Tanzania Wildlife Research Agenda

Third Edition - 2023

Tanzania Wildlife Research Institute

Tanzania Wildlife Research Institute

(TAWIRI)

TANZANIA WILDLIFE RESEARCH AGENDA

Third Edition

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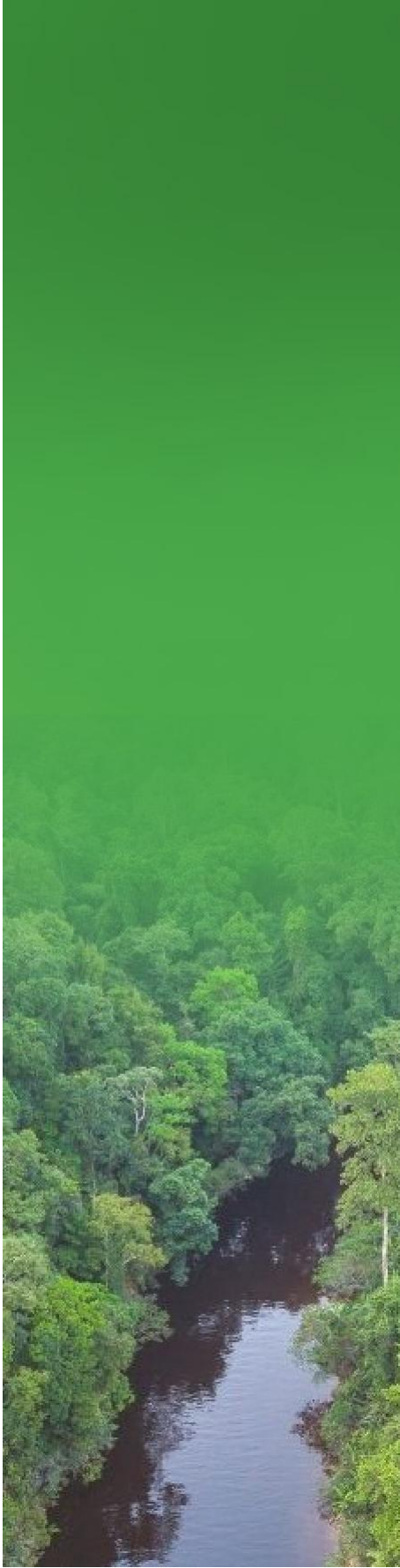

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LIST OF ACRONYMS

CBNRM	Community Based Natural Resource Management
COSTECH	Tanzania Commission for Science and Technology
DNA	Deoxyribonucleic Acid
EU	European Union
FNRs	Forest Nature Reserves
FRs	Forest Reserves
GCAs	Game Controlled Areas
GDP	Gross Domestic Product
GIS	Global Information Systems
HWCs	Human-Wildlife Conflicts
ICT	Information and Communications Technology
IUCN	International Union for Conservation of Nature
JMRC	Joint Management Research Committee M&E Monitoring and Evaluation
MNRT	Ministry of Natural Resources and Tourism
MoLF	Ministry of Livestock and Fisheries
MoUs	Memorandum of Understanding
NBSAP	National Biodiversity Strategy and Action Plan
NCA	Ngorongoro Conservation Area
OIE	Office Internationale des Epizooties (World Organization for Animal Health)
PAs	Protected Areas
PI	Principal Investigator
R.E.	Revised Edition
REC	Research Ethics Committee
RPC	Research Programme Committee
RFWR	Renewable Fresh Water Resources
RPAS	Remotely Piloted Aircraft Systems
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
SDGs	Sustainable Development Goals
SRI	Serengeti Research Institute
STDs	Sexually Transmitted Diseases
TANAPA	Tanzania National Parks
TAWA	Tanzania Wildlife Management Authority
TAWIRI	Tanzania Wildlife Research Institute

TFS	Tanzania Forest Services
TV	Television
UAVs	Unmanned Aerial Vehicles
URT	United Republic of Tanzania
USAID	Unites States Agency for International Development
WHO	World Health Organization
WMAs	Wildlife Management Areas

PREFACE

The first Tanzania Wildlife Research Agenda was developed in 1999 to present priority areas for wildlife research in Tanzania. The second edition was produced in 2012 to accommodate emerging challenges as part of priority research areas. For the past two decades, many wildlife conservation challenges have emerged that necessitated the revision of the 2012 Agenda to address stakeholders' needs and other developments in science and technology. I am delighted to say that this third edition of the Agenda has captured stakeholders' needs and development in science and technology that have happened in the past 20 years.

The first Wildlife Research Agenda centred on five (5) priority research themes, namely Human-wildlife interactions, Ecological interactions, Biodiversity Inventory, Database and Ecosystem history. The second edition of the Agenda (2012) consisted of eight (8) priority research themes namely Human-Wildlife interaction, Biodiversity Conservation, Water Resources and Wetland Conservation, Climate Change and Ecosystem Dynamics, Wildlife Diseases and Ecosystem Health, Wildlife Ecology and Ecological Interactions, Natural resources Governance and Infrastructure Development, and Beekeeping, Bee Ecology, Bee Products, and Pollination Services. There has been remarkable scientific information generated by research on these themes that contribute to sustainable conservation of wildlife resources in the country. Furthermore, in the outgoing Agenda, we have realized an increasing trend of Tanzanian wildlife researchers from various local research and academic institutions. I encourage more Tanzanian researchers to engage in research as presented on this Agenda.

The third edition of the Agenda of 2023 comprises eleven research themes that will enable TAWIRI to make informed management advises to the Management Authorities, policymakers, and the public at large. On behalf of the Management and Staff of TAWIRI, I am grateful to all stakeholders who contributed to the development of this Agenda. It is my expectation that addressing conservation challenges through research will enhance wildlife conservation and increase the contribution of the wildlife sector to the National economy. I welcome all researchers to join TAWIRI in doing wildlife research in Tanzania.

Dr. David Nkanda Manyanza
CHAIRMAN, TAWIRI BOARD OF DIRECTORS

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My sincere thanks and gratitude are due to the team from the Research Development and Coordination Directorate at TAWIRI for spearheading the development of this Tanzania Wildlife Research Agenda. Special thanks go to Dr. Julius D. Keyyu (Director of Research-Team Leader), Dr. Victor M. Kakengi, Dr. Angela R. Mwakatobe, Dr. Asanterabi N. Lowasa, Dr. Emmanuel Mmassy, Dr. Devolent Mtui, Dr. Edward M. Kohi, Dr. Dennis K. Ikanda, Dr. Alex L. Lobora and Ms Kezia D. Oola for reviewing the research agenda and incorporation of inputs from stakeholders. Members of TAWIRI Management and other staff of TAWIRI are also thanked for their inputs in the Agenda.

I am also very grateful to our stakeholders especially the Wildlife Division, Tanzania National Parks (TANAPA), Ngorongoro Conservation Area Authority (NCAA), Tanzania Wildlife Management Authority (TAWA) for the provision of their priority research areas and research issues as building blocks for themes and areas of the research agenda. Their formal and informal comments and constructive inputs were very useful during the development of the research agenda. I am also indebted to wildlife researchers, research institutes, academic institutions, Non-Governmental Organizations (Conservation NGOs), and the Private sector for their various inputs and comments on the research agenda, as well as participation during the stakeholders webinar to discuss and agree on the third edition of the Tanzania Wildlife Research Agenda.

The development of the research agenda involved many dedicated individuals, and we would therefore take this opportunity to thank them all for their various inputs and comments. Last but not least, the Government of Tanzania, through the Ministry of Natural Resources and Tourism, is highly thanked for fully funding the whole process involved in the preparation and printing of the research agenda. Let me call upon all stakeholders to own the research agenda and participate fully during its implementation to generate scientific information for sustainable conservation and utilization of wildlife resources in Tanzania.

