RCMRD VISION 2050

Shaping the future of Geospatial Industry.

RCMRD

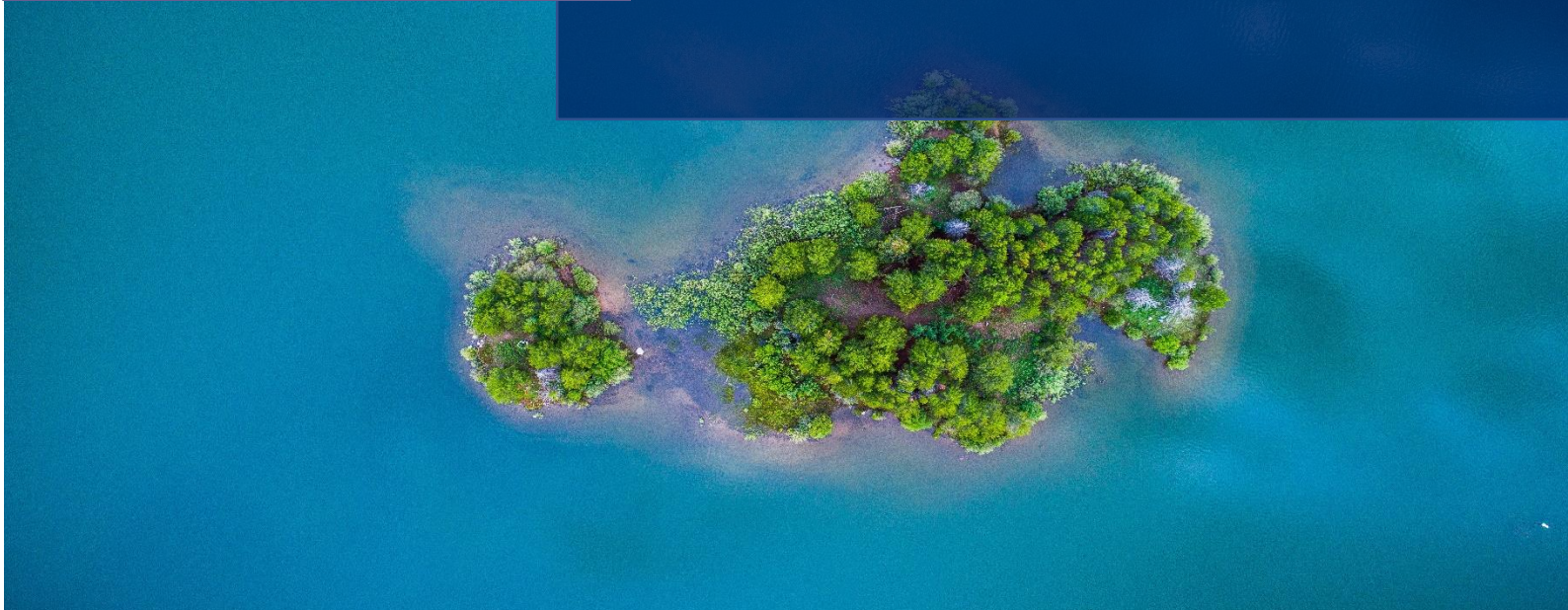

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AARSE	African Association of Remote Sensing of the Environment
ACFTA	African Continental Free Trade Area
AERC	Africa Economic Research Consortium
AFDB	African Development Bank
AFREF	African Geodetic Reference Frame
AFRIGIST	African Regional Institute for Geospatial Information. Science and Technology
AGCOM	Autorità per le Garanzie nelle Comunicazioni
AGRA,	Alliance for a Green Revolution in Africa
AGRHYMET	Agriculture, Hydrology, Meteorology Research Center
AI	Artificial Intelligence
ALPC	The African Land Policy Centre
ASEAN	Association of Southeast Asian Nations
AU	African Union
AUV	Autonomous underwater vehicle
BIOPAMA	The Biodiversity and Protected Areas Management
CBD	Central Business District
CHIRPS	Climate Hazards center InfraRed Precipitation with Station data
CILSS	Comité permanent Inter-Etat de Lutte Contre la sécheresse dans leSahel
CoM	Conference of Ministers
COMESA	Common Market for East and Central Africa
DRC	Democratic Republic of Congo
EAC	East African Community
EO	Earth Observation
EU	European Union
FAO	Food and Agriculture Organization
GC	Governing Council
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite System
ICDL	International Computer Driving License
ICPAC	IGAD Climate Prediction and Applications Centre

ICT	Information and Communication Technology
IEC	International Electro technical Commission
IGAD	Intergovernmental Authority on Development
IMF	International Monetary Fund
IT	Information Technology
ITC	International Trade Centre
KNEC	Kenya National Examination Center
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NDMA	National Disaster Management Authority
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental organizations
OSS	Sahara & Sahel Observatory
RCRMD	Regional Centre for Mapping of Resources for Development
RCTI	Regional Centre Training Institute
RECTAS	Regional Centre for Training in Aerospace Surveys
SADC	Southern African Development Community
SAR	Specific Absorption Rate
SQM	Square Meters
TC	Technical Committee
TVET	Technical and Vocational Education and Training
TVETA	Technical and Vocational Education and Training Authority
UAV	Unmanned aerial vehicle
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFAO	United Nations Food and Agriculture Organization
USAID	United States Agency for International Development
VGI	Video Graphics Interface
WHO	World Health Organization

EXECUTIVE SUMMARY

The Regional Centre for Mapping of Resources for Development (RCMRD), previously known as Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS) was established in Nairobi, Kenya in 1975 under the auspices of the United Nations Economic Commission for Africa (UNECA) and the then Organization of African Unity (OAU), now the African Union (AU).It is mandated to provide services to the member States in the fields of surveying, mapping, remote sensing, Geographical Information System, Global Positioning System and in natural resources and environmental management.

RCMRD Vision 2050 was created after identification of core priorities that will not only support growth but long-term sustainability of the Centre beyond the year 2050 but also support the achievement of the aspirations of the member States and key stakeholders. This Vision is aligned to AU Agenda 2063 (The Africa we want), UN vision 2030 and SDGs, RECs priorities areas and aspirations of member States (as identified in EAC Vision 2050, SADC Vision 2050, IGAD and COMESA secretariat Aspirations), and emerging socio-economic dynamics (globally, regionally and nationally) affecting geospatial industry.

The RCMRD vision 2050 is anchored on Centre's vision to "*be a Premier Centre of Excellence in the provision of geo-information and allied technologies for Sustainable Development in the Member States and other stakeholders".* To realize this vision, the Centre has identified the following key aspirations that will shape the future of the Centre; *Growth and Expansion of RCMRD, Sustainable Urban Planning & Infrastructure Development, Modernized Land Administration Management & Earth Observation, Disaster Management, Weather & Climate Change, and Agriculture, Food Security & Poverty Eradication.* The enablers for achieving Vision 2050 were identified as Adoption of Modern Geospatial & 4IR Technologies, Cloud Storage, Information Sharing & Dissemination, Collaborative Partnerships in Research & Development, and Membership support & Good governance.

RCMRD Vision 2050 aspires to shape the geospatial industry in the region and indeed Africa and was developed through a participatory approach that considered the expectations and inputs from members of staff, key stakeholders and member States.

The Vision 2050 will create a pathway for realization of the new agenda for the Centre that will propel its growth and future sustainability.

CHAPTER 1: BACKGROUND INFORMATION

1.1 INTRODUCTION

The Regional Centre for Mapping of Resources for Development (RCMRD), previously known as Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS) was established in Nairobi, Kenya in 1975 under the auspices of the United Nations Economic Commission for Africa (UNECA) and the then Organization of African Unity (OAU) presently the African Union (AU). Its founder members are Kenya, Uganda, Somalia, Tanzania and Malawi and the Government of the Republic of Kenya hosts it. It is a non-profit intergovernmental organization.

RCMRD was set up as a sub-regional non-profit intergovernmental institution in the belief that substantial cost-effectiveness could be achieved by complementing common facilities and services in surveying, mapping and remote sensing with a view to enabling the member States to derive greater benefits. The Centre's current contracting Member States are Botswana, Burundi, Comoros, eSwatini, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Namibia, Rwanda, Seychelles, Somalia, South Africa, South Sudan, Sudan, Tanzania, Uganda, Zambia and Zimbabwe. Its Non-Contracting Member States are Angola, DRC, Djibouti, Eritrea, Madagascar, and Mozambique.

The **mandate** of the Regional Centre for Mapping of Resources for Development (RCMRD) is "*To provide capacity building; advisory services; implement programmes, and undertake Research & Development of innovative solutions and services on geo-information and allied technologies to Member States and other stakeholders*".

The **Vision** of the Centre is *"To be a Premier Centre of Excellence in the provision of geo-information and allied technologies for Sustainable Development in the Member States and other stakeholders".*

The **Mission** of the Centre is *"To Strengthen the Member States and our stakeholder's capacity through Generation, Application and Dissemination of Geo-information and Allied Technologies for sustainable development".*

The core values for RCMRD are as follows;

i) *Team Work*; Driven by team spirit and a sense of belonging through the pursuit of collaborations and synergy.

ii) *Customer Focus*; Committed to the effective and efficient delivery of quality and appropriate services/products to all our stakeholders.

iii) *Stakeholders Engagement*; proactively and continuously engage our stakeholders and users for relevance and value proposition.

iv) *Innovation and creativity*: Continuously improve our operations and add value to our stakeholders by embracing and pursuing innovative and creative solutions.

v) *Accountability & Transparency*; Uphold professionalism, integrity, honesty, and ethical practices in all our programs and operations.

vi) *Equity & Inclusiveness*; embracing value for people by treating our staff and our stakeholders with respect and dignity while appreciating their diversity.

To realize its mandate and improve performance and enhance growth, RCMRD is focusing on the following strategic issues;

- Enhance stakeholder engagement and increase relevance to stakeholders through the raising of RCMRD profile
- Enhancing institutional capability and competence to deliver on its mandate and emerging stakeholder needs.
- Develop a robust resource mobilization framework for financial sustainability.
- Develop and maintain an up-to-date infrastructure that can enhance staff work environment to execute the Centre's mandate effectively and efficiently.
- Offer relevant and impactful geo-spatial innovations and solutions to diverse stakeholders.
- Establish an effective and reliable knowledge management system that can enhance Centre's capacity and capability to deliver on its mandate.

1.1.1 Centre's Vision 2020

The Centre's 2020 Vision was adopted and ratified for implementation by the 31st Governing Council meeting held from 4th - 5th Dec 1997, in Nairobi Kenya, the following are the objectives of the Centre;

a) To generate natural resources and environmental information using appropriate technologies such as surveying, mapping, remote sensing, etc.; organize this information into suitable formats, readily available for immediate use for development purposes;

b) To advise on the options and the optimum applications in the use of resource and environment information for development and the implications of the different types of information on the national and the regional development processes;

c) To provide services in the calibration and maintenance of surveying, mapping and other equipment and hardware utilized in resource mapping and environmental monitoring; and to advise on the acquisition, procurement and use of such equipment in national resource mapping and environmental projects;

d) To transfer new technologies in resource mapping and environment monitoring to Member States by way of conducting training, seminars, workshops, as well as providing technical backstopping services;

e) To carry out studies and research into new technologies and techniques of resource mapping and environment management and make available to the contracting parties the results of such studies and research;

f) To provide advisory services on the problems relating to resource mapping and environmental management to the Governments of the member States and their agencies;

g) To establish and maintain an operational networking info-structure to facilitate the provision of these services to their Member States whilst enhancing the accessibility and exchange of information within and between the member States.

1.2 RATIONALE OF VISION 2050

The Centre has over the years been guided by Centre's 2020 Vision adopted and ratified for implementation by the 31st Governing Council meeting held from 4th - 5th Dec 1997, in Nairobi. Over the past years, Member State's expectations and other key stakeholders have been changing and evolving over time requiring a new Vision. The new Vision 2050 comes at an opportune time when the global socio-economic dynamics have shifted to address the challenges presented by COVID-19 pandemic and innovating on new ways to adopt to the 'new normal'.

Vision 2050 takes into consideration the current Centre's capabilities and Member States evolving long-term expectations to create synergies and advance the growth of the Centre beyond 2050. The Vision 2050 for RCMRD is intended to act as a benchmark and basis for the long-term aspirations of the Centre. The Vision will identify new strategic thrusts and key pillars that will help RCMRD realize its mandate and exceedingly surpass the expectations of its Member States.

1.3 METHODOLOGY AND APPROACH

The methodology used for the preparation of this document was highly consultative to enable understand the salient issues regarding the Centre's situation and expectations through inputs obtained from key staff, management, and member States and other key stakeholders. The methodology employed interviews, consultations and discussions to get broad views and input.

A review of important background documents provided by the RCMRD including Centre's Vision 2020, past and current strategic plans amongst other enabled to gain a deeper understanding of the current gaps, critical issues and identifying underlying pertinent issues that needed to be considered during the entire assignment that the Vision should address to enhance growth, sustainability and long-term continuity of the Centre.

A consultative approach was employed to enable the consultant to understand the salient issues regarding Centre's situation and expectations through inputs obtained from key stakeholders including members of staff, management, partners and Member States amongst others.

CHAPTER 2: SITUATIONAL ANALYSIS

2.0 INTRODUCTION

RCMRD plays a critical role in helping Member States and Africa as a whole in development and implementation of solutions/interventions in Geospatial Information, remote sensing, mapping and surveying of resources for inclusive growth and sustainable development.

RCMRD headquarter occupy a 6.112ha piece of land located in Kasarani, within Nairobi, the capital city of Kenya. The headquarter features the new Administration Complex, old office block, RCTI, and Student Cafeteria. The Centre also has another undeveloped piece of land measuring 4.047ha located in Kajiado County in Kisamese.

To deliver on its mandate and accomplish the objectives stated above, the Centre undertakes the following core functions:

- Resource mapping and surveying.
- Environmental management and impacts assessment.
- Research and Development.
- Early warning and disaster management.
- Dissemination of geospatial data.
- Project implementation and advisory services.
- Training/capacity building in geo-information and basic information technology.
- Maintenance and repair of surveying and mapping equipment.

This situational analysis provides a constructive mechanism for evaluating and rationalizing the strategic focus of the Centre in pursuit of its vision and implementation of its core mandate. The analysis is expected to increase the Centre's understanding of major regional and global trends, including the focus on how these trends are likely to affect the long-term future of the Member States and Africa at large.

2.1 UN AGENDA 2030

Adopted by all UN Member States at the United Nations Sustainable Development Summit in New York on 25 September 2015, the 2030 Agenda for Sustainable Development is the global sustainable development action plan. Agenda 2030 is a transformational vision of the world "resolve to free the human race from the tyranny of poverty and want and to heal and secure our planet". The 2030 Agenda features 17 Goals known as the Sustainable Development Goals (SDGs) and 169 targets, designed to instigate action on issues of "critical importance for humanity and the planet". It encompasses the three core dimensions of sustainable development: economic, social and environmental, and includes areas such as poverty, education, healthcare, sustainable energy, human rights, equality and sustainable consumption patterns.

The Agenda 2030 builds upon multilateral development plans and commitments developed over the past decades and the Millennium Development Goals (MDGs) that had guided global development efforts since the year 2000, and was first conceptualized at Rio+20, the 2012 UN Conference on Sustainable Development in Rio de Janeiro. The MDGs initiated a global effort to tackle poverty through the establishment of measurable objectives for addressing poverty, disease and a wide range of other development issues and was applied to developing countries. The MDGs were constructed under the premise of richer donor countries providing official development assistance (ODA) to poorer countries to fund the goals, with many ODA obligations not met. The SDGs, universal and applicable to all countries, will be financed by a global framework developed to align financial flows and policies with economic, social and environmental priorities. The SDGs are intended to build upon the progress of the MDGs, completing unfinished work in areas such as poverty, health and food security. However, there are more encompassing, including a wider range of economic, social and environmental objectives, whilst also including a defined means of implementation in the Addis Ababa Action Agenda (AAAA) that was absent from the MDGs.

While the SDG targets are defined as global, governments are expected to implement them within the context of their own states', individual circumstances and synchronization between global and national/regional objectives. Through this process the SDGs were able to better reflect the African development priorities as highlighted

in the Common African Position on the Post-2015 Development Agenda (CAP). As reflected in the SDGs and the final version of Agenda 2030, the CAP states that the Post-2015 Development Agenda should "enhance Member States' ownership of development; generate the required political will to address the unfinished business of the MDGs; and respond to the emerging issues and gaps in implementation, particularly with regard to data collection and monitoring". The CAP also outlines six key pillars of Africa's development priorities including: structural economic transformation and inclusive growth; science, technology and innovation; People-centred development; Environmental sustainability, natural resources management, and disaster risk management; peace and security; and finance and partnerships. These six key pillars overlap with the core functions and mandate of RCMRD.

2.2 AU AGENDA 2063

Agenda 2063 is a 50-year strategic framework with the main objective of guiding Africa's development for the next half-century and to achieve the vision of The Africa We Want. Agenda 2063 is aimed at being Africa's blueprint and master plan for transforming the continent into the global powerhouse of the future. It is the continent's strategic framework that aims to deliver on its goal for inclusive and sustainable development and is a concrete manifestation of the pan-African drive for unity, self-determination, freedom, progress and collective prosperity pursued under Pan-Africanism and African Renaissance.

AU's Agenda 2063 is a universal framework produced through extensive consultations and aiming at common objectives and aspirations in key areas of sustainable development in economic, social and environmental agendas. The Goals, Targets and Priority Areas of AU Agenda 2063 and the Goals and Targets of Agenda 2030 overlap in broad areas of convergence such as: human development (poverty eradication, education, health), sustainable economic opportunity (transforming economies, infrastructure and rural sector), gender equality and youth empowerment, peaceful and inclusive societies, accountable institutions, justice and environmental sustainability.

According to AUDP- NEPAD, Africa's main challenge for the next 50 years is the realization of the AU vision of "building an integrated, prosperous and peaceful Africa, driven by its own citizens representing a dynamic force in the international arena".

Agenda 2063 has provided a shared strategic framework for inclusive growth and sustainable development by Africa States and is anchored on the AU vision and is based on the seven aspirations namely:

a. A prosperous Africa based on inclusive growth and sustainable development;
b. An integrated continent, politically united, based on the ideals of Pan Africanism and the vision of Africa's Renaissance;
c. An Africa of good governance, respect for human rights, justice and the rule of law;
d. A peaceful and secure Africa;
e. An Africa with a strong cultural identity, common heritage, values and ethics;
f. An Africa whose development is people-driven, relying on the potential of African people, especially its women and youth, and caring for children; and
g. Africa as a strong, united, resilient and influential global player and partner.

