threats facing humanity today and possibly in the long term future. The Intergovernmental Panel on Climate Change - IPCC (2013), noted that there is unequivocal evidence that nature and humanity are bearing the full brunt of severe weather events that are climate change driven. It further recommends that the world acts speedily on climate change and adopts mitigation and adaptation strategies. Humanity and

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all its activities are dependent on nature for sustenance. As such, anthropogenic climate change is already adversely affecting and will continue to adversely affect economic activities across the world. This situation is expected to worsen if humanity does not urgently act to address climate change (IPCC, 2018). Climate change, which is in many respects a consequence of environmental degradation resulting from rapid industrialisation and globalisation, is in 2019 for the third year in a row the biggest challenge to the world economy in terms of its likelihood to occur, its impact and its severity (World Economic Forum - WEF, 2019).

Environmental failure and climate change are undoubtedly the most significant challenges to nature-based, vulnerable and climate-sensitive activities like nature-based tourism (Hall, 2011). Kilungu, Leemans, Munishi, Nicholls, and Amelung (2019) argue that nature-based tourism activities are dependent on ideal climatic and environmental conditions. The assertions above confirm earlier observations by Amelung, Nicholls, and Viner (2007:285) that "tourism is a climate-dependent industry, and many destinations owe their popularity to their pleasant climates during traditional holiday seasons". Several empirical studies have been conducted across the world, especially in the global north, and have shown that tourism will suffer because of climate change although there could be few pockets of gains (Fang, Yin, & Wu, 2017; Hall et al., 2015).

The impact of climate change on tourism is disturbing, given the crucial role that tourism plays. In developing countries, tourism employs a significant number of people and contributes to economic development and foreign currency generation (Hambira & Saarinen, 2015; Dube & Nhamo, 2018). Tourism is considered one of the most sustainable ways of fostering previously disadvantaged people into the mainstream economy where such moves are aimed at reducing poverty and inequality. Developing regions like Africa battling poverty, inequality and marginalisation will therefore benefit.

Regardless of tourism's economic contributions to the African economy, there have been very few empirical studies conducted to ascertain the impact of climate variability and change on the tourism industry (Hall, 2011). Boko et al. (2007:459) highlighted that "there is a need to enhance practical research regarding the vulnerability and impacts of climate change on tourism". This call was further reiterated by Scott, Hall, and Gössling (2016) who pointed out that although the impact of climate change on tourism in Africa is expected to be severe, there has been almost no climate change impact studies in respect of tourism (see also Pandy, 2017; Pandy & Rogerson, 2018).

Mushawemhuka, Rogerson, and Saarinen (2018) and Kilungu et al. (2019) described there is a "dearth of empirical studies" on the impact of climate change on tourism on the African continent. Kilungu et al. (2019) further point out that the bulk of literature that has emerged from the African continent over the past few years has mainly consisted of literature reviews – which add little to no value in the debate.

Given the size of Africa and its tourism product, vast knowledge gaps exist in respect of many attractions across Africa. This study, therefore, is a response to the knowledge gaps that exist within the climate change tourism space. The study is aimed at investigating the vulnerability of nature-based tourism in the Kariba resort, Zimbabwe, as part of existing efforts to increase knowledge and understanding of the previous and current states of affairs about the impact of climate, variability and change on nature-based tourism.

2. Literature review

Dubois et al. (2016) noted that tourism has a complicated relationship with climate. While the climate in tourism can be an enabler of tourism activities, it can also be an inhibitor, posing a threat to the role of tourism as one of the most vibrant and promising economic sectors in the sub-Saharan Africa (SSA) region (Hambira & Saarinen, 2015). It does not require rocket science to understand why the impact of climate change on tourism has generated interest over the past few years. In the absence of climate change impact studies, tourism climate change adaptation and mitigation studies will be challenging to undertake. Interest has been ignited in and attention drawn to the dual relationship between tourism and climate change across the world, given the global, regional and local centrality of the tourism economy. Recent treaties, international protocols and agreements such as the Paris Agreement (United Nations Framework Convention on Climate – UNFCC, 2015) and the United Nations Sustainable Development Goals (United Nations – UN, 2015) have further reignited the debate on the role of tourism in climate change and the impact of climate change on nature-based tourism. Berrittella, Bigano, Roson, and Tol (2006) and Scott, Jones, and Konopek (2007), noted that climate shapes both nature and the physical resources on which tourism is dependent on and hence, any changes to climate can alter the biophysical environment and in turn reduce the perceived attractiveness of the destination and, consequently, the activities that can be undertaken there.

Kilungu et al. (2019) maintain that although increasing temperature and droughts had improved trekking on Mount Kilimanjaro, the aesthetics of the mountain were negatively affected due to a reduction in snow, waterfalls and animal population. This could lead to fewer tourists coming or could trigger last-chance tourism to this iconic destination. Precipitation and temperature changes have been blamed for the loss of biodiversity and for altering seasonality in the Serengeti National Park, something which could result in severe financial losses. Studies conducted by Hoogendoorn, Grant, and Fitchett (2016) and Fitchett, Grant, et al. (2016) and Fitchett, Hoogendoorn, et al. (2016) exposed the vulnerability of beach and coastal tourism in the Eastern Cape to climate change which threatens the palatability of some beach resorts and the economic sustainability of some tourism businesses operating in those areas.

Although the relative level of tourism-specific climate change knowledge in Africa is extremely poor, the impact of climate change on tourism is expected to be moderately strong to strongly negative (Hall, 2011). A few empirical and perception studies that have emerged in the recent past indicate that climate change will undermine tourism activities and consequently, tourism economies in SSA. Perception studies conducted on the impact of climate change on the Okavango Delta by Hambira, Saarinen, Manwa, and Atlhopheng (2013), Hambira and Saarinen (2015), and Dube, Mearns, Mini, and Chapungu (2018), show that tourism stakeholders are increasingly worried by the continued occurrence of extreme weather events. Tourists have indicated that, based on their observations, climate change is reducing the attractiveness of some of the most iconic natural tourism resorts in Africa. St Lucia Wetland Park, Victoria Falls, Serengeti National Park and Etosha National Park were some of the tourism resorts most vulnerable to climate change, and this has the potential to affect future travel (Dube et al., 2018).

In Zimbabwe, up until 2018, there were no tourism and climate change-specific studies. According to Mushawemhuka et al. (2018), "there is a dearth of empirical studies on climate change perceptions and adaptation in nature-based tourism operations across southern Africa and specifically from Zimbabwe". In 2018, however, four studies emerged with three focussed on the Victoria Falls National Park and one on the Hwange National Park. Both are located in the North West of Zimbabwe, with Hwange being in an arid region and the Victoria Falls being in a semi-arid region and spilling into Southern Zambia. Dube and Nhamo (2018) and also Dube & Nhamo, 2019a observed that extreme weather events attributed to climate change would have a mostly negative impact on nature tourism at Victoria Falls as a result of the increased frequency of both drought and extreme rainfall events and the impact of these on water flow at the waterfalls and in the surrounding national parks. It was also found that increased temperatures would hurt the aviation industry – which is central to tourist movement on the Victoria Falls tourism route – if efforts towards sustainable aviation are not fast-tracked (Dube & Nhamo, 2019b).

An empirical study conducted by Mushawemhuka et al. (2018) found that climate change has a detrimental impact on Hwange National Park, one of the largest national parks in Africa. The findings were that extreme weather events – at the hands of climate change such as increased temperature – often lead to flooding and that this disrupts tourism activity in the national park. Temperature increases also often lead to tourists experiencing discomfort and adaptation measures were thus being put in place to deal with adverse and recurring adverse weather events.