Dr. Eblate E. Mjingo
DIRECTOR GENERAL, TAWIRI

1.0 Introduction

Tanzania is arguably Africa's most important nation for conservation (Caro and Davenport, 2018). The country has set more than 40% of its landmass for the conservation of biological diversity (Kideghesho et al., 2013), making it one of the four mega-biodiversity Nations in the world. In terms of wildlife biodiversity, Tanzania is endowed with a high abundance of biodiversity and endemic species (Foley et al., 2014), found across its 22 national parks, Ngorongoro Conservation Area (NCA), 23 Game reserves, 44 Game Controlled Areas (GCAs), 38 Wildlife Management Areas (WMAs) and 4 Ramsar sites (URT, 2018). The network of protected areas and wetlands is important to the national economy in terms of game viewing, tourist and resident hunting; wildlife farming, breeding and ranching; eco-tourism; zoos, and game sanctuary. The sector, which is the number one tourist attraction in the country, contributes about 21% of GDP, 25% of foreign currency and 11% of employment (URT, 2016).

Although Tanzania has abundant wildlife resources, there have been increasing challenges to managing these valuable resources, and the contribution of wildlife to community development/livelihood requires research attention. The current challenges for wildlife conservation in Tanzania include human-wildlife conflicts (costs of living with wildlife), loss of habitats and wildlife connectivity (corridors), illegal hunting, ecological disturbances, people-park relationships, livestock incursion, invasive species, and diseases, which are exacerbated by human population increase and inadequate social-economic opportunities (food and income poverty).

Solutions for these challenges need concerted research efforts to generate sound scientific information for use by the Government, Management Authorities, and the general public. Despite these challenges, the Government through Tanzania National Parks (TANAPA) upgraded six game reserves into national parks in 2019, namely Nyerere, Burigi-Chato, Ibanda-Kyerwa, Rumanyika-Karagwe, Kigosi and Ugalla River National Parks; no other country has such a record (Sinclair, 2019). In this regard, Tanzania is living up President Nyerere's Proclamation of 1961 (Sinclair, 2019), famously known as the Arusha Manifesto.

Arusha Manifesto

"*The survival of our wildlife is a matter of grave concern to all of us in Africa. These wild creatures amid the wild places they inhabit are not only important as a source of wonder and inspiration but are an integral part of our natural resources and our future livelihood and wellbeing. In accepting the trusteeship of our wildlife, we solemnly declare that we will do everything in our power to make sure that our children's grand-children will be able to enjoy this rich and precious inheritance. The conservation of wildlife and wild places calls for specialist knowledge, trained manpower, and money, and we look to other nations to cooperate with us in this important task- the success or failure of which not only affects the continent of Africa but the rest of the world as well" (J.K. Nyerere, 1961).*"

To address the various challenges for the management of wildlife resources in the country, a wildlife research agenda with priority research themes must be in place. Research plays a very crucial role in the socio-economic development of any society, and that research has been responsible for the economic prosperity currently enjoyed by all developed Nations (URT, 2010). Wildlife research will allow the generation of specialized knowledge and scientific information for informed wildlife management decisions.

In the early years of wildlife research in Tanzania, priority areas for research were guided by the Serengeti Research Institute Strategic Plan (SRI, 1994). Thereafter, the first Tanzania Wildlife Research Agenda was developed in 1999 (TAWIRI, 2000); this was followed by the development of the second edition of the wildlife research agenda in 2012. Over the past eight years of existence of the outgoing Tanzania Wildlife Research Institute Agenda, there have been changes that have happened including the establishment of Tanzania Wildlife Management Authority (TAWA) and Tanzania Forest Services Agency (TFS), which necessitated the incorporation of their priority areas, as well as to align the research agenda with the time frame of the Strategic Plan of the Ministry of Natural Resources and Tourism, and the time frame of the Strategic Plan of the Institute. Also, the revision has been due to emerging priority areas in conservation science and technology including Unmanned Aerial Vehicles (UAVs), application of GPS satellite collars, geofencing technology,

Automated Bioacoustics Monitoring Devices, GIS and remote sensing. Wildlife research is therefore highly needed to enhance sustainable wildlife conservation, community development, and contribution to GDP. According to the Wildlife Policy of Tanzania, research and monitoring of wildlife and wetland resources remain an integral part of wildlife and wetland development (URT, 2007). In this case, the development of the third Wildlife Research Agenda is very important.
The third Wildlife Research Agenda aims to strengthen the linkage between wildlife research, conservation and national development. The revised wildlife research agenda will allow wildlife researchers to focus on research activities on priority areas to influence policy for informed decision- making.

This third edition of the Wildlife Research Agenda was developed in line with the United Nations Sustainable Development Goals (SDGs) or Global Goals (2015 - 2030) especially goals to end poverty (Goal No. 1), stop degradation, preserve the forest, desert and mountain ecosystems (Goal No. 15), and protect that makes the planet habitable, and ensure that all people enjoy peace and prosperity, now and in the future (Stephen et al., 2017). The research agenda addresses the Wildlife Policy of Tanzania that calls for strengthening resources monitoring and research (URT, 2007), the research agenda has also taken into consideration the National Research and Development Policy (URT, 2010) on priority research areas, the National Science and Technology Policy (URT, 2015) on conservation and protection of the environment and rational and efficient utilization of natural resources, the Research priorities for Tanzania on wildlife and tourism (COSTECH, 2015), and the Tanzania Wildlife Research Institute Act (Conduct of Wildlife Research) Regulations 2020 on the coordination of research and dissemination of research results. This research agenda was developed in a participatory manner involving all key wildlife stakeholders and contains priority themes and priority areas for wildlife research in Tanzania.

One of the main challenges for robust wildlife research activities in Tanzania is inadequate financial resources. Although considerable research has been taken in Tanzania and has contributed significantly to knowledge and publicity of wildlife, so far little research results have been used for decision making, due to inadequate communication between researchers and wildlife managers (URT, 2007). In this regard, conservation stakeholders are invited to raise awareness of this Agenda, call upon all sectors to collaborate to promote and strengthen implementation of this research agenda as well as ensure timely dissemination and use of research results.

2.0 Priority Research Themes and Areas for Wildlife Research

The wildlife research agenda of 2012 had eight research priority themes, most of which still are relevant and hence carried on in this new research agenda of 2021-2031. However, due to the evolution of events in the past eight years of the previous Agenda, some research themes and areas have been dropped or merged; and new themes/areas added making a total of eleven (11) research thematic areas namely; Human-Wildlife Interactions; Wildlife Ecology and Ecological Interactions; Wildlife Population Monitoring; Habitat and Biodiversity Conservation; Tourism Development and Cultural Heritage; Wildlife Diseases and Ecosystem Health; Water Resources and Wetland Conservation; Natural Resource Policies and Good Governance; Climate Change and Variability; Emerging Technologies and Conservation; and Beekeeping and Bee Development. Objectives and justification for each theme are provided below, and a summary of the research agenda in terms of research themes and research areas are presented (Table 1).

2.1 Human-Wildlife Interactions

Objective: Enhance provision of scientific data that will effectively manage human- wildlife interactions with the participation of local communities in conservation while maintaining ecosystem services for effective conservation and management of critical ecosystem processes.

Human-wildlife interaction, especially conflicts between wildlife, livestock and people are increasing in all ecosystems in Tanzania. The interactions might often undermine the objectives of wildlife conservation and the sustainable utilization of the natural resource. The commonest forms of conflicts are crop-raiding, livestock depredation, infrastructure damages as well as human and or wildlife attacks. The common drivers of conflicts are increasing human population and settlements, land-use changes, poverty and increasing livestock populations.

An increase in the human population and associated increases in natural resources and habitat use are forcing wildlife to live in proximity to humans that lead to an increase in Human-Wildlife Conflicts (HWCs). This situation increases the demand for food, settlements, infrastructure development, fuelwood, furniture, building materials and other products. Tanzania is reported to be one of the fastest-growing populations in the world, and its population has increased from 9.1 million people

in 1961 during Independence (URT, 2006) to 44.9 million in 2012, with an average annual growth rate of 2.7 (URT, 2012). In the case of livestock population, Tanzania accounts for 11% of African cattle population (MoLF, 2017) with 19.2 million cattle in 2012 and increasing at an average annual growth rate of 4.7 (URT, 2017). Currently, Tanzania is estimated to have about 30.5 million cattle, 18.8 million goats and 5.3 million sheep (MoLF, 2017). Other livestock includes; 1.9 million pigs, 38.2 million local chicken and 36.6 million improved chicken (URT, 2017). Therefore, due to increasing human and livestock populations in the country, there is a growing extent of land-use conflicts among stakeholders, including wildlife management authorities and communities living adjacent to protected areas which are heavily dependent on natural resources for their wellbeing. While some years ago, the boundary between protected areas and human settlement was soft (500m of buffer zone), most protected areas currently have hard boundaries with adjacent communities. Hence, protected area ecosystems in Tanzania are under threat due to anthropogenic processes such as illegal harvesting of natural resources, habitat fragmentation/loss and livestock incursion for grazing, encroachment for settlement, expansion of agricultural lands and infrastructure development.

