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effects of climate change on *lycaon pictus*

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DECLARATION

The undersigned certify that they have read this research project and have approved its submission for marking in relation to the department's guidelines and regulations.

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DEDICATION

This research project is dedicated to my family who were always supportive and inspiring.

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ABSTRACT

Climate change models have become an important tool for understanding the impact of climate change on species distribution and guiding biodiversity conservation efforts. In this particular study, the researchers focused on assessing the effects of climate change on *Lycaon pictus*, an animal species found in Zimbabwe, South Africa, Namibia, Angola and Botswana. RStudio software was used to model the distribution of the species, utilizing 1418 occurrence records and 19 bioclimatic variables. The projections were made for the years 2050 and 2070 using two Representative Concentration Pathways (RCPs) known as RCP_8.5 and RCP_2.6.

The results of the study indicated that the range of *Lycaon Pictus* is expected to decline in the future 2050 under RCP 2.6, with a probability of occurrence outside the current area exceeding 0.2. The ecological niche models for the species under both climate scenarios showed significant changes in its current suitability. RCP 8.5 2070 predicted extensive range expansion for the species, highlighting the substantial impact of climate change on its survival. However, unlike many other species that may face negative consequences due to climate change, the study suggests that the predicted suitability areas for *Lycaon pictus* can be used to assess the conservation status of the animal species at a regional scale. The researchers recommend conducting further field studies to determine the actual range size of *Lycaon pictus* and to validate the model projections. Ultimately, the study emphasizes the importance of considering climate change in biodiversity conservation efforts and highlights the potential for increased biodiversity resulting from the expansion of *Lycaon pictus* range.

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LIST OF ACRONOMY AND ABBREVIATIONS

AUC	Area under Curve
BIO	Bioclimatic variables
BIODIVERSITY	Biological Diversity
CO2	Carbon dioxide
GBIF	Global Biodiversity Information Facility
IODZM	Indian Ocean Dipole/Zonal Mode
IUCN	International Union for Conservation of Nature
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
RCPs	Representative Concentration Pathways
%	Percent
^{0}C	Degree Celsius

CHAPTER 1: INTRODUCTION

1.1 **Background to the study**

Climate change refers to long-term alterations in temperature, precipitation, and other atmospheric conditions on Earth (Creel et al., 2023a). Over the past decades, the consequences of climate change have intensified, posing a growing threat to ecosystems and biodiversity. The rise in greenhouse gas emissions, driven by human activities, has contributed to a warming planet, more frequent extreme weather events, and disruptions in natural processes. According to recent statistics, global temperatures have increased by approximately 1.2 degrees Celsius since the pre-industrial era, leading to widespread impacts such as rising sea levels, melting ice caps, and altered precipitation patterns (Marneweck et al., 2022). As time progresses, the urgency to address and mitigate the effects of climate change becomes increasingly apparent, as failure to do so could result in irreversible damage to the planet's delicate balance.

The global perspective underscores the far-reaching consequences of climate change on wildlife, with species facing unprecedented challenges in adapting to rapidly changing environments. Painted dogs (*Lycaon pictus)*, as a keystone species in most ecosystems, are particularly vulnerable. Their social structures, specialized hunting behaviours, and dependence on stable habitats render them highly sensitive to environmental shifts (Creel et al., 2023b). The implications of climate change on wild dog (*Lycaon pictus)* populations extend beyond direct impacts on their physiology, affecting prey availability, water sources, and the overall balance of their ecosystems (Jones et al., 2016).

The unique ecosystems and diverse species found in Africa are interlinked, creating a delicate balance that is easily disrupted by climatic shifts (Rabaiotti et al., 2021). Rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events are influencing the availability of prey, water sources, and suitable habitats for wild dogs (*Lycaon pictus)*. These changes pose significant challenges to their hunting and breeding behaviours, as well as overall population dynamics. Additionally, the heightened risk of diseases and the potential for increased human-wildlife conflict further compound the challenges faced by these already endangered animals (Creel et al., 2016). As climate change continues to reshape African landscapes, understanding and mitigating its effects on wild dogs (*Lycaon pictus*) are imperative for the conservation of this iconic species and the broader biodiversity of the continent.