AU Member States and RECs are required to realign their priorities to include Agenda 2063 in the following areas; Sustainable and Inclusive Economic Growth; Human Capital Development; Agriculture/ value addition Agro-business; Industrialization / Manufacturing and value additions to natural resources; Employment Generation; Social Protection; Gender / Women's Development and Youth Empowerment; Good Governance, including capable institutions; Infrastructural development; Science, Technology and Innovation; Peace and Security; and Culture, Arts and Sports.

The emergence of Africa Free Trade Area (AfCFTA) which was launched in Kigali, Rwanda, on 21 March 2018, with 44 out of Africa's 55 countries signing the agreement establishing the free trade area presents an opportunity for further integration of the Africa Continent focused on increased intra-Africa trade. Many studies carried out have indicated that successful implementation of AfCFTA would help integrate Africa's significant informal trade into the formal sector and drive the development of regional value chain. Furthermore, this provides a unique opportunity for more partnerships

and collaboration of RCMRD with other development partners and other players leveraging on AfCFTA with a population of 1.2bn and a combined GDP of $3.4 trillion.

The United Nations Economic Commission for Africa (UNECA) supports the African Union Commission in monitoring the implementation of Agenda 2063.

RCMRD has continued to play a critical role in the implementation of AU agenda through partnership and collaboration with NEPAD, AfDB, RECs and Member States.

2.3 REGIONAL ECONOMIC BLOCKS

The Regional Economic Communities (RECs) are regional groupings of African states. The RECs have developed individually and have differing roles and structures. The main purpose of the RECs is to facilitate regional economic integration between members of the individual regions and through the wider African Economic Community (AEC), which was established under the Abuja Treaty (1991). The 1980 Lagos Plan of Action for the Development of Africa and the Abuja Treaty proposed the creation of RECs as the basis for wider African integration, with a view of enhancing regional and eventual continental integration. The RECS are increasingly involved in coordinating AU Member States' interests in wider areas such as peace and security, development and governance.

The RECs are closely integrated with the AU's work and serve as its building blocks. AU recognises eight RECs, namely: Arab Maghreb Union (UMA); Common Market for Eastern and Southern Africa (COMESA); Community of Sahel–Saharan States (CEN–SAD); East African Community (EAC); Economic Community of Central African States (ECCAS); Economic Community of West African States (ECOWAS); Intergovernmental Authority on Development (IGAD)2; and Southern African Development Community (SADC).

Currently, all the RCMRD Member States are from Eastern, Central and Southern Africa. The diverse regional and political orientation amongst the Member States and different membership in different Regional Economic blocks such as EAC, SADC, COMESA, IGAD, with competing priorities and interests requires the Centre to adopt a wholistic approach in the execution of its strategies and operations.

2.3.1 Southern African Development Community (SADC)

The Southern African Development Community (SADC) was founded and maintained by countries in Southern Africa and aims to further socio-economic, political, and security cooperation among its Member States and foster regional integration in order to achieve peace, stability, and wealth. SADC has fifteen (15) members, namely; Angola, Botswana, DR Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, eSwatini, United Republic of Tanzania, Zambia, and Zimbabwe.

SADC Vision 2050 is expressed in three pillars; Industrial Development and Market Integration, Infrastructure Development in Support of Regional Integration, and Social and Human Capital Development. To achieve vision 2050, member countries are committed; to creating an industrialized regional economy by leveraging science, technology, and innovation; transformed agricultural sector that practices sustainable management of the environment and its natural resources; and interconnected, integrated, competitive Blue, Green, and Circular Economies that are sustainably developed for the benefit of all SADC citizens amongst other things.

SADC also aspires to by 2050 to have efficient and effective, technologically-driven cross-border infrastructure services and networks to support and facilitate deeper regional integration. SADC aspires to have a high quality of life, in which its citizens are well educated and enjoy long, healthy, and productive lives that reinforce the link between economic growth and sustainable human development, in order to end poverty in all its forms. This strong and inclusive human capital base will enable SADC citizens to play a pivotal role in the region's socio-economic development, through enhanced productivity.

One of its aspirations is to Improve food and nutrition security for the socio-economic well-being of people in the region as well enhancing living conditions of the people through the promotion of sustainable cities in the region. The block envisions Strengthened climate change, adaptation, and mitigation; Improved disaster risk management in support of regional resilience; Sustainable utilisation and conservation of natural resources and effective management of the environment amongst other cross cutting issues.

SADC Vision 2050 is complementary to the United Nations' 2030 Agenda for Sustainable. Development, and the African Union's (AU) Agenda 2063 and its flagship projects and continental frameworks. Through strategic partnership and collaboration with institutions such as RCMRD, the member States who are members of SADC have a unique opportunity to advance their technical expertise in GIS and Remote Sensing technology for implementation and realization of SADC Vision 2050.

2.3.2 East African Community (EAC)

The East African Community (EAC) was initiated in 1999 as the regional inter-governmental organisation of the five East African countries. Article 5 of the Treaty for the Establishment of the East African Community states that the objectives of the community shall be "to develop policies and programmes aimed at widening and deepening co-operation among the Partner States in political, economic, social and cultural fields, research and technology, defense, security and legal and judicial affairs, for their mutual benefit". The EAC countries established a Customs Union in 2005 and a Common Market in 2010. EAC aims to create a monetary union as the next step in integration and ultimately become a political federation of East African States. Currently, EAC has six (6) members, namely; Burundi, Kenya, Rwanda, Uganda, United Republic of Tanzania and South Sudan.

EAC developed EAC vision 2050 in August 2015. The EAC Vision 2050 articulates the dreams and aspirations of the East African peoples and makes a commitment to what they will do to achieve these dreams. It follows closely on the development of the African Union Agenda 2063 which articulates the aspiration of all the people of the African continent.

The Vision 2050 lays out a broad East Africa's perspective in which the region optimizes the utility of its resources to narrow the gap in terms of social wellbeing and productivity. The Vision 2050 pinpoints the rationale as that of proving catalyst for the region to enhance transformation for growth and development and move the community to higher income cohort and subsequently achieving an upper middle-income status. By creating conducive environment for investment, coupled with effective institutional capacities, the region will expand its production capacity and

widen its exports, both by composition and value. With effective resource management, it is envisaged that East Africans will be prosperous, competitive, secure and politically united region.

The Vision 2050 focuses on initiatives that will create gainful employment to the economically active population. The identified pillars and enablers are integral to the very idea of long-term transformation, value addition and growth needed for accelerating momentum for sustained growth over the long term. They include infrastructure and transport network that is easy, fast and cheap means both for people and goods for regional competitiveness; energy and information technology that are accessible to citizens; and industrialization that is built on structural transformation of the industrial and manufacturing sector through high value addition and product diversification based on comparative and competitive advantages of the region.

The vision also puts emphasis on agriculture and rural development that is based on improved agricultural practices including mechanization, irrigation, improved seeds and use of fertilizers among others, in order to ensure increased productivity for food security as well as economic prosperity for the citizenry.

The vision identified effective natural resource management with enhanced value addition as high priority coupled with human capital development aimed at creating well-educated and healthy human resources in the region. Establishment of centers of Excellence in the region will provide a pool of resources that are innovative and competitive globally. The critical role played by the Centre in providing innovative solutions and technical expertise in GIS and Remote Sensing to Member States complements the EAC Vision 2050 aspirations.

2.3.3 Common Market for Eastern and Southern Africa (COMESA)

The Common Market for Eastern and Southern Africa (COMESA) is a regional economic community of 21 Member States with a population of over 560 million people spread across 11.8 million km^2 of land. It has a combined gross domestic product of US$ 768 billion and a vibrant youth population of over 100 million (COMESA, 2020). COMESA has twenty-nine (29) members, namely; Benin, BurkinaFaso, Cabo Verde, Central African Republic, Chad, Comoros, Côte d'Ivoire, Djibouti, Egypt, Eritrea, Gambia,

Ghana, Guinea, Guinea Bissau, Kenya, Liberia, Libya, Mali, Mauritania, Morocco, Niger, Nigeria, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, Sudan, Togo, and Tunisia.

The COMESA Vision is stated as follows: 'to be a fully integrated economic community that is prosperous, internationally competitive, and ready to merge into the African Economic Community.' COMESA secretariat runs various programs namely; infrastructure development, Agriculture, Industry and Private Sector Development, Trade and Custom Services, and Gender & Social Affairs to facilitate implementation of its strategic goals and vision.

The attainment of COMESA's Vision is threatened by the impacts of climate change as Africa faces the greatest threats as a result of the interaction of multiple stressors including; low adaptive capacity, weak systems and governance, poverty and dependence on climate vulnerable activities. This is despite Africa having contributed the least to the accumulated greenhouse gases that are responsible for the crisis. The COMESA region has diverse ecosystems, landscapes and climates including rainforests, drylands, deserts, highlands, savannahs and tropical islands. Climate change causes extreme weather events varying from large decreases in precipitation, more frequent and intense tropical storms and cyclones, recurring droughts and rising sea levels. The ever-increasing threat of unpredictable and extreme weather impacts the COMESA sub-regions differently adding a layer of complexity to the crisis.

Through collaboration with Member States, the Centre's partnership and engagement can provide solutions and critical interventions that could address challenges being faced by its members as a result of climate change.

2.3.4 Intergovernmental Authority on Development (IGAD)

The Intergovernmental Authority on Development (IGAD) in Eastern Africa was created in 1996 to supersede the Intergovernmental Authority on Drought and Development (IGADD) which was founded in 1986 to mitigate the effects of the recurring severe droughts and other natural disasters that resulted in widespread famine, ecological degradation and economic hardship in the region. Djibouti, Ethiopia, Kenya, Somalia, Sudan and Uganda - took action through the United Nations to establish the intergovernmental body for development and drought control in their region. Eritrea

became the seventh member after attaining independence in 1993 and in 2011 South Sudan joined IGAD as the eighth Member State.

During the 5th Summit of IGAD Assembly of Heads of State and Government held on 25-26 November 1996 in Djibouti, decision to enhance regional cooperation in three priority areas of food security and environmental protection, economic cooperation, regional integration and social development, peace and security was endorsed.

The founding leaders of IGAD were motivated by a vision where the people of the region would develop a regional identity, live in peace and enjoy a safe environment alleviating poverty through appropriate and effective sustainable development programmes with the following objectives;

- Promote joint development strategies and gradually harmonize macro-economic policies and programmes in the social, technological and scientific fields;
- Harmonize policies with regard to trade, customs, transport, communications, agriculture, and natural resources and environment, and promote free movement of goods, services, and people within the region.
- Create an enabling environment for foreign, cross-border and domestic trade and investment;
- Initiate and promote programmes and projects to achieve regional food security and sustainable development of natural resources and environmental protection, and encourage and assist efforts of Member States to collectively combat drought and other natural and man-made disasters and their consequences;
- Develop and improve a coordinated and complementary infrastructure, in the areas of transport, telecommunications and energy in the region;
- Promote peace and stability in the region and create mechanisms within the region for the prevention, management and resolution of inter-State and intra-State conflicts through dialogue;
- Mobilize resources for the implementation of emergency, short-term, medium-term and long-term programmes within the framework of regional cooperation;
- Facilitate, promote and strengthen cooperation in research development and application in science and technology.
- Provide capacity building and training at regional and national levels; and
- Generate and disseminate development information in the region

IGAD has identified areas of cooperation among the Member States which have been clustered in the following pillars; Agriculture, Natural Resources and Environment; Economic Cooperation, Integration and Social Development; Peace and Security; and Humanitarian Affairs; and Corporate Development Services.

IGAD recognizes the need for close and cooperative partnerships with all stakeholders and has entered into partnerships with relevant actors at the local, national, regional and global levels who have similar mandates for achieving sustainable development in the region. Key IGAD partners include: the African Development Bank, the World Bank, the European Union (EU), Denmark, Finland, Norway, Sweden, Germany, Netherlands, Spain, Italy, Ireland, USAID, and Switzerland. Furthermore, IGAD enjoys close cooperation with the African Union (AU), RECs, UN-system agencies, and range of international, regional civil society organisations.

This presents a collaboration opportunity with RCMRD in developing and implementing programs towards the achievement of sustainable development for its Member States.

2.4 AFRICA POPULATION TRENDS

According to the UN Department of Economics and Social Affairs Population Dynamics-World Population Prospects 2019, world population is expected to increase from 6.9 billion to more than 9 billion, with 98% of this growth happening in the developing and emerging world with more than half of global population growth expected to occur in Africa. The population of sub-Saharan Africa which is estimated at 1.09 billion in 2020 is projected to double by 2050 attributed to the large number of young people currently on the continent, who are expected to reach adulthood in the coming years hence playing a central role in shaping the size and distribution of the world's population over the coming decades.

According to World Economic Forum 2020, this exponential population growth is in tandem with the rate of urbanization in Sub-Saharan Africa that is unmatched in the rest of the world. Africa's urban population is expected to nearly triple by 2050, to 1.34 billion. Coupled with a high rate of urban primacy in African countries (whereby one city is multiple times bigger than the next nearest) and the high number of mega cities,

enormous stress is going to be placed on the physical, political, economic and societal infrastructure in these places.

Urbanisation in SSA is majorly being driven by rural-urban migration, however the city planners and management are not well prepared to implement necessary changes required to match the increased demand for services and public utilities. This has resulted in unplanned, unregulated and beyond control of the city planners and management. This has manifested into problems such as: High levels of unemployment leading to high levels of informal employment, which in turn is improperly taxed, denying vital financial capital to the state; Physical infrastructure unable to keep pace, leading to overcrowding and informal accommodation; and Waste management unable to keep up, bringing its own environmental dangers. SDG 11 has the stated goal of making cities and human settlements inclusive, safe, resilient and sustainable. The environmental impact at local, national and regional scale is at high risk, with rapidly-growing urban populations demanding instant solutions for sustainability.

This population growth within Sub-Saharan Africa will greatly impact on Member States priorities and strategies as most governments shift their focus more on provision of basic needs (food, shelter, health, education and security) and essential utilities such as roads, water, electricity amongst others to support this population growth. Despite these challenges, World Economic Forum recognized the fact that Africa is witnessing some of the most innovative, forward-thinking ideas with development of truly smart cities with smarter infrastructure when it comes to tackling the issues such as Diamniadio in Senegal, Tatu City in Kenya, or Vision City in Rwanda.

The adoption of the Fourth Industrial Revolution has given the continent unparalleled access to data analytics, providing real time solutions to real world problems, based on empirical data. This has been driving smarter decision making and the Centre should continuously align its strategic focus to link with emerging diverse Member States priorities, focus areas and expectations for sustainable development.

2.5 AFRICA WEATHER AND CLIMATE CHANGE

In 1972, as part of the United Nations Conference on the Human Environment, countries worldwide agreed that natural resources should be safeguarded, and pollution should not exceed the environment's capacity to clean itself (United Nations 1972).

Since 1972, a proliferation of United Nations conferences, summits and international agreements have set targets for environmental protection and sustainable human development. The years 2015 and 2016 were a landmark for environmental multilateralism formulation and adoption of global frameworks, including the Paris Agreement (United Nations Framework Convention on Climate Change [UNFCCC] 2015) and the 2030 Agenda for Sustainable Development (United Nations 2015).

According to *The State of the Climate in Africa 2019 report*, a multi-agency publication coordinated by the World Meteorological Organization (WMO), there is increasing climate change threats for human health, food and water security and socio-economic development in Africa. Climate change is having a growing impact on the African continent, hitting the most vulnerable hardest, and contributing to food insecurity, population displacement and stress on water resources. The continent in the recent past has witnessed devastating floods, an invasion of desert locusts, and looming spectre of drought because of La Niña event. The human and economic toll has been aggravated by the COVID-19 pandemic.

The continent has been recording rising temperatures with the trend expected to continue. Much of Africa has already warmed by more than 1 °C since 1901, with an increase in heatwaves and hot days and reduction in precipitation. Temperatures in Africa in recent decades have been warming at a rate comparable to that of most other continents, and thus somewhat faster than global mean surface temperature. The latest decadal predictions by WMO, covering the five-year period from 2020 to 2024, show continued warming and decreasing rainfall especially over North and Southern Africa with extensive areas of Africa exceeding 2 °C of warming above pre-industrial levels by the last two decades of this century.

The continent has also witnessed rising sea levels and coastal erosion. According to WMO 2019, there is significant regional variability in sea-level trends around Africa with sea-level increase reaching 5 mm per year in several oceanic areas surrounding the continent and exceeding 5 mm per year in the south-western Indian Ocean from Madagascar eastward towards and beyond Mauritius. This is more than the average global sea-level rise of 3–4 mm per year. Rising sea levels, coastal degradation and

erosion is also a major challenge, a situation that is expected to worsen in the future and exacerbate the negative consequences of environmental changes.

More than half of the SDGs have an environmental focus and/ or address the sustainability of natural resource use with more than twelve promoting human well-being through the sustainable use of natural resources with targets concerning environmental sustainability (United Nations Environment Assembly of the United Nations Environment Programme [UNEA] 2016). These targets link to the quality of the physical environment either directly (i.e. air, climate, biodiversity, oceans, land and freshwater) or indirectly (e.g. via health, education, agriculture, drinking water and sanitation, energy, and governance and institutions such as RCMRD).

Agriculture is the backbone of Africa's economy, and accounts for the majority of livelihoods across the continent. The impacts of climate change and variability have exposed the continent to vulnerable devasting effects on crop production and food security. Key risks to agriculture include reduced crop productivity associated with heat and drought stress and increased pest damage, disease damage and flood impacts on food system infrastructure, resulting in serious adverse effects on food security and on livelihoods at the regional, national and individual household levels. Africa's Agenda 2063, which was concluded in 2013, recognizes climate change as a major challenge for the continent's development. Since 2015, the Nationally Determined Contributions (NDCs) to the Paris Agreement have become the main instrument for guiding policy responses to climate change.

To manage the impacts of climate change in Africa, science-based climate information is the foundation of resilience building, a cornerstone of climate change adaptation, as well as an oasis for sustainable livelihoods and development. The Centre through strategic partnerships and collaborations with key stakeholders in Member States can contribute to developing interventions and strategies that can enhance uptake and use of climate information services in development of sustainable economies and achievement of Agenda 2063 on climate change.

In line with RCMRD's mandate, the Centre is uniquely positioned to help Member States tap into Blue Economy opportunities and address inherent climate change threats

through generation, application and dissemination of Geo-information and Allied Technologies for sustainable development.

2.6 CORONA VIRUS -(COVID-19) CHALLENGES

Volatility in the global environment due to COVID-19 pandemic, which is taking a heavy toll on human life and placing excessive pressure on health systems, continues to negatively impact Sub-Saharan Africa. Economic and social impacts are immense, costing the region between $37 and $79 billion in estimated output losses in 2020, reducing agricultural productivity, weakening supply chains, increasing trade tensions, limiting job prospects, and exacerbating political and regulatory uncertainty. With such formidable challenges, economic growth is expected to contract from 2.4% in 2019 to between -2.1 and -5.1% in 2020, sparking the region's first recession in 25 years.