There seem to be very few studies in Zimbabwe on the potential impact of climate change on tourism, yet this is a significant contributor to Zimbabwe's flagging economy. This is a concern given projections, which point to increasingly severe weather events in the country and the region soon. Concerning the Kariba area, a few studies have been conducted focussing on climate change and its impact on the generation of hydroelectricity (Spalding-Fecher, Joyce, & Winkler, 2017; Yamba, Walimwipi, Jain, Cuamba, & Mzezewa, 2011), the vulnerability of the Zambezi Basin to climate change (Nhemachena & Beilfuss, 2017) and the impact of climate change on the fishery industry (Ndhlovu, Saito, Djalante, & Yagi, 2017). Regardless of the economic significance of the tourism industry to Kariba, on both the Zimbabwean and Zambian sides, no studies have been conducted to understand how climate change will affect tourism in the resort town of Kariba. This study is, therefore filling this gap.

3. Materials and methods

A case study was implemented, adopting a mixed-methods approach that made use of both primary and secondary data. The use of a case study offered the researchers the ability to conduct in-depth and focused research into the study area. Since climate occurs in space and time, with each place having unique climatic parameters that are different from those of other places, it was assumed that a case study approach would represent the most suitable approach. This has also been the approach taken by most other tourism and climate change studies in responding to their research questions (Kilungu et al., 2019). Some tourism studies recommend the use of the Tourism Climate Index (TCI) model, first developed by Mieczkowski (1985). The model was, however, found to be of little value to the African context, given the challenges required to populate the data which is not available at many weather stations across Africa (Fitchett, Grant, et al., 2016).

Weather data from Kariba Airport opened in 1958 was obtained from the Zimbabwe Meteorological Services for the period 1963 to 2017 was analysed to track evidence of extreme weather events. This is the oldest weather station in the area, with a much longer climate record compared to other local stations. Due to aviation demands, the records are deemed to be some of the most accurate in the basin. The water inflow and levels at Lake Kariba were also analysed regularly from the period of the dam's construction in 1961 up to 2019. Hydrological data was further obtained from the Zambezi River Authority (ZRA). The aim behind analysing this data was to understand how hydrometeorological activities could have affected tourism and tourism activities in the town and other tourism facilities surrounding the lake.

In addition, remotely sensed images were obtained from the Landsat 8 Operational Land Imagers (OLI) Jason-1 and Jason-2. They were processed and analysed using ArcGIS 10.3 in order to determine how various climatic activities could have affected water levels. Archival reports from Zimbabwe National Statistical Agency and Zimbabwe Tourism Authority (2000–2018) were also scrutinised to triangulate and cross-reference with other data sources.

In order to further understand the impact of various climatic events on tourism in the resort area, 50 guided interviews were conducted. The purposive sampling technique was utilised to identify critical stakeholders who have resided and worked in the town for more extended periods – that is, ten years or more. The guided interviews sought to understand climatic changes including hydrologic changes in the resort town and how these had affected tourists' volumes (arrivals), tourist activities, business traffic in the town and general tourism products in the resort area over the years. The interviews also sought to establish the trends concerning these changes (Table 1).

The fieldwork was conducted during the first half of 2018. Climate and hydraulic data were analysed using Atlas.ti and the non-parametric Mann-Kendall trend analysis, the latter being run on XLSTAT, 2018. A significance level of 5% was used, and continuity correction was done for the meteorological data. The Mann-Kendal trend analysis is a commonly used tool in climate and hydrological trend analysis the world over and offered the researchers an opportunity to analyse trends over selected periods and the ability to detect the significance of the change in each case (Basarir et al., 2017, pp. 3–12; Lettenmaier, Wood, & Wallis, 1994). Qualitative data were transcribed adequately from field notes that were obtained during fieldwork into an electronic document where the thematic and content analysis was conducted using the research question as the guiding principle.

Fieldwork revealed that Kariba town is a settlement that developed in the 1950s during the construction phase of the dam wall for the world's largest human-made inland lake. The lake is 223 km long and 40 km wide. Tourist activities in and around Kariba include boat racing, fishing, canoeing, hunting, wild safari and tiger fishing. The fieldwork revealed that significant drawcards of the resort town include the annual tiger fishing tournament and the opening of the floodgates which occurs in years of very high rainfall. Kariba town, which has been declared a recreational park, is home to around 26,541 people (Zimbabwe National Statistical Zimbabwe National Statstical Agency, 2012), most of whom work in tourism establishments and the Kariba hydropower station. Tourism and fishing are the mainstays of the town as the town is surrounded by national parks and game reserves with no farming activities in the area.

Some of the national parks and game reserves in the area include

Table 1
Tourism stakeholders in Kariba.

Group	Population	Data sought
Staff from the energy sector	3	Climate trends and impact on operations and educational tourists to the facilities
Traditional leaders	2	Impact and trend perceptions and observations of extreme weather events
Tourism role players (including DMOs, travel agencies, immigration officers, and NGOs amongst others	7	Impact of extreme weather events on tourism operations, visiting trends and activities
Policymakers	3	Treatment of extreme weather events, observations and policy-related issues
Zambezi River Authority	2	Observations of water level trends during various extreme weather events
Meteorologists	2	Weather-related trends observations and their impact on tourism operations such as aviation.
Local government representatives	3	Observations and trends of extreme weather events and tourism operations impact
Representatives of tourism businesses	15	Observations, impact, perceptions and business experience during extreme weather events
Local political leadership	5	Observations and impact of extreme weather events on tourism trends in the area
Members of civil society	5	Observations and impact of extreme weather events
Zimbabwe National Parks officials	3	Observations, experiences and impact of extreme weather events on national parks and other areas controlled by the national parks.

Charara Safari area, Matusadonha National Park, Hurungwe Safari area, Chete Safari area and Mana Pools National Parks (see Fig. 1). In 2018, Matusadonha received 2705 domestic tourists and 2618 international tourists, respectively. This is almost a third of the numbers received at the dawn of the year 2000. On the other hand, Mana Pools witnessed 2849 domestic tourist and 3041 international tourists, respectively. This figure is less by about a third compared to the year 2000. Kariba recreation area reported that in 2019 about 27,890 domestic tourists visited the area against 2527 international tourists. Quantifying the number of tourists who visit Kariba is complicated given that its always packaged as part of the Victoria Falls tourism package. Kariba lies between Zambia and in Zimbabwe's upper north in the country's climatic region 5. This region is the driest and hot, particularly during the day. The area is vulnerable to various climatic changes which include rainfall fluctuations as already highlighted in several studies amongst them, Dube and Nhamo (2018a&b).

There were, however, some data limitations. Only data for maximum temperature was used as a proxy for the area. Although it is standard practice in climate change studies to use maximum temperature as a proxy, this leaves out the picture that is presented by minimum temperature which could be different from the one presented by maximum temperature. Only maximum temperature data up to 2014 were obtained from the meteorological station with data between 2014 and 2017 being unavailable from the meteorological station. Given the size of the basin and the challenges of data access, only data from one station was used. Data from the station does not necessarily have a bearing on dam water levels. In this study, the data is used only as a proxy to interpolate basin climate.

The next section presents the key findings from the study. The section is organised into subsections looking at three aspects of evidence of climate change, namely temperature, precipitation and hydrological levels in the dam. A discussion on how changes to these climatic variables might affect tourism in Kariba is included.

4. Presentation of data and discussion of findings

4.1. Evidence of climate change

Almost all the tourism players in the Kariba resort town concurred that the climate pattern had changed. They cited the drastic decline in water levels in Lake Kariba, an increase in temperature and the extreme pattern in which rainfall was occurring in the area. It emerged from the interviews that most people complained about rainfall intensity and the recurrence of droughts. Such incidences were blamed for disrupting the life pattern of the resort and surrounding areas, which was blamed for tourism visit declines. The following section seeks to look at the scientific evidence of these observations and how they could affect tourism in the area and the region.