Climate change in Southern Africa is significantly impacting the country's wildlife, including population of wild dogs. The altered weather patterns, increased temperatures, and changing precipitation regimes are influencing the availability and distribution of prey species, directly affecting the hunting behaviours and success rates of (*Lycaon pictus)* (Meer et al., 2019). Prolonged droughts and water scarcity can further challenge their survival by limiting access to vital water sources (Pole et al., 2004). Additionally, the increased frequency of extreme weather events, such as floods or heat waves, poses additional threats to wild dog habitats and their ability to raise and protect their young. As a result, the conservation efforts for wild dogs (*Lycaon pictus*) in Southern Africa face heightened complexity, requiring adaptive strategies that account for the evolving challenges posed by climate change to ensure the long-term survival of this endangered species (Pole et al., 2004).

1.2 Problem statement

The wild dog has been categorized as endangered on the ICUN Red List species since 1990 and there is a possibility that it may soon be classified as critically endangered. In Southern Africa around two decades ago, the population of painted dogs was approximately 600,000 20 years ago but currently, their numbers have significantly declined to less than 5000 individuals (Davies-Mostert, et al 2013. Despite the growing awareness of the threats posed by climate change, there is a notable gap in the understanding of how these environmental shifts directly impact wild dog (*Lycaon pictus*) populations in this region in Africa.

1.3 Justification of the study

The implications of this study are significant for a wide range of individuals and organizations. It represents a chance to participate in ground-breaking research and expand our understanding of the intersection of wildlife conservation and climate change. Research institutions can benefit by demonstrating their commitment to impactful research, improving their academic reputation, and attracting future scholars. Policymakers, armed with the findings of the study, can create conservation policies based on concrete evidence that address the unique challenges faced by wild dog populations in the Southern Africa. Environmental stakeholders can gain a deeper understanding of the links between climate change and wildlife, empowering them to advocate for sustainable practices and contribute to biodiversity preservation. By promoting collaboration between academic research, policy development, and on-the-ground stewardship, this study advances conservation efforts that will benefit present and future generations.

1.4 Aim

The main aim of the study is to investigate the effects of climate change on wild dogs (*Lycaon pictus)* in Southern Africa.

1.5 Specific objectives

- To determine the effects of climate change on the distribution of wild dogs in Southern Africa.

1.6 Research questions

- What is the effect of climate change on the distribution of wild dog in Southern Africa?

CHAPTER 2: LITERATURE REVIEW

2.1 Distribution of Wild Dogs (*Lycaon Pictus)*

Wild dogs, (*Lycaon pictus)* have historically inhabited a wide range of habitats across sub-Saharan Africa (Comely, et al, 2023). However, their distribution has significantly decreased over the past century due to habitat loss, human encroachment, and persecution. Estimates suggest that wild dog populations have declined by as much as 80% over the last 50 years, with current populations fragmented into isolated pockets across their former range (Marneweck et al., 2022). According to the International Union for Conservation of Nature (IUCN), wild dogs are now primarily found in scattered populations within protected areas in countries such as Botswana, Angola, Zimbabwe, South Africa, and Namibia. These remaining populations face ongoing threats from habitat fragmentation, disease, and conflict with humans, highlighting the urgent need for conservation efforts to safeguard the future of this endangered species (Creel et al., 2023a).

In Africa, wild dogs are primarily distributed in savannah and woodland habitats, where they form cohesive packs and exhibit complex social structures (Mbizah, et al, 2014). They are often associated with areas of high prey abundance, such as regions inhabited by ungulates like impalas, gazelles, and wildebeests. Countries with significant wild dog populations include Botswana, Angola, Zambia, Zimbabwe, and South Africa (Fraser-Celin, Hovorka and Silver, 2018). However, even within these countries, wild dogs are facing increasing pressure from human activities, including habitat destruction, poaching, and the spread of diseases such as canine distemper and rabies (Comley, et al, 2023). Despite efforts to conserve these carnivores, their distribution in Africa continues to be threatened, underscoring the importance of targeted conservation measures and habitat protection to ensure their long-term survival (Creel et al., (2023b)

2.2 Conservation Status of Wild Dogs

Zimbabwe, Angola, Zambia and South Africa supports some of the largest remaining populations of wild dogs in Africa, with significant numbers found in various ecosystems across the country.