The COVID-19 pandemic poses significant challenges to the already strained health, food and nutrition security and broad socio-economic conditions in Africa. The growing direct impact of the pandemic is affecting health, in terms of morbidity and mortality, quickly overburdening health care services with negative repercussions for non-COVID-19 related health problems. The decline in demand and production from the most economically developed countries where contagion had initially hit hardest is causing a global recession, with direct repercussions in Africa. With the spread of the virus in the continent, containment measures, including social distancing and lockdowns, closing of schools, the prohibition of public gatherings and the closure of non-essential businesses and economic activities, with far-reaching consequences.

With most of African economies being dependent on Agriculture, which is highly labor-intensive, shortages of workers due to restrictions on people's and labor mobility may compromise the provision of inputs in upstream, farming activities and downstream trading, processing and transportation activities. According to Ministers for Agriculture of the African Union Member States, convened virtually on 16 April 2020 with the support of the African Union Commission (AUC) Department of Rural Economy and Agriculture and the Food and Agriculture Organization of the United Nations (FAO), COVID-19 pandemic was anticipated to exert a significant supply shock on food in the region threatening food security and nutrition.

The COVIC-19 pandemic further exacerbates the situation of already high rates of hunger, malnutrition and poverty due to challenges affecting rural areas, including the desert locust outbreak, fall armyworm impacts, droughts, conflict and insecurity. This puts strategic institutions such as RCMRD at the fore front of management of adverse effects attributed to such occurrences and environmental issues and challenges.

2.7 GEOSPATIAL TECHNOLOGICAL ADVANCEMENT & ICT

Africa, just like other economies in the world is quickly embracing advanced technologies and ICT solutions. The emergence of the Fourth Industrial Revolution (4IR)—characterized by the fusion of the digital, biological, and physical worlds, as well as the growing utilization of new technologies such as artificial intelligence, cloud computing, robotics, 3D printing, the Internet of Things, and advanced wireless technologies, among others has ushered in a new era of economic disruption with uncertain socio-economic consequences for Africa and the world in general.

Improvements in Africa's ICT sector have been largely driven by expanding digital platforms ranging from mobile digital platforms to digital telecommunication and broadcasting. Artificial intelligence (AI) and blockchain technology are also attracting a lot of interest in Africa due to their potential to successfully address social and economic challenges facing many African countries.

Digitization has also resolved information asymmetry problems in the financial system and labor market, thus increasing efficiency, certainty, and security in an environment where information flow is critical for economic growth and job creation. Africa has yet to harness the full potential of its agricultural sector, and 4IR technologies provide an opportunity to do so. Farming alone accounts for 60 percent of total employment in sub-Saharan Africa, and the food system is projected to add more jobs than the rest of the economy with adoption of 4IR technologies. Furthermore, African entrepreneurs and startups are also using the Internet of Things to help farmers optimize productivity and reduce waste through data-driven "precision farming" techniques.

Africa's vision to achieve universal and affordable access to information and communications technology for every African individual, business, and government by

2030, with an interim goal to double broadband connectivity in each country by 2021 will enhance actualization of the 4IR in Africa.

Through adoption of 4IR technologies, the Centre shall continue to provide innovative and creative products and services that resonate with the technological advancements amongst the Member States.

2.8 AFRICA SPACE SECTOR

According to Space Generation Advisory Council (2021), African countries continue to invest in space Sector with accelerated investments and interest witnessed in the last four year since the launch of South African SunSat-1 in 1999. A total of 20 satellites have been launched by African states since 2016 totaling 41 satellites with Egypt leading with nine, South Africa with eight, Algeria with seven, Nigeria with Six and Morocco with three with Ghana, Sudan, Ethiopia, Angola, Kenya, Rwanda and Mauritius also joining the list in the space sector.

The space industry in Africa will contribute not only to the realization of AU Agenda 2063, but will contribute immensely to smart, sustainable, and inclusive growth through improved telecommunications, navigation, and Earth observation. These systems and services not only provide critical information and data that African Countries need to use for effective policy and management decisions on pertinent issues facing the continent including peace and security and other major societal challenges such as food insecurity, climate change, water scarcity, urban sustainability, amongst others. More so, African States have also joined hand in launching of GEO telecommunications multilateral satellites under Regional African Satellite Communication Organization (RASCOM) representing interests of 44 African telecommunication operators covering the whole continent.

Other African countries such as Nigeria, South Africa, and Egypt have expanded their focus to include developing infrastructure for assembly of satellites with others such as Algeria operating a Center for Satellite Design (CDS). Of the 41 African satellites launched in space, 9 were designed, manufactured, and assembled in Africa and led by African states while the rest were partially or fully delivered by foreign states. However, due to high funding requirements and lack of adequate local expertise, many African

countries are partnering with foreign companies in development and manufacturing of satellites through international educational CubeSat projects such as The Joint Global Multi-Nation Birds Satellite in 2017 (GhanaSat-1 and NigeriaEduSat-1), KiboCube in 2018 (1Kuns-PF from Kenya and MIR-Sat 1 from Mauritius) and TUBSAT in 2001 (Morocco) while other countries such as Morocco have directly purchased satellites from Airbus and Thales Alenia.

The lack of funding has been noted as one of the major challenges facing Africa space industry. This has resulted to increased interests in Small Satellites development (Nanosatellites) such as CubeSats. This underpins the importance of African countries coming together to form strategic partnerships and collaborations focused on common addressing common issues affecting the continent such as Disaster Monitoring Constellation (DMC) a consortium of EO satellites for disaster monitoring and mitigation. With diverse interests and different technical capacities on space Industry by various Member States, RCMRD stands out as a key player in the space sector, given its strategic position in Geospatial industry and engagements in various EO programs such as SERVIR project funded by USAID.

The Centre will continue to enhance Member States' technical capacity building programs focused on Space Industry. This will go along way in assisting Member States tackle critical issues facing the continent especially on implementation of systems and programs for adaptation to climate change for sustainable development and growth. More so, the Centre can facilitate development of a harmonized framework for the implementation of an all-inclusive space agency program targeting all Member States. This framework will not only focus on a harmonized approach but also on leveraging on existing technical capabilities within Member States to develop the Centre as a Member States Space Agencies excellence centre.

2.9 RCMRDS ANALYSIS OF INTERNAL ENVIRONMENT

Through this analysis, the Centre undertook an extensive review of its institutional requirements aimed at assessing its capacity to deliver effectively on its mandate and core functions. The following were the strengths, weaknesses, opportunities and threat that shape the ability of the Centre to take advantage of the available opportunities and those that protect it from external threats:

2.9.1 Strengths

Member States Support: The Centre has since its establishment in 1972, continued to enjoy goodwill from Member States through subscription and access of Member States for implementation of various programs and projects.

Strong Partnership and Collaborations: The Centre has implemented numerous programs and projects through development partners and donors from different Multilateral Agencies such USAID, GIAZ, AGRA, NEPAD, EAC amongst others.

RCTI: The Centre establish a KNEC accredited TVET training institutions in the 2000 (RCTI) that offers Certificate and Diploma Courses in Land Survey, Photogrammetry & Remote Sensing, Cartography & GIS, Information Technology and ICDL to both local and international students.

Human resource: Over the years, the Centre has invested in the development of a critical mass of skilled and experienced technical and support staff with the capacity and capability to carry out its mandate.

Infrastructure: The Centre has an ultra-modern well-developed physical infrastructure with adequate capacity for offering quality geo-information and allied ICT services and products for Member States and other clients.

Products and services: The Centre has accumulated experience in geo-information and allied ICT technologies, products and services offered over time which it can leverage upon to respond to different client-demands.

2.9.2 Weaknesses

Technical Specialized Skills; The Centre requires personnel with adequate Specialized technical skills to effectively fulfill its mandate. The Centre needs to attract and retain highly qualified staff and fill up vacant positions in the staff establishment. Due to competitive demand for specialized technical staff within the sector, the Centre risks losing key staff to competition due to limitation in staff compensation structure hence need for continuous review of the same.

Governance Structure. The Centre's governance structure requires the management to seek ratification and approval on certain decisions from the Governing Council which limits decision-making process.

ICT Software and Licenses: The Centre is highly IT oriented in provision of Geospatial Information and Allied technologies solutions, some of which require acquisition and annual renewal of licenses some of which are very costly with a limited lifespan due technological advancement.

Dependence on Member States contribution; A substantial proportion of the Centre's funding comes from Member States contribution and development partners, rendering the Centre's capacity to deliver its programmes within planned timeframes limited.

2.9.3 Opportunities

ICT Advancements: New technological advancement presented by the 4IR technologies presents the Centre with opportunities to offer innovative products and services such as artificial intelligence, cloud computing, robotics, 3D printing, the Internet of Things, and advanced wireless technologies, among others.

AU Agenda 2063 and the Blue Economy: RCMRD Member States continue to support and implement key flagship projects and priority areas focused on AU vision 2063. The emerging need to exploit resources presented by the Blue Economy and the Free trade market presents the Centre with diverse opportunities for developing innovate products and services for Member States.

Member States support & Commitment: RCMRD continue to enjoy support both financially and technically from Member States and other key stakeholders in the industry. This provides the Centre with a unique opportunity to engage Member States to implement programs and projects that can positively impact regional sustainable growth and development.

2.9.4 Threats

COVID-19; Unprecedented occurrence of COVID-19 pandemic has adversely hampered effective implementation of some of the Centre's programs and projects due to WHO containment measures that include social or physical distancing and limited non-essential travels.

Staff Turnover; Due to increasing competition for specialized technical skills, the Centre faces a threat of losing key staff to competition in the labor market hence needs to develop competitive staff retention strategies.

2.10 EMERGENT ASPIRATIONS AND PRIORITIES

Based on the situational analysis undertaken, and after a careful consideration of RCMRD's operating environment, Member States needs assessment, Vision 2050 priorities and aspirations for the Centre were identified and are detailed in the section below.

CHAPTER 3: RCMRD VISION 2050

RCMRD Vision 2050 was created after identification of core priorities that will not only support growth but long-term sustainability of the Centre beyond the year 2050 and aspiration of the Member States and key stakeholders.

3. 0 CENTRE'S ASPIRATION FOR 2050

Attainment of Aspirations under Vision 2050 will not only facilitate Member States realize AU agenda 2063 and UN SDGs 2030 but will also enhance achievement of sustainable growth and development through people, infrastructure and environment.

The overview of RCMRD Vision is as illustrated below;

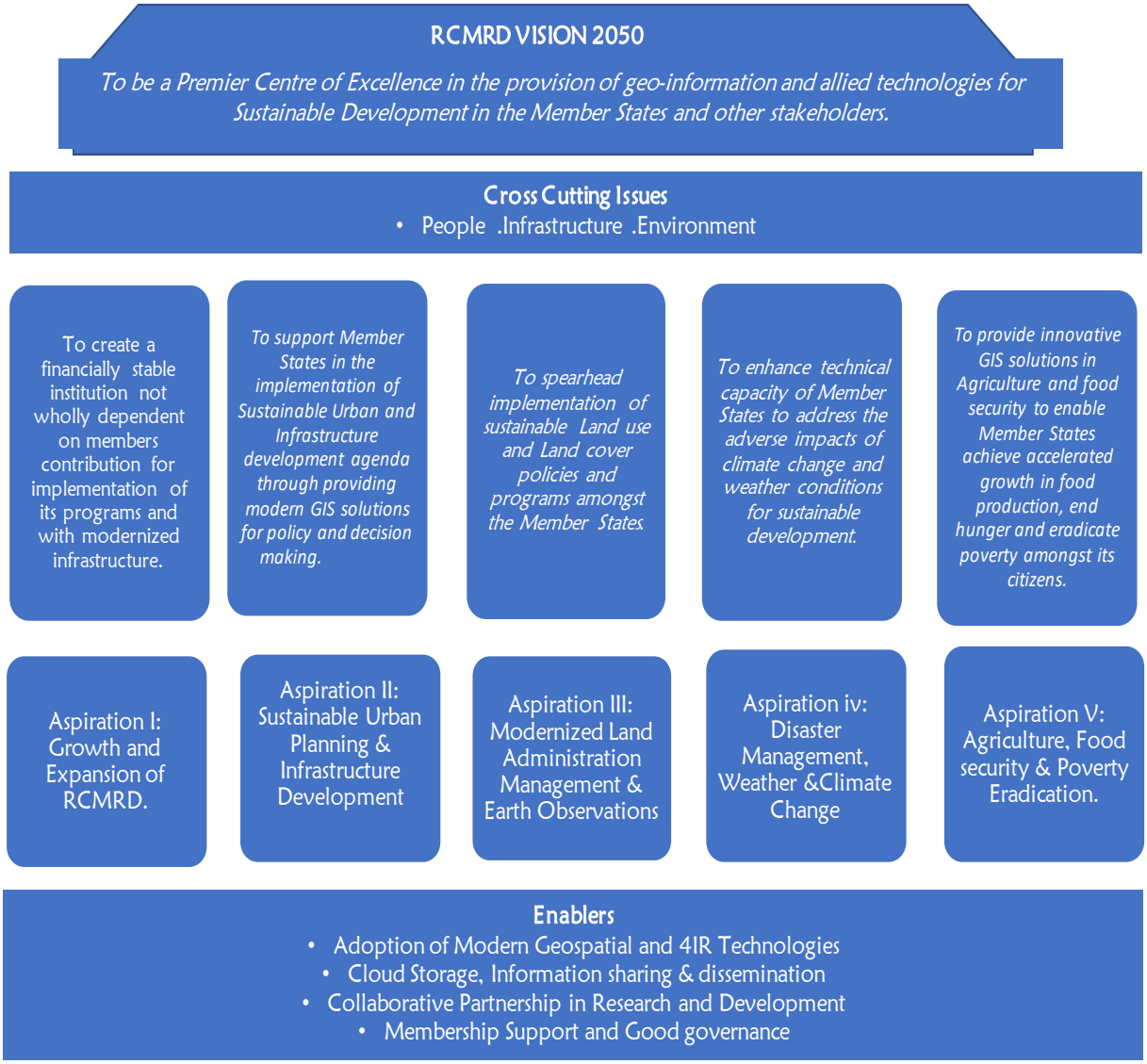

Figure 1: RCMRD Vision 2050

The ultimate objective of Vision 2050 is to consolidate the gains made by the Centre since establishment and to lay a strong solid foundation for long-term growth and the ultimate realization of Centre's vision 2050. Being a not-for-profit membership organization focused on promoting social change in geospatial sector, the vision has adopted theory of change to define the aspirations, long-term goals, activities and inherent key outcomes anchored on RCMRD's Vision are as illustrated below.

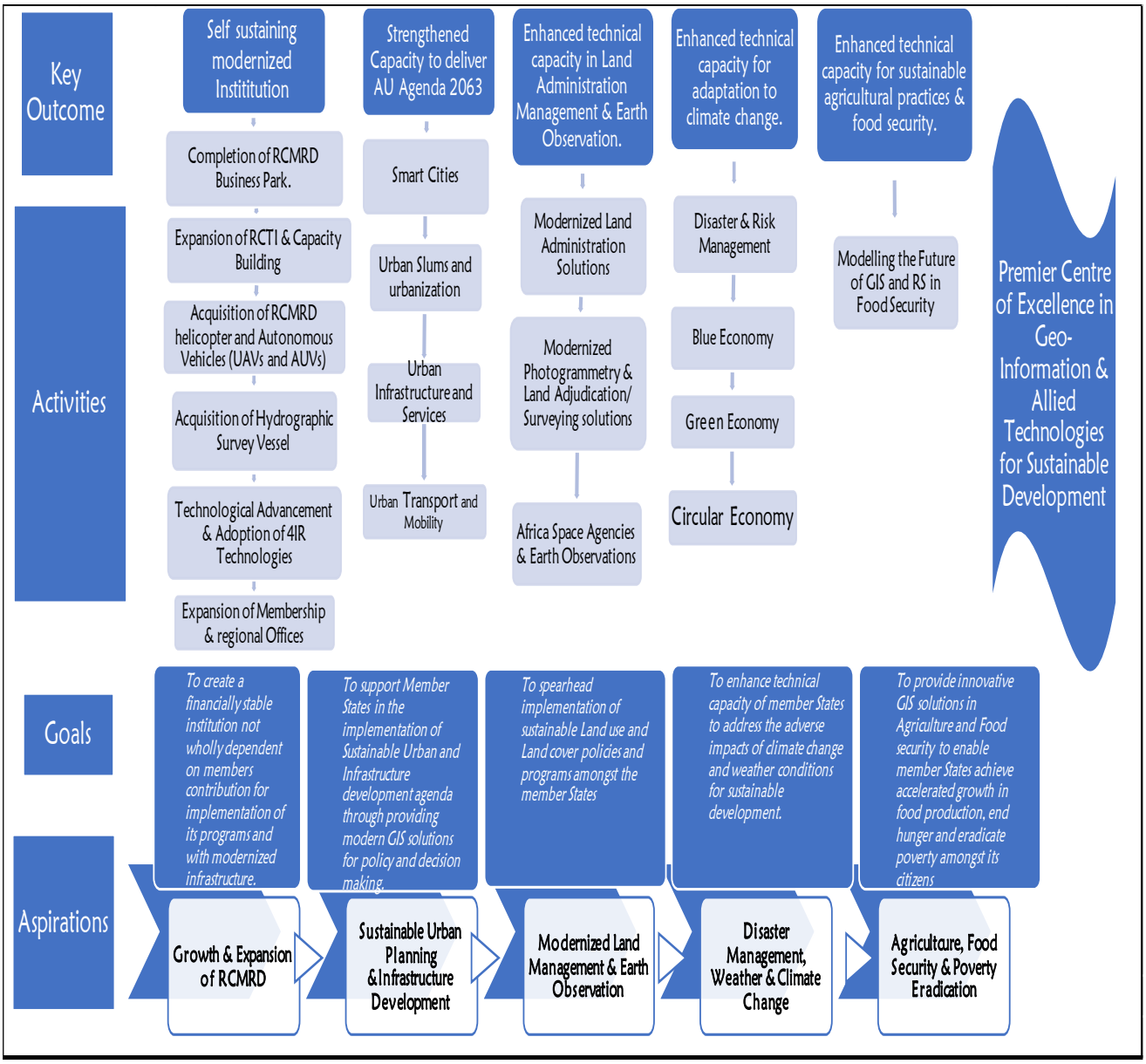

Figure 2:RCMRD Theory of Change

The theory of change highlights Centre's Aspirations comprising of key strategic long-term goals and pillars that will propel the Centre into 2050 and beyond and are as detailed in the sections below.

3.1 ASPIRATION I - GROWTH AND EXPANSION OF RCMRD

RCMRD is located approximately 12 kilometers, by road, from the Nairobi's CBD, and situated along Kasarani-Mwiki road, opposite Kasarani police station, off Thika Superhighway, which connects Nairobi to various primary commercial centers of Kenya. Kasarani stands out as a 'Sub Centre', according to Nairobi Integrated Urban Development Master Plan (NIUPLAN) of 2014. As a sub center the node is envisaged to be major commercial center and one of the economic arteries in the city hinged on Thika superhighway, Northern bypass, the eastern bypass and rail networks to disperse activity away from the central business district (CBD). RCMRD occupies 6.112ha registered under L/R No. 12190.