4.1.1. Temperature

According to Fitchett and Hoogendoorn (2018), tourists are sensitive to weather as this determines what they can do and also wear at destinations. As such, climate conditions can affect the tourist's enjoyment of a destination (Gössling, D, Hall, Ceron, & Dubois, 2012). The study found that the Zambezi Basin is regarded by most Zimbabweans as being uncomfortably hot and humid during the summer months, especially during daytime. An analysis of monthly maximum temperatures was conducted. It was found that, between 1963 and 2014 (51 years), the average maximum temperature in Kariba town had increased by about 2 °C. The average annual temperature in 1963 was about 30.1 °C, rising to about 32.1 °C in 2014 (see Fig. 2). The trend shows that the temperature has been increasing at an average rate of about 0.4 °C per decade over the past five decades. The evidence further shows that the resort town has already exceeded the 1.5 °C temperature rise cap that the 2015 Paris Agreement seeks to impose concerning global temperature and in order to avoid dangerous climate change-related weather extremes (Rogelj et al., 2018). In line with this narrative, 2014 marked the beginning of a three-year unbroken drought in southern Africa. During the same period, Kariba experienced the third hottest year in the past half-century and saw its monthly average rising to 32.4 °C.

The highest temperature increase for the period under study was recorded in November, which witnessed a 3.4 °C temperature increase. This was followed by June, which recorded a 2.5 °C increase over the period under study. Temperature increases have been witnessed in both the winter and the summer months over the past few years, starting in the late 1980s and with the early 1990s marking a further turning point and contributing significantly to this increase. Figs. 2 and 3 shows the temperature pattern for the resort town of Kariba and indicates a

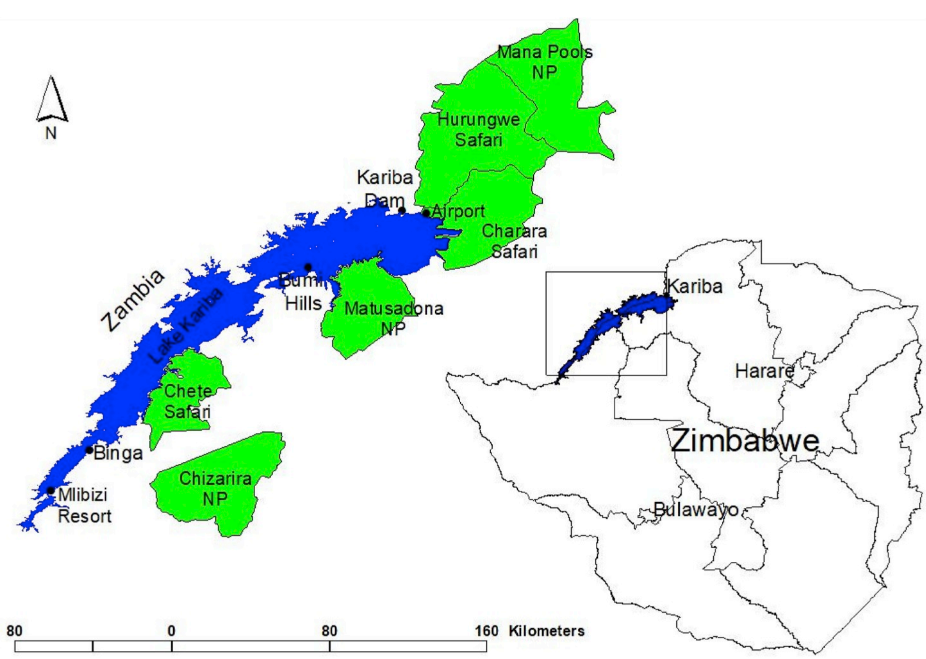

Fig. 1. Location and Some of the attractions in Kariba resort town
Source: Authors (2019).

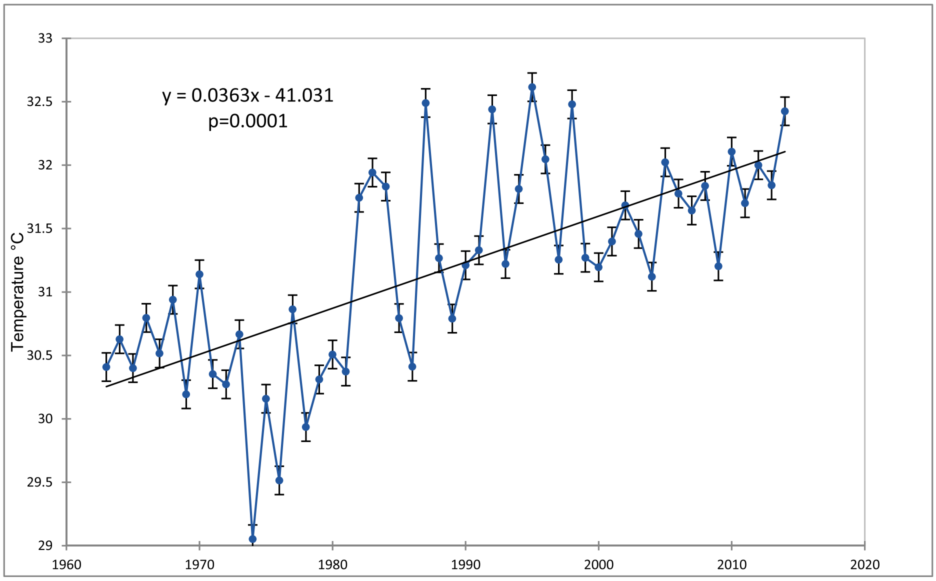

Fig. 2. Annual average maximum temperature for Kariba resort town 1963–2014.
Source: Authors (2018) – original data supplied by Zimbabwe Meteorological Services Department.

warming scenario.

Such extremes have implications for the comfort of tourists visiting the resort town, for tourism activities in the area and tourism employees in the area – more so during the summer months when temperatures soar to around 40 °C during the day. A study by Dube and Nhamo (2019c), found that such high temperatures were presenting severe challenges for both tourists and employees in the Kruger National Park. The study found that due to high temperatures, there were chances of tourists and tourism employees suffering heatstroke and other heat-related challenges. As a consequence, there is a need to reschedule some of the tourist activities, particularly those that take place during peak temperature periods of the day. Such development has potential implications on how long tourists can stay in the area to participate in all the activities. A change in the duration has implications on tourists budget intending to visit the area as well.