The largest concentrations of wild dogs are typically observed in protected areas such as Hwange National Park, Mana Pools National Park, Pilanesberg National Park, Marakele National Park, and the Save Valley Conservancy. These areas offer suitable habitat and prey availability for wild dogs to thrive. However, human-wildlife conflict and habitat degradation due to agricultural expansion and deforestation remain significant threats to wild dog populations (Bouley, et al, 2021). Conservation efforts in the country often focus on mitigating these threats through community engagement, anti-poaching measures and habitat restoration initiatives. Despite these challenges, Southern Africa remains a critical stronghold for wild dogs, highlighting the importance of continued conservation efforts to preserve this iconic species within its borders (Woodroffe et al., 2007).

2.3 Effects of climate change on the distribution of Wild Dogs

Climate change is exerting significant pressure on the distribution of wild dogs across their range (Woodroffe, Groom, & McNutt, 2017). As temperatures rise and rainfall patterns become more erratic, the availability and distribution of suitable habitats for wild dogs are being altered. Studies have shown that wild dogs are extremely sensitive to changes in temperature and precipitation, which can directly impact the abundance and distribution of their preferred prey species. For instance, in a study by Marneweck et al., (2022), researchers observed shifts in the distribution of key prey species, such as impalas and wildebeests, in response to changing climate conditions, thereby affecting the foraging behaviours and distribution of wild dogs.

Additionally, the increased frequency and intensity of extreme weather events associated with climate change, such as droughts and floods, further exacerbate the challenges faced by wild dogs. Droughts can lead to water scarcity and reduced prey availability, forcing wild dogs to expand their ranges in search of resources or face starvation (Marneweck et al., 2022). Conversely, floods can disrupt habitat connectivity and fragment populations, limiting dispersal and gene flow among wild dog groups. A study by Meer et al., (2019) highlighted the vulnerability of wild dog populations to extreme weather events, with localized population declines observed following periods of prolonged drought in southern Africa.

According to a study conducted by Mbizah, Marino, and Groom (2012), habitat fragmentation, exacerbated by climate change-induced habitat loss, poses a significant challenge to wild dog populations. As habitats become increasingly fragmented due to factors such as deforestation, urbanization, and agricultural expansion driven by climate change, wild dog populations may find themselves isolated in smaller patches of suitable habitat. This fragmentation can restrict the movement and dispersal of wild dog populations due to agricultural fields, roads and human settlements that inhibit their ability to access resources or interact with neighbouring populations (Kapuka and Hlásny, 2021). Moreover, fragmented landscapes may lead to increased human-wildlife conflict as wild dogs are forced to navigate through human-dominated areas in search of food and water, further exacerbating population isolation and decline.

Changes in prey distribution driven by climate change also have profound effects on wild dog populations. Mbizah, M., Marino, J., & Groom, R. (2012), Wild dogs rely on a diverse array of prey species for sustenance, and any alterations in the distribution or abundance of these prey species can significantly impact the availability of food resources for wild dogs (Ripple et a,l. 2014). Climate-induced shifts in temperature and precipitation patterns can influence the distribution and abundance of prey species by altering their habitat preferences and population dynamics. For example, changes in temperature regimes may lead to shifts in the distribution of herbivores or changes in their seasonal migration patterns. Similarly, alterations in precipitation patterns can affect vegetation growth and productivity, subsequently impacting the abundance of herbivorous prey species. These changes in prey distribution can directly affect the foraging success and reproductive success of wild dogs, potentially leading to changes in their range and distribution as they adapt to the availability of food resources in their environment.

The effects of climate change on wild dog distribution are not limited to terrestrial habitats; they also extend to aquatic ecosystems (Woodroffe et al., 2017). Rising temperatures and altered precipitation patterns can impact the availability and quality of water sources, which are essential for wild dog survival. In regions where wild dogs rely on permanent water sources for drinking and hunting, such as riverine habitats, changes in hydrological regimes can disrupt their access to water and prey. A study by Meer et al., (2019) documented the decline of wild dog populations in regions experiencing prolonged droughts, attributing the decline to reduced access to water and increased competition with other carnivores for limited resources.