The Centre in line with the Principal Agreement Establishing RCMRD (Revised 2010) relies on contributions made by the Member States; internally generated funds from products and services; surplus generated from the Training Institute and donor funding from partners and donors implementing projects through the Centre to fund its operations.

However, caution needs to be taken before implementation of Centre's Expansion strategies to ensure proper feasibility studies to inform viability and sustainability.

Goal: *To create a financially stable institution not wholly dependent on Member States contribution for implementation of its programs and with modernized infrastructure.*

Key Outcome: *Self-sustaining modernized institution.*

Key Stakeholders: The Centre will work closely with Member States, Donors, learning institutions, TVET Regulators, Maritime Authorities, Civil Aviation Regulators, and key government agencies amongst other key stakeholders.

The Centre will pursue the following strategies;

3.1.1 RCMRD Business Park

To propel the sustainable growth of the Centre into the long-term future, the Centre shall focus on expansion of its existing infrastructure through completion of RCMRD Business Park.

As part of Centre's growth and sustainability strategies, the Centre undertook a detailed feasibility study in 2017 on RCMRD business park conceptual land-use based market survey needs and existing facilities and Centre's physical infrastructure. Subsequently the RCMRD Business Park Concept was approved and ratified by the Governing Council and CoM after it was considered prime and in line with Centre's vision (RMRD Master Plan and Feasibility Study 2017). RCMRD Business Park ground breaking and construction started in the year 2018, starting with the phase 1 -the RCMRD Office Complex, New modern Gate, perimeter wall and service roads and associated amenities which was completed in 2020.

RCMRD Business Park will create an environment that inspires creativity through use of recreation spots for breaks from work such as open spaces. This aims at promoting social and intellectual interactions. Once completed RCMRD business park will feature five main land use activities, which are further translated into 9 building blocks on site with a total floor area of 25,800 m^2, namely:

(i) RCMRD complex [administrative support offices and a day care facility].
(ii) Conference facility.
(iii) Serviced apartments and meeting rooms.
(iv) Hotel.

Figure 3 RCMRD Business Park Model

The entire RCMRD business park occupies a total floor area of 25,800 m^2.

3.1.2 Expansion of RCTI & Capacity Building

The RCTI was started in the year 2000 as a source of income to the Regional Centre for Mapping of Resources for Development (RCMRD) to supplement the organizational financial sources and over dependence on Member States contributions. RCTI is TVETA accredited and offers KNEC examined training programs at Certificate and Diploma levels and short courses. The Training Institute has grown over time and is currently been set up to provide training as part of the Centre's endeavor to meet its mandate in capacity building. The student population has grown over the years since establishment in 2000 and is expected to more than quadruples to over 6,500 by 2035. The Training Institute is expected to be self-sustaining by 2035 and to supplement RCMRD revenue stream.

These will additionally be achieved through the following strategies;

a) Implementation of RCTI Master Plan

Through the implementation of RCTI master plan, the Centre will construct two new blocks which will feature additional lecture rooms, RCTI modern Laboratories, Modern Library and Staff Administration office block in the area marked out in blue.

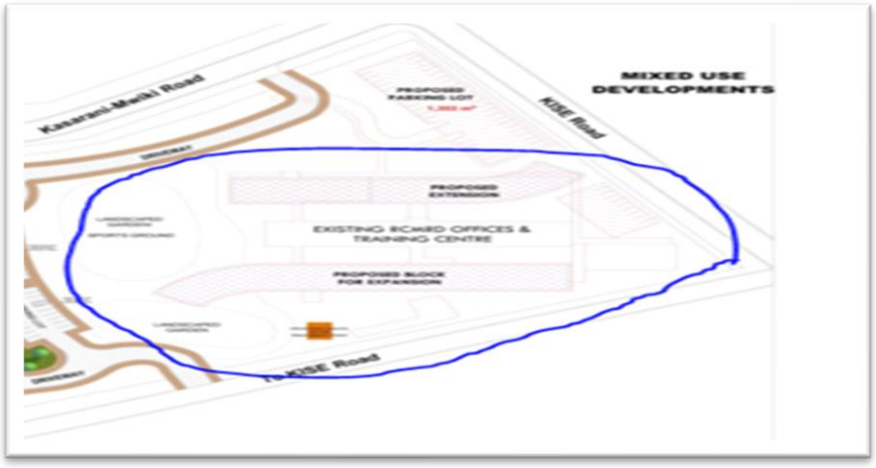

Figure 4:RCTI Expansion wing

b) RCTI Curriculum Development

As a commercial wing of the Centre, the training institute will continue to offer relevant academic programs in Geo-Spatial Information and Allied technologies. To ensure the programs are sustainable, the Training Institute shall develop a detailed Curriculum

program for all its program. To ensure relevance and wider acceptance, the Curriculum will be developed in collaboration with various TVETs in the Member States and benchmarked with other learning institutions such as ITC, AFRIGIST among others. Through the GC the Centre will lobby for the endorsement of the RCTI Training Curriculum and accreditation with TVETs in their respective countries. The Training Institute will position itself to offer competitive academic short term and long-term programs in the sector for Member States as an institution of choice. In this endeavor, the Training Institute will benchmark with AFRIGIST and ESAMI and any other institution of learning in the region.

c) RCMRD Satellite Campus

The Centre has an unutilized piece of land measuring about 4.047ha under registry map number 147/4.148/3,160/2 & 161/1 in Kajiado county at Kisamese. To promote sustainability and open up growth opportunities, we propose that the Centre establishes a satellite campus after conducting a detailed feasibility study. The Campus will be developed to become a Centre of Excellence in Geo-Information and Allied Technologies in the region. The Satellite campus will seek recognition to a fully-fledged technical learning institution and will collaborate with selected accredited universities and offer relevant degrees and masters programs. Students graduating from the main campus will have an opportunity to advance their studies at the Satellite Campus through pursuance of degrees and master's degrees programs.

The Centre will undertake a feasibility study and develop a master plan to develop the Satellite campus.

d) Professional Geomatics Certification Standard

To enhance professionalism and ethics within the Sector in Africa, the Centre shall work closely with Member States to develop a Professional Geomatics Certification Standard for certifying practitioners in the sector offering Surveying, Remote Sensing and GIS services to the general public. The Standard will be developed in line with international best practices to enhance the growth of the profession within Africa and build capacity of professionals and experts within the SSA and the region. The practitioners through the certification program will be targeted for specific capacity building programs on emerging contemporary issues within the sector as well get expert training on new

technologies and solutions as part of their professional growth and development. The Centre through the guidance of the GC and CoM will set up a Certification Advisory Board with clear implementation framework, systems and structures to ensure effective implementation amongst Member States.

3.1.3 RCMRD helicopter and Autonomous Vehicles (UAVs and AUVs)

To increase the Centre's capability to offer Geospatial solutions within the region and amongst the Member States, the Center shall endeavor to acquire or through strategic partnership with Aviation Institutions to operate RCMRD Helicopter and other Autonomous Vehicles in pursuit of its mandate.

The enhanced Airborne capabilities supported with appropriate LiDAR systems and other support applications will enhance Centre's product and services provision to address evolving needs and expectations from the Member States and Africa as a whole.

To support this a Construction of a helipad and Autonomous Vehicles associated facilities should be considered in the Centre's master plan and structural designs.

The Centre should seek collaboration with civil aviation industry regulators and key players to develop favorable policies and regulations that will encourage use of UAVs and AUVs in adoption of sustainable development interventions especially in management of blue economy and agriculture.

3.1.4 RCMRD Hydrographic Survey vessel

To enhance the Centre's capacity to offer Member States with modern weather and environment management including solutions on in marine and coastal zones management. The Centre can acquire a modern hydrographic Survey vessel fitted with high resolution multibeam echosounder system, vessel-based LiDAR, A-Frame and winches to support diverse survey tasks such as marine asset inspections, geophysical and geotechnical investigations among others for sustainable environmental management system in support of effective implementation of Blue Economy initiatives amongst the Member States. The Hydrographic Survey vessel will also go a long way in facilitating Member States undertake critical research and investigations on coastal marine ecosystems, and rising of sea levels especially in inland water bodies, lakes and rivers as part of climate change adaptation systems and management framework.

To leverage on existing technical capabilities among the Member States, the Centre will strive to acquire the modern hydrographic survey technologies and equipment that can fitted on Member States vessels in the interim before acquisition of a Centre wholly owned hydrographic survey vessel. The Centre will seek collaborations with member States Maritime Authorities for specifications of the Hydrographic Survey vessel to ensure maximum benefits and returns on investment.

The Hydrographic Survey vessel will also be used for marking of common water boundaries and adjudications amongst the Member States.

3.1.5 Technological Advancement and 4IR Technologies

Geospatial Industry as a field has undergone significant transformation in recent years. In the past, the process of collecting geospatial data was laborious and performed with ground-based methods. The updating cycles often spanned several years, and the outcomes (such as paper maps) could not be easily shared across government agencies. The potential for integration and multiple applications, a key characteristic of geospatial data, could not be exploited. Recent technological advancements have changed this state of affairs. Earth Observation, Geo Information Sciences and GIS uses modern software and hardware to store, access, visualize, map, analyze and disseminate geographic data. Geospatial data can now be referenced to a globally defined coordinate system. Global Navigation Satellite Systems (GNSSs) such as the Global Positioning System (GPS) use satellites to allow users to determine their exact location, velocity, and time in any conditions, making traditional positioning instruments such as tapes and theodolites obsolete.

Through embracing 4IR technologies, RCMRD can collaborate the with Member States to offer innovative products and services in pursuit of its mandate and the vision to be the Centre of Excellence in Africa. The 4IR technologies offers an enabling platform for "one stop- shop for Geospatial solutions through strategic focus on the following key 4IR interventions;

i) Modern Cameras, Imaging and Sensing;
ii) Modern Survey, Measurement and Scanning;
iii) Artificial Intelligence;
iv) Smart Sensors and Internet of Things;

v) Immerse Technologies;

vi) 3D modelling and Simulation; and

vii) Connectivity technologies.

The Centre will also continuously invest in modern cyber security and malware systems to secure key IT infrastructure and systems developed by the Centre.

These new geospatial technologies will be critical for developing Member States' technical capacity in Geo Information Sciences, Earth Observation, GIS and remote sensing and ultimately support in the realization of AU Agenda 2063 and UN Vision 2030.

3.1.6 Expansion of Membership and Regional Offices

The Centre will expand its membership to capture wider SSA countries including other Anglophone speaking and Francophone speaking countries within Central Africa. The Centre will open strategic regional offices in other Anglophone and Francophone countries to facilitate effective implementation of its services and mandate to Member States. This expansion will not only reinforce the Centre's strategic position as a key player in Geospatial Industry in SSA and beyond but also strengthen its future sustainability.

3.2 ASPIRATION II: SUSTAINABLE URBAN PLANNING & INFRASTRUCTURE DEVELOPMENT

Introduction

Urbanization is one of the most significant global processes in the world today. With more than 50 per cent of the world's population now living in cities and a trend for further urbanization, particularly in the world's less developed countries, we are witnessing urban development at an unprecedented scale (UNHABITAT, 2010). According to the UN Department of Economics and Social Affairs Population Dynamics-World Population Prospects 2019, the population of sub-Saharan Africa which is estimated at 1.09 billion in 2020 is projected to double by 2050 attributed to the large number of young people currently on the continent. This young population is expected migrate into urban areas in search of employment and better livelihoods resulting in high rural-urban migration.

The rapid expansion of existing towns and cities to cater for the rising population growth, through both planned and unplanned development, as well as the creation of

new towns and cities, is relentless. This urbanization has resulted in many basic concerns related to natural environment which they depend on for water, food, waste disposal and energy or their vulnerability to natural and man-made disasters. Urban regions across Africa of all sizes share many basic processes and concerns. There are also common concerns as to how to provide efficiently for the basic needs of the residents and those who visit the city for economic or leisure activities. Adequate and safe shelter, accessible social services, efficient transportation systems, energy and telecom services, business and commercial services and public administration and governance services must all be planned for, delivered and operated in a sustainable manner.

Geospatial information is a vital element in the quest for sustainability in urban and regional development. Planning for future development should be based on a sound understanding of both the current situation and the historical development path of the urban region. Given the scale and speed of contemporary urbanization, this requires different geospatial data for:

- The natural environment management;
- The infrastructure networks for water, drainage, transport, etc.; and
- The occupation geospatial data consisting of the buildings and the activities that take place within them.

This geospatial information consisting of multiple thematic and topographic data sets needs to be updated at regular but different time intervals, according to the appropriate rates of change.

For sustainable urbanization, United Nations Conference on Trade and Development (UNCTAD 2019), recognized the need for creating formidable networks and collaboration with institutions such as RCMRD to support urbanization activities and strategies. Moreover, these expansions should be designed on the basis of a sound understanding of the new structures and processes will impact and implications on the environment. Thus, establishing properly synchronized and coherent geospatial connections between the entire data set comprising environment, infrastructure and occupation is paramount for sustainable urban development.

The above underpins the importance of National Spatial Plans (NSP) which can be used as a guiding spatial framework for proper land management in order to reap maximum

benefits from long-term spatial development of a country. Kenya developed its first NSP for 2014-2045 to guide implementation of NSP flagship project identified under Kenya Vision 2030 as one of the foundations for socioeconomic transformation aimed at achieving an organized, integrated, sustainable and balanced development of the country. RCMRD as a key leader in the industry can facilitate formulation and implementation of Member States National Spatial Plans through collaboration with relevant key stakeholders and players within the sector for sustainable urban development and national development.

Goal: *To support Member States in the implementation of Sustainable Urban and Infrastructure development agenda through providing modern GIS solutions for policy and decision making.*

Key Outcome: Strengthened Member States capacity to deliver AU Agenda 2063 flagship projects.

Key Stakeholders: The Centre will work closely with Member States, Key donors, national spatial planning agencies, and key government agencies amongst other key stakeholders.

The Centre will support implementation of sustainable urban planning and infrastructural development programs amongst the Member States through the following strategies;

3.2.1 Smart Cities

Africa like other parts of the World is embracing the Concept of Smart Cities. The emergence of the 4IR technologies such as 3D Modelling has made it possible to conceptualize different aspects of Smart Cities aimed at making human life more comfortable in the future. The paradigm of Smart Cities arises as a response to the goal of creating the city of the future, where;

- the well-being and rights of their citizens are guaranteed,
- industry and
- urban planning is assessed from an environmental and sustainable viewpoint.

Smart Cities still face some challenges in their implementation, but gradually more research projects of Smart Cities are funded and executed. Moreover, cities from all around the globe are implementing Smart City features to improve services or the quality of life of their citizens.

The emergence of Smart Cities in SSA has also been fueled in part by the need to counter urban-rural immigration. This has been a key milestone in rural development. Many governments such as Kenya and Rwanda have advanced smart city concepts to strategic rural areas away from the much developed and already congested urban areas eg. Tatu City and Konza City in Kenya, Vision City in Rwanda.

RCMRD through emerging 4IR Geospatial technologies stands out as key industry player within Sub-Saharan Africa and Africa at large on generating crucial information to support the implementation of Sustainable Smart cities in Africa and amongst the Member States.

3.2.2 Urban Slums and urbanization

In many developing countries, urbanization means the "urbanization of poverty" and hence higher rates of child morbidity and mortality. Although in general child mortality rates are higher in rural areas than in urban areas, the rates in urban slums may exceed those of rural areas (UNHABITAT, 2019).

In some cities of sub-Saharan Africa, more than 60 per cent of the population live in so-called informal settlements, often with more than one of these urban deprivations. Urban deprivations (e.g. high infant mortality rates, lack of safe shelter, overcrowding and inadequate water and sanitation systems) in the world's many slum communities are symptomatic of urban poverty (UNHABITAT, 2019)

Responding effectively to urban poverty dynamics is a major challenge for local and national governments, particularly in the world's poorest countries, whose governments have limited human, technical and financial resources. Key development information and indicators become quickly outdated as a result of rapid urbanization. The lack of current data is an obstacle to understanding the scale, speed and locations of newly developing urban areas, particularly informal development.

As VHR imagery becomes more widely known through web-based mapping services such Google Earth, Google Map Maker, OpenStreetMap, ArcGIS Online, Microsoft Bing Maps etc., the range of geospatial information users is dramatically expanding. Organizations and individual citizens which or who would have once relied on official maps from a national government mapping agency now have the ability to generate their own maps and even correct, manage and disseminate spatial data on an increasing scale.

RCMRD through remote sensing can use VHR images for slum detection, classification and monitoring among Member States and help generate and disseminate critical geospatial data to address poverty and other urban management issues. VHR images can be used to bridge the time gap between official census surveys, allowing local planners and engineers to monitor the physical development process in order to make reliable estimates of population data for fast-changing urban areas.

3.2.3 Urban Infrastructure and Services

Clean drinking water, electricity for 24 hours a day, proper sanitation, and good-quality education and health care, security are important public services that help create the conditions for human well-being and social and economic development. They are provided through both public and privately funded physical and social infrastructure.

Provision of physical infrastructure is guided by principles of equity (ensuring that all segments of society enjoy equal access to appropriate, good quality and safe infrastructure); affordability (providing infrastructure that people can afford); and efficiency (organizing the development, delivery and operation of infrastructure in the most efficient way) in line with UN-Vision 2030 and SDGs. In many developing countries, however, huge challenges exist in catering for the rapidly growing urban population and the spatially dispersed rural population. Notwithstanding large investments by national governments and international donors, the infrastructure challenge remains real: for example, despite recent improvements, close to a billion people in developing countries lack clean drinking water and over two billion do not have access to improved sanitation.

Even where the correct infrastructure exists, services may still not reach the population. For example, water may be supplied but not be fit for consumption; an area may be electrified but only actually receive electricity for a few hours a day and so on. The poor are often the least served and also pay high costs for alternative services which in most cases can be informal and often illegal. Due to poor planning, engineering, operations and maintenance, the useful life of infrastructure facilities is often much shorter than the normal design lifetime. This leads to a rapid depreciation of assets and high costs of replacement.

The provision and operation of physical infrastructure are complex, as they need to respond to a wide variety of often conflicting demands. The reconciliation of conflicting goals creates many dilemmas: financial sustainability versus technological choice, economic performance versus environmental impacts, short term versus long-term planning horizons (UNCTAD 2019), for which trade-offs are inevitable. This balancing act requires the best available strategies and methods and up-to-date information to support decisions.

