SPACE BRIEF

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EXTENDED BRIEF ON MONITORING AFRICA'S SEAS AND OCEANS USING SATELLITES

INTRODUCTION

Seas and Oceans are of economic, political and strategic importance to Africa. In recognition of this, the African Union Commission (AUC) marked the first edition of the African Day of the Seas and Oceans on 25th July, 2015. The theme of the event was: "Harnessing the Blue Economy in achieving the African Union Agenda 2063." On the same day, the AUC launched the Decade of African Seas and Oceans (2015-2025) and held the Inaugural Session of the Strategic Task Force on the 2050 Africa's Integrated Maritime Strategy (2050 AIM-STRATEGY).

One of the outcomes of the maiden event is the realisation of the need for regular monitoring of Africa's seas and oceans. This will enable sustainable utilization of the resources derivable from them, increase safety and security, and increase economic benefits to Africa. This publication highlights how space science and technology, and in particular, satellites, offer the best means for monitoring seas and oceans. It also presents a long-term collaborative endeavor between African countries and other partners, in using satellite data and *in situ* measurements for monitoring seas and oceans.

THE BLUE ECONOMY: SEAS AND OCEANS

The Blue Economy refers to the resources that are found in the seas and oceans. Africa's seas and oceans are strategic sources of wealth for the continent, supporting trade in fishing, salt, oil and gas. Industries dependent on seas and oceans include tourism, marine transport, fiber-optic communication, ship building and service. It is estimated that the value of goods and services from coastal and marine resources is about US$18 billion annually.

Bryde whale in False Bay, South Africa, showing upright dorsal fin
Credit: Wikipedia

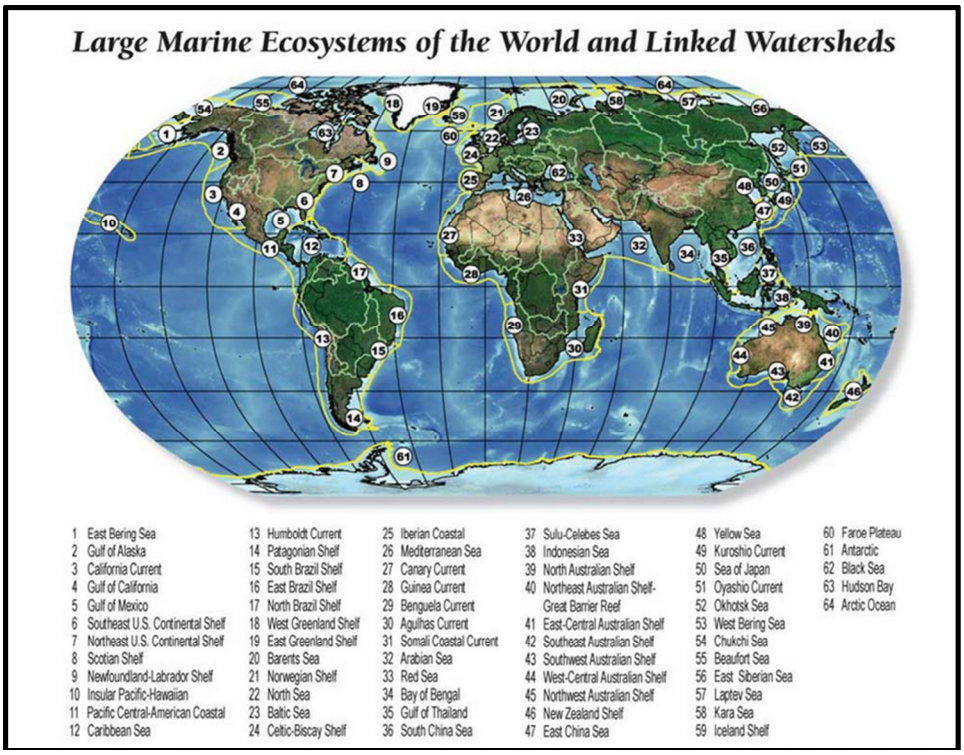
Dolphins off the coast of Mozambique
Source: travel4wildlife.com