As a consequence of increased temperature, it emerged during the

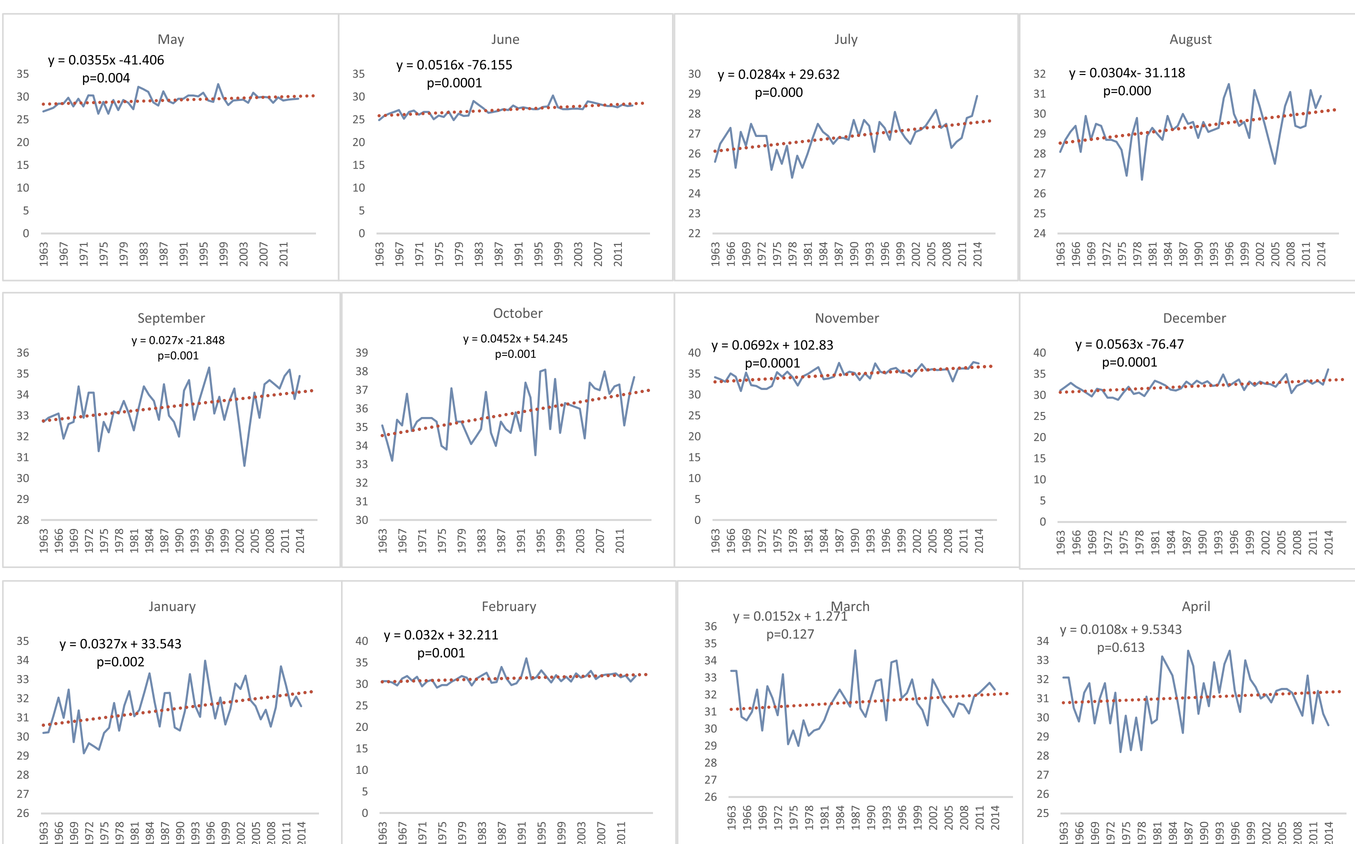

Fig. 3. Monthly maximum average temperatures for Kariba.

research that the hospitality sector is worried about the increased burden that was added as there are corresponding increases in capital projects financing for the increased demand on retrofitting buildings with air-conditioning installations. Tourism Business GQ argued that

> "… Kariba is a very hot place; however, in the past five, we have witnessed far higher temperatures, and tourists complained a lot as a result. We cannot sleep properly at night due to heat, and during the day we have to limit some outdoor activities except for water activities. As a business, we are forced to invest air conditioning equipment to ensure the comfort of our guests and employees as a result of this."

This sentiment was echoed by other tour operators in the area. Investment in air conditioners will push up capital project investment costs and will also result in increased energy demand throughout the year. Increased energy demand will increase operational budget costs as well as the carbon footprint of the tourism industry. Air conditioners have been noted as one of the critical drivers of the ever-increasing carbon footprint from the hospitality sector (Cadarso, Gómez, López, Tobarra, & Zafrilla, 2015). Given the increased demand for accountability and a need to curb anthropogenic climate change, measures should be put in place to reduce the carbon footprint of the hospitality sector. Given the current climate reality, it might be imperative for the tourism industry to adopt and invest in green building and put in place climate-resilient and smart buildings.

The high temperatures thus imply a need for the additional sustainable cooling of accommodation establishments even in the traditional winter months. However, hospitality leaders indicated that, where property owners cannot afford to install such equipment, this might have a detrimental effect on the comfort of tourists and may result in tourists not wishing to return for repeat visits. This will negatively impact the tourism value chain resulting in reduced tourist traffic to such establishments and with a ripple effect on the entire tourism value chain in the area.

Given the rich wildlife endowment of the region – especially in areas such as Matusadonha National Park, Mana Pools National Park (which is also a UNESCO World Heritage site) and other game parks and game ranches surrounding the resort town, conservationists in the areas have indicated that extreme weather events would have a severe impact in this regard. There are fears among tourism stakeholders that increased temperatures – hovering around 40 °C during summer – might result in forest collapse, a drop in the water table, and an increase in the chances for and occurrence of fires, an outcome that would result in a loss of biodiversity and, ultimately, lead to animal starvation. Such concerns and fears are well-founded as García-Valdés et al. (2018), noted that climate change presents challenges for forests. There is evidence of high forest mortality and subsequently, biodiversity. Diminishing of biodiversity has implications for ecosystem services and ecotourism as it is the main attraction in Zimbabwe and the southern Africa region at large.

The Kariba area is home to the so-called Big Five (lion, leopard, rhinoceros, elephant, and Cape buffalo). These and other animals are already under threat from the increased occurrence of drought and losses among them would undoubtedly reduce the attractiveness of the area as a tourism destination. Droughts in Zimbabwe and other weather extremes have been associated with animal mortality Hwange and Mana Pools national parks. Mana Pools is 100 km away from Kariba. Tourists are generally risk-averse at best (Walters & Mair, 2012) and destinations affected by disasters like droughts often have to embark on strategic and aggressive marketing to clear the negative picture and turn the tide of negative publicity (Ritchie, 2008).

High temperatures might cause landing and take-off challenges for certain types of aircraft. The high temperatures tend to lead near-surface density making it difficult for take-off, which might require load take off reduction (Dube & Nhamo, 2019b; Ren et al., 2019). Archival material from Kariba Airport confirmed that an Air Zimbabwe aircraft (MA 60) was forced to abort landing as temperatures surpassed 40 °C in November 2015. The aircraft aborted landing as there were fears that wheels could burst or cause engine problems upon landing. The incident was confirmed during fieldwork by one tour operator who indicated:

> "… Such incidents are problematic for everyone in the tourism industry from car rental companies, tour operators with vehicles that went to fetch tourists to accommodation establishments, people who sell curios on the streets and also those who make money from activities … we all lost because visitors did not come. We all did not make money that day."

Such extremes are problematic for the tourism industry value chain as everyone in the industry loses out on revenue through lost room occupancy and attraction utilisation. Dube and Nhamo (2019a) observed that similar increases in temperature at other airports, such as at Victoria Falls, called for a rethinking of flight schedules at such airports or runway extensions as a climate adaptation measure.

The high temperatures recorded in the summer months make Kariba resort town uncomfortable for tourism role players, especially for the tourists themselves who are not familiar with the area. The expectation is that this trend will likely pick up in the future if the current temperature trend is sustained. The increased incidence of heatwave days is likely to trigger hyperthermia and dehydration and increase the urban heat island effect locally. For instance, studies conducted in Mediterranean resort cities have found increased heat to be associated with increased stress, and increased levels of cardiovascular and respiratory diseases (Mika et al., 2018).

4.1.2. Rainfall pattern

Rainfall pattern is an essential consideration for nature-based tourism. This is particularly true for inland water-based tourist destinations where most activities are based on the availability of water. This study analysed 55 years' worth of rainfall data from the Kariba weather station acting as a proxy for the Zambezi river basin. It emerged that the first half of the period under study (1964–1990) was characterised by episodes of high rainfall and fewer episodes of droughts when compared to the later period (post-1990) as shown in Fig. 4.