Increased competition with other species emerges as a significant concern for wild dog populations in the context of climate change. As climatic conditions undergo transformation, ecological communities may experience disruptions, altering species interactions and resource availability (Sandoval-Serés, et al, 2022). These changes can potentially escalate competition between wild dogs and other predators or scavengers for limited resources such as food, water, and territory (Kapuka and Hlásny, 2021). Shifts in temperature and precipitation patterns may influence the distribution and abundance of prey species, affecting the availability of food resources for wild dogs and their competitors alike. Additionally, alterations in habitat structure and vegetation composition can impact the suitability of habitats for different species, further influencing competitive dynamics (Ndaimani, et al, 2016). Consequently, increased competition for resources poses challenges to wild dog populations, as they navigate a changing landscape where securing essential resources becomes increasingly challenging amidst heightened competition from other species (van der Meer and Dullemont, 2021). Understanding and mitigating the impacts of increased competition are crucial for the long-term conservation and survival of wild dog populations amidst the challenges posed by climate change.

Overall, the cumulative impacts of climate change on wild dog distribution highlight the urgent need for adaptive management strategies to mitigate the threats posed by changing environmental conditions. Conservation efforts should prioritize habitat conservation, restoration, and connectivity to ensure the long-term viability of wild dog populations in the face of climate change (Bateman, et al, 2020). Furthermore, interdisciplinary research collaborations and initiative-taking conservation planning are essential for effectively addressing the complex challenges posed by climate change on wild dog distribution and ecosystem dynamics.

Human-wildlife conflict emerges as a pressing issue for wild dog populations amidst the shifting environmental landscape shaped by climate change. As wild dog populations endeavour to adapt to changing environmental conditions, they may increasingly find themselves in conflict with human communities over critical resources such as water and livestock. This competition for resources can escalate tensions and lead to instances of persecution, which in turn can result in population declines and localized extinctions of wild dog populations. Ndaimani, et al, (2016) highlighted that climate change-induced alterations in habitat availability and prey distribution may further exacerbate these conflicts, as wild dogs are compelled to range further in search of resources, bringing them into closer proximity to human settlements and agricultural areas. Additionally, extreme weather events and habitat degradation driven by climate change can disrupt traditional resource utilization patterns for both humans and wild dogs, intensifying competition and conflict (van der Meer and Dullemont, 2021). Addressing human-wildlife conflict in the context of climate change requires integrated conservation approaches that prioritize coexistence and sustainable resource management, while also addressing the socio-economic factors driving conflict dynamics. Such efforts are crucial to ensuring the long-term survival and well-being of wild dog populations amidst the challenges posed by a changing climate.

Disease susceptibility emerges as a significant concern for wild dog populations amid the backdrop of climate change. Musakwa, Mpofu and Nyathi, (2020) in their study on the local perception on ecosystem changes highlighted that evolving climatic conditions can profoundly affect the distribution and prevalence of diseases, thereby exposing wild dog populations to novel pathogens and heightening their vulnerability to infectious diseases. Muringai, Mafongoya and Lottering (2022) in their study on climate change perceptions, effects and adaptation also supported the above assertion highlighting that climate change-driven alterations in temperature and precipitation patterns can create favourable environments for the proliferation and spread of disease vectors and pathogens, potentially expanding the geographical range of diseases previously restricted to specific regions. Moreover, changes in habitat structure and vegetation composition may alter the ecological dynamics between hosts, vectors, and pathogens, further influencing disease transmission pathways. For instance, a study by Jones et al., (2016) highlighted the potential impacts of climate change on the spread of canine distemper virus, a major threat to wild dogs, with warmer temperatures and altered precipitation patterns creating favourable conditions for disease transmission. As a result, wild dog populations may face increased exposure to infectious diseases, posing significant threats to individual health and population persistence.

Changes in reproductive success present a critical concern for wild dog populations in the context of climate change. Mushawemhuka, Fitchett and Hoogendoorn, (2024) in their study on climate change on tourism highlighted that, extreme weather events and shifts in environmental conditions, such as prolonged droughts or unseasonal rainfall patterns, can disrupt wild dog breeding cycles and impact reproductive success rates. For instance, extended periods of drought can lead to water scarcity and reduced prey availability, affecting the nutritional status of breeding individuals and their ability to successfully rear offspring. Conversely, unpredictable rainfall patterns may influence the timing and availability of resources critical for breeding, such as denning sites or suitable prey abundance. These environmental stressors can lead to decreased reproductive output and survival rates of wild dog pups, ultimately impacting population growth and viability.