Therefore, research is urgently required to address issues related to human-wildlife interaction in Tanzania holistically. Priority research areas under this theme include crop-raiding, livestock depredation, land-use conflicts, harvesting of natural resources (legal and illegal), human attacks (injury and death), cultural values, social economics and marketing of natural resources products (flora and fauna) and climate change and human-wildlife interactions. Specifically, researches should look into the nature and trends of interactions, spatial-temporal distribution (hotspot areas), scale or magnitude of interactions as well as the effect or impact of interactions, and outline/recommend mitigation strategies for sustainable conservation of biodiversity.

2.2 Wildlife Ecology and Ecological Interactions

Objective: Increase ecological knowledge and insight of species interaction together with their processes for effective wildlife conservation.

The future of wildlife conservation across the globe depends on the ecological knowledge that will guide various dynamics occurring over time. The wildlife conservation continues to face challenges in the midst of increasing human population and as such novel ecological researches are required to help to understand the relationship between ecological processes and society/human dynamics. With the current debate that major changes in ecology are related to human development considered by some scholars as "Anthropocene" suggests that human impact on the ecological process is as important as natural processes.

The current research agenda aims at gaining ecological knowledge in several specialized areas to address the shifting or changing of the ecological process, including behavioural, nutritional, and reproductive dynamics of wildlife species. Other areas include animal-plant interaction, fire ecology, range and restoration ecology, plant/vegetation ecology and ethnobotany. This Agenda also advocates the gaining knowledge on species interaction, dispersal areas and migratory routes; and habitat conservation.

The advancement of molecular sciences in the current time has changed taxonomy of various wildlife and plant species (such as giraffe and several bird species) but also becoming an important tool for wildlife protection through the use of forensic sciences. Therefore, in this Agenda, conservation genetics will also cover population genetics which is important in managing a small and isolated population of endangered and endemic species. Various species management plan advocate for Metapopulation management approach to improve gene flow to help reduce hereditary diseases or inferior traits and manage invasive traits.

Advancement of technology and computer sciences has allowed scientists to conduct robust analyses of global data on species diversity, distribution and their habitat. Loss of habitat, including loss of forage, an increase of invasive species and loss of connectivity of wildlife protected areas is of concern. In recent years the world has experienced the rapid loss of migratory routes, dispersal areas and corridors that has an impact on animal behaviour, movement ecology and gene flow of some species. The investment of research in these areas will address a global concern of biodiversity loss through restoring ecological processes.

2.3 Wildlife Population Monitoring

Objective: Increase knowledge on wildlife population status, trends, distribution, and human activities adjacent to protected areas for effective species management and conservation planning.

Community and species monitoring is a major indicator for evaluating the performance and effectiveness of conservation. The IUCN Red List has thousands of species that are categorized in various levels of risk, and year after year, many species move towards greater extinction risk. Globally, 27% of all assessed species (116,177) are at risk of extinction. Preventing extinction need a strong monitoring system that will provide early warning on the conservation status of a particular species.

Investment and economic development in the wildlife sector rely on monitoring data and information for decision making. For example, major tourism investment in wildlife follows charismatic species such as lion and elephant density, non-human primates (e.g. Chimpanzee and Mangabey), large herds of migratory species (e.g. wildebeest) and ecological features. Monitoring utilization of wild species is also critical, especially for the trade of live animals and the hunting industry to sustain the wild population.

2.4 Habitat and Biodiversity Conservation

Objective: Improve understanding on status of habitats and biodiversity through the provision of scientific data and information for effective planning and sustainable conservation.

Tanzania ranks among the four world's top mega biodiversity Nations, with her economy largely supported by biodiversity resources (URT, 2014). Among the major role of biodiversity is to provide ecosystem services through daily captures of rainfall, regulation of river flows, supplies of fodder for animals, control erosion, and cleans pollutants from the air, water, and soils. Habitat is the physical and biological setting in which organisms live and in which the other components of the environment are encountered (Krebs, 1985; Jones, 1987). Habitat forms one of the four components of a species' environment, along with climatic variables, nutrients, and other interacting organisms (Andrewartha and Birch, 1954). The fact that habitat serves a multitude of organisms is critical to understanding its full role in biodiversity conservation. This requires a clear knowledge of the habitats and biodiversity components within. It has been shown that the biodiversity of Tanzania is extremely diverse with 14,500 known species, of which 54% are plants, and about 3,000 are endemic species (URT 2014).

Biodiversity inventories, including the monitoring of species composition, distribution, and abundance as well as the drivers governing population, ecosystem viability, and variability are vital to forecasting, planning, and managing biodiversity loss, and in auditing the success of alternative conservation policies and practices. Besides, there is a high need to promote education and health awareness by preparing a suitable environment for the development and maintenance of human minds to be able to balance vital needs through the extraction of ecosystem services from natural biodiversity. Furthermore, the idea that climate limits species distributions are growing, if unaddressed, has the potential to overwhelm any biodiversity conservation goals. Thus, there is a need to investigate current habitat dynamics and predict the effects of climate change on biodiversity, propose conservation strategies and policies to mitigate the effects of climate change on species conservation. Without concerted effort for research to properly guide conservation actions, we are likely to lose many species and the ecosystems in which they are found.

The need to conserve biodiversity is well emphasized in the National Biodiversity Strategy and Action Plan (NBSAP) (URT, 2014). This theme will focus on twelve

research areas namely Habitat diversity and Connectivity, Composition, Distribution and abundance of wildlife in Protected Areas and Non-Protected Areas, Biodiversity inventories, Drivers of Biodiversity Loss, Biodiversity and Ecosystem Health Indicators, Biodiversity Monitoring, Alien and Invasive species, Conservation policy Analysis and Conservation Education and Awareness, Climate change and Biodiversity Conservation, Climate Change and Vegetation Dynamics, Climate Change; and Pollinators and pollination services.

2.5 Tourism Development and Cultural Heritage

Objective: Promote research that will enhance tourism and cultural heritage for economic development.

The tourism sector has a pronounced imminent contribution to socio-economic development in various parts of the country. Tourism is well centered in various natural attractions which are an important key resource in tourism and in turn it requires deliberate research effort for improvement. Some of these attractions include cultural heritage (tangible and intangible), abundance and diversity of wildlife, spectacular landscape scenery, paleontology and archaeology. Though the aforementioned attractions are the major source of tourists visits, yet there are other important attractions attributes that influence the number of tourists' visit including infrastructure, hospitality, visitor experience, services quality, local people's attitudes, safety and marketing of tourists' attractions. Research is therefore needed to improve, promote and ultimately generate information that will enhance the promotion of tourism, tourism resources and cultural heritage, to improve and promote the tourism industry in the country.

The specific research areas under this theme will focus on; the impact of changes in culture to conservation and tourism development, the impact of tourism on the social-economic development, explore tangible (heritage) and intangible (traditional knowledge, skills, performing arts, theatre arts, folklore and traditions) cultures, investigate, classify and map archaeological sites that are culturally sensitive. Other priority areas include dynamics of domestic tourism development, hospitality, services quality, infrastructure needs and marketing of tourist attractions, understanding of characteristics, preferences, attitudes and opinions of visitors, investigate new markets to promote the tourism sector, sustainable eco-tourism development, determine the impact of tourist hunting for sustainable conservation and promotion of api-tourism for sustainable wildlife conservation.

2.6 Wildlife Diseases and Ecosystem Health

Objective: Strengthen knowledge on ecology of diseases in order to safeguard the health of wildlife, livestock and humans through prevention, early detection, diagnosis, and control.