The Blue Economy is referred to as 'the new frontier of the African Renaissance'. As such, Africa is now making more deliberate efforts to obtain optimum value from its Blue economy. Africa is party to several international conventions pertaining to maritime. This includes the United Nations (UN) Convention on the contract of international goods transported wholly or partially by sea (2009 Rotterdam Rules), the UN Convention on transit trade of landlocked States (1965) and the Convention on the facilitation of International Maritime Transport (FAL Convention-1965). Other regional initiatives include Indian Ocean Memorandum of Understanding (MoU), Mediterranean MoU, and the West and Central Africa MoU on Port State Control (Abuja MoU), which are instruments signed in response to the global initiative for the eradication of substandard vessels, working conditions of seafarers and preservation of marine environment; the Maritime Organization of West and Central Africa (MOWCA) MoU on Establishment of an Integrated Coast Guard Function Network; the Abuja Declaration on Sustainable Fisheries and Aquaculture in Africa (2005); the African Maritime Transport Charter (AMTC), 2010, as well as the Durban resolution on maritime safety, maritime security and protection of the marine environment in Africa; and the Economic Community of Central African States (ECCAS) Merchant Marine Community Code.

Large Marine Ecosystems (LMEs)

Seas and oceans are impacted by harmful fishing practices, pollution, different forms of degradation and piracy. To mitigate these and conserve the seas and oceans, the National Oceanic and Atmospheric Administration (NOAA) of the United States of America has identified 64 Large Marine Ecosystems (LMEs) for conservation purposes.

LMEs are large areas of about 200 000 square km, stretching from river basins and estuaries to the outer margins of oceans. They are delineated by depth, flow, physical conditions, and biological life. About 80% of the world's fishery is found within the LMEs. Conservation of the LMEs will reduce pollution, restore the environment and ensure sustainable fishing.



Source: https://www.cbd.int/ecosystems/newsletters/ea-2009-10.htm

Africa's Integrated Maritime Strategy (AIMS)

On 31st January, 2014, at the 22nd Summit of the African Union (AU) in Addis Ababa, African Heads of States and Governments adopted the 2050 Africa's Integrated Maritime Strategy (2050 AIM-Strategy) and Plan of Action. The 2050 AIM-Strategy is a framework for the preservation, utilization, and sustainability of Africa's Marine Domain. Its vision is "to foster increased wealth creation from Africa's oceans and seas by developing a sustainable thriving blue economy in a secure and environmentally sustainable manner."

AIM-Strategy identifies the following threats to Africa's seas and oceans:

(i) Transnational organized crimes in the maritime domain (including money laundering, illegal arms and drug trafficking, piracy and armed robbery at sea, illegal oil bunkering/crude oil theft along African coasts, maritime terrorism, human trafficking, human smuggling and asylum seekers travelling by Sea);

(ii) Illegal, unreported and unregulated Fishing - IUU Fishing - and overfishing, and environmental crimes (including deliberate shipwrecking and oil spillage as well as dumping of toxic wastes);

(iii) Natural disasters, marine environmental degradation and climate change;

(iv) Strategic communications systems;

(v) Vulnerable legal framework;

(vi) Poorly maintained and/or lack of aids to navigation and modern hydrographic surveys, up-to-date nautical charts and maritime safety information in a number of AU Member States.

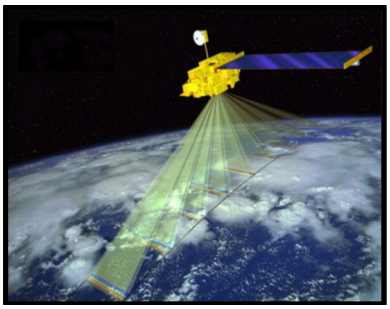
To mitigate these threats, AIM-Strategy sets out to ensure security and safety of maritime transportation; minimize environmental pollution; expedite recovery from catastrophic events; prevent hostile and criminal acts at sea; protect the Africa Maritime Domain (AMD) heritage, assets and critical infrastructure; among other objectives. These objectives can be achieved with the use of satellites as discussed below.

USE OF SATELLITES IN MONITORING SEAS AND OCEANS

Use of Earth Observation satellites

Earth Observation (EO) refers to the gathering of data and information about earth's physical, chemical and biological systems. EO satellites offer the best option for local and global measurements of Earth's variables. They do this through a process called 'Remote Sensing'. Sensors on the satellites measure the radiation emitted or reflected from the Earth and objects on the Earth's surface. As every object has a unique radiation (its spectral signature), objects can be identified or distinguished by processing and analysis of the data imagery. Also, depending on the nature of the radiation, and the type of technology employed, EO can provide information related to the Earth's atmosphere, land surface, rocks, soils, vegetation, rivers, lakes, oceans, and the cryosphere. It can also provide information related to processes happening below the surface, such as changing levels of ground-water or inside volcanoes.