Overall, the cumulative impacts of climate change on wild dog populations underscore the urgent need for adaptive management strategies and conservation efforts (Bateman et al. 2020). Mitigating the effects of climate change on wild dog populations requires interdisciplinary approaches that address habitat conservation, sustainable resource management, and disease monitoring (Mushawemhuka and Hoogendoom 2024). Collaborative research initiatives and community-based conservation programs are essential for developing effective strategies to safeguard wild dog populations against the threats posed by climate change and ensure their long-term survival in the face of environmental uncertainty (Rabaiotti et al., 2021).

CHAPTER 3: MATERIALS AND METHODS

3.1 Acquisition of occurrence of data

Occurrence data of the *Lycaon pictus* in southern Africa were downloaded from the Global Biodiversity Information Facility (GBIF). Duplicate occurrences were removed during the filtering process in R. leaving 812 occurrences. Bioclimatic data such as temperature and precipitation were downloaded from the WorldClim database using R.

Figure 3.1 R.C.P models used in climate modelling.

3.2 Description of R.C.P models

The study utilized climate data from the period 1950- 2000 and made predictions about future CO2 concentrations in 2050 and 2070. The data were downloaded from WorldClimate at using a package known as geodata. Four representative concentration pathways (RCPs) set by the Intergovernmental Panel on Climate Change (IPCC) (2.6, 4.5, 6 and 8.5 watt/m2) (Mudereri et al., 2020) were considered and RCP 8.5 and RCP 2.6 were considered in the study. RCP 8.5, the most extreme scenario where greenhouse gas emissions continue to increase throughout the 21st century while RCP 2.6, considers that CO2 emissions will decrease. The study found that if current trends persist, RCP_8.5 provides a reasonable estimate of future conditions, as it aligns with historical emissions within a 1% margin. Emissions will continue to rise throughout the 21st century. RCP_8.5, which is commonly use to model worst-case climate change scenarios, was based on overestimation of projected coal outputs. RCP 2.6, according to the IPCC (2007), calls for CO2 emissions to begin declining by 2020 and reach zero by 2100.

3.3 Bioclimatic variables

Bioclimatic variables used in this are presented in Table 3.1

Table 1 climatic variables relevant to habitat suitability employed in this study

Name	Variable	Units
Bio 1	Annual Mean Temperature	^oC
Bio 2	Mean diurnal range	^oC
Bio 3	Isothermally (BIO2/BIO7) * (100)	^oC
Bio 4	Temperature seasonality (standard deviation *100)	^oC
Bio 5	Max Temperature of Warmest Month	^oC
Bio 6	Min Temperature of Coldest Month	^oC
Bio 7	Temperature Annual Range (BIO5-BIO6)	^oC
Bio 8	Mean Temperature of Wettest Quarter	^oC
Bio 9	Mean Temperature of Driest Quarter	^oC
Bio 10	Mean Temperature of Warmest Quarter	^oC
Bio 11	Mean Temperature of Coldest Quarter	^oC
Bio 12	Annual Precipitation	Mm
Bio 13	Precipitation of Wettest Month	Mm
Bio 14	Precipitation of Driest Month	Mm
Bio 15	Precipitation Seasonality (Coefficient of Variation)	Mm
Bio 16	Precipitation of Wettest Quarter	Mm
Bio 17	Precipitation of Driest Quarter	Mm
Bio 18	Precipitation of Warmest Quarter	Mm

Bio 19	Precipitation of Coldest Quarter	Mm

3.3. Ecological Niche Modelling

In this study, species distribution modelling was conducted using several packages installed in R version 4.3.2., RStudio, including raster, rgdal, map-tools, mapdata, jsonlite, maps, rJava and dismo packages. *Lycaon pictus* was modelled under given scenarios (RCP 2.6 and RCP 8.5 for the years 2050 and 2070).

CHAPTER 4: RESULTS

4.1 Current suitability of *Lycaon pictus*

The African wild dog (*Lycaon pictus*) is predicted to be found in the south-eastern parts of South Africa, the southern regions of Botswana and some areas within Zimbabwe. All the recorded occurrences of this species are found in regions that have a habitat suitability value above 0.2. (Fig 4.1)