The geospatial analysis capabilities of GIS help analyze service provision levels and act as a support tool in the physical planning of infrastructure. GIS data analysis capabilities enable organizations to link their traditional engineering drawings and maps of the distribution, transportation and collection networks with a wide variety of information about infrastructure assets to optimize their operations. Geospatial Technologies offers important functionalities for managing infrastructure assets, from relatively simple tasks such as being able to quickly locate an underground pipe or cable (thereby reducing the cost of unnecessary damage and service disruption) to more complex operations of maintenance optimization or service planning and distribution adjustment.

In many developing countries, the infrastructure sector has been one of the first to use GIS routinely in day-to-day operations, and the opportunity for governments to partner with infrastructure companies to jointly develop and maintain their spatial databases is therefore obvious.

RCMRD through strategic partnerships and collaboration can embrace developments in Geospatial Technologies and provide governments and other operators and owners of infrastructure with tools to support physical planning to better manage existing urban

infrastructure and better plan for future needs and developments. Better management and planning of infrastructure will ultimately help to alleviate some of the problems attributed to rapid urbanization in Africa (such as unavailability of clean drinking water and intermittent electricity supply etc.) leading to sustainable urbanization with numerous benefits to the society.

3.2.4 Urban Transport and Mobility

People take part in activities such as employment and education that are connected to specific locations. Urban transport facilitates the movement of people and freight. The attractiveness of locations of work or leisure depends on how accessible they are, which is influenced by the performance of the transport system. The transport system is composed of various types of more or less integrated infrastructure networks; roads, bus lanes, railroads etc. These networks may be used by different transport modalities such as cars, buses, motorcycles, bicycles and pedestrians depending on the preferences of travelers and their socioeconomic profiles. Sustainable transport is increasingly promoted as an alternative to the traditional transport model. In terms of policy, planning and implementation, the traditional model has been dominated by the paradigm of the automobile. The "predict and provide" approach of building on forecasted demand has led to ever higher expansion of roads and facilities, use of space and urban sprawl.

Many cities in developed and developing countries alike are grappling with how to manage their urban growth, land use and transport. These cities are already confronted with high levels of congestion and pollution, mainly caused by the "predict and provide" approach that has led to inefficient land use and transport systems. This has threatened the quality of life, reduced the economic growth potential and aggravated the massive problem of climate change. Similar to the previous discussion on urban infrastructure, the key to promoting sustainable transport is to restructure the way urban mobility is organized.

More so, African countries are implementing the flagship projects under AU Agenda 2063 which aspires for an Africa Free Trade Area (AfCFTA) with a well integrated common market where people and goods can move freely. Infrastructural connectivity has become a defining feature of the modern economies and has become of major

geostrategic importance for trade, growth and the economy overall. These efforts are evidenced in some countries, for example, there are a number of major corridors in East Africa linking the East African Community, the Northern Corridor is the main corridor in East Africa and connects four of the five East African Community (EAC) countries (Kenya, Uganda, Rwanda, and Burundi) to the port of Mombasa. It also provides connections to South Sudan, eastern DRC, and parts of northern Tanzania, Ethiopia and Somalia. The Central Corridor also plays an important role connecting the port of Dar es Salaam to markets in Tanzania, Burundi, Rwanda, Uganda, and the DRC.

According to UNCTAD (2019), sustainable transport provision emphasizes has shifted from mobility to accessibility with focus on multi-modality (with a much bigger role for public and non-motorized transport) while internalizing all environmental and social costs. (World Bank, 2020). Emerging Geospatial technologies can play a pivotal role in the development of sustainable transportation applications in transport planning and management, traffic control, logistics and intelligent transport systems. The use of geospatial tools in sustainable urban transport systems and infrastructure provides insights into spatial accessibility, equity and environmental sustainability in urban areas. This is because GIS systems combine three main information sources:

(i) Infrastructure information, with all its characteristics associated with the geospatial features allowing for proper operation and maintenance;
(ii) Movement information, allowing for data on flows, modalities, energy use, pollution etc. to be modelled and analysed; and
(iii) Physical, social and environmental contextual information, allowing for spatial analysis of access, equity, and environmental externalities.

Through adoption of appropriate modern geospatial technologies, RCMRD can provide Member States with crucial information and analysis to support evidence-based, sustainable urban transport policies.

Table 1:Intervention Framework for Sustainable Urban & Infrastructure Development

Enabler	RCMRD Intervention	Member States Benefits
Web-based Mapping Service	Filling the gaps in existing maps and information	Provide the **Member States** with geospatial information on choice

		of updated potential service providers.
	Create, update and share urban maps more quickly and easily	Spatial data readily available via mobile devices including smart phones
Advanced object-oriented approaches for automatic feature extraction	More rapid and effective urban mapping (including slum identification and classification)	Lower costs for urban mapping and map updating.
Infrastructure management tools	Better managed and maintained infrastructure assets with increased lifespans	Lower costs for operation and maintenance; less disruption of services due to breakages
	Better informed planning decisions on future infrastructure development	Synchronization of operation and maintenance works leading to less disruption of usage
Transport GIS applications	Provides insights into urban accessibility	Reduced travel times through integrated land use and transport
	Better informed planning decisions on future transport development.	Cleaner, safer and more habitable cities; reduced urban sprawl

Adoption of intervention framework during implementation of urban plans and development of related infrastructure will help drive sustainable economic growth amongst the Member States with improved accessibility to public utilities, reduced congestion and limited environmental degradation.

3.3 ASPIRATION III: MODERNIZED LAND ADMINISTRATION MANAGEMENT AND EARTH OBSERVATION

Introduction

Land administration is a proven enabler of economic, social, and environmental development (UNCTAD,2019). Geospatial Technology is at the heart of land administration systems. However, successful implementation involves overcoming a range of technical, legal, institutional, and social impediments. Land administration systems collect, maintain and disseminate information about land tenure, land use and land value. The bases of the systems are also known as land registers and/or cadastres. They include both textual and geospatial information. The textual part contains information about people, land tenures, land uses, and land values. The geospatial part relates to the location of that textual information, and is often visualized as a map of land parcels or cadastral map. Both types of information are collected through processes of adjudication, demarcation, surveying and recordation. The information is brought together in an information system: land parcel identification codes and geospatial coordinates are used to create links between the different types of information.

The establishment of a continental reference using GPS and consistent with global systems such as ITRF is important in land administration and management. Through facilitating the full implementation of The African Reference Frame (AFREF) project, the Centre continues to lead the debate on establishment of geodetic control network for Africa, which continue to be used in the planning and implementation of all geodetic and development projects in Africa and amongst Member States. The Centre will continue to engage Member States in fast tracking the establishment of Continuously Operating Reference Stations (CORS) and realization of Africa Earth Observation community amongst Member States and within Africa and globally.

The Centre will continue to enhance and build Member States technical capacity to effectively implement sustainable modern land administration management and Earth Observation solutions.

Goal: *To spearhead implementation of sustainable Land use and Land cover policies and programs amongst the Member States.*

Key Outcome: *Enhanced technical capacity in Land Administration Management & Earth Observation.*

Key Stakeholders*:* The Centre will work closely with Member States, Key donors, Land Survey Institutions, key government agencies, Space Agencies, amongst other key stakeholders.

To achieve this the Centre will pursue the following;

3.3.1 Modernized Land Administration Solutions

The land administration system should be accurate, authoritative, verified, unambiguous and available. Land administration systems support social development in a number of ways. For individuals and citizens, they secure land tenures; enable access to credit; facilitate cheaper and faster land dealings; and reduce land disputes. For Member States and governments, the systems facilitate the assessment and collection of land tax; provide a land inventory to support land reform, land consolidation, or land readjustment (UN-HABITAT, 2019); facilitate controls on land transactions (e.g. maximum amount of property ownership per individual); support many other government activities (e.g. environmental management); and reduce information duplication by acting as an authoritative base register for Government. However, these benefits only materialize if financial services and adequate institutional capacity exist within a society.

Geospatial technologies offer opportunities for increasing the efficiency and effectiveness of establishment, maintenance, and renewal of their land administration systems. Emerging geospatial tools can deliver cheaper, faster or higher-quality spatial information with respect to collection, maintenance, and dissemination. This is of particular importance for governments in developing countries, because systems must be faster and cheaper to establish and maintain.

Modern Geospatial technologies can assist in delivering these progressive land administration solutions. Applications of GPS and two alternative methods of collecting VHR images, high-resolution satellite imagery (HRSI), and low-altitude remotely sensed imagery (LARSI), offer RCMRD with a unique opportunity to support Member States better in matters of Land Administration. Other emerging GNSS technologies such as GPS can support highspeed land surveying. GPS receivers using signals from a number

of satellites to calculate the coordinates of a location. GPS can be used in the high-speed establishment of a ground control network for a jurisdiction or country.

Given that Land administration systems are expensive to establish and maintain, RCMRD partnering and collaborating with Member States will fast track establishment of Continuously Operating Reference Stations (CORS) with high levels of accuracy amongst Member states, greatly increasing the speed in adjudication and surveying. Through AFREF project, the Centre will also continue to engage Member States on full implementation of Africa geodetic control network to facilitate planning and implementation of key flagship projects as identified in AU Agenda 2063.

More so, African Earth Observation community is continuously growing and with the establishment of AfriGEO initiative within GEO framework. The Center will continue to play critical role in realization of a Pan-African aspirations whose vision is a continent where decisions on policy and implementation programs, involving the production, management and use of earth observation, are taken with the involvement of all stakeholders, through a coordination framework enabling the linkage country-region-continent and globally. RCMRD will continue to play the critical role of coordinating and strengthening the link between the current GEO activities with existing capabilities and initiatives in Africa and provide the necessary framework for countries and organizations to access and leverage on-going bilateral and multilateral EO-based initiatives across Africa, thereby creating synergies and minimizing duplication for the benefit of the entire continent.

This coordination initiative has been recognized essential to enhance Africa's capacity for producing, managing and using Earth observations, thus also enabling the Region's participation in, and contribution to, the Global Earth Observation System of Systems (GEOSS). The Centre will continue to seek strategic partnerships in providing modernized Earth observations to deliver decision-ready products to enable policy makers, scientists, private sector and civil society to address social, environmental and economic changes on the African continent and develop innovative sustainable ecosystems.

The Centre will continue to strengthen connections with other GEO's global partners and expand regional engagement across Africa by ensuring increased awareness and use

of Earth observation data in Africa, promoting long-term capacity development, and driving contributions to global, regional and African priorities including the Sustainable Development Goals and the African Union Agenda 2063.

3.3.2 Modernized Photogrammetry & Land Surveying solutions

Emerging photogrammetric methods, including use of orthophotos (geometrically corrected aerial images) or enlarged photo prints, offer the potential for high-speed land administration. This is especially the case when systematic countrywide adjudication projects are being undertaken. Imagery is collected from sensor-equipped manned aircraft, unmanned aircraft (LARSI) or high-resolution sensors mounted on satellites (HRSI). However, in many cadastral applications 25 to 50cm accuracy is still not considered good enough and LARSI has emerged as a new technique capable of increasing the speed of adjudication and surveying processes. Until recently, the application of satellite imagery was limited for land administration purposes: image resolutions were not good enough for determination of potential cadastral features such as fences, hedges or even buildings. Cadastral maps require larger scales, in the order of 1:500 through to 1:10,000, depending on the size of parcels. Application of imagery from these satellites was limited to areas with large parcel sizes, open terrain, and scales smaller than 1:25,000.

Increasing demand for use of satellite imagery with high resolutions has witnessed resurgence of a new range of commercially owned satellites and constellations equipped with high-resolution sensors that are now in operation eg GeoEye's GeoEye-1 satellite; Digital Globe's WorldView-1 and Quickbird satellites; SPOT's range of satellites; RapidEye's constellation of five satellites; and ImageSat International's EROS satellites.

This presents RCMRD with an opportunity to establish strategic partnership with Member States and other emerging players as they offer more solutions in geospatial industry in land administration management through adoption of the following.

Table 2:Geospatial Technology in Land Administration

Enabler	RCMRD Intervention	Benefits to member States

GNSS ground control networks	Faster and Cheaper establishment of cadastral ground control at jurisdiction level	• Secured land tenures • Access to credit • Facilitation of cheaper and faster land dealings • Reduction of land disputes • Facilitation of the assessment and collection of land tax • Provision of a land inventory to support land reform • Lad consolidation/land readjustment • Controls on land transactions • Support for many other government activities • Reduction of information duplication through its roles as an authoritative base register
GNSS Receivers	Faster surveying and demarcation at parcel level	
LARSI	Faster adjudication and surveying potentially in urban areas	
HRSI	Faster adjudication and surveying in rural areas	
Point Cadastres	Lower cost of adjudication, surveying, demarcation and recording in urban and slum areas	
Crowdsourced geospatial data	Lower cost of surveying and recordation	

This coupled with other 4IR technologies adopted by the Centre, will enhance the technical capacity of Member States to deliver services more effectively on Land Administration and Management.

3.3.3 Africa Space Agencies & Earth Observations

The Space Industry in Africa is growing rapidly with many African Countries showing keen interests on the same. Africa to date has launched over 41 satellites with some of Member States of the Centre such as South Africa, Kenya, Rwanda, Sudan, Ethiopia, Angola, and Mauritius having one or more satellites in the space. South Africa pioneered the launch of African satellites in 1999 with SunSat-1, and is leading amongst the SSA countries with eight satellites today.

Many African countries however do not have adequate financial resources and technical capacity to launch their own satellites into the space. To fully realize the benefits and exploit EO interventions and solutions, Member States need to come together and form strategic partnerships and collaborations focused on a common all-inclusive approach

implementation framework that will not only address diverse interests but also address common problems and challenges affecting Member States.

Through establishing a Member States Space Agencies Excellence Centre, the Centre will not only facilitate effective implementation of harmonized and synergized space programs that can be used to address common problems and challenges facing Member States. The Centre will also continue to develop the much-needed technical capacity amongst Member States to facilitate effective participation in different space programs.

The Centre will marshal financial and technical resources from its membership and key donors to launch satellites that can be used to deliver critical and much needed services such as; resource mapping, environmental management programs, disaster and risk management systems, and for public policy and planning decision by Member States governments and other policy makers.

Concerns on the adverse impact of urbanization on climate change continue to be a great concern world over. The increased rate of urbanization amongst African countries poses a major challenge on increased rate of pollution especially with deteriorating air quality due to increased carbon and other industrial gases emissions leading to increased health risks and global warming. The Centre through EO initiatives and interventions, will continue to provide critical information on air quality in Member States urban current and emerging cities for policy decisions on air pollution management. Currently the Centre is monitoring the air quality over Nairobi, Kenya, Dar es Saalam, Tanzania and Addis Ababa, Ethiopia, with a projection of increased demand for air quality data across the SSA countries over the years.

More so, the Centre is strategically placed to mobilize Member States to adopt a harmonized approach for their different space agencies agenda and develop an all-inclusive implementation framework that will facilitate leveraging on synergies from different Member States.

3.4 ASPIRATION IV: DISASTER MANAGEMENT, WEATHER AND CLIMATE CHANGE

Introduction

Africa is the most vulnerable continent to climate change impacts under all climate scenarios above 1.5 degrees Celsius. Despite having contributed the least to global warming and having the lowest emissions, Africa faces exponential collateral damage, posing systemic risks to its economies, infrastructure investments, water and food systems, public health, agriculture, and livelihoods, threatening to undo its modest development gains and slip into higher levels of extreme poverty.

According to the Africa Development Bank report on Climate change in Africa 2019, the following factors contribute to Africa's vulnerability:

- Sub-Saharan Africa has 95% of rain-fed agriculture globally.
- A large share of agriculture in GDP and employment adds to vulnerability, as do other weather-sensitive activities, such as herding and fishing, leading to income losses and increased food insecurity.
- Seven of the 10 countries that are most vulnerable to climate change are in Africa. In 2015, four African countries ranked among the 10 countries most affected: Mozambique (1st), Malawi (3rd), Ghana and Madagascar (joint 8th position).

Climate change represents a major threat to Africa achieving the Sustainable Development Goals. The Intergovernmental Panel on Climate Change (IPCC) report 2018 highlighted the grave consequences of a temperature increase above 1.5°C, especially for Africa. UNEP-commissioned research estimates that the cost of adapting to climate change across Africa could reach $50 billion a year by 2050, if the global temperature increase is kept within 2°C above preindustrial levels. Under the Paris Agreement reached at COP21, all countries agreed to take collective action on climate change to keep global temperature increases to no more than 2°C above pre-industrial levels. African countries have outlined bold aspirations to build climate resilient and low-carbon economies in their Nationally Determined Contributions (NDCs) to the Paris Agreement. As of November 2019, 49 African countries out of 54 had ratified their NDCs. Having signed and ratified the Paris Agreement, nearly all African countries

have committed to enhancing climate action through reducing their greenhouse gas emissions and building resilience. For the continent, adaptation to the adverse impacts of climate change is urgent.

However, many of their commitments are conditional upon receiving adequate financial, technical and capacity building support. Nevertheless, climate change also provides opportunities for Africa to harness its huge resource potential to achieve the targets of the Sustainable Development Goals. Addressing climate change in Africa will create significant market opportunities on the continent, especially for the key sector players and institutional investors.

The Centre through strategic partnerships and collaborations with key stakeholders in Member States can strengthen the technical capacity of Member States in developing well researched interventions and strategies for adaptation to climate change that will enhance uptake and use of climate information services in development of sustainable economies and achievement of Agenda 2063.

Goal: *To enhance technical capacity of Member States to address the adverse impacts of climate change and weather conditions for sustainable development.*

Key Outcome: Enhanced technical capacity for adaptation to climate change.

Key Stakeholders: The Centre will work closely with Member States, Key donors, and key government agencies, Space Agencies, amongst other key stakeholders.

The Centre will build Member States technical capacity in the following areas;

3.4.1 Disaster and Risk Management

The issues of Disasters are headline news almost every day. They often take the form of sudden events causing widespread losses and human suffering, such as earthquakes, landslides, famine and floods among others. Hazards are potentially dangerous phenomena, substances, human activities or conditions that may cause loss of life, injury or other health impacts, property damage, loss of livelihood and services, social and economic disruption, or environmental damage. Risk results from the combination of hazards, conditions of vulnerability, and insufficient capacity or measures to reduce the potential negative consequences of risk. Disasters can therefore be prevented even

where natural hazards occur. If steps are taken in advance to limit the damage and loss of life caused by a hazardous event, a disaster will be averted.

The United Nations International Strategy for Disaster Risk Reduction (UN-ISDR) defines disasters as "a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources".

About 85 per cent of disaster-related casualties occur in developing countries, where over 4.7 billion people live with greater loss of life and damage to property due to a number of reasons, including:

- ✓ Construction of buildings and settlements in hazardous areas due to lack of land use planning and regulation (urban sprawl);
- ✓ Lower awareness and disaster preparedness (lack of community resilience);
- ✓ Lack capacity to intervene on the structural and organizational causes of disasters (e.g., building codes or their enforcement, raise awareness on mitigation and prevention);
- ✓ Missing or non-effective early warning systems;
- ✓ Lack of disaster risk management plans, including evacuation planning and facilities for search-and rescue operations and medical attention.