There are several satellites that are currently being used for marine ecosystem management. This includes GOES series, GeoEye, IKONO series, Earthnet mission, and meteosat series. The African Resource Management Constellation (ARMC) is a constellation of EO satellites jointly owned by interested African countries. Each contributing member-state procures satellite(s), shares its data with other members, and gets access to data from all other members of the group. The current members are Algeria, Kenya, Nigeria, and South Africa.



Terra satellite carrying five sensors for monitoring pollution (Credits: NASA)

Use of Meteorological Satellites

Meteorological (or weather) satellites are used for monitoring weather and climate. Sensors on these satellites measure wind speed and direction, cloud height, surface temperature, sea ice cover, vegetation cover, precipitation, and carbon dioxide concentrations. Global observations have been made possible, even in the remotest areas. Weather forecasting institutions generate models based on satellite data and use it to analyze state of the atmosphere. These models are called Numerical Weather Prediction (NWP) models. Sophisticated satellite instrumentation also allows improved estimation of moisture, cloud, rainfall and also monitors the concentration of carbon dioxide in the atmosphere.

Use of Navigation Satellites

Navigation satellites are satellites that enable people to determine their location anywhere on land, sea or air, and to navigate from one place to another. They also help to determine one's velocity, orientation, and for the transmission of accurate time across the globe. These satellites are collectively called Global Navigation Satellite Systems (GNSS). They include the Global Positioning System (GPS) owned by the US, Glonass owned by Russia, Galileo owned by Europe, and Beidou owned by China. While these systems cover the globe, there are others that cover smaller geographical areas. This includes the Indian Regional Navigation Satellite System (IRNSS) and Quasi-Zenith Satellite System (QZSS) that are currently under development by India and Japan respectively.

Navigation satellites enable captains and sailors to identify their position anywhere on the sea. With the mandatory fixing of Automatic Identification System (AIS) transponders, ships, goods and persons could be tracked on the high seas. This will prevent collisions at sea, monitoring of trade routes and fuel efficiency. Navigation satellites are also used for accurate siting of buoys, navigation through narrow channels and for docking. They are utilized for oceanography, marine surveys, glacier measurements and tsunami studies. Navigation satellites are also used for tracking of ocean wildlife and migration. This in turn helps in the conservation of wildlife.

Use of Communication Satellites

Basically, communication satellites facilitate the relay of information from a source on one point of the Earth surface to a receiver at another point. In particular, they enable long-distance communication around the Earth. One satellite or multiple satellites could be used for this purpose. Communication satellites offer crucial services in maintaining contact of ocean and sea vessels with land stations for safety.

A ship with antennas for communicating via satellites

Use of Search & Rescue satellites

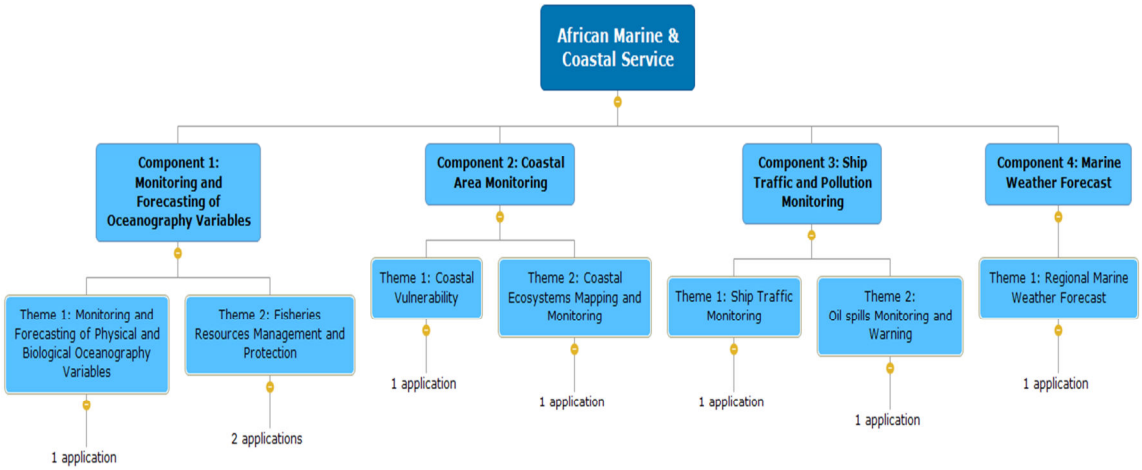
Search and Rescue satellites carry equipment that are able to detect and locate emergency beacons carried by ships. The best known search and rescue system is the Cospas-Sarsat system. This system is made up of a network of satellites in space, ground stations, control centres, and rescue coordination centres. Anywhere and at anytime on the sea, a distressed person can activate the emergency beacon. A Cospas-Sarsat satellite in view picks the signal and sends to the nearest ground station. After processing the signal, the position of the distressed person is sent to the mission control centre. The mission control centre then informs the nearest rescue coordination centre. The Cospas-Sarsat system has greatly minimized the time that help reaches a distressed person on sea and saved thousands of lives.