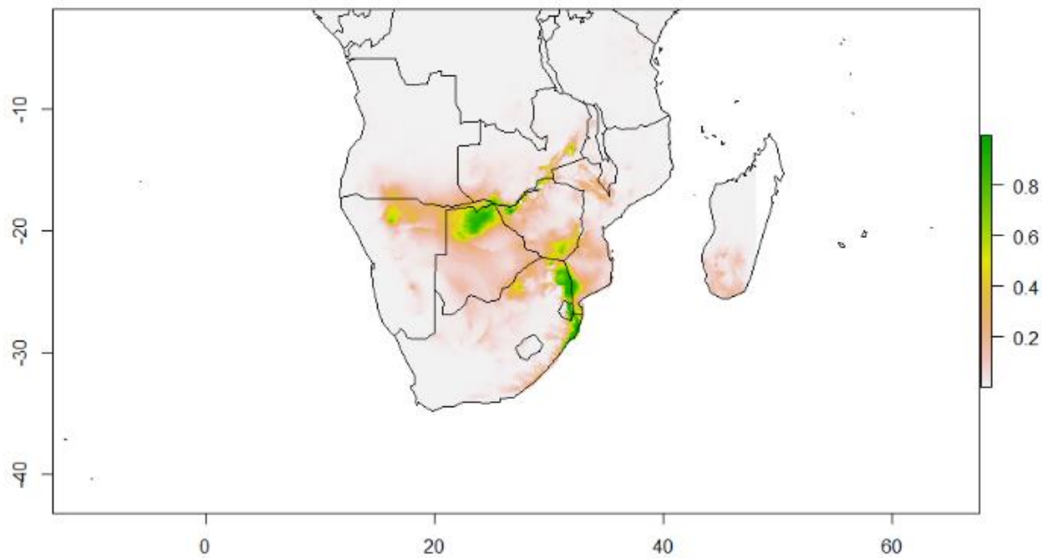

Figure 4.1 current distribution of *Lycaon pictus*.

4.2 Projections under R.C.P 2.6 in 2050 and 2070

The ecological niche models for *Lycaon pictus* in current suitability predicted a significant change than under two different climatic scenarios of the species in the future. According to the models, which were projected to 2050 and 2070 using the RCP_2.6 and RCP_8.5 scenarios, there will be an extensive expansion in the area suitable for *Lycaon pictus*. (Fig 4.2a and b, Fig 4.3a and b)

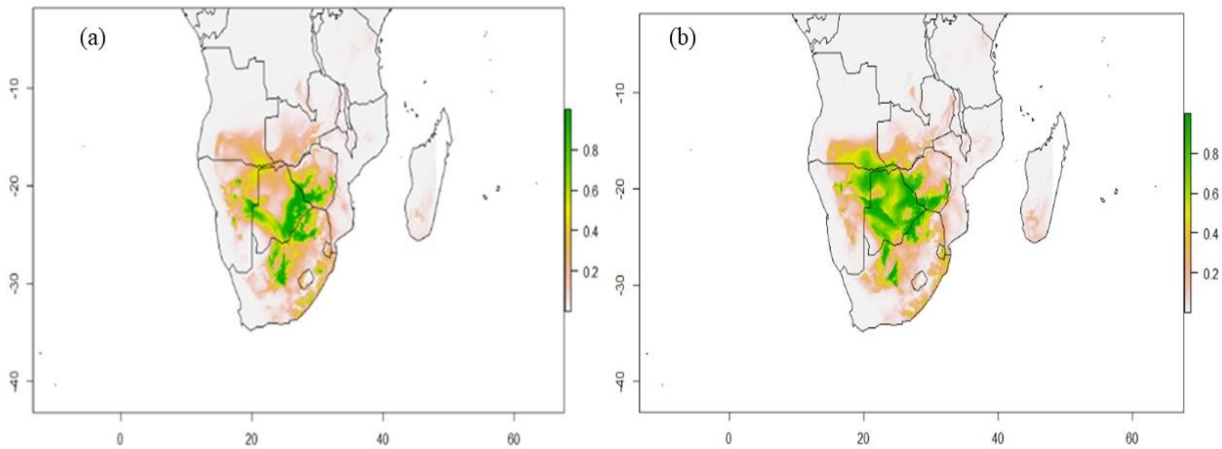

Figure 4.2a and b projections under R.C.P 2.6 in 2050 and 2070

The suitable climate for *Iycaon pictus* is projected to decline in territories like Angola, Namibia and South Africa for 2050 under RCP 2.6. Niche suitability is expanding in Botswana from 0.2 to 0.6, Botswana for 2070 under RCP 2.6. RCP 2.6 2070 Showed that the suitability area will expand towards Botswana, Zimbabwe and some regions of South Africa.