The effects of hazardous events are felt disproportionately highly in the developing world compared to the developed countries. The focus has slowly shifted from disaster recovery and response to risk management and mitigation, and ways to reduce the vulnerability of communities by strengthening their capacity to develop coping strategies.

Geospatial data and technologies are now an integral part of disaster risk management because both hazards and vulnerable societies are changing in space and time. In real-time emergency and response phases, Earth observation (EO) can be coupled with meteorological forecasts to monitor events, evaluate their magnitude and expected impacts and, most importantly, define near real-time event scenarios to support decision-makers in managing resources and organizing emergency plans.

RCMRD can assist the Member States to enhance existing risk management framework through providing technical expertise in Member Sates' implementation framework.

Table 3:Implementation Framework for Disaster and Risk Assessment

Phases	RCMRD Intervention	Member States Benefits
Relief	• Damage assessment and • Relief Resource analysis	Satellite-based damage assessment, high-resolution images, crowdsourcing, mobile GIS applications, collaborative web-mapping, GIS databases, Web-GIS, telecommunication, planning, GIS analysis
Recovery	• Mapping of Rehabilitation initiatives	High-resolution EO data, collaborative web-mapping, mobile GIS, Global Positioning Systems
Reconstruction	• Reconstruction mapping and planning	Land administration, High-resolution EO data, GIS analysis, multi-hazard assessment, maps updating
Prevention	• Disaster database • Risk/Hazard and vulnerability assessment • Land use planning and building codes • Capacity building and awareness	EO-derived input data, digital elevation models, magnitude frequency analysis, lining of advanced modelling tools with GIS analysis, EO-derived assets data, Mobile GIS, spatial multi criteria evaluation, probabilistic risk assessment, participatory GIS, cost-benefit analysis, decision support systems, environmental impact assessment, risk atlases, web-GIS
Preparedness	• Detection & Early warning • Community planning & Monitoring	Participatory GIS, networks and satellite measurements, change-detection, geospatial data on infrastructure, web-GIS, remote sensing

This disaster and risk assessment management framework is critical for Member States in management of disasters whether weather related or manmade.

3.4.1.1 Disaster Relief, Recovery and Reconstruction management

Geospatial Technologies play a major role in rapid damage assessment after the occurrence of major disasters. Automatic and manual classification methods, based on optical, thermal or microwave satellite images, have been developed to extract hazard related features (e.g. flooded areas, burnt areas, landslides) or damaged infrastructure from satellite images. Satellite-derived information is one of the key contributions of Geospatial Technologies to disaster risk management. The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER, 2017) has been established by the United Nations to ensure that all countries have access to and develop the capacity to use space-based information to support the disaster management cycle.

The Centre will continue to seek strategic partnerships with key stakeholders engaged in global monitoring for environment and security within Africa to provide on a 24/7 basis, covering the on-demand and fast provision of geospatial information supporting worldwide requests coming from government authorities in charge of crisis management in the aftermath of major events such as earthquakes, floods, tsunamis, wind storms, industrial accidents and humanitarian crises. By developing disaster management systems, the Centre will help in building the technical capacity of Member States to track assessment of damage directly after the occurrence of major events. The geospatial technologies and data collection methods help provide essential information rapidly to aid responses to disasters. This information can be disseminated to and used by a wide range of organizations such as RCMRD on the ground to improve their effectiveness in delivering assistance to those in need.

RCMRD through systematic identification of disaster and risks inherent in Member States ecological ecosystems and human habitation will play a pivotal role in spearheading Risks and Disaster Management in Member States and Sub-Saharan Africa through strategic partnership and collaboration with key Geospatial Industry Players.

3.4.1.2 Disaster preparedness

Geospatial technologies play a major role in disaster preparedness by monitoring and forecasting hazardous events. Several Geospatial technologies-based early detection, warning and monitoring systems are operational. Disaster risk reduction (DRR)

framework requires clear and detailed information on the potential risk being faced. Objective and reliable information on hazards, vulnerability and exposure, presented through an analysis of expected impacts for given scenarios, can trigger and sustain the political will and economic commitment needed to achieve adaptation and mitigation for risk reduction. Within this framework, Geospatial technology has the powerful capacity to represent and describe complex dynamics and processes by means of detailed, objective and up-to-date risk assessment maps. Additionally, Geospatial technology has an important role to play in supporting the scientific community through the development of large-area vulnerability modelling and mapping.

Governments and policymakers can then use this information to prepare for the hazardous event and reduce its impact. If such preparations are sufficiently effective, a potential disaster resulting from a natural hazard can be prevented altogether. Within this framework, Geospatial Technologies and GIS can make a difference, since the use of satellite imagery, combined with all the available in situ data, makes it possible to dramatically improve the management of risk in all phases: before, during and after a disaster.

Global focus is shifting to more timely dissemination of information through better coordinated systems for monitoring, predicting, risk assessment, early warning, mitigating, and responding to hazards at local, national, regional, and global levels.

Through establishment of close networks with global players such as GEONETCast, the UN-SPIDER among others, Member States will benefit from access of wide range of environmental data and products on risk and disaster management. The UN-SPIDER which works to give all countries across the world access to space-based information to support the full disaster management cycle including early warnings and risk and hazard assessment as well as post-disaster damage assessments while GEONETCast has been developed as a global network of satellite-based data dissemination systems providing a wide and growing range of environmental data and products to a worldwide user community.

Through partnership such global institutions, RCMRD can promote Risk governance agenda for effective and sustained disaster risk reduction among the Member States and in deed Africa at large by promoting and improved dialogue and cooperation among

scientific communities and practitioners working on disaster risk reduction, and encourage partnerships among stakeholders, including those in public and private sectors.

Through identification of key enablers of disaster and risk management, the focus will greatly facilitate effective management of disasters and hazards in Member States as highlighted below.

Table 4:Disaster and Risk Assessment Technologies.

Enabler	RCMRD Intervention	Member States Benefits
Crowd-Sourcing	Rapid damage assessment with access for rapid information collection	Faster and more accurate assessment of damage disaster response, leading to less loss of lives and damage or property
GEOSS	Improved use of access to observations and information related to disaster, risk and hazard assessment	Better informed policies, decisions and actions associated with disaster preparedness and mitigation. More effective access to observations and related information to facilitate disaster warning, response and recovery
UN-SPIDER	Dissemination of Space-based information for disaster responses	Coordination of multiple organizations involved in disaster management in a better and faster way leading to less loss of lives and damage to property
CAPRA, HAZUS and other hazard risk assessment tools	Hazard risk assessments indicating where hazard may occur, how frequent and how much damage is expected	Estimation of possible losses dues to disasters allowing adoption of measures to reduce their effects in terms of loss of lives and economic damage
Early warning systems	Early warning of impending hazard events	Gives Member States time to prepare response operations, evacuate people and stop activities that would cause more damage

However, the emergence of new sensing techniques, miniaturization of electronics, more powerful software, and an ever-increasing range of applications has led

advancement in Autonomous systems technologies to include terrestrial-based remote sensing and remote embedded sensing. These autonomous remote sensing (ARS) systems are truly transformational with benefits in cost / risk reduction and can enable entirely new capabilities in applications where direct human control is not possible due to inaccessibility, speed of decision making, or other human limiting factors. They are also finding new applications in hazardous or challenging environments and areas where human lives may be exposed to greater risk and also in providing situational awareness in fields such as precision farming, forestry, monitoring of critical infrastructure, fire detection and flood monitoring, bio-security, and security / law enforcement amongst others.

Modernized geospatial technologies amongst Member States can be used to offer critical EO climate data and tools for climate analysis to be used by various stakeholders to determine climate trends, anomalies, vulnerabilities, early warning etc. to support climate resilience building efforts in the region. More so RCMRD should continue to undertake regular R&D and adoption of 4IR emerging technologies to inform new products and services development to bridge the geospatial capabilities and capacity gaps amongst the Member states and in line with AU Agenda 2063.

3.4.2 Blue Economy

In Africa, 38 of 54 African States are coastal states with over 90% of Africa's imports and exports transported by sea, making the continent a strategic gateway for international trade. The continent's geopolitical importance and of sound ocean governance is therefore of significant prominence to the African Union. At the Africa@Nor-Shipping 2019 conference held under the theme "Unleashing the potential of Africa's Blue Economy", the African Union Commission reiterated the need to create an enabling framework for the development of Africa's blue economy while ensuring environmental and economic sustainability and improving maritime safety and security in Africa's waters.

While some challenges threaten the sustainable use of oceans and sea resources such as marine plastic, litter and micro-plastics, biodiversity loss and climate change still persist and many African governments are addressing the plastic pollution and waste management through banning the use and sale of plastic bags amongst other strategies.

To address the threats of climate change to the Blue Economy, the AU Commission is developing a continental strategy on climate change and the impacts of climate change. The strategy is envisaged to address climate impacts on oceans, the ecosystems and biodiversity according to AU Consultative Forum for the Post 2020 Global Framework for Biodiversity 2019.

The Blue Economy in the African context covers both aquatic and marine spaces, including oceans, seas, coasts, lakes, rivers, and underground water. It encompasses a range of productive sectors, including fisheries, aquaculture, tourism, transport, shipbuilding, energy, bioprospecting, and underwater mining and related activities.

The Blue Economy concept includes recognition that the productivity of healthy freshwater and ocean ecosystems is a pathway for aquatic and maritime based economies and can ensure that islands and other coastal countries, as well as land-locked States, benefit from their resources. It also requires an integrated, holistic and participatory approach that includes sustainable use and management of Blue Economy resources for societal progress in a diverse Africa. The Blue Economy framework is therefore intended to move from the current sectoral approach to a multisectoral, integrated, and participatory approach at multiple levels.

The Blue Economy builds on Integrated Coastal Zone Management (ICZM) which promotes the conservation of aquatic and marine ecosystems and sustainable use and management of associated resources and builds on principles of equity, low carbon development, resource efficiency, and social inclusion. The AU plays a crucial role in developing and implementing the Blue Economy policy and strategy in the African region. Over the past decade, the African Union Commission (AUC) has built an enlarged Africa-wide consensus regarding the critical role that the Blue Economy could play in fostering structural transformation in Africa. This is encapsulated AU's Agenda 2063 and in the African Union's 2050 Africa's Integrated Maritime Strategy (AU 2050 AIMS) which describes the Blue Economy as the "new frontier of African Renaissance" and a catalyst for socioeconomic transformation. In July 2015, the African Union launched the African Day (25 July) and Decade of Seas and Oceans 2015–2025 to rally action on the Blue Economy.

The Blue Economy facilitates the design and implementation of processes that integrate science, awareness, and social change and lead to real improvement in environmental and ecological health and social well-being. Moving into more collaborative and inclusive patterns of work by harnessing the full potential of all actors becomes essential. According to UN-Economic Commission for Africa, Blue Economy policy formulation process could provide opportunities for inquiry, experimentation, and policy innovation around four key objectives:

i) Exploring individual and collective leadership challenges; The Blue Economy policy formulation process would seek to foster transformative forms of leadership to create the enabling conditions for collaboration and societal transformation. This will stimulate a collective conversation, providing an opportunity for the exchange of ideas considering different cultural paradigms.
ii) Encouraging multisectoral collaboration toward joint transformation action; The policy formulation process could provide an opportunity to develop and consolidate links among all stakeholders committed to a social and economic transition in Africa. Enhancing such links can strengthen the Blue Economy framework with evidence, new data, pilot initiatives, and widespread applications, thus overcoming the implementation gap in some of the current approaches to economic transition.
iii) Producing prototypes of transformative actions; The policy formulation process could provide opportunities to merge research and practice with a view to generating innovations for a Blue Economy, resulting in the development of prototypes. These prototypes should be concrete in nature, involving different sectors and actors, as well as producing evidence for change. Some of them may be small-scale while others may span across countries.
iv) Stimulating a network of change agents; Through its research-action orientation, the policy formulation process could contribute to the development of a continent-wide network of change agents. It could also help establish an Africa Blue Economy community of practice.

All stakeholders can engage in integrative strategic thinking and build sustainable alternative practices in government, business, civil society, and communities. Continental universities, think tanks, private companies, civil society organizations, and

communities are in a position to generate homegrown knowledge, experiences, and practices that can respond to the specific challenges and objectives of the member States.

Coastal and inland waters within the SSA have been under increasing stress and risk of pollution. The health and biophysical status of their ecosystems need to be regularly monitored in order to ensure that they maintain their ecological functionality and services. This includes estimating concentrations of organic and inorganic constituents in water, monitoring the health and distribution of submerged aquatic vegetation and corals, characterizing the biodiversity of phytoplankton, and tracking spatio-temporal dynamics of complex biophysical and biogeochemical processes occurring in the water and adjoining wetlands. With technological advancement in geospatial industry, experts including RCMRD can address this challenge through development and application of innovative measurement technologies and water quality parameter retrieval algorithms for remote sensing using AUVs, UAVs, CubeSats in addition to conventional airborne and spaceborne systems, and water quality parameter retrieval techniques for remote sensing of coastal and inland waters, including coastal wetlands.

As a key stakeholder in the sector, RCMRD through strategic collaborations and partnerships can join the continent-wide network of change agents in Africa Blue Economy and participate in generation of vital knowledge in GIS and Remote Sensing technologies and steer Blue Economy agenda amongst Member States and in Sub-Saharan Africa through investing in modern LiDar systems, AUVs, UAVs, CubeSats and other equipment.

3.4.3 Green Economy

The United Nations Environment Programme (UNEP) describes a green economy as "an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2011). It is also an economy whose growth in income and employment is driven by reallocation from unsustainable industries to ones that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent losses of biodiversity and ecosystem services. Actions can refer to sectors (e.g. energy), topics (e.g. pollution), principles (e.g. polluter pays), policies (e.g. taxes or regulations) or an effort to mainstream certain principles over time. Green economy integrates economic, social

welfare and environmental policies, and focuses on new opportunities for economic growth that reduce pressure on the quality and quantity of natural capital systems (UNEP, 2011).

Recognizing that the green economy is a means to achieve Africa's objectives of sustainable development, employment creation, economic growth and poverty reduction, African ministers made a strong commitment on green economy at the 14th African Ministerial Conference on the Environment (AMCEN). As the permanent forum of Africa's Environment Ministers, AMCEN aims to strengthen cooperation between African governments on economic, technical and scientific activities in order to address the degradation of Africa's environment and promote the conservation and sustainable use of the Continent's abundant natural resources. The AMCEN also takes decisions at a Ministerial level regarding Africa's response to climate change issues and related programmes. AMCEN's mandate is to provide information and advocacy for environmental protection in Africa; ensure that basic human needs are met adequately and in a sustainable manner; ensure that socio-economic development is realized at all levels; and ensure that agricultural activities and practices meet food security needs of the region.

During 14th AMCEN session, decision on Africa's Post Rio+20 Strategy for Sustainable Development established mechanisms that provide coordinated support to Member States for the promotion of the green economy in Africa, including the development of partnerships and national strategies, the promotion of regional and international cooperation, including South-South cooperation, and the transfer of resource-efficient and green technologies and know-how was adopted. It also adopted a compendium of other decisions and programmes aiming to advance the sustainable development agenda in Africa that include an African Green Economy Partnership (AGEP) to facilitate coordinated support for Member States and contribute to the implementation of the global Partnership for Action on Green Economy (PAGE) ; review the African 10-Year Framework on Sustainable Consumption and Production (10YFP on SCP) and to strengthen and consolidate commitments to promote sustainable development.

During the AMCEN 17th Ordinary Session held in November 2019, South Africa, the main focus was on advancing the Green Economy in Africa, through advancing the

Circular Economy; promoting the Biodiversity Economy and Natural Capital Accounting; environmental contribution to the development of Oceans Economy; and Climate Change.

The green economy revolution is already underway in Africa. Across the continent, governments are formulating strategies to initiate growth in the green economy. Ethiopia, Ghana, Kenya, Mauritius, Mozambique, Rwanda and South Africa and many other African governments have developed, or are developing, green economy strategies and action plans (Building Inclusive Economies in Africa, UNEP 2015). RCMRD should conduct Green Economy Assessments in Member States in close collaboration with governments and national policy institutions which have been instrumental in formulating green economy national strategies and action plans; and have encouraged the integration of green economy principles in national planning documents.

3.4.4 Circular Economy

In a circular economy, all resources are used to their highest value and reused continuously rather than being thrown away. The United States Environmental Protection Agency (US EPA) estimates that for every 10,000 tonnes of used goods, putting them in landfill would create six jobs, recycling them would create 36 jobs, and reuse and repair could create up to 296.

The World Economic Forum is playing a crucial role in spurring Africa's transformation to a circular economy that delivers economic growth, jobs and positive environmental outcomes. During the World Economic Forum on Africa in Kigali in 2016, the African Circular Economy Alliance (ACEA) was conceived and founded by three countries Rwanda, Nigeria and South Africa along with UN Environment and the World Economic Forum as a country-led platform, that aims to lead advocacy projects, undertake policy research and support high-impact circular-economy projects. Its strategic partners include the African Development Bank, Africa Circular Economy Network, Global Environment Facility, Government of Finland, PACE, UN Environment, UN Development Programme and World Economic Forum.

Co-chaired by the environment ministers of Rwanda, Nigeria and South Africa, with 10 member countries from across the African continent, the ACEA has given rise to a multi-donor trust fund with initial capital of €4 million. The Africa Circular Economy Support Programme (ACESP) will fund circular economy entrepreneurs and circular economy activities in countries that have joined the alliance (World Economic Forum, 2021).

The 17th Ordinary Session of the African Ministerial Conference on the Environment (AMCEN), which took place in Durban, in November 2019, called for the widespread adoption of the circular economy on the continent. AMCEN is committed to replicate, scale-up and use circular approaches as part of Africa's transformation efforts, in line with African Union "Agenda 2063", and to support the work of the Alliance. To spur Africa's transformation to a circular economy that delivers economic growth, jobs and positive environmental outcomes at the national, regional and continental levels. African countries with their vast untapped natural resources and fast-growing population have the chance to leapfrog to a low-emission and climate-resilient development model by adopting circular economy principles that enhance social inclusivity.

An effective circular model for Africa must; emphasize green innovations and job creation to seize local and cross-border market opportunities, as well as enhancing climate resilience through economic diversification; and share best practices for the creation of legal and regulatory frameworks, the building of partnerships and the financing and creation of circular economy projects; as well as advocate for and raise awareness of the circular economy at a national, regional and global level.

In line with the aspirations of AMCEN and ACEA, the Centre stands a better chance to facilitate the realization of Circular Economy Agenda amongst its member States through establishing and facilitating strategic partnerships to champion and facilitate implementation of ground projects and programs on circular economy. More so, the Centre can collaborate with ACEA secretariat for joint research on how circular economy approaches can aid sustainable economic growth across Africa and particularly in member States.