We, therefore, concluded that during the period of study, there were no statistically significant changes to the annual average rainfall received in Kariba. This is not to say that there might not have been changes to the pattern of rain, such as the intensity and the manner and periodical spread of the rainfall in the area. A decline in rainfall of about 70 mm over the period under study was observed. This translates to about 13 mm of rainfall decline per decade. The results confirm earlier findings by Muchuru, Botai, Botai, Landman, and Adeola (2016) who observed a slight drop in rainfall in the Kariba catchment area between 1970 and 2010.

Although no trend has been noted on annual climate data, it was observed that 16 droughts occurred post-1990, marking an increase in drought episodes in the area. The absence of a trend on the Mann Kendal Trend test points to weather extremes marked by peaks and lows of rainfall which consequently cancels off the variations. The World Meteorological Organization (WMO, 2005, p. 7) defines drought as "the degree of dryness (in comparison to some 'normal' or average amount) and the duration of the dry period for a specific region over a while, typically 30 years". Against the annual average rainfall of 737 mm, the most severe droughts were recorded in the second half of 1995 when 273 mm of rainfall was recorded. This amount was almost three times lower than the expected rainfall. The third worst drought was recorded in 2016, which resulted in the Kariba weather station recording about 449 mm of rain. This followed years of below-average rainfall in 2014 and 2015. In some parts of the basin, this drought extended up to 2016 and 2017 and was recorded as one of the longest El Niño induced droughts to have affected the Southern Africa region (Dube & Nhamo, 2018 & 2019a).

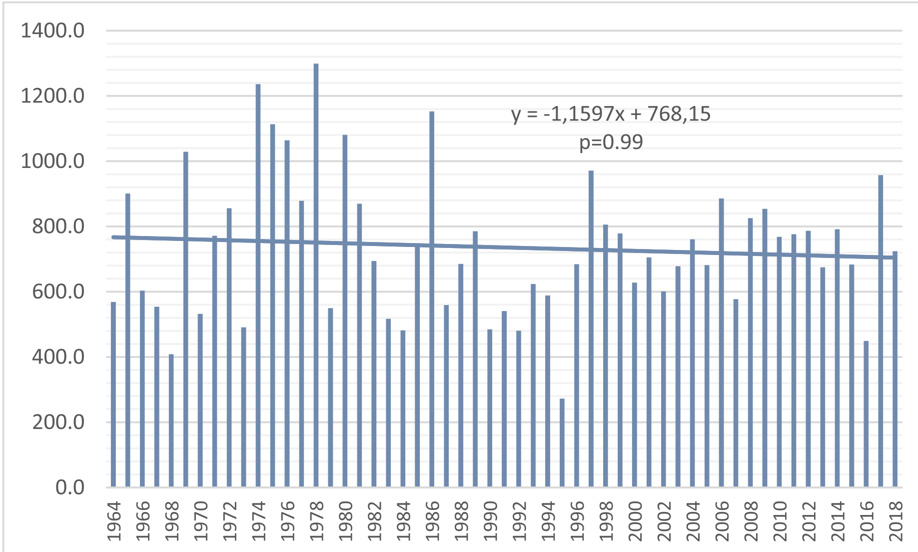

Fig. 4. Total Annual Rainfall for Kariba Station 1964–2018.
Source: Authors (data supplied by Zimbabwe Meteorological Services Department).

On a month-to-month basis, closer scrutiny of each month's p-value produced from the Mann-Kendall trend analysis shows that there were no significant changes in average monthly rainfall either, as all p-values are higher than 0.05. Annual rainfall variability is evident as shown by a substantial standard deviation of rainfall during the summer months, pointing to extremes of high and low rainfall recorded in those months, as shown in Fig. 5. The highest rainfall deviations were recorded in December, March, January and February in that order, indicating high seasonal and annual variability in rainfall patterns. The summer months in Kariba are characterised by extreme rainfall events ranging from heavy rainfall to extreme aridity in some months (Fig. 5). A deviation of close to a third of expected rainfall may have serious negative implications on vegetation and groundwater recharge and run-off, with potential consequences for water drinking points and waterholes used by wildlife in the area, some which might be water-dependent.

Nonetheless, regarding a month-on-month data analysis, the

Fig. 5. Monthly total rainfall data for Kariba Station.

research revealed that although statistically not significant, some decline in rainfall was recorded in the summer months of November, January and February. These months recorded a decline of 32 mm, 15 mm and 20 mm respectively. While this might seem insignificant, given the geographic location and high evaporation rates characteristic of climatic regions 3 and 4 of Zimbabwe, this trend is a cause for concern, given that the area is classified as semi-arid and can easily trigger desertification. Fig. 5 shows that November, January and February recorded the highest interannual rainfall variability and highest rainfall change between 1963 and 2017. There is evidence that February is experiencing increased mid-season drought episodes, which is a departure from the norm. Changes in rainfall have the potential to disturb the natural ecosystem of the area, which is also home to the Big Five with potential implications for tourism and the safari industry in the area.

4.1.3. *Vegetation loss and lake water levels*

According to Shumba, Gumindoga, Togarepi, and Edward (2018), climate change and variability within the Kariba catchment area is one of the factors responsible for vegetation loss and deterioration, as observed from remotely sensed image analysis spanning the period 1973 to 2015. The study noted a 20% vegetation loss during the period in question. The same study showed a severe shrinkage of water levels, especially in 2015, which coincided with a severe drought recorded in that year. Given that the Kariba resort town is in the middle of national parks and game reserves, this is of concern as vegetation loss is a threat to biodiversity and the entire animal food chain. Any consequent decline in animal populations might thus compromise safari operations in the area.

Conservationists and other tourism stakeholders in Kariba have complained of severe food shortages because of drought in the national parks and drought has also heightened human-wildlife conflict on both sides. One community leader noted that

> "… we have seen an increase in cases of animal attacks and movement into human settlement due to these droughts in search of food and water; animals are also becoming more daring and aggressive which puts the lives of tourists and residents at risk. The situation is better in normal years".

Moreover, the extreme fluctuations in the lake levels are a threat to wildlife, including some of the big five which have been trapped on islands and left without food. The areas known as Starvation Island and Antelope Island have been identified as problematic in this regard. Animals can cross from the mainland onto the islands if water levels are shallow, but they find themselves trapped and cut off from their food supply when water levels rise. In such instances, their food must be supplemented by water and road transport and at a high cost if they are to be saved.

The impact of droughts and reduced flooding from Lake Kariba is well documented in the Kariba area, particularly in Mana Pools. Dunham (1994:489), noted there was generally a decline in large mammal populations in drought years due to shortage of rainfall and the:

> Cessation of flooding by the Zambezi River, rather than to low local rainfall in some years. During the drought, the large grazers (e.g. buffalo) died before the smaller grazers (e.g. warthog). Waterbuck density declined less than the density of other grazers because waterbuck could cross to vegetated sandbanks in the Zambezi River.

A wave of media reports, which was confirmed by Zimbabwe National Parks noted that massive animal evacuations were underway in Mana Pools and Hwange due to the extreme drought that has affected the area with reported 50 mammals having succumbed to drought as of November 2019. Such news would likely repel some visiting tourists to the area as noted earlier.