4.3 projections under 8.5 in 2050 and 2070

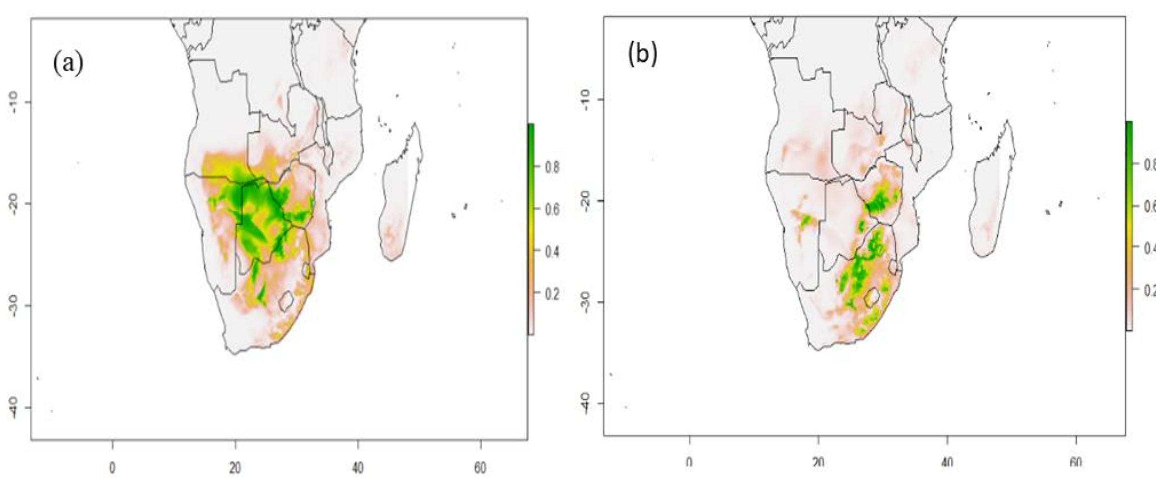

Fig 4.3a and b projections under 8.5 in 2050 and 2070

R.C.P 8.5 showed that *Lycaon pictus* experienced a greater expansion in suitable habitats in 2050 .In 2050 the species covered a larger area compared to 2070.The model predicted that by 2070, the suitability of *Lycaon pictus* for Botswana would decline from 0.4 to 0.2 and then decline to below 0.2.The models indicated that by 2050, the species' suitable habitat would expand towards parts of Botswana, the southern regions of Zimbabwe, and certain areas of South Africa. By 2070, Zimbabwe and South Africa would become the primary suitable habitats (with a suitability range above 0.2) for the *Lycaon pictus*. Overall, the results demonstrated that by 2050, the species' suitable habitat would expand towards the southern part of Africa.

4.4 Variable contribution

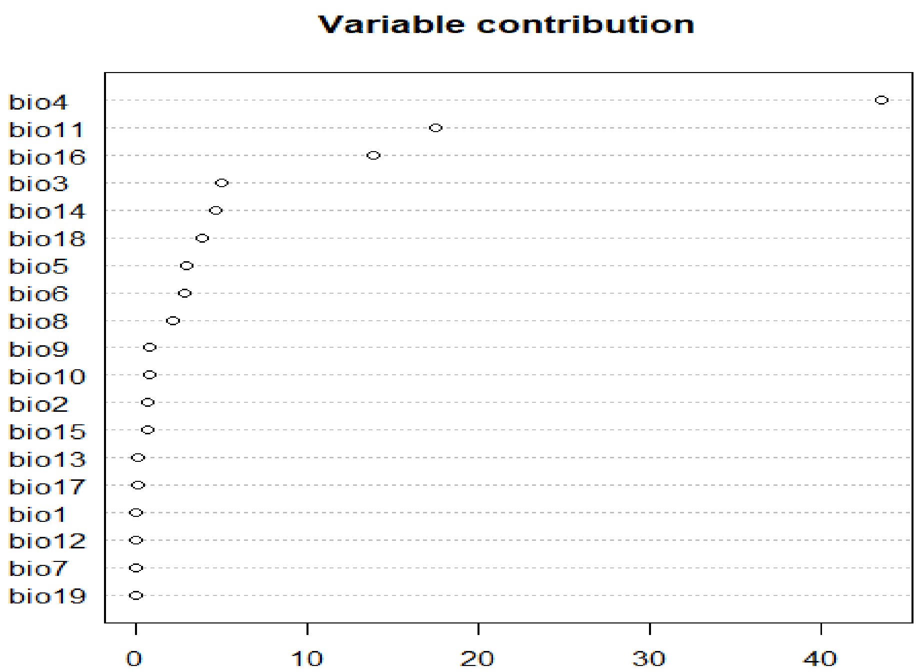

Fig 4.4 Variable contribution (%)