Wildlife diseases and ecosystem health are becoming increasingly important aspects of wildlife conservation and management. Reasons for this is that some diseases pose a high risk of species extinction, the majority of emerging zoonotic diseases that threaten human health originates in wild animals and the difficulties, as well as economic impacts such diseases pose to the wildlife conservation authorities when it comes to their management. Many of these diseases pose significant impacts on human health, livestock health, wildlife health and biodiversity at large (Cox-Witton et al., 2014). Wildlife diseases that are transmitted from animals to human (zoonoses) are causing significant impacts to humans, including the two reigning pandemics (HIV AIDS and COVID-19). Studies have shown that of 335 (data from 1940 to 2004) human diseases that have recently emerged, 202 diseases (66%) were caused by zoonotic pathogens and that 144 (43%) originated from wildlife (Jones et al., 2008; OIE 2010), thus, understanding the dynamics of diseases is paramount and is a global priority.

Diseases and health threats to wildlife and humans are exacerbated by several issues including; human population growth, habitat loss, co-existence of wildlife and livestock populations (interface areas), global and local movement of people, livestock and wildlife as well as climate changes. The above phenomena create favourable conditions for the pathogens to cross the species barrier and hence, frequent diseases outbreaks. Based on the recent facts, emerging and re-emerging diseases will likely be center-stage, particularly those infectious agents that have pandemic potential and can rapidly spread among ecosystems and continents. Such disease agents if not researched, have the potential not only to threaten the ecosystem health but also disrupting the country and global economies (Henke et al. 2007).

For this case, research on wildlife diseases is a priority, and clearly, there is a need for information that will help provide better disease surveillance, early warning, detection and response before pathogens reach epizootic (an outbreak of diseases affecting many animals of one kind at the same time) or panzootic (an outbreak of an infectious disease of animals that spreads across a large region, e.g. continent(s)) situations. To implement effective wildlife diseases management plans, it is critical to have priority areas of research that addresses key issues in wildlife conservation countrywide and regionally. Priority research areas under wildlife diseases and ecosystem health include; Emerging and re-emerging wildlife diseases of


conservation importance, Ecology, epidemiology and control of wildlife diseases, Zoonotic and epi-zoonotic diseases at the human-wildlife interface, Prediction, detection and management of wildlife diseases, the impact of climate change on vectors and diseases ecology, sexually transmitted (STDs) and other viral diseases in non-human primates as well as health programs for conservation employees and at human-wildlife interfaces. Others include Wildlife diseases diagnostics, the welfare of wildlife in captivity, health and diseases dynamics associated with translocations of wildlife, Wildlife diseases pathogens and Biological Resource Bank and Trans-boundary diseases of conservation importance.

2.7 Water Resources and Wetland Conservation

Objective: Enhance knowledge of water and wetland resources management for sustainable conservation and community livelihood.

To sustain growing consumptive demand, research needs to translate understanding into reliable and robust predictions of water availability under weather conditions that could be average but might be extreme. These predictions are needed to support current and long-term planning. This call upon research on areas like hydro-geology to understand the distribution and movement of groundwater and rocks of the earth's crust; Hydrology to understand water movement, distribution and management on earth. Others include the water cycle, water resources and environmental watershed/catchment sustainability.

To sustain growing consumptive demand, research needs to translate understanding into reliable and robust predictions of water availability under weather conditions that could be average but might be extreme. These predictions are needed to support current and long-term planning. This call upon research on areas like hydro-geology to understand the distribution and movement of groundwater and rocks of the earth's crust; Hydrology to understand water movement, distribution and management on earth. Others include the water cycle, water resources and environmental watershed/catchment sustainability.

The climate system puts an upper limit on the circulation rate of available renewable freshwater resources (RFWR). Although current global withdrawals are close to the upper limit, already more than two billion people live in highly water-stressed areas because of the uneven distribution of RFWR in time and space (https://science.sciencemag.org/content/sci/313/5790/1068.full.pdf). Climate change is expected to accelerate water cycles and thereby increase the available RFWR. This would slow down the increase of people living underwater stress; however, changes in seasonal patterns and increasing probability of extreme events may offset this effect. Research on the impact of climate change on water availability might lead to predictions on water availability and develop strategies towards reducing current vulnerability and prepare for such anticipated changes.

To cope with prolonged drought, some protected areas have done some interventions by creating man-made water sources such as dams, ponds, etc. The effect of these interventions warranty research to understand the response of wildlife to this anthropogenic interference. Water scarcity in some protected areas forces wildlife to wonder in villages searching for water desperately. This results in augmented human-wildlife conflict, furthermore, the same source of water is shared by the trinity of human, livestock and wildlife. Studies have revealed that more than 60% of diseases affecting human being today emanates from wildlife (Jones et al., 2008; OIE 2010). Researches are called up on to understand the impact of water sharing at the human-livestock-wildlife interface.

Alien species as used herein refers either to an exotic species, originating in a different country or region, or one that is non-native (or non-indigenous) that may originate within the same region or country but not occur naturally in a particular water body until colonization is facilitated by humans. An invasive species is an alien (exotic or introduced) (https://onlinelibrary.wiley.com/doi/full/10.1002/aqc.2711) or an indigenous pioneer species that either give rise to ecological, economic, health or other concerns as a result of its establishment and spread (i.e. bio-invasion) or has the potential to do so. We need to research on the effect of invasive species being flora or fauna on the diversity of native species and propose mitigation measures.

2.8 Wildlife Conservation Policies, Good Governance and Infrastructure Development

Objective: Promote research on wildlife conservation policies, good governance and infrastructure development for informed decision making.

Promoting the use of scientific evidence in designing conservation policies and legislations can enhance good governance of natural resources. This can be achieved by encouraging stakeholders to work together in linking science to policy decisions and governance. The use of scientific evidence in the decision-making process will likely address research gaps and promote both livelihoods and conservation goals. Wildlife in Tanzania is governed by Wildlife policy of 2007 under protected areas ranging from different conservation status such as National Parks, Game Reserves, Game Control Areas, Ngorongoro Conservation Area (NCA), Wildlife Management Areas (WMAs) and Open Areas. The wildlife policy is implemented by other various Acts such as the National Parks Act, 2017, Wildlife Act 2009, NCA Act, 1975 (CAP 284, R.E. 2002), Forest Act of 2002, the Land Act 1999, and the Village Land Act No. 5 of 1999). The assumption and aim of using all these Acts and legislations are to strengthen all issues related to natural resource management, support conservation goals and human development needs. Despite the use of all these legislations, wildlife conservation has remained a challenge and livelihoods of local communities around protected areas have not been improved. The failure of wildlife conservation policies and legislations to achieve its goals is associated with contradictions between the policies, legislations and other sectoral policies. For instance, we have sectoral policies and developmental policies with the framework of reducing hunger and poverty implemented around wildlife protected areas under a big umbrella known as “Feed the future’. It is funded by USAID and EU fund (SAGCOT and Rice Project around Ruaha National park) through irrigation schemes.

Also, we have recently experienced development projects such as Hydroelectric Power and mining within protected areas. The mechanism to achieve these projects may involve clearing or harvesting resources within the Protected areas, that or may ruin the quality of biodiversity. Therefore, research should help in developing mitigation measures that will ensure the sustainability of both development projects and sustainable conservation. Also, the Land Act, 1999 has given every citizen equal right to land ownership, but some customary laws are still restricting women and youth to access and benefit from land. Lack of land rights has forced some women and youth to depend more on natural resources and put more pressure on the resources within the protected areas through illegal harvest of natural resources such as timber, charcoal, bush meat to support family needs.

Furthermore, there are emerging issues which have not been adequately addressed by wildlife policies such as consolation scheme, land use planning, gender, wildlife conservation and climate change adaptation plans around protected areas. In the context of protected areas, governance refers to who holds authority and responsibility and can be held accountable according to legal, customary or otherwise legitimate means. It relates to both formal and informal processes of taking decisions, and to contemporary as well as customary and culture-bound institutions. In this sense, governance is all about who holds authority, and who makes decisions; and about how these decisions are made.