Equally, there have been concerns that climate change and variability were starting to affect fish stocks in Lake Kariba (Ndebele-Murisa, Mashonjowa, & Hill, 2011), although this is disputed by Marshall (2017). According to Marshall (2017), the rapid warming of the lake in the 1980s might have triggered evaporative cooling at the surface. Winter warming is blamed for triggering a new cycle of stratification, which in turn disturbs the lake's ecosystem (Marshall, 2017). The warming lake can be attributed to the observed temperature increases reflected in Figs. 2 and 3, above. A decline in fish stocks, if confirmed, might dent fishing tourism which is one of the most popular tourist activities in the town. One fisherman noted the concerns of other fishers that "… we do not know what to do now we have to venture very far from the bays into the lake to get fish and even after that we often get below targets which affect our businesses negatively". This might also, in turn, affect the tourist traffic and hurt the economic prospects of the tourism sector and all its subsectors. What cannot be escaped is the fact that the changes in water quality will have implications for the lake's biodiversity.

As noted earlier, the primary tourist attraction in the resort town is Lake Kariba. The lake provides a range of tourist activities such as houseboat recreation, boat racing, and fishing, to mention but a few. Most importantly, people enjoy dam wall visits and are particularly attracted to the lake during the opening of the floodgates to watch the outpouring of water. During the opening of the floodgates, tourists visit en masse to watch the spectacle. Droughts mean less and less opening of the flood gates and a decline in tourist numbers to the area. Other attractions for tourists include a visit to the hydroelectric power station. The water level in the lake is, therefore, a critical component of the local tourist industry. A study of water levels was therefore undertaken, which revealed evidence of climate change-induced fluctuations, as shown in Fig. 6a and b.

The water levels in the lake have been fluctuating much since the construction and filling of the dam in the early 1960s. The water level in Lake Kariba seems to follow rainfall patterns, although there is a lag in the lake's response. In the 1960s and 1970s, which were characterised by more rainfall, water levels in the lake were high and remained close to the full supply level of 488.5 m, as shown in Fig. 6b. However, changes were noticed in the late 1970s when the water levels started dropping off year by year, reaching an all third-time low on 21 January 1985 when the water level reached 476.54 m–1.04 m above the minimum operating level of 475.5 m. This was after three successive droughts had been recorded between 1982 and 1984. Water levels remained in the lower half of the lake, rising significantly in 1987 before falling again, closer to their minimum operating levels, and then reaching their lowest levels on 18 December 1992. This followed one of the most extreme droughts in living memory that started in 1990 and continued through to 1992 (Fig. 4). The lowest recorded water level was 475.91 m in January 1985–0.41 m higher than the minimum operating level. The second-lowest water level was recorded in 1996 following the 1995 drought (which was the second-worst drought during the period of study). During that year, a low water level of 475.93 m was recorded – about 0.43 m above the minimum operating level for electricity generation.

The second highest water level was recorded on 30 May 2000 after heavy rains between the 1997 and 1999 seasons. On the day in question, a 487.53 m lake level was reached – less than 1 m from the dam's full capacity of 488.5 m. Maximum water levels were recorded on May 31, 2011, after the good rains that were received between 2008 and 2011 and stretching to 2012, marking four years of the highest rainfall in the area. Another spike in high water flow levels was only to be recorded in 2018 (Fig. 6a and b).

During the early days, in the 1960s, floodgates were opened more often and released much more water than in the post-1990s period – a factor which has influenced the levels of tourism traffic to the resort town. It is thus shown that lake levels influence tourism in the resort town as the lake is the main attraction. This was a concern to various stakeholders in the town who argued

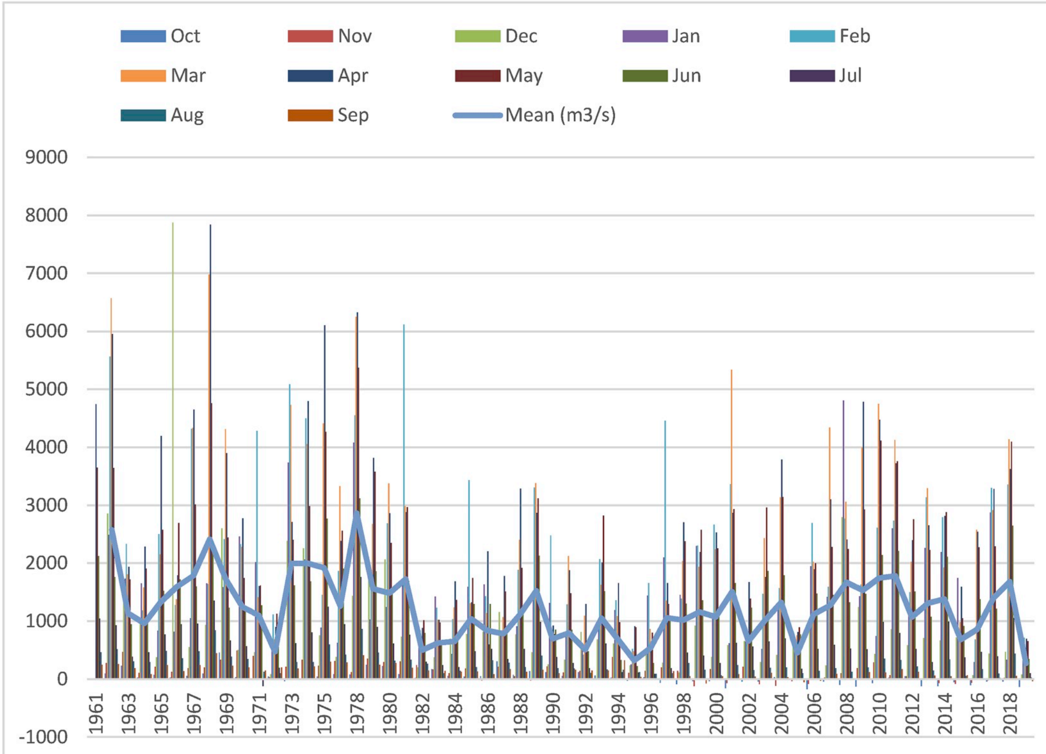

Fig. 6a. Lake Kariba Net Inflows m^3/s 1961–2019.

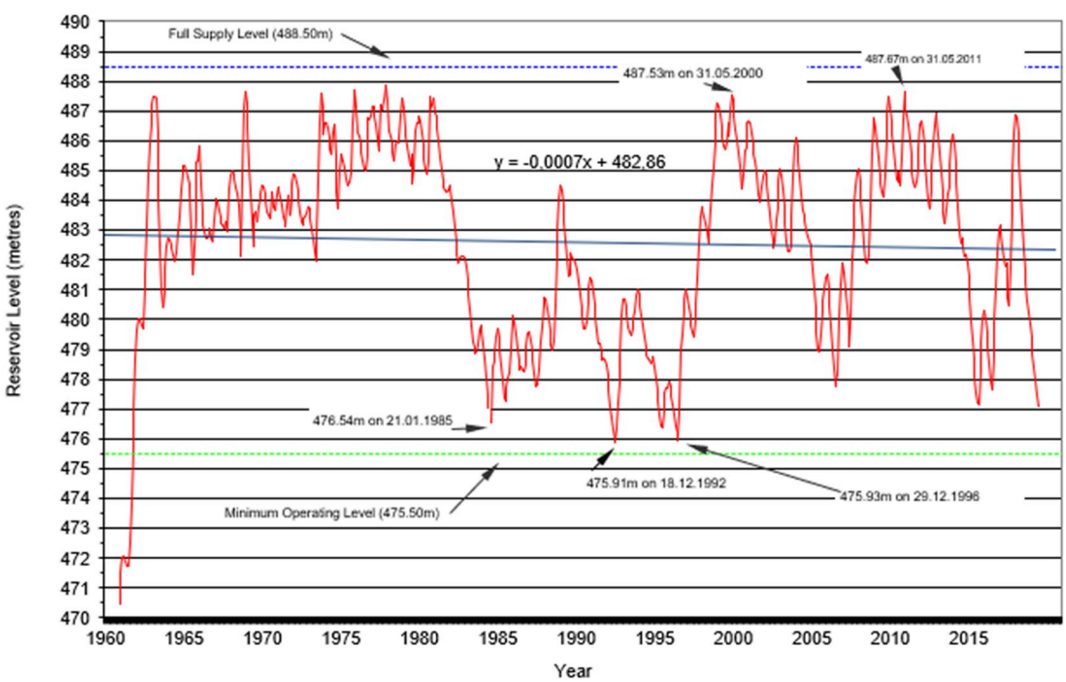

Fig. 6b. Lake Kariba water levels 1961–2019 (Impoundment started in 1958). Source Fieldwork (2019) – data supplied by Zambezi River Authority.