Fig 4.4 illustrates the contribution of climatic variables to *Lycaon pictus*. The study revealed a strong connection between bioclimatic variables and future distribution of *Lycaon pictus* displayed Under the Curve (AUC) value of 0.977. Analysis indicated that Temperature Seasonality (bio-4) was the most influential variable, accounting for 42% of the impact in all four scenarios (RCP_ 2.6 2050 and 2070 and RCP 8.5 2050 and 2070), followed by the Mean temperature of coldest Quarter (bio-11) 19 % and precipitation of wettest Quarter (bio-16) 12%.

CHAPTER 5: DISCUSSION

The findings of this study offer valuable insights into how climate change might impact *L. pictus's* habitat suitability and distribution. The study used ecological niche modelling to assess how the species' habitat might change under two different representative concentration pathways, RCP 2.6 and RCP 8.5, by 2050 and 2070.

Chen, J., Zhang, X., & Wang, Y. (2021), the occurrence data and current suitability models indicate a strong correlation between the species' present suitable habitat and the environmental conditions, suggesting the wild dogs are well-adapted to the current climate.

Under the more moderate RCP 2.6 scenario, which projects lower greenhouse gas emissions and limited global temperature rise, the models forecast an expansion of suitable habitats for the wild dog by 2050 and 2070. This expansion is particularly notable in Botswana and Zimbabwe. This suggests that with emissions mitigation efforts, there is a greater chance for the conservation and survival of the wild dog populations in these regions (Intergovernmental Panel on Climate Change (IPCC). 2021).

Pacifici et al., (2017), the more severe RCP 8.5 scenario, which assumes high and continued emissions, projects a decline in niche suitability for the wild dog by 2070. The models indicate the population may face significant challenges due to intense heat stress and rising temperatures, potentially leading to a catastrophic collapse and risk of extinction.

The variable contribution analysis highlights the importance of temperature seasonality, mean temperature of the coldest quarter, and precipitation of the wettest quarter as key climatic drivers of the wild dog's distribution. This underscores the sensitivity of the species to changes in temperature and precipitation patterns (Pacifici et al., 2017).

Importantly, the high AUC values for the model's training data (above 0.2) demonstrate the excellent performance of the ecological niche models in simulating the wild dog's future potential habitat (Pearson et al. 2007). This lends confidence to the reliability of the study's fundamental findings and outputs.

The results suggest that climate change, particularly under the more severe RCP 8.5 scenario, poses a significant threat to the long-term persistence of the African wild dog in Southern Africa. Targeted conservation efforts and emissions reduction measures may be crucial to ensuring the species' survival in the coming decades.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Unlike numerous species that are expected to be significantly impacted by climate change. *L. pictus* stands out as one of the few examples that, based on our findings is projected to not only survive but also adapt effectively, especially under the extreme scenario (RCP_2.6). Predictions indicate that the species' distribution is likely to expand under both current and future climate change scenarios, suggesting its potential to thrive under harsh conditions associated with climate change.

6.2 Recommendations

Predicted suitability areas in this study can be useful to evaluate conservation status and predict the future distribution of other animals globally. The modelling approach used for *L. pictus* could be applied to analyse how climate change may impact the ranges of other vulnerable species.

The findings indicating *L. pictus'* potential expansion under climate change scenarios could help guide the selection of suitable areas for species regeneration or reforestation as part of conservation efforts. Research building on this study could further refine the modelling by examining *L. pictus* projected distribution at a more detailed, country-level scale. Real population size data could also enhance the accuracy of the species distribution forecasts.

Overall, this research on wild dogs provides insights not only into the climate resilience of this particular animal species, but also demonstrates methodologies and findings that could have wider applications for assessing climate change risks and informing conservation strategies for diverse plant species worldwide.

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