However, in some situations, politicians seem to make decisions that overshadow the scientific recommendations, especially in the implementation of development projects. Due to poor decision-making and poor governance, we have also seen inappropriate infrastructure development projects inside the protected areas. National progress is dependent on developing infrastructure such as effective transportation networks; however, roads can be ecologically catastrophic in terms of disrupting habitat connectivity and facilitating illegal activity (Hopcraft et al., 2015). Studies showed that lack of evidence-informed policy in conservation could lead to bad decision-making for biodiversity conservation (Sutherland and Wordley, 2017). Greater use of scientific evidence increases the likelihood of making better decisions for wildlife conservation. Therefore, using scientific data to design relevant wildlife conservation policies and good governance is a critical issue in sustainable management and utilization of wildlife resources in the country. Lack or poor governance in the management of natural resources has resulted in illegal utilization, overutilization and loss of revenues related to natural resources.

Hence, there is a need for research that will assist in the determination of drivers of poor governance, implementation of policies, and development of appropriate policies and legislation for sustainable natural resources management. Priority

research areas under this theme include (i) Harmonization of conflicting wildlife policies and legislation; (ii) Prospecting and mining of oil, gas and uranium in the protected areas; (iii) Political - ecology in wildlife conservation, trade and trafficking; (iv) Land use planning for supporting livelihoods and conservation goals; (v) Linkages between conservation policies/laws, By-laws and customary laws on conservation and livelihoods; (vi) Consolation scheme policies and legislations; (vii) Governance of infrastructure development in the protected areas; (viii) Community Based Natural Resource Management (CBNRM) in conservation; (ix) Policies and legislations governing conservation and natural resources use; (x) Conservation and corruption and (xi) Fencing policy in protected areas.

2.9 Climate Change and Variability

Objective: Improve understanding on how climate change impacts wildlife conservation as well as ecosystem services and propose rational mitigation measures.

Climate change, also called global warming, refers to the rise in average surface temperatures on earth. The causes of climate change are mainly human activities, specifically increases in anthropogenic greenhouse gas which is disrupting the climate system. Tanzania, like other countries, is impacted by climate change and climate variability. Although the impacts of climate change are global, the most vulnerable are the poor and marginalized people from developing countries who depend on their ecosystem services for livelihood; these are the same people who have the least capacity to mitigate and adapt to climate change (WHO, 2008; Mboera et al.,2011). Long term data has shown that for the past decades, there has been a steady increase in temperature, and extreme weather events especially prolonged drought and floods that have affected almost all sectors of the economy in Tanzania.

Climate change poses fundamental challenges for current approaches to wildlife conservation (Shannon and Kai, 2019). Changing temperature and precipitation regimes are likely to interact with other drivers to impact a range of biological processes and influence species distributions (Anonymous, 2007; Thomas et al., 2004). There is now ample evidence that climate change will affect ecosystem processes including phenology (Root et al., 2003; Parmesan and Yohe, 2003; Menzel et al., 2006), net production (Nemani et al., 2003), and species interaction (Suttle et al., 2007) and species distribution (Walther et al., 2002; Pounds et al., 2006). In Tanzania, extreme weather events have resulted in the death of wildlife during periods of prolonged drought; and that floods have resulted into impairment of tourism infrastructures including bridges, roads and tourist circuits.

Due to climate change, there will be fundamental challenges to current approaches to wildlife conservation, especially in Tanzania, which is characterized by open ecosystems and a network of protected area categories. Therefore, there is a great need to embark on research on climate change and wildlife conservation to understand how Tanzania can manage wildlife and overall biodiversity in the face of climate change.

Research priority areas in the theme of climate change and variability for this wildlife agenda include ecosystem dynamics, adaptation and resilience to effects of climate change; climate change mitigation strategies; climate change and biodiversity in ice and glaciers areas; gender and climate change; gender and wildlife conservation; and climate change and conservation policy.

2.10 Emerging Technologies and Conservation

Objective: Enhance development of technologies that will aid wildlife research and management.

The population of mammals, birds, fish and reptiles has declined by 60% in less than two human generations due to habitat and environmental degradation, poaching and trafficking of wildlife; diseases, invasive species and other human activities (Loh et al. 2018). These anthropogenic activities have hindered the attainment of the Sustainable Development Goal (SGD) 15 to halt biodiversity loss by 2020 (United Nations, 2019) and continue to thwart efforts to protect and restore vital ecosystems and species.

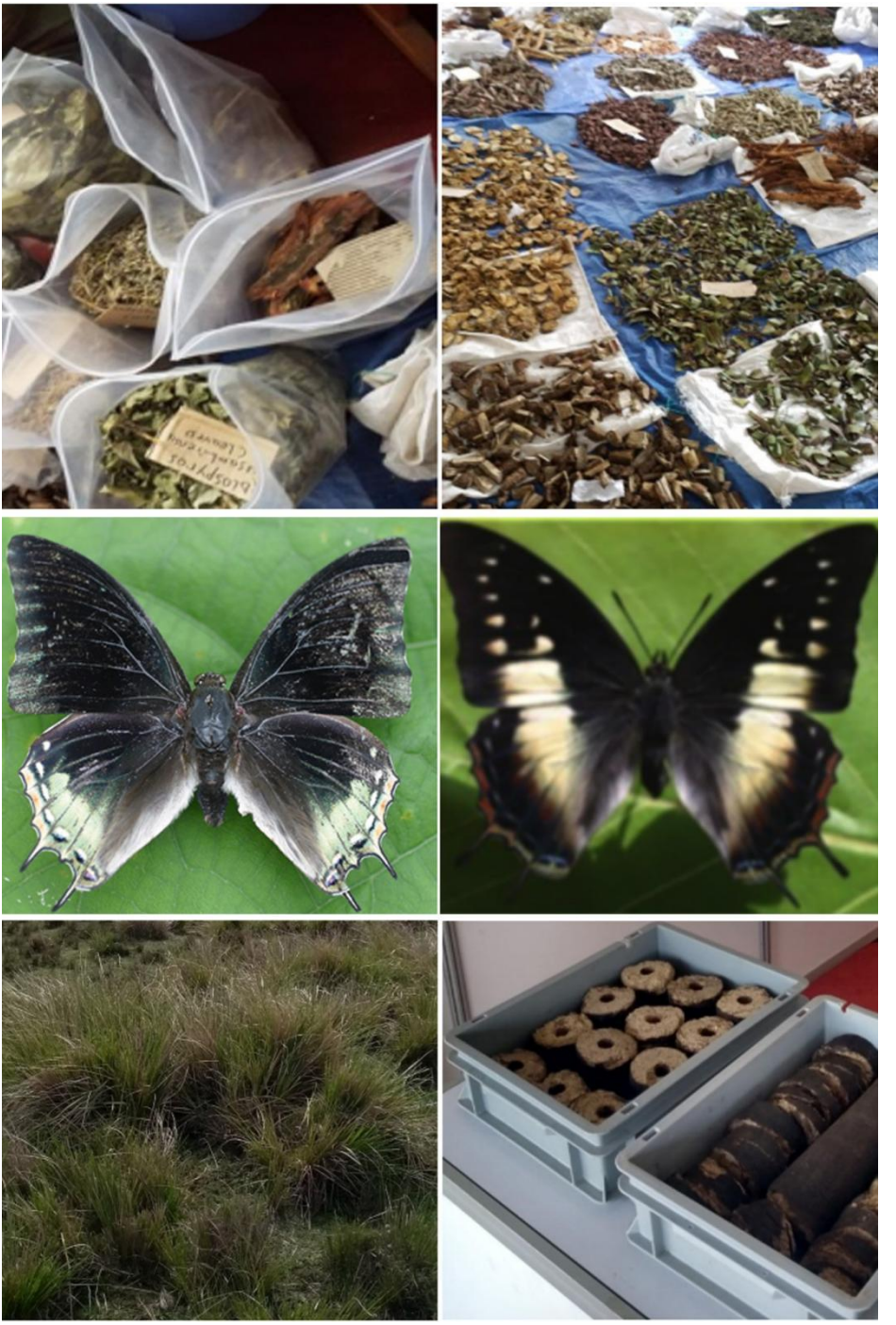
Despite the failure of achieving the SGD 15 target by 2020, there have been some positive developments in innovation and application of new technologies to improve conservation efforts. Such technologies have enabled conservation scientists in identifying individual animals, tracking their movement, and monitoring species, collect data on poachers, animals and habitat, assessing habitat degradation and loss, data on human-wildlife conflicts etc. (Pimm et al., 2015). Using the new technologies, scientists can gather data in locations that are too remote, inhospitable, or unsafe for them to work, and cutting down research expenses. Data generated from these technologies enable scientists to determine factors contributing to declining of species population, habitat degradation and biodiversity loss; spreading of invasive species; increasing/decreasing of human-wildlife conflicts; and the eruption of certain wildlife diseases; and to predict the future of population of wildlife species and level of human-wildlife conflicts. The new technologies, e.g. remote sensing technology, provide data that are more precise and accurate and cover wider geographical areas than data obtained

using traditional methods, thus assisting management decisions and conservation actions.