GLOBAL MONITORING OF THE ENVIRONEMNT AND SECURITY & AFRICA (GMES & AFRICA)

The Global Monitoring of the Environment and Security in Africa (GMES & Africa) initiative is a long term partnership between Africa and European stakeholders which aims at the full use of space systems for sustainable

development. It is an extension of the European Copernicus programme to Africa. Nine thematic areas were identified, namely: (1) long term management of natural resources, (2) marine and coastal management, (3) water resource management, (4) climate variability and change, (5) disaster risk reduction, (6) food security and rural development, (7) infrastructure and territorial development, (8) conflicts resolution, and (9) health. In addition, five cross-cutting areas were identified; these are: (a) policy and institutional framework, (b) infrastructure framework, (c) capacity building, (d) financial issues, (e) monitoring and evaluation.

The 4th Africa-EU Summit held in Brussels in 2014, agreed to begin implementation with three areas: Long Term Management of Natural Resources; Marine and Coastal Areas; and Water Resource Management. An identification study focusing on needs assessment and implementation process for these thematic chapters has been concluded. The GMES & Africa initiative is expected to roll out implementation in mid-2016. This publication will focus on the marine and coastal areas thematic chapter.



The Marine and Coastal Areas Thematic Chapter

GMES & Africa Marine thematic chapter seeks to utilize data both from satellite and *in situ* observations, to provide information; daily and seasonal forecasts; and capability to observe, understand and anticipate marine environment events. The basic ocean parameters to be measured include sea surface temperature, ocean currents, ocean winds, salinity, sea level and ocean colour.

The Marine and Coastal Areas thematic chapter is divided into four components. These components are further divided into themes and then specific applications are developed for each theme. The applications are:

(i) Canary Current Large Marine Ecosystem (LME) monitoring and forecasting of physical and biological oceanography variables

(ii) Guinea Current LME monitoring and forecasting of physical and biological oceanography variables

(iii) Benguela Current LME monitoring and forecasting of physical and biological oceanography variables

(iv) Agulhas Current LME monitoring and forecasting of physical and biological oceanography variables

(v) Indian Ocean Commission (IOC) Exclusive Economic Zone (EEZ) monitoring and forecasting of physical and biological oceanography variables

(vi) Somali Current LME monitoring and forecasting of physical and biological oceanography variables

(vii) Red Sea LME monitoring and forecasting of physical and biological oceanography variables

(viii) Mediterranean Sea LME monitoring and forecasting of physical and biological oceanography variables

(ix) Potential Fishing Zones Monitoring and Protection

(x) Potential Aquaculture Site Monitoring and Protection

(xi) Coastal Ecosystems Mapping and Monitoring

(xii) Coastal Vulnerability

(xiii) Ship Traffic Monitoring

(xiv) Oil Spill Monitoring and Warning

(xv) 3 days Marine Weather Forecast

These applications will be implemented by relevant institutions (called Regional Implementation Centers, RICs) in the different Regional Economic Communities (RECs) of Africa. A forthcoming edition of Space Brief will give more details on the GMES & Africa programme.

CONCLUSION

Satellites have many applications in the blue economy. This includes collection of imagery using Earth Observation satellites; location and navigation of persons, goods and ships using navigation satellites; weather monitoring and forecast using meteorological satellites; long-distance communication of persons and ships using communication satellites; and rescue of distressed persons using Search & Rescue satellites. As Africa begins deliberate efforts to harness and optimize resources from the seas and oceans, concerted efforts also need to be put in place for the use of satellite technology.

This publication is a product of The African Youth for Space Programme, Department of Human Resources, Science and Technology (HRST), in collaboration with the Directorate of Information and Communication (DIC), African Union Commission, Addis Ababa, Ethiopia. Contact Email: AUSpaceProgramme@africa-union.org