"we have witnessed less and less opening of the dam when the dam is full, and flood gates are opened our accommodation establishments are 100% booked but in drought years very few people come to visit, and domestic tourists are very few as people do not have money for luxury activities. We can only pray for more rains".

Recent droughts and the resulting low water levels have forced the Zambezi River Authority to allocate less water for power generation, thus forcing Kariba South and North Power Stations to operate below capacity. Table 1 shows water allocation and consumption by the Zimbabwean and Zambian electricity generation companies for the period 1963 to 2017. The data shows reduced water allocation in drought years and for a year or so post a drought event. In 2015 and 2016, this resulted in over-withdrawal of water by electricity generation companies' way beyond their allocated amounts and a period coinciding with one of the most severe droughts in recent years. This was confirmed by the Zimbabwe Power Company in an interview. Table 2 shows that the years 2015 and 2016 had the most significant withdrawals, which might be an indication of increased power demand. In what could be the worst hydrological drought in the Zambezi basin, 2019 witnessed one of the lowest water levels in the Kariba Dam and by default power generation at both Kariba North and South banks. This led to a massive reduction in power production and supply in Zimbabwe. Given the reliance of the company on hydroelectricity, this led to massive blackout going on for about 12 and in some cases 24 h.

The reduction of electricity generated in drought years further undermines economic activities in power-deficit countries, reducing the amount of disposable income which, in turn, undermines domestic tourism particularly small tourism players who do not have the capacity to invest or adopt alternative energy. Moreover, reduced energy generation affects the tourism industry negatively as load shedding takes place. In most cases, this takes place precisely when cooling technologies are needed, thus leaving tourists vulnerable to the soaring temperatures in the Kariba resort town. One hotelier noted that, "… regardless of being in Kariba where the bulk of the power is generated, we often struggle when there is no electricity, fridges, air conditioners cannot work, and at times perishable food is wasted as we go for hours and in some cases days with no electricity. Those with generators resort to generators, but fuel is expensive and at most unavailable on the local market. Running a business in such an environment is a challenge".

4.2. *Impact of climate change on water-based tourism in Kariba town*

The study found that the changes in climate in the resort town and surrounding areas have a tremendous impact on tourism performance in the area. Extreme rainfall events, such as drought and the subsequent drop in lake levels over the past years in the area, have resulted in a low inflow of tourists to the area. Interviews conducted revealed that during the recent drought years between 2013 and 2016, the drought had a significant impact on the tourism sector. One respondent noted that "Kariba was turned into a ghost town because of very little business as tourists were not coming". Most tourists who travel to Kariba are attracted to safaris, water sports, sports fishing and boat cruises. Interviews with all the major tourism stakeholders indicated that due to recent droughts, tourism activities were brought to a near halt during severe droughts, leaving tourism facilities such as hotels and food outlets struggling to survive. Petty traders and curio vendors were also adversely affected. Most businesses and community leaders reported that as a result many people were retrenched from tourism businesses because of slow business in the resort town, which, in turn, has led to depression and anxiety amongst the local population.

Table 2
Combined water usage at Kariba North and South Power Stations.

YEAR	COMBINED WATER USAGE AT KARIBA COMPLEX		
	Water allocated (MCM)	Actual water used (MCM)	% of allocation
2005	40,000.00	37,004.73	93
2006	38,000.00	39,272.22	103
2007	36,000.00	36,255.03	101
2008	48,000.00	39,555.15	82
2009	48,000.00	34,319.16	71
2010	40,000.00	35,413.29	89
2011	40,000.00	35,229.53	88
2012	42,000.00	37,571.25	89
2013	42,000.00	41,580.33	99
2014	42,000.00	46,956.84	112
2015	40,500.00	43,831.48	108
2016	20,000.00	27,780.09	139
2017	30,000.00	29,309.84	98

MCM = Million Cubic Metres.
Source: Authors

Data from Zimbabwe Tourism Authority annual reports for the period 1998 to 2018 supports the notion that tourism was being severely affected by extreme weather events, particularly droughts (Fig. 7). Post-1999, the high water levels in the dam was affected by several droughts as discussed earlier, starting in 2000. Starting with the year 2000, which was a drought year and a year that marked the beginning of the land reform programme, the occupancy rates at Kariba went down. Fig. 8 show that there was a slight upsurge in tourist accommodation uptake in years of average rains and increased or decent water levels at the lake such as between 2006 and 2008, 2012 and 2018. Years of extreme drought were punctuated by low occupancy of hotels.

The low hotel occupancy mirrors a troubled tourism market, which spells severe challenges for tour operators who are on average operating below 45%. This scenario also talks to the profitability of such enterprises. One would assume that operating at such low levels will require a small number of staff and hence any disaster that worsens the situation spells trouble for the tourism market suffering from extreme weather events and political turmoil. Increased drought incidences equally raise concerns about the impact of the same on tourist arrivals given that this is a water-based tourism resort as studies elsewhere have noted a decline in tourist arrivals at Kruger National Park according to a study by Mathivha, Tshipala, and Nkuna (2017). This study observed that evidence from Kariba Recreation Park and Matusadonha National Park all located in Kariba shows that years of drought, in general, were punctuated by low visitor numbers which in turn affects the entire tourism value chain within the town and its vicinity.

Droughts further compound the challenges for water-based activities. At its peak in 2000, Lake Kariba had about 4000 boats and about 1500 houseboats used for recreation purposes according to reports from Zimbabwe Tourism Authority. It emerged from interviews that boating companies have reported that, due to droughts and shallow water levels, some boats have been severely damaged as islands pop up from beneath the water. Such a scenario increases the running costs of business which is often passed on to the consumer. At various harbours some boating companies also pointed out that extreme droughts have rendered slipways ineffective, making it difficult for boats to dock and launch with ease. Fig. 9 shows the water level for an average year and an extreme year. The second image, taken on November 2015 at the height of an El Niño year, shows the exposed shallow banks of Lake Kariba and numerous protruding islands in the lake. Due to these low water levels, some islands – such as the Antelope Island – are joined to the mainland, which is not the case during years of average rainfall, such as in 2013. Due to shallow water levels, boating companies reported that, at the time, they had to resort to the use of tender boats to fuel their boats in order to transport passengers. This made boating expensive and laborious for many tourists leading to many of them shunning the resort and its town altogether.

5. Conclusion and recommendations

The study was aimed at examining the vulnerability of nature-based tourism to climate variability and change in Kariba. The research found that, in as much as annual precipitation has not changed over the period, there was evidence of interannual variability of monthly precipitation. The research also noted the increased frequency of drought in recent years, in line with global patterns. The increased frequency of droughts is detrimental to the wildlife habitat and is also a threat to flora and fauna, thus threatening the biodiversity-rich area. There are concerns that this will affect the animal distribution and density in the area, which might lead to the area losing its attractiveness to tourists, with a consequent ripple effect on the tourism market.