Although the emerging technologies are improving our conservation efforts by making it easier, faster and cheaper to monitor wildlife species, alone they do not save species. We need to connect technologies with related information so that we have more meaningful information to aid species conservation. For example, we can connect habitat information from sophisticated satellite remote sensing with species occurrence data to predict where species remain (Pimm et al., 2015). Furthermore, there is need to collect and manage a wide range of data in various areas of conservation to help develop creative solutions to meet anticipated future challenges in wildlife conservation (Pimm et al., 2015).

Tanzania, with its economy, may not be able to implement some of the technologies because they are expensive. For example, the price for single second hand Remotely Piloted Aircraft Systems (RPAS) equipment from Spain was 13,750 € (Massawe et al., 2017). Nevertheless, if we are to curb the current massive loss of biodiversity, researchers can engage in collaborative researches to access the application of those technologies and/or develop new ones.

In Tanzania, there are few researches which are applying the new technologies to conserve wildlife, e.g. telemetry and drones which are used to monitor animal movements and keeping away problematic elephants from crop-raiding but in few protected areas. TAWIRI in collaboration with partners in developing technologies for identification of animals from aerial photos (Automated image analysis) and analysis of aerial photos. However, more researches are needed both in the application and development of new technologies into all aspects of wildlife conservation including diseases, human-wildlife conflicts, tourism, policy and governance, invasive species and climate change. But more importantly, we need to establish a big database that will connect all information generated from all other technologies to allow effective and efficient use of the generated information.
Research priority areas under this theme are Telemetry technology for conservation, e.g. radio collar, camera traps; GIS and Remote Sensing for conservation, e.g. Unmanned Aerial Vehicles/Drones for conservation, satellite data imagery; Biotechnology in wildlife (DNA technology); Information Communication Technology in wildlife conservation (Bioinformatics, databases, web-portals); Artificial Intelligence for conservation (detection/sniffer dogs, Automated bioacoustics monitoring devices/sensors); Internet of Things for Conservation (Wireless Sensor Networks; camera traps, online platform and mobile apps); Leaf Technology and Indigenous traditional knowledge.



2.11 Beekeeping and Bee Development

Objective: Enhance beekeeping by conserving bee resources and strengthening its contribution to improved livelihood and socio-economic development.

Tanzania is endowed with over 48.1 million hectares of forests and woodlands whereby about 28.09 million ha (58.4% of all forests) is conserved as either catchments forests or biodiversity hotspots and the remaining 20 million ha (41.6% of all forests) are for utilization i.e., supplying wood demands etc. (NAFORMA 2015). The country harbours a significantly higher number of melliferous plants especially miombo trees (*Brachystegia, Julbernadia, Isoberlinia*, *Combretum*, *Terminalia spp* etc.). These forests offer unique natural ecosystems and habitats for wildlife and also are highly suitable for beekeeping practices (MNRT, 1998). Beekeeping activity plays an important role in conserving the environment and improving the livelihood of local communities. Some of the conservation services from beekeeping include pollination services and the protection of forests through the management of honeybee apiaries (Daniel, 2007; CIFOR, 2008). Also, it helps in poverty alleviation through increased household income and food security by harvesting and selling bee products such as honey and wax (URT, 1998; Ajao and Oladimeji, 2013). These potential roles of beekeeping activity are widely recognized across the world (FAO, 2012; Famuyide et al., 2014). In this regard, the activity has been seriously promoted in various countries including Tanzania and many people have been attracted to engage in beekeeping (FAO, 2012; Famuyide et al., 2014).

The country has high production potential with an estimated 9.2 million honeybee colonies (URT 1998; Kihwele et al., 2001; Latham, 2001), and hence the second in Africa's and the 10thworld's highest producer of natural honey. In 2019, it produced a total of 30,856.00 tons, (FAO, 2003-2021; URT, 2021). Tanzania's honey is naturally organic and of high quality and demand (BTC, 2007), hence, contributing about US$
2.5 million per annum to the national economy and at the same time employing over 2 million people (MNRT, 2019; Tutuba &Vanhaverbeke, 2018). Beekeeping industry plays a major role in socio-economic development and environmental conservation (Mwakatobe &Mlingwa, 2006). Beekeeping plays a valuable part in rural livelihoods and is considered to be an important part of livelihoods to forest dependent people in many developing countries (FAO, 2009; Ntalwila, et al. 2017). Some of the ecosystem services from beekeeping include pollination and forests protection through the management of honeybee colonies and apiaries (Daniel, 2007; CIFOR, 2008). Beekeeping practices help in poverty alleviation through increased household income and ensure food security through the harvesting and selling of bee products such as honey and beeswax (URT, 1998; Ajao & Oladimeji,

2013; Kimaro, et al. 2013). These potential roles are widely recognized across the world (FAO, 2012; Famuyide et al., 2014) and with this regard, the activity has been seriously promoted and many people have been attracted to engage in it (FAO, 2012; Famuyide et al., 2014).

However, the sector is undergoing various challenges including low understanding of appropriate apiculture practices (poor apiary management, improper handling of products and inappropriate equipment); limited number of researches on bee races, product standards, honeybees' resource base, impact from climatic changes and reliable data management.

Research is called upon on bees conservation and their habitats, bee races and their distribution, honeybees colony censuses, bee reserves and their potentials, markets and marketing, ecology and management, hive occupancy/colonization, api-tourism and its establishment, indigenous knowledge, disease, pests/pesticides and predators, climate change, honey processing plants, Invasive plant species, database establishment, and Socioeconomic, policy and extension.

Table 1: Summary of research priority themes and areas for wildlife research in Tanzania ranked according to priority.

	Priority Research Theme	Research Areas	Priority Rank
1	Human wildlife interaction	i) Crop raiding	H
		ii) Livestock predation	H
		iii) Land-use conflict	H
		iv) Harvesting of natural resources (legal and illegal)	M
		v) Human attacks (injury and death)	L
		vi) Cultural values and social economics	M
		vii) Marketing of natural resources products (Flora and Fauna)	H
		viii) Infrastructure damages	L
2	Wildlife ecology and ecological interactions	i) Behavioural and nutrition ecology	M
		ii)Population, distribution and reproductive ecology	M
		iii) Inter-species ecology (Competition, symbiosis, mutualism and	M
		vi) Animal-plant interaction	H
		v) Fire ecology	H
		vi) Range ecology/management and restoration	H
		vii) Population genetics, conservation genetics and wildlife forensics	M
		viii) Plant ecology	M
		ix) Geo-ecology (volcanic, tectonics, etc.)	L
		x) Wildlife Resource ecology	M
		xi) Ecology of alien and invasive species	H
		xii) Microorganism, invertebrate and soil ecology	L
		xiii) Migratory routes, corridors, buffer zones and dispersal areas	H
		xiv) Invertebrates and Pollinators ecology	H
		xv) Ethnobotany/medicinal plants	H
		xvi) Ecological monitoring methods	M
		xvii) Prey-predator interactions	L
3	Wildife population monitoring	i) Population monitoring of large mammals	H
		ii) Population monitoring of Rare, endemic and endangered	M
		iii) Monitoring of small mammals, amphibians, reptiles and entomolog ical species of economic/conservation importance	H
		iv) Ecological monitoring methods and applications	H
		iv) Monitoring of pollinators of economic and conservation importance	H
		v) Tourist hunting and population dynamics	M
		vi) Social, environmental and ecological drivers of population	H
		viii) Wildlife population monitoring methods	M