3.5 ASPIRATION V: AGRICULTURE, FOOD SECURITY & POVERTY ERADICATION.

Introduction

Africa has 60 percent of the world's available arable land and agriculture is the source of livelihood for 70 percent of the population. However, food production in Africa is highly dependent on rain-fed agriculture which is prone to adverse effects of climate change characterized with unpredictable poor rainfall, persistent drought, perennial flooding amongst others. Agriculture is the backbone of Africa's economy, and accounts for the majority of livelihoods across the continent.

According to AU 2021 report on Food security, African agriculture is plagued by low productivity, under-investment, urban-biased policies, low value addition and poor rural infrastructure. For several decades, Sub-Saharan Africa (SSA) has faced multiple challenges, including rapid population growth, rampant urbanization, climate change, and chronic food insecurity. This has put agriculture as one of the main priorities in the development agenda for AU Agenda 2063 as well as the UN 2030 Agenda for Sustainable Development.

The African Union Assembly of Heads of State and Government, through the Maputo Declaration in 2003, adopted the African Union Comprehensive Africa Agriculture Development Programme (CAADP) to improve food security and nutrition, and increase incomes in Africa's agriculture-based economies which committed to increase annual national budgetary allocations for agriculture to at least 10% to ensure a growth of the agricultural output of at least 6% annually. This among other frameworks adopted by AUC in collaboration with NPCA and RECs is focused on increasing food production and accessibility to facilitate food sufficiency and reduce drought triggered food crisis in Africa.

Further, the 2014 Malabo Declaration by AU member states, to achieve accelerated agricultural growth and transformation made a commitment to ending hunger by 2025 through doubling productivity, halving post-harvest losses and significantly improving nutrition amongst other commitments. This is in line with UN Agenda 2030 to strive to end hunger, achieve food security, improve nutrition and promote sustainable agriculture. The Agenda seeks to double the agricultural productivity and incomes of

small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fisherfolks, as well as ensure sustainable food production systems.

Africa is the fastest growing region in the world. With 2.2 billion people expected by 2050 and more than 4 billion by 2100 (FAO, 2017). It is projected that SSA could account for more than half of the world's population growth between 2019 and 2050, with a projected addition of 1.05 billion people (Mabiso & Benfica, 2019). This rapid population growth, fueled by high fertility rates, is driving an increased demand for food hence the need to reflect deeply on the future of agriculture and its ability to satisfy growing food demand, particularly for Sub-Saharan Africa, where 60% of the population is smallholder farmers.

According to FAO, 2020, food security which is defined as a household's availability to healthy food that is consistently accessible in order to sustain an active and healthy lifestyle is threatened on a community and global level by three important factors;

- the access and availability of food in local environments,
- the effects of the changing climate on agriculture and natural resources, and
- the active participation in planning, developing, and managing effective strategies to optimize and sustain food production with the available existing land.

Several strategies have been developed using Geospatial Information Systems (GIS) and Remote Sensing techniques, which contribute knowledge and understanding to food security. These strategies include techniques which examine local food environments, assess changes in land use and land cover, identify areas of importance in specific regions to determine the relationships between biophysical and socioeconomic attributes, and the use of 3D models to demonstrate landscape and construct methods to sustain our food sources. GIS and Remote Sensing play significant roles in securing the future of our food production and our population.

Application of IoT solutions using geospatial technologies can be used to enhance food production through building capacity of farmers to monitor important environmental factors such as water quality, water levels, soil condition, ambient temperature, moisture, irrigation, and fertilizer for improving crop production and alleviate poverty amongst citizens.

Working closely with AfriGEO community is Digital Earth Africa providing modernized Earth observations to deliver decision-ready products to enable policy makers, scientists, private sector and civil society to address social, environmental and economic changes on the African continent and develop innovative sustainable ecosystems. The establishment of Digital Earth Africa (DE Africa) funded by US-based Leona M. and Harry B. Helmsley Charitable Trust and the Australian Government with a focus of providing the technical and operational expertise from Digital Earth Australia (DE Australia) through institutionalization of DE Africa program in Africa, leveraging on existing capacity across Africa and working with partner institutions such as RCMRD to maximize the potential impact of the program. DE Africa will process openly accessible and freely available data to produce decision-ready products. With close collaboration with the AfriGEO community, DE Africa will be responsive to the information needs, challenges and priorities of the African continent and will leverage and build on existing capacity to enable the use of Earth observations to address key challenges across the continent. DE Africa has developed products and services such as Water Observations from Space(WOfS) a continental scale water monitoring service which allows African countries to map, assess and visualize surface water and understand water availability trends over time, including the impacts of floods and drought; Continental-wide satellite imagery and crop-based services allow anyone to better understand the year-to-year spatial foot-print of food crop growth across Africa; and a wide range of analysis tools to support users address agriculture and food security issues at a regional scale.

A continental scale cropland area mapping service, currently under-development for the DE Africa platform, will provide a baseline environmental layer required for crop monitoring. The vital information and insights gained from regularly mapping food crops will support farmers, scientists, and policy makers to understand how crops respond to variations in farming practices and the climate. This information is valuable for understanding change over time to support optimized planting, fertilizing, and irrigation practices as well as enabling yield forecasting. The ability to monitor change to farms over time through annual calculations of cropland extent also helps us to understand how agricultural productions are shifting in the context of a changing climate. The data can also provide a rapid, standardized and objective assessment of the biophysical impact of agricultural practices in terms of vegetation cover. This

information can inform more sustainable agricultural practices and supports decision makers with information to call for restoration interventions when they are most needed. Member states can use the continental-wide cropland map product to monitor and compare with neighboring countries on seasonal performance so they can determine where to import food from and what to import. This also may include gender sensitivity interventions targeting women and local communities who depend on agriculture for their livelihood.

RCMRD has been involved in mapping and implementation of climate vulnerability maps that evaluate communities at risk based on climate extremes, their sensitivity to disasters and their coping mechanisms. These Vulnerability Impact Assessments have been used to structure climate adaptation strategies at regional level, with down scalable actions such as rangeland ecosystems and water basins in Kenya and Tanzania.

RCMRD has also ventured into risk financing, with projects focusing on developing quality standards for evaluating index insurance and developing gender sensitive index insurance as an adaptation mechanism for small holder farmers with more focus in developing gender sensitive climate adaptation and mitigation outputs, maps, advisories etc.

RCMRD will continue to play a critical role amongst Member States in developing innovative geospatial solutions to support sustainable agricultural practices and food security decisions by promoting data driven decision making to transform agricultural practices using GIS and Remote Sensing to model and forecast food production trends, monitoring of croplands and pasture conditions, optimizing agricultural insurance amongst other interventions. The Centre, through strategic partnership with programs such as SERVIR, AGRA, AfriGEO, DE Africa amongst others will continue to help members States develop digital food balance sheets driven by geospatial data and models for effective policy and decision making on food production and security amongst citizens.

Goal: *To provide innovative GIS solutions in Agriculture and food security to enable Member States achieve accelerated growth in food production, end hunger and eradicate poverty amongst its citizens.*

Key Outcome: Enhanced technical capacity for sustainable agricultural practices and food security.

Key Stakeholders: The Centre will work closely with Member States, Key donors, and key government agencies, Space Agencies, amongst other key stakeholders.

The Centre will enhance technical capacity of its member States through adoption of the following strategies on climate change;

3.5.1 Modelling the Future of GIS and RS in Food Security

Coinciding with changes in populations and land use, climate plays an influencing factor on food production and biodiversity. GIS and Remote Sensing technologies such as satellites and software can be used to gather and map data concerning soil fertility, elevation models, population, poverty index, food production, and Landsat images. Correlating these data sets and analyzing them with GIS techniques is useful in analyzing changes in the climate and their effects on agriculture production. GIS and Remote Sensing systems are also able to monitor changes in climate and demonstrate its effect on soil fertility, rainfall, growing conditions, and approaching food shortages. Remote Sensing systems such as the SPOT-4 and 5 satellites with the VEGETATION instrument create imagery on a global scale that can be used to identify disaster prone regions where changes in vegetation may become insecure. The FAO ARTEMIS is a widely used system to monitor food supply and demand conditions for proper preparation for disasters such as food shortages, droughts, and hunger. By monitoring rainfall, soil fertility and vegetation, disasters such as drought can be foreseen and proper planning can be put in to action to prevent catastrophic effects.

GIS and Remote Sensing applications provide the information and knowledge necessary to adapt sustainable agriculture practices and yield insight to threats caused by climate change and other environmental factors. This provides critical information to facilitate member State's policy decisions on droughts, food shortage, crop growing conditions, and other conditions that may threaten food security. By enhancing the capacities of member States in terms of improving supply and access to earth observation and climate information through collaboration with programmes such as the Monitoring for Environment and Security in Africa (MESA) Programme, the African Monitoring of the Environment for Sustainable Development (AMESD) Programme, the Great Green Wall

Programme for the Sahara and Sahel Initiative (GGWSSI) and SERVIR (E&SA) program among others.

RCMRD through application of modern GIS and Remote Sensing technologies and enhancing Member States technical capacity in adaptation of climate change management systems, will continue to play a critical role providing critical information and knowledge on adoption of sustainable agricultural practices. The Centre is strategically place to enhance Member States capacity in developing GIS based systems to influence government policy frameworks for implementation of modern food production practices anchored on digitized food balance sheets driven by geospatial data and models, adoption of machine learning and artificial intelligence for within season crops detection and real estimation for yield and production estimation to support agricultural insurance. This will enable Member States develop sustainable national agricultural sector growth and transformation strategies as well as National Agricultural Investment Plans (NAIPs) such as Galana-Kulalu Food project in Kenya.

This will facilitate in the realization of sustainable agriculture and food security in SSA and Africa as a whole.

CHAPTER 4: ENABLERS

This chapter highlights the key enablers to the achievement of vision 2050. These are key input areas that the Centre will have to focus on in order to be make the vision a success.

4.1 ADOPTION OF MODERN GEOSPATIAL AND 4IR TECHNOLOGIES

Geospatial Industry as a field has undergone significant transformation in recent years. In the past, the process of collecting geospatial data was laborious and performed with ground-based methods. The updating cycles often spanned several years, and the outcomes (such as paper maps) could not be easily shared across government agencies. The potential for integration and multiple applications, a key characteristic of geospatial data, could not be exploited. Recent technological advancements have changed this state of affairs. GIS uses modern software and hardware to store, access, visualize, map, analyze and disseminate geographic data. Geospatial data can now be referenced to a globally defined coordinate system. Global Navigation Satellite Systems (GNSSs) such as the Global Positioning System (GPS) use satellites to allow users to determine their exact location, velocity, and time in any conditions, making traditional positioning instruments such as tapes and theodolites obsolete.

These new geospatial technologies can support the realization of many diverse benefits which as outlined in Agenda 2063 and UN Vision 2030 for sustainable development. Through embracing 4IR technologies, RCMRD can collaborate the with member States to offer innovative products and services in pursuit of its mandate and the vision to be the Centre of Excellence in Africa. The 4IR technologies offers an enabling platform for "one stop- shop for Geospatial solutions in Africa through strategic focus on the following key 4IR interventions to revolutionize Geospatial Industry in Africa;

i) Cameras, Imaging and Sensing;
ii) Unmanned Vehicle Systems and Drones;(autonomous underwater vehicles (AUVs), unmanned aerial vehicles (UAVs),)
iii) Survey, Measurement and Scanning;/
iv) Artificial Intelligence;
v) Smart Sensors and Internet of Things;

vi) Immerse Technologies;

vii) 3D modelling and Simulation; and

viii) Connectivity technologies.

4.1.1 Modern Cameras, Imaging and Sensing

Definition: "Modernize equipment and instruments being used to collect, store and process EO data instruments used to collect, store and process EO data." The ongoing digital revolution is unleashing an era of **near-persistent observation.** The range of imaging sensors are becoming as diverse as they are different with space, airborne, drone, vehicle, and ground-based imaging and sensing, as well as new sophisticated camera networks. This has opened up tremendous opportunities for the geospatial industry and the advances in technology in this area have been tremendous such as; the development and widespread adoption of new platforms for collecting EO data, including **High Altitude Pseudo Satellites (HAPS), small satellites** and **drones**, which resulted in greater coverage across satellite constellations, more accurate targeting, increased capture options (time and place) for customers of EO data and the ability to undertake persistent observation and monitoring; and significant improvements in the resolution and accuracy of cameras and sensors, which has unlocked a number of new geospatial use cases with improved EO capabilities in sectors such as infrastructure, asset management and agriculture besides defense.

The increase in the range of sensing capabilities available in **Multi-spectral and Oblique Imaging, Thermal IR** and **LiDAR** will benefit Member States that require highly granular ground level data for policy formulation and decision making especially in agriculture and farming. Additionally, there will be opportunities in new sectors with the combination of aerial imagery with other map data and land use data, for instance deeper understanding of urban environments, enabling highly **accurate 3D models**. At the ground-level, **vehicle sensors** are becoming increasingly common, with a number of different public and private sector organizations undertaking vehicle drive-by imaging and mapping surveys. These projects are being completed for a wide range of applications, including asset management, 3D city modelling, street canyon imaging and utility surveys. In addition, drive-by surveys are used as data sources for global on-line mapping, imaging and navigation platforms. **Static and Backpack Imaging** is

another emerging trend in ground-based imaging. The emergence of backpack-mounted imaging systems and static camera options has been brought about by the requirement to image and texture 3D city models, provide imagery context for indoor spaces and support for floor plan mapping.

4.1.2 Unmanned Vehicle Systems and Drones

Definition: *Unmanned Vehicle Systems are vehicles that are either controlled remotely or operate autonomously, by sensing their environment and navigating without human intervention.* Currently, there are three areas of major geospatial interest relating to drones. Drones are being used as an aerial platform for **EO and mapping projects** and also being used as **delivery systems** for the delivery of lightweight packages, postal services and medicines. In recent times drones are being developed to carry and **transport passengers** within urban areas. Drones are increasingly being used to support the monitoring and inspection of the condition of **energy distribution assets** and networks by leveraging **Computer Vision** to recognize images of infrastructural assets, using deep networks and convolutional neural networks to identify different types of faults and anomalies.

As drones become an integral part of urban environments, they are likely to be used more frequently as part of the wider **urban traffic management** initiatives. Further, research is also underway to develop future **Swarm Capabilities** in command and control systems. In addition to policing and security, Drone Swarms will become increasingly applied to the monitoring of urban infrastructure. Over the next decade, we should expect to see the use of drones to extend from EO, mapping and monitoring to provide first and last mile geospatial reference and navigation data to support systems such as geo-awareness, geofencing and GNSS- based locational requirements.

Remote sensing has become an indispensable tool for monitoring coastal and inland waters, and hyperspectral remote sensing has gained increased use in the last decade. The optical complexity typically encountered in coastal and inland waters necessitates hyperspectral sensors with a fine spectral resolution. Hyperspectral capability enables species discrimination of aquatic vegetation and detection of fine reflectance features of biogenic and inorganic substances in water and accessory pigments such as

phycocyanin and phycoerythrin that occur in significant amounts during bloom conditions. To support Blue Economy, organizations such as RCMRD will be required to invest in emerging **Autonomous Underwater Vehicles (AUVs)** and Sensors with hyperspectral capability to capture spatial heterogeneity of bio-optical features in waters where spatial variability may occur in scales as fine as a few meters for coastal and inland water. With appropriate software and hardware options, multiple water quality parameters from airborne and spaceborne multispectral and hyperspectral data can be monitored for crucial information on conservation and sustainable blue economy strategies.

4.1.3 Modernized Survey, Measurement and Scanning

Definition: *Modernized Survey, Measurement and 3D Scanning systems provide the foundation upon which the geospatial ecosystem is built.* These technologies underpin above-ground, underground and indoor positioning systems, in addition to being crucial for enabling numerous emerging technologies, such as Internet of Things, Autonomous Vehicles, Building Information Modelling, Virtual Reality, Artificial Reality and Mixed Reality. More accurate and **precise positioning systems** are central to operation of complex sensors systems at scale, such as IoT systems, where connected devices collect and communicate location intelligence by transmitting signals in real-time. At the ground-level, there are a number of sensors that are becoming more widespread in surveying and measurement. **Telemetry** is the traditional process by which ground-based remote sensors transmit data to stationary data acquisition systems. Advances in ground sensors can enable **Ubiquitous Positioning,** where positioning can extend to indoor and more remote locations. This allows surveying and measurement to be conducted using multiple remote sensors, and is an important enabler of IoT systems and an 'always on' concept of operation, which allows different sensors to communicate continuously.

LiDAR is a well-established geospatial technology that involves using pulses of light to capture and model a feature or an area environment in three dimensions. It can be applied across multiple sectors and requirements, including mapping an industrial site in granular detail, providing ground model data for different geospatial modelling such

as flooding, windstorms, forest fires among others and providing the spatial context for developing immersive environmental management solutions and applications.

Indoor positioning is a particularly significant opportunity for the geospatial community since developments in this area has struggled to match the levels of innovation and widespread uptake seen in outdoor positioning. However, applications utilizing a mixture of bluetooth, WiFi and magnetic positioning can connect to smartphone without requiring any additional infrastructure. **Crowdsourcing** or **Volunteered Geographic Information** (VGI) is another key emerging geospatial technology area. Other new techniques such as **Analysis Ready Data** (ARD), where EO data is processed into a useable form in real-time, and **Robotic Process Automation** (RPA) are being leveraged to support automated **Feature Extraction** for thematic and national mapping requirements.

4.1.4 Artificial Intelligence

Definition: *Artificial Intelligence refers to systems or programs that can complete tasks that would normally require human intelligence, such as data analysis, visual perception, speech recognition or decision-making.* AI will fundamentally change how analysis supports the day-to-day business operations, providing enhanced intelligence opportunities for entities a multitude of sectors. **Machine Learning** (ML) involves building statistical models based on sample data to make predictions or decisions without being explicitly programmed to perform the task. This has been effectively leveraged by geospatial industry players to allow systems to derive insights and make decisions from structured and unstructured datasets with minimal human intervention. The EO industry in recent times has been able to apply change detection algorithms to automatically identify areas of change, including the identification of new areas of deforestation, urban development, or to support damage assessment mapping following disasters.

In **Location Intelligence**, GNSS and positioning technologies are being positively affected by AI, affecting industries such as logistics and navigation systems. For instance, through processing millions of GPS points in real time, systems will be able to forecast changing road and traffic conditions in the transport sector. **LiDAR** and **Radar** will also

require enhanced automated analytical capabilities if future applications such as Connected and Autonomous Vehicles (CAV) are to become a reality to explore how CAVs can share positioning and safety information in real-time.

Combining AI with other emerging technologies such as **IoT** will also bring about a number of new opportunities for the geospatial sector. The increasing number of sensors within **Smartphones** and other tracking devices require advanced analytics to draw meaning from the information that they transmit.