Concerning temperature, there has been a significant increase in average temperatures, with some months reaching exceptionally high levels. A combination of droughts and increased temperature is challenging to flora and fauna due to increased incidence of fire in what is already a fire-prone area. Increased temperatures can also trigger high

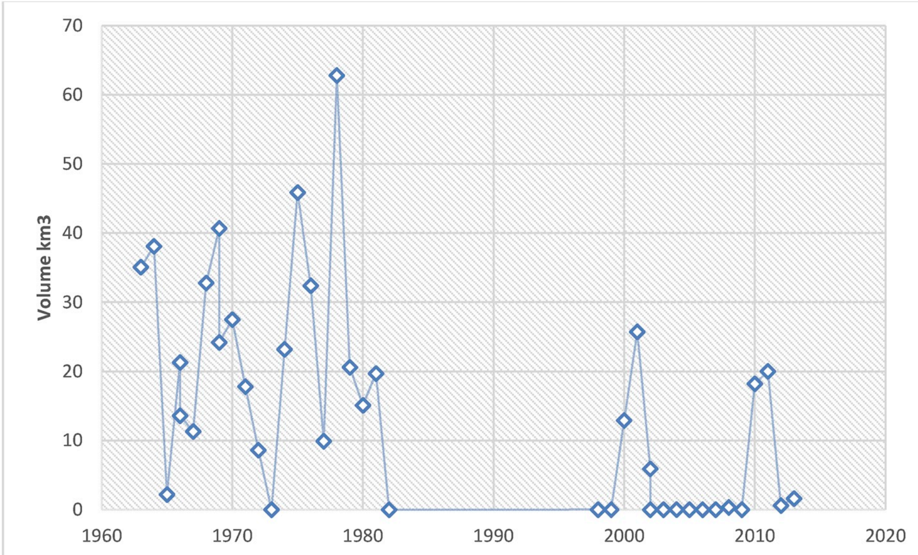

Fig. 7. Kariba complex spillage 1963-2017.
Source Authors.

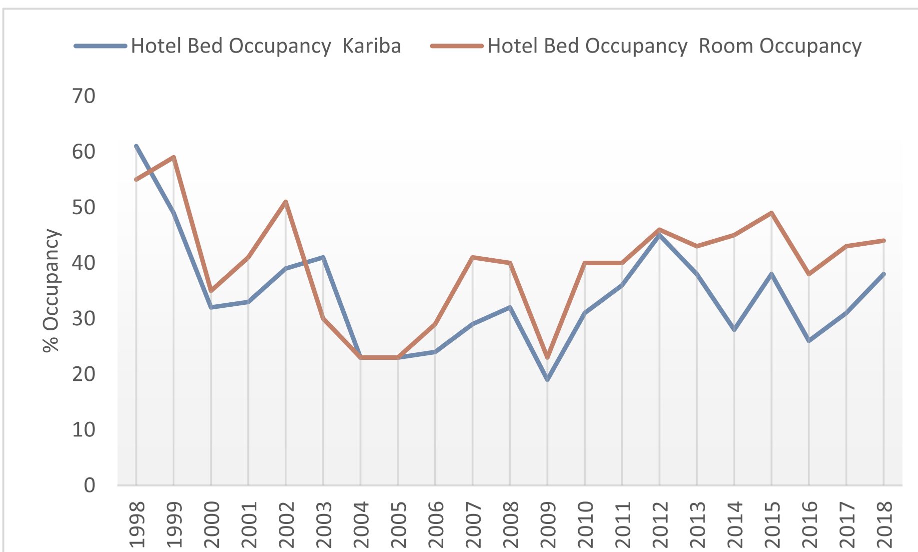

Fig. 8. Hotel Occupancy Rate for selected periods In Kariba Resort town.
Source: Authors.

evapotranspiration rates which could result in yet further reduced water levels in Lake Kariba and in the drying-up of waterholes used by animals, thus endangering the biodiversity of the area. Increased temperatures have also been blamed for the increased demand for cooling in the area, and this has increased tourism company utility bills as well as tourists' discomfort in the area. Extreme temperatures, especially during certain months, have been found to cause challenges for aviation in the area, threatening to disrupt tourist movements both into and out of the area. In that regard, the study recommends forage harvesting where possible to ensure food supply in areas of drought to assist the animals. With regards to aviation, there is a need to develop landing and take-off schedules that takes into consideration current temperature realities to avoid costly diversions where possible. The increased temperature was noted to cause challenges for tourists and tourism employees in the resort town during summer month when temperatures reach on some days, way above the 40 °C mark. Investment into the green building for hotels and lodges can be a critical tool used in climate change mitigation and adaptation in the area. Affording and offering incentives for green building through a government facility or other such support will go a long way in assisting the tourism sector to remain viable in the light of the climate challenges.

Further evidence of climate variability and change was observed in dam levels which during the period under study reached some of their lowest levels in recorded history due both directly and indirectly to climate change. Due to these variations and particularly to the overall drop in dam water levels recreation activities at the dam have been compromised throughout the years of drought. The opening of the floodgates, a considerable attraction to tourists, has become less and less frequent, and this has affected the business cycle in the area negatively. Years of drought have coincided with some of the lowest levels of hotel occupancy in the area wherein which the impact of droughts as a natural disaster on tourism in the area cannot be disputed resulting in staff layoffs. Destination marketing organisations need to be proactive during and post-drought to highlight some of the most viable activities in low

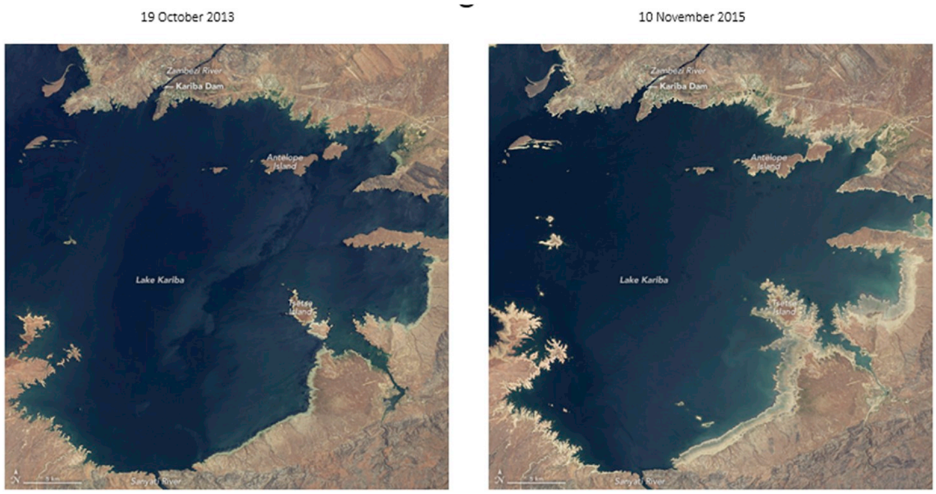

Fig. 9. A comparison of water levels in Lake Kariba between a typical year (2013) and an El Niño year (2015).
Source: NASA (2016).

water season so as to ensure continued tourist arrivals in the resort area.

The study highlights the urgent need by the tourism sector to align operations to Sustainable Development Goal 13 on climate action to ensure sustainability. Given the significance of the tourism industry to national economies, there is need to assist developing countries to build climate resilience to buffer the sector from increased incidences of extreme weather events which are becoming intense and severe. There are also other threats to Lake Kariba which need to be taken into consideration, such as the Batoka dam project which might have severe implications for the ecosystem and tourist activities at Lake Kariba. Options for Kariba include economic diversification into activities that can act as a buffer to climate change such as increased investment into aqua farming and a fish processing industry to create and add value. Investment into solar energy projects and opening of training institutions focussing on green energy production can offer excellent rewards for the resort town.

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