4	Water resources and wetland conservation	i) Water availability, quantity, quality, safety and pollution	H
		ii) Hydrology, Eco-hydrology and Geo-hydrology	H
		iii) Water resources mapping and management	H
		iv) Social and economic influence on water and wetland resources	M
		v) Water and wetland ecology and biodiversity	M
		vi) Aquatic alien and invasive species	H
		vii) Water abstraction in relation to conservation	H
		viii) Man-made dams and ponds in protected areas	M
		ix) Water use conflict at human-Livestock and wildlife interface	H
5	Tourism development and cultural heritage	i) Tourism and Culture	H
		ii) Tourism and livelihood	H
		iii) Natural and cultural (tangible and intangible) attractions	H
		iv) Archeology and paleontology	H
		v) Dynamics of domestic tourism development	H
		vi) Hospitality, services quality, infrastructure needs and marketing of tourist attraction	H
		vii) Characteristics, preferences, attitudes and opinions of visitors	H
		viii) New markets in tourism sector	M
		ix) Eco-tourism	L
		x) Tourist hunting	H
		xi) Apitourism	H
6	Wildlife diseases and ecosystem health	i) Emerging and re-emerging wildlife diseases of	H
		ii) Ecology, epidemiology and control of wildlife diseases	H
		iii) Zoonotic and epi-zoonotic diseases at the human-wildlife	H
		iv) Prediction, detection and management of wildlife diseases	H
		v) Wildlife diseases diagnostics	M
		vi) Health and welfare of wildlife in captivity (holding grounds,	M
		vii) Health and diseases dynamics associated with	M
		viii) Wildlife diseases pathogens and Biological Resources/ Banks	M
		ix) Trans-boundary diseases of conservation importance and	M
		x)Vector-Parasite dynamics	M
		xi) Impact of climate change on Vectors and diseases ecology	H
		xii) Sexually transmitted (STDs) and other diseases in non-human	H
		xiii) Health programmes for conservation employees	H
		xvi) Host-parasite relationship	H
		xv) One health approach for management of zoonotic diseases	H
		xvi) Wildlife forensic science	H

7	Habitat and biodiversity conservation	i) Habitat diversity and connectivity	H
		ii) Composition, distribution and abundance of Wildlife in Protected Areas and Non-Protected Areas	H
		iii) Biodiversity inventories	H
		iv) Biodiversity and Ecosystem Health Indicators	H
		v) Biodiversity Monitoring	H
		vi) Alien and Invasive species	H
		vii) Conservation policy Analysis	M
		viii) Drivers of Biodiversity Loss	H
		ix) Conservation Education and Awareness	M
		x) Climate change and Biodiversity Conservation	H
		xi) Climate Change and Vegetation Dynamics	H
		xii) Climate Change; and Pollinators and pollination services	H
8	Natural resources, good governance and infrastructure development	i) Harmonization of conflicting wildlife policies and legislation	H
		ii) Prospecting and mining of oil, gas and uranium in the protected areas	M
		iii) Political- ecology in wildlife conservation, trade and trafficking	M
		vi) Land use planning for supporting livelihoods and conservation	H
		v) Linkages between conservation policies/laws, By-laws and customary laws on conservation and livelihoods	H
		vi) Consolation scheme policies and legislation	H
		vii) Governance of infrastructure development in the protected	H
		viii) Community-Based Natural Resource Management (CBNRM)	M
		ix) Policies and legislation governing conservation and natural	M
		x) Conservation and corruption	M
		xi) Fencing of protected areas	M
		xii) Gender Mainstreaming around protected areas	M
		xiii) Infrastructure development in protected areas	H
9	Climate change and variability	i) Ecosystem dynamics, adaptation and resilience to climate	H
		ii) Climate change and biodiversity conservation-move to biodiversity	H
		iii) Climate change; and pollinators and pollination services-move to habitat and conservation service	H
		iv) Climate change mitigation strategies	H
		v) Climate change and biodiversity in ice and glaciers areas	M
		vi) Carbon emission and sequestration	M
		vii) Climate change and water resources-move to water resources	H
		viii) Climate change and ecological interactions	H
		ix) Climate change and vegetation dynamics	H
		x) Climate change and human-wildlife interactions	H
		xi) Gender and climate change	H
		xii) Gender and wildlife Conservation	H
		xiii) Climate change and conservation policy	M

10	Emerging technologies and conservation	i) GIS and remote sensing for conservation (Unmanned Aerial Vehicles/Drones)	H
		ii) Telemetry technology for conservation	H
		iii) Camera traps, Infrared/digital, thermal imaging sensors	H
		iv) Automated bio-acoustics monitoring devices/sensors	M
		v) Detection science/sniffer dogs for conservation (detection of ammunition, snares, humans, chemicals, and invasive plants,	L
		vi) Leaf technology for conservation	M
		vii) Bio-informatics in wildlife conservation	H
		viii) Molecular technology in wildlife conservation	H
		ix) Internet of Things (IoT), Artificial Intelligence, Machine Learning and Mega data	H
		x) Mobile, Internet and Web Technologies	H
		xi) Reverse Engineering for Conservation technologies	H
		xii) Emerging technologies for research and conservation	H
11	Beekeeping and bee development	i) Conservation and habitats	H
		ii) Bee races and distribution	M
		iii) Honeybees colony census	H
		iv) Bee reserves and their potentials	H
		v) Market and marketing	H
		vi) Ecology and management	M
		vii) Hive occupancy/colonization	H
		viii) Apitourism and its establishment	H
		ix) Indigenous knowledge	L
		x) Diseases, pests, pesticides, and predators	H
		xi) Climate change	H
		xii) Honey processing plants	M
		xiii) Invasive plant species	H
		xiv) Database establishment	H
		xv) Socioeconomic, policy, and extension	L

3.0 Implementation strategy and coordination arrangements

3.1 Implementation Strategy

An implementation strategy is important for the achievement of the intended objectives of the Tanzania Wildlife Research Agenda. The implementation of the research agenda is the responsibility of all stakeholders; although the overall implementation, coordination, monitoring and evaluation is vested to TAWIRI. Among others, the first group of stakeholders during implementation of the research agenda includes the Ministry of Natural Resources and Tourism (MNRT), Management authorities namely Tanzania National Parks (TANAPA), Ngorongoro Conservation Area Authority (NCAA), Tanzania Wildlife Management Authority (TAWA); Regional Administration and Local Government Authorities (RALG) and sectoral Ministries. These stakeholders will be responsible for supporting of research activities, use of research findings, and provision of issues or conservation challenges that need research. The second group of stakeholders includes research institutions, academic institutions and the Tanzania Commission for Science and Technology (COSTECH). These stakeholders will be responsible for conducting wildlife research, communication of research findings, training of wildlife researchers, soliciting research funds as well as coordination of research activities. The third group of stakeholders includes Development partners, the International Community, Private sector, Non-Government Organizations (NGOs) and the Media; which will be responsible for funding and supporting research activities, offering scientific expertise, collaboration in research activities, as well as communicate research findings. Indeed, many other stakeholders are very valuable during the implementation of the research agenda, it is not possible to mention everyone, but all of them are invited together with the general public as their role towards successful implementation of the agenda is very important. The most important requirement for the implementation framework is the availability of research funds for the various research themes and priority areas as well as the availability of adequate researchers in terms of number and research skills. In this regard, all stakeholders are invited to contribute towards the required resources for the implementation of the research agenda.

The total budget for implementation of this Research Agenda for a period of ten years is 110,388,891,375 Tanzanian shillings; which is an average of 11,038,889,137.50 Tanzanian Shillings every financial year (Table 2). In this regard, we call upon all Management Authorities, Development Partners, Conservation Organisations and other stakeholders to contribute funds towards achievement of implementation

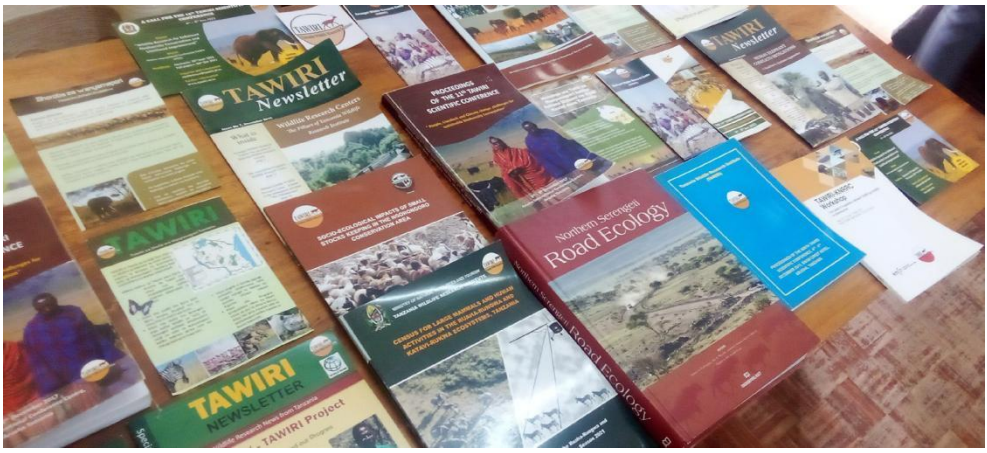
of this research agenda. The success of which will significantly contribute to sustainable wildlife management through informed decision making.