4.1.5 Smart Sensors and Internet of Things

Definition: Smart Sensors and the Internet of Things are the networks of physical objects that contain embedded technology to sense changes in their internal states or in the external environment, and communicate this information with other connected devices. To realize the true value of IoT, it is necessary to have greater integration between multiple sensors and smart devices, especially in the context of 'Smart Cities' or other large connected ecosystems. Perhaps the most highly anticipated use of geospatial technologies and sensors is in the **Smart City domain**. Smart City applications rely on an integrated IoT network of devices across a set of different services and businesses.

Collation and consolidation of data from multiple geolocated and timestamped sensors and public sector datasets are becoming crucial to monitoring the security and resilience of assets in urban areas. Similarly, data-gathering motion sensors offer opportunities for continuous and real-time footfall analysis. Similarly, it is now becoming increasingly common to see mobile phone sensor data being used to analyze transport activity. There are a number of emerging companies using **Crowdsourced** mobile data to provide transport insights to cities and local councils.

In **agriculture and farming**, IoT solutions using geospatial technologies are seeing significant results. The main aim of IoT in farming is to monitor important environmental factors such as water quality, water levels, soil condition, ambient temperature, moisture, irrigation, and fertilizer for improving crop production. There is an opportunity for geospatial analysis used in sensors for monitoring and supporting

the management of future **smart energy grids**. These grids are composed of connected devices and sensors (including smart meters and smart appliances) and are capable of detecting changes in local energy usage in real-time. The roll-out of the smart grid relies on highly accurate geospatial information to ensure that demand analysis is accurate and reliable.

4.1.6 Immersive Technologies

Definition: *Immersive technologies emulate physical environments through the creation of a digital space allowing visualization and interaction with an environment.* Within the geospatial community, these technologies are typically used to produce advanced geo-visualization environments and to allow presentation of geospatial data. Any level of geospatial detail can be presented within an immersive reality, from a skeleton geometry in **3D**, through to an **Intelligent Point Cloud** which updates as a real-time digital representation of a target. Geospatial acquisition technologies, such as **LiDAR**, provide a greater level of detail and context in the immersive model. Some **GIS** technologies are also becoming integrated with immersive systems and we have seen the early adoption of these solutions in certain niche sectors.

A significant amount of **Virtual Reality and Augmented Reality** innovation is taking place; using wearable mobile devices, AR can transport users into new geographic locations to bring about context-awareness remotely.

While in its relative early stages today, more R&D and innovation work in the geospatial enablement of immersive technologies in the near future, could just make this a highly important domain area for geospatial exploitation going forward.

4.1.7 3D Modeling and Simulation Technologies

Definition: *3D Modeling and Simulation technologies allow a user to model various scenarios within a digital environment. This involves building digital representations, or 'Twins', of a specified geographical area, and manipulating relevant variables to model likely effects.* Today, maps are increasingly becoming digital representations of a specific time and place, with users able to interact with and manipulate the underlying data.

Geospatial simulations are already being widely applied in specific thematic areas such as flooding simulation and road traffic movement. The most significant future opportunities relate to the integration of thematic models at a city-wide, or even national level.

3D Modelling is now a commonplace service offered by geospatial companies, and is expected to grow as the emerging technologies in this area mature. With advances in **AI** and **ML**, multi-dimensional modelling and simulation will improve maintenance and decision-making processes within the Geospatial sector. **GIS** technologies also offer a number of benefits for modelling facility management scenarios, including space management, visualization and planning. **Facility Operating Systems**, which manage large operations such as airports, industrial and power plants will be the main beneficiaries of such developments. Increasingly, Smart Cities will coordinate these systems with smart sensor capabilities which will model and simulate urban planning. Fields such as construction and development are also increasingly adopting continual sensor monitoring and reporting on assets. **Digital Twin** and Simulation technologies are growing rapidly in the geospatial sector. These technologies have the potential to support multiple future models.

3D laser scanners are increasingly being used to understand and interpret the shape of things such as buildings or land by collecting clouds of points to create digital 3D models. Through mobile mapping systems geospatial experts can create 3D models from a wide variety of environments within a short period of time. Indoor, outdoor and underground areas can all be extensively detailed with 3D mapping technology since it presents fairly straightforward geospatial solutions to collect data and use software for fast and simple mapping. Surveyors can create digital replicas without cumbersome equipment or the need to wait hours to see the results. Versatile equipment options, handheld devices and aerial recording make mobile 3D mapping a viable and effective approach for many land surveyors.

LiDAR technology is a form of 3D laser scanning. LiDAR stands for Light Detection and Ranging and uses a pulsed laser in ultraviolet, visible or near-infrared light to measure variable distances to the ground or nearby objects. The machine is composed of a laser,

a special GPS receiver and a scanner, and they usually utilize airplanes and helicopters to gather their data across large areas. This remote sensing method collects information from the light pulses and other data collected from the aerial system to create detailed 3D models or gather survey information about the physical characteristics of the Earth.

There are several different types of LiDAR, including:

- **Terrestrial:** This type of LiDAR maps the Earth's surface through topographical measurements that are mounted on the ground. Surveyors can map 3D-point clouds from the scanner with digital images to quickly make realistic 3D models. It can bypass the cumbersome tasks of measuring each item, like power lines, bridges, trees and more that may be in an area.
- **Bathymetric:** Many advancements have been made in producing measuring devices using sonar technology, including side- and multi-beam models for more detailed observations in varying conditions. Bathymetric LiDAR measures elevations of riverbeds and seafloors with the help of a green light that penetrates water and its reflection back to a sensor. The measurements are typically taken from the air.
- **Airborne:** A laser scanner can be attached to an aircraft and used to create a 3D-point cloud model of a landscape. It is detailed and accurate, helping to create digital elevation models (DEM) and digital surface models (DSM).

This system provides a new level of precision and flexibility to the measurement of both organic and manmade structures. LiDAR is growing in use in a wide range of applications and specifically in the following key areas:

- Agriculture: Topographical data from LiDAR can help identify patterns of sun exposure, insect behavior and features in the landscape to improve farming tactics.
- Atmosphere: LiDAR is used in meteorological applications to provide information on surface pressure, greenhouse gas emissions, fires and photosynthesis. It can measure backscatter from the atmosphere and reflections that scatter off a hard surface.
- Wind farms: LiDAR can measure wind speeds and turbulence to help optimize the performance of wind farms.

One of the major benefits of LiDAR is that it offers real-time point clouds. This feature can provide significant advances in the way of speed and accessibility, making projects more flexible and efficient.

Through LiDAR systems and associated equipment and facilities e.g. helicopter among others, RCMRD can offer the much needed holistic environmental management solutions within the Sub-Saharan region.

4.1.8 Connectivity Technologies

Definition: *Connectivity technologies refer to the communications infrastructure across which geospatial data is transferred and exchanged. This includes satellite communications, as well as fixed and mobile telecommunications networks.* The higher speed and lower latency offered by 5G will allow data to be transferred more efficiently, cost-effectively and securely. Further, the geospatial community and geospatial data also has a key role supporting the planning, roll out and operation of our communications infrastructure. In addition to the ongoing investments to achieve full-fiber networks, going forward, the single largest game-changer in geospatial connectivity is likely to be **5G**. 5G technologies use existing and high-frequency spectrum, enabling rapid data transfer speeds, making it easier to download and upload on mobile devices.

In addition, there have been dramatic advances in the network capacity of satellites over the past decade. Going forward, small and miniaturized satellite constellations — such as those operated by OneWeb will present new global network and communications opportunities for example in the UK there cross-governmental **Public Service Network** (PSN) and **Emergency Services Network** (ESN) connectivity, which supports communications between front-line officers and other essential service providers. These emerging high-capacity, fast, and low latency communications channels will enable geospatial data to be transferred securely at high speed and in large volume. Improved network capacity and data speeds will allow the expansion of the use of real-time image and video streaming, including **HD** and **Ultra-HD Video**. Better connectivity will also allow more geospatial players to leverage the scalability and computing power offered by Cloud computing. Improved connectivity to the cloud

will allow data to be stored and processed in Cloud centres in real-time, allowing constant connection between field, office and Cloud.

Improved local connectivity will also allow geospatial actors like RCMRD to develop new **Edge Computing** strategies. Edge Computing relies on local networks of micro data centers close to the sensor or scanner, and is particularly important for delivering lower-cost data processing and storage for IoT systems. The reduced latency of 5G technology will be crucial to the future adoption of **Autonomous Vehicles** and **drones**. Since autonomous vehicles require extremely fast networks with no delay or lag to operate, this reduced latency will also better support the effective streaming of real-time imaging data on the move, as well as continuous sensor availability to support spatial analysis at scale in real time. Constant and secure connectivity will also be crucial for drones and other unmanned vehicles when performing missions covering large land areas, including surveying, mapping e.g. monitoring of energy grids, monitoring of hazards and natural disasters, environmental resources among others.

Improvements in **Satellite Communications** are enabling high- volume geospatial data to be transmitted across these networks, which could previously only handle low volume audio data such as voice. To support the significant investments and operation of our communication infrastructure, telecommunications and utility companies require a wide range mapping, survey and geospatial analysis services. These not only represent significant future opportunities for the geospatial community, but also demonstrate how the geospatial community can both benefit from and enable the development of key emerging technologies.

4.2 CLOUD STORAGE, INFORMATION SHARING & DISSEMINATION

Many organizations such as RCMRD have to store data for thousands of projects, and they can repeatedly outgrow their capacity as they accumulate more projects and business. To remedy this, many organizations are turning to cloud storage, in which data is kept off-site, in a secure location and managed by a third-party company. Often, these companies offer high levels of security with dedicated experts working around the clock to protect their clients' data. Most importantly, it takes the burden of finding space for the data away from the survey companies. They can spend less time worrying

about the security of their information and more time working on projects or investing in better equipment. Cloud storage is scalable and allows the Centre to manage data storage batter and avoid the costly and time-consuming physical storage infrastructure.

Cloud storage will not only allow the Centre significant amounts of processing capabilities but also will enhance its ability to share and access data with member States and other key stakeholders faster and securely. Cloud storage eliminates the need to send files, which is essentially copying and redownloading them, often resulting in duplicates or creating unnecessary data. With cloud storage, member States can instead access the same data, and they can do so from a variety of devices wherever they have a connection.

Cloud storage will enable users' access to critical data remotely while undertaking field work. With Cloud Storage, RCMRD can establish collaborations with diverse industry players and offer cloud services to surveyors, policy makers, partners and other stakeholders. The Centre can commercialize cloud storage as a 'data service' that will be a one stop information center for customizable GIS data that can be modelled to unique products and services and provide critical information to support essential services such as weather forecasting and trends in transport and agriculture sectors.

More so, the Centre needs to engage all its key stakeholders through adoption of effective communication interventions and strategies to popularize the Vision 2050 and seek support for effective implementation.

4.3 COLLABORATIVE PARTNERSHIP IN RESEARCH & DEVELOPMENT

Significant research is still needed in a number of areas within Geospatial industry in Africa especially on the use of emerging Geospatial technologies and capacity building gaps, the crowdsourcing phenomenon, and how to develop prototypes of geospatial operational models and software products amongst other areas.

The Centre will also undertake research and development of innovative products and services that will not only enhance Member States technical capabilities to address problems and challenges on sustainable growth and development. By undertaking Member States focused needs assessments on existing frameworks their Geospatial

Sectors, the Centre will facilitate a harmonized all-inclusive approach with a standardized common regulatory framework supporting implementation of key programs and interventions within the sector. More focus will be on the need to find a better way to offer innovative geospatial products and services that adequately meet the needs of Member States expectations and other stakeholders. The Centre shall enhance partnerships and collaboration with the Member States through deliberate stakeholder engagement initiatives through continuously lobbying strategic partners and other key stakeholders in geospatial industry. The Centre should seek to strengthen existing partnerships and collaborations arrangements with Member States and key stakeholders to pursue well researched interventions that will shape the regional and national geospatial strategies for sustainable growth and realization of AU Agenda 2063.

4.4 MEMBERSHIP SUPPORT & GOOD GOVERNANCE

To realize RCMRD vision 2050, the Centre requires continued support and commitment from Member States to identify and implement projects and programs in their countries as well as through their annual subscription remittances.

Through coordinated identification of members needs by the Centre in collaboration with relevant institutions and government agencies in Member States, the Centre will create synergies in implementation of key programs and projects anchored on RCMRD Vision 2050.

The Centre will continue to formulate and pursue deliberate medium and long-term strategies in the implementation of its future corporate strategic plans and workplans that are focused on realization of this vision as well as on the long-term sustainability of the Centre in line with the mandate and objectives of the Centre. The Centre will continue to be guided by the objects as defined in the Principal Agreement stablishing the Centre and embrace good governance practices in all its operations as outlined in the Corporate Governance Guidelines and as will be guided by the GC and CoM from time to time. In line with the best practice, the Vision 2050 will be reviewed within the Corporate Strategic planning cycles after every four (4) years and to align with emerging contemporary issues facing the Member States from time to time and progress reported to Governing Council and CoM.

The Centre will endeavor to continue to enhance its internal systems and management practices to ensure good governance and long-term sustenance of the institution and support from Member States.

REFERENCES

Africa Development Bank, (2021). Climate Change in Africa, https://www.afdb.org/en/cop25/climate-change-africa

African Union (UN), (2013). African Union Agenda 2063: A Shared Strategic Framework for Inclusive Growth and Sustainable Development. https://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf

Africa Union Commission, (2021). Food Security 2021 report. https://au.int/en/auc/priorities/food-security

Common Market for Eastern and Southern Africa (COMESA). (2018). Inclusive and Sustainable Industrialization. Biennial Report; 2017-2016. https://www.comesa.int/wp-content/uploads/2019/02/COMESA-Annual-Report-2016_17_final-web.pdf

Common Market for Eastern and Southern Africa (COMESA) Secretariat, (2020). COMESA Strategy on Climate Change 2020-2030

Department, Forestry, Fisheries and the Environment, Republic of South Africa, (2020). 17th Session of African Ministerial Conference of the Environment (AMCEN).

East Africa Community (EAC), (2015). East African Community Vision 2050. Regional Vision for Socio-economic Transformation and Development. Arusha Tanzania. http://repository.eac.int/bitstream/handle/11671/567/EAC%20Vision%202050%20FINAL%20DRAFT%20OCT-%202015.pdf?sequence=1&isAllowed=y

Economic Commission for Africa, (2016). Africa Blue Economy- A Policy Handbook

Food and Agriculture Organization, (2019). The State of Food Security and Nutrition in the World 2019.

Regional Centre for Mapping and Resource Development (RCMRD), (2019). RCMRD Strategic Plan 2019-2022 CoM Adopted. (November 2019). Kasane, Botswana.

Southern African Development Community (SADC), (2020). Regional Indicative Strategic Development Plan. South Africa. https://www.sadc.int/files/5713/5292/8372/Regional_Indicative_Strategic_Development_Plan.pdf

The Green Economy Project, UN Environment Program, 2021. www.unep.org/explore-topics/green-economy/what-we-do/advisory-services/africa-green-economy-project.

UNCTAD (2015). Commission on Science and Technology for Development Eighteenth session. Mapping of international Internet public policy issues.

Geneva, 4-8 May 2015. Retrieved from https://unctad.org/system/files/official-document/ecn162015crp2_en.pdf

United Nations. (2018). The Sustainable Development Goals Report 2018. United Nations, New York.

UNEP, (2015). Building Inclusive Green Economies in Africa Experience and Lessons Learned 2010-2015

Word Bank, (2013). Unlocking Africa's Agricultural Potential. An Action Agenda for Transformation. Sustainable Development Series. https://openknowledge.worldbank.org/bitstream/handle/10986/16624/769900WP0SDS0A00Box374393B00PUBLIC0.pdf?sequence=1.

World Bank, (2018). Atlas of Sustainable Development Goals 2018: From World Development Indicators. Washington, DC: World Bank.

World Bank, (2020). Understanding the Cost of Achieving the Sustainable Development Goals. Equitable Growth, Finance and Institutions Practice Group-Policy Research Working Paper 9146. New York. http://documents1.worldbank.org/curated/en/744701582827333101/pdf/Understanding-the-Cost-of-Achieving-the-Sustainable-Development-Goals.pdf

World Health Organization (WHO), (2020). Coronavirus disease (COVID-19). Situation Report – 113. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200512-covid-19-sitrep-113.pdf?sfvrsn=feac3b6d_2

World Agroforestry Centre (ICRAF), John Dixon et al, (2020). Farming Systems and Food Security in Africa; Priorities for Science and Policy under Global Change.

Centre Vision 2050 Linkage to AU Agenda 2063 and UN Vision 2030.

Vision 2050 Aspirations	RCMRD Goals	Agenda 2063 Goals	UN Sustainable Development Goals
Aspiration I: Growth and Expansion of RCMRD.	*To create a financially stable institution not wholly dependent on members contribution for implementation of its programs and with modernized infrastructure.*	20.Africa takes full responsibility for financing her development Goals.	10. Reduce inequality within and among countries.
			17.Strengthen the means of implementation and revitalize the global partnership for sustainable development.
		2.Well educated citizens and skills revolution underpinned by science, technology and innovation.	4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
		12.Capable institutions and transformative leadership in place.	16.Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
Aspiration II: Sustainable Urban planning and Development	*Support member States in the implementation of Sustainable Urban development agenda through providing modern GIS solutions for policy and decision making.*	4.Transformed economies.	11.Make cities and human settlements inclusive, safe, resilient and sustainable.
			8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
			9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
Aspiration iii: Modernized Land administration and Management	*Spearhead implementation of sustainable Land use and Land cover policies and programs amongst the member States.*	10.World class infrastructure criss - crosses Africa.	9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
		19.Africa as a major partner in global affairs and peaceful co-existence.	17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.
Aspiration iv: Disaster Management, Weather and Climate Change	*Enhance technical capacity of its member States to address the adverse impacts of climate change and weather conditions for sustainable development and food security.*	7.Environmentally sustainable and climate resilient economies and communities.	6. Ensure availability and sustainable management of water and sanitation for all.
			13. Take urgent action to combat climate change and its impacts.
		6.Blue/ocean economy for accelerated economic growth.	14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
		7.Environmentally sustainable and climate resilient economies and communities.	15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
			13. Take urgent action to combat climate change and its impacts.
Aspiration V: Agriculture, Food security & Poverty Eradication	*To provide innovative GIS solutions in Agriculture and*	1.A high standard of living, quality of life and well-being for all citizens.	1. End poverty in all its forms everywhere in the world

	food security to enable member States achieve accelerated growth in food production, end hunger and eradicate poverty amongst its citizens.	3. Healthy and well-nourished citizens.	3. Ensure healthy lives and promote well-being for all at all ages.
		5.Modern agriculture for increased productivity and production.	2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Figure 5: Vision 2050 Linkage with AU Agenda 2063 & UN Vision 2030