

Space Technology in Transport Disaster Search and Rescue Operation: the Challenge for Africa

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Abstract Science and technological advancement is not so pronounced in any sector globally as in the transport sector that is obvious since the first Ford's Model Ts vehicle in 1908 which has metamorphosis into the present day hybrid vehicles. But the towering environmental hazard accompanying these developments is of major concern. Disasters are sometimes natural, human-induced or both. But the long time-lag between the occurrence of mishap and the rescue operation carried out is the major factor responsible for the great loses of life and properties especially in the developing countries like Nigeria with high road and air accident records. This paper is aimed at exploring the critical role of space technology in the provision of timely and qualitative information that facilitates the works of the disaster management agencies especially in critical decision making for better preparedness as a challenge for African countries. The analysis reveals that GIS and RS is the pivot on which a timely SAR revolve, and that the present status of most African countries' SAR operations is obsolete, disjointed and none real-time based. It is therefore recommended that a more dynamic synergy and coordinated SAR operation that leverage on remote sensing techniques be developed.

Keywords *Environment Hazards; Rescue Operation; Remote Sensing and Transportation*

1. Introduction

Human imperfection in its entire ramification often leads to natural or man-induced hazards and vehicular crashes that call for one search and rescue operation or the other. Human intrusion into the space began when the first Russians launch Sputnik-1 into space on October 4, 1957 and the first man (Yuri Gagarin) was launched into space on April 12, 1961 when he orbited the earth for just 108 minutes. Environmental hazard can be in the high sea, in the air, or on the earth surface. The more we probe into any of these earth spheres, the more we are exposed to accident of different degrees. The method of rescue operation carried out depends to a large extent on the technological know-how at that point in time in a giving society.

Although much can be said to have been achieved in the area of science and technology especially in communication, transportation and space exploration; but human imperfection in all these field are glaring with the rate of crashes which do result in loss of life and property in the national and international project investments. For instance, SEASAT, launched on 28 June 1978 operated for only 105 days due to power failure. On January 28, 1986, the greatest tragedy in space flight occurred when the Shuttle Challenger exploded in the air 73 seconds after it was launched. The seven members of the crew including a civilian space teacher Christa Mc Auliffe were all killed. Also, in November 2010 and just in July, 2013, Russia lost billions of dollars in the rocket launch failure.

1.1. Aims and Objectives

The aim of this paper is to explore the critical role of space technology in the provision of timely and qualitative information that facilitates the works of the disaster management agencies especially in critical decision making for better preparedness as a challenge for African countries. The objectives include:

- a. Examine the experiences of UN Agencies and other specialist that used remote sensing data for transport disaster management;
- b. Review various hazards that often plague human ingenuity under the various transport modes;
- c. Examine some of the African countries SAR operational structure and techniques, and
- d. Assess the link between the applications of remote sensing data and ground control stations, and the associated benefits arising from effective spectrum management.

2. General Hazards in Various Spheres of the Earth

Hazards that plague man-kind in the various spheres are either natural or man-induced following the school of thought of environmental possibility as against determinism. The intrusion of man into the spheres as a result of technological advancement has trigger lots of mishaps that tend to overwhelm the existing combating system as revealed in the following incidences.

2.1. Water Related Hazard

The great water bodies like the oceans, rivers, and lakes have been a major support to human survival in different ways. The key activities in these water bodies are animal and fish hunting, off-shore mining (crude oil), sea bed exploration and marine transport. All this activities are not free of one hazard or the other that involve the loss of both human life and properties. Flooding activities in the form of tsunamis that ravage most coastal cities globally like that of India flash flood in June, 2013 leaving 65,000 people stranded and 5,000 people unaccounted for. African countries like Nigeria have her own share in 2012.

2.2. Atmospheric (Air) Related Hazard

Another major hazard that plagues space exploration and aviation industry is the issue of power failure and malfunctioning of spacecraft and other related causes.

Whenever aviation mishap is discussed in Nigeria, three important years would always bring back reminiscences of fresh mourning and agonies to some individuals. Dates such as July 11, 1991 when the nation lost 247 pilgrims who were on their way home from Jeddah, Saudi-Arabia; September 26, 1992 in which a generation of young military officers (about 163) perished at Ejigbo at the out-skirt of Lagos and November 7, 1996 a day the nation recorded a casualty figure of 143 lives through plane crash. Also the case of DC-9 commercial plane, owned by Sosoliso Airlines, that was carrying 75 school children (aged between 12 and 16) home for the Christmas holidays and staffs of Loyola Jesuit

School in Abuja were among the 103 people that crashed in Port Harcourt (Midweek Concord [1]; National Concord [2]).

Another one was ADC airlines flight to Sokoto in which the spiritual leader of Nigerian Muslims; his Eminent Muhammadu Maccido and his son, a senator, and other northern leaders were among the 104 people crashed near Abuja; see Figure 1 for the relics.

At Somalia, an Ethiopian military aircraft carrying ammunition crash-landed at Mogadishu's international airport, bursting into flames and killing four of the six crew members. Somalia's aviation record is among the worst on the continent that has a history of plane disasters; see Figure 2 for the relics (Abdi and Feisal) [3].



Figure 1: ADC Airline to Sokoto Crash
Source: BBC News



Figure 2: Plane Crash at Mogadishu's International Airport
Source: BBC News

2.3. Land Related Hazard

Land related hazard include fire accidents, road traffic crash etc. Loss of lives and destruction of various sources of livelihood (properties) as a result of road accidents is unquantifiable as reveal by the pages of daily newspapers and network programmes, see Figure 3 and 4 for such instances. For instance, no fewer than 22 people lost their lives in an auto accident which occurred on Kwanar-K of road, about 62 kilometres from Kano, on Wednesday as a result of tyre burst. The accident occurred a week after the state was thrown into mourning following the death of 22 members of a family in another road accident on Gwarzo road, Kano State.



Figure 3: 100 Nigerians Burnt to Death in Trailer Tanker Fire Accident (June, 2012)



Figure 4: Multiple Trailer Carnage Burnt by Petrol Tanker Accident

Science can predict the activities of weather and climate, wave and wave actions, but less of how to predict whether a particular trip will crash midway of a journey or a particular stroke will cause a wild-fire and also lack the necessary up to date technique to respond to those incidences.

From the foregoing discussion on areas of environmental hazard and disasters, the question then is “what are the effective techniques of rescue operation that can mitigate the total loss of life and properties in all this occurrences. Space Technology is the worldwide accepted panacea to environmental hazard surveillance and mitigation technique as will be discussed in this paper.

3. Space Technology and Search/Rescue Operation

The alarming rate of environmental hazard at the three spheres of human activities (hydrosphere, lithosphere and atmosphere) have agitated the mind of experts in space operation technology that calls for series of national and international summits on natural and human-induced environmental hazards among which are:

The World Telecommunication Development Conference 2006 (WTDC-06) - Resolution 34 focused on the role of telecommunications/information and communication technology in early warning and mitigation of disasters and humanitarian assistance. While Plenipotentiary Conference 2006 (PP-06) - Resolution 136 focused on the use of telecommunications/information and communication technologies for monitoring and management in emergency and disaster situations for early warning, prevention, mitigation and relief.

The World Radio-communication Conference 2007 (WRC-07) recognizes that the radio frequency spectrum is a critical resource for remote sensing and environmental management, particularly in the search and rescue operation. Also in the international workshop on crew Safety and Rescue held at Le Bourget on 7 June 1987 which brought together more than 150 space professionals including engineers, astronauts and managers