3.2 Coordination of Implementation

The overall coordination of research activities for the various themes and priority areas will be vested to TAWIRI. Due to its mandate, TAWIRI will be responsible for receiving research proposals for wildlife research in the country for various priority areas, conduct scrutinization of research project proposals through the Joint Management and Research Committee (JMRC), which is TAWIRI Research Ethics Committee (TAWIRI-REC) and the Research Programme Committee (RPC) of thew TAWIRI Board before approval by the TAWIRI Board for research ethics clearance and later a research permit from COSTECH after decision from the National Research Registration Committee (NRRC). TAWIRI will maintain a database of wildlife research in the country in terms of project title, names of researchers, research area(s), objectives, and methods being used. The wildlife research database will help to know the number of research projects, reduce overlap of research activities, avoid duplication of research projects, as well as assist in determining coverage of research projects across research themes and research areas for monitoring and rapid response to address themes or areas attracting few research projects. TAWIRI will conduct regular field coordination trips for assessing the conduct of research activities, compliance of researchers, as well as dissemination and use of research results by stakeholders.

3.3 Dissemination of Research Findings

According to Section 5 of TAWIRI's Act No. 4 of 1980, among the functions of the Institute is to establish and operate a system of documentation and dissemination of the findings of inquiries, experiments and research carried out by or on behalf of the Institute, or other information on wildlife acquired by the Institute. TAWIRI will contribute to enhanced quality and dissemination of research findings by ensuring proper project formulation, research data management, laboratory standards, scientific standards and community acceptability of research, knowledge management and capacity building for sustainable development of wildlife resources. According to the TAWIRI Act, all wildlife researchers are required to furnish the institute with data and information regarding wildlife research to influence policy and informed decision-making among management authorities. Dissemination of research findings for all themes and priority areas of the research agenda will follow the TAWIRI Information Communication and Dissemination Strategy.



The tools developed for enabling dissemination of information will include the TAWIRI Website, Newsletters, Policy briefs, Scientific conferences and technical books with key research findings. Other tools of information dissemination will include research documentaries, national public promotional events, press release and press conferences, social media, journal articles, conference proceedings, Mass media, Newspapers, seminars and workshops, stakeholders' workshops and community sensitization and feedback meetings.

4.0 Monitoring and Evaluation of the Agenda

4.1 Monitoring and Evaluation

Monitoring and evaluation (M&E) is an important management tool that is used to follow up or find out if the research agenda is being implemented accordingly; and therefore, it will be used to assess if every research theme and priority areas under each theme are equally served by researchers to meet desired impact(s). The M&E will also be used to analyze, measure and detect any deviation from the agreed themes and research areas and where there is a need for adjustment; an appropriate and timely action will be taken. Monitoring and evaluation of the agenda will be carried out progressively and reports submitted to TAWIRI Management and Board of Directors every year.

To inform and appraise stakeholders on the progress made towards implementation and overall performance of the research agenda, regular performance reviews will be conducted and results incorporated during the preparation of annual reports for feedback to stakeholders. Performance indicators will be developed to enable monitoring and evaluation of research activities for each priority theme as well as research areas. Monitoring indicators will include research projects conducted for each research theme, research priority area, study area, wildlife species involved, as well as capacity building for each thematic area.

To implement M&E, TAWIRI will establish an M&E focal point for the research agenda to ensure its effective implementation. The M&E focal point will use baseline data from minutes of the JMRC (the TAWIRI-REC), reports of the Research Program Committee (RPC), Institute annual research budget, Institute annual reports, and other reports to analyze research themes, research areas and study areas for each research project. The desk officers will then compile monitoring reports and submit them to the Directorate of Research Development and Coordination for validation and onward transmission to the Management and the Board.

4.2 Evaluation of the Research Agenda

To evaluate the research agenda in terms of relevance, effectiveness, efficiency, impact, sustainability and lessons learnt; two evaluation missions will be conducted, mid-term and final evaluation. The mid-term evaluation will be conducted after five years, results of which may necessitate some minor revision or adjustment of priorities to accommodate emerging conservation challenges within the five years. Final evaluation of the research Agenda will be conducted after ten years of implementation of the Agenda. The final evaluation process will consider emerging conservation issues that have not been addressed by the Agenda, lessons learnt and challenges that might have affected the successful implementation of the research agenda. The final evaluation report will be the base for the formulation of a fourth revised edition of the Tanzania Wildlife Research Agenda; which will again be led by the Tanzania Wildlife Research Institute in collaboration with stakeholders.

Table 2: Budget for implementation of the Research Agenda from 2023/24 – 2032/33 (in Tanzanian Shillings)

AGENDA THEMATIC AREA	BUDGET FOR IMPLEMENTATION OF THE RESEARCH AGENDA FROM 2023/24 - 2033/34 (IN TZS)									
	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/30	2031/32	2032/33
Human Wildlife Interactions	1,008,508,428	1,058,933,849	1,101,291,203	1,134,329,939	1,157,016,538	1,168,586,703	1,180,272,570	1,192,075,296	1,203,996,049	1,216,036,009
Wildlife Ecology & Ecological interactions	2,765,273,481	2,903,537,155	3,019,678,641	3,110,269,001	3,172,474,381	3,204,199,124	3,236,241,116	3,268,603,527	3,301,289,562	3,334,302,458
Wildlife Population Monitoring	1,200,000,000	1,260,000,000	1,310,400,000	1,349,712,000	1,376,706,240	1,390,473,302	1,404,378,035	1,418,421,816	1,432,606,034	1,446,932,094
Habitat and biodiversity Conservation	1,496,513,251	1,571,338,914	1,634,192,471	1,683,218,245	1,716,882,610	1,734,051,436	1,751,391,950	1,768,905,869	1,786,594,928	1,804,460,877
Tourism Development and Cultural Heritage	1,008,508,428	1,058,933,849	1,101,291,203	1,134,329,939	1,157,016,538	1,168,586,704	1,180,272,570	1,192,075,296	1,203,996,049	1,216,036,010
Wildlife Diseases and Ecosystem Health	520,503,604	546,528,784	568,389,936	585,441,634	597,150,466	603,121,971	609,153,191	615,244,723	621,397,170	627,611,142
Water Resources and Wetland Conservation	65,062,951	68,316,098	71,048,742	73,180,204	74,643,808	75,390,246	76,144,149	76,905,590	77,674,646	78,451,393
Natural Resources Policies and Good Governance	357,944,313	375,841,528	390,875,189	402,601,445	410,653,474	414,760,009	418,907,609	423,096,685	427,327,652	431,600,928
Climate Change and Variability	260,251,802	273,264,392	284,194,968	292,720,817	298,575,233	301,560,985	304,576,595	307,622,361	310,698,585	313,805,571
Emerging Technologies & Conservation	1,000,000,000	1,050,000,000	1,092,000,000	1,124,760,000	1,147,255,200	1,158,727,752	1,170,315,030	1,182,018,180	1,193,838,362	1,205,776,745
Beekeeping & Bee Development	65,062,951	68,316,098	71,048,742	73,180,204	74,643,808	75,390,246	76,144,149	76,905,590	77,674,646	78,451,393
Total	9,747,629,208	10,235,010,668	10,644,411,095	10,963,743,428	11,183,018,296	11,294,848,479	11,407,796,964	11,521,874,934	11,637,093,683	11,753,464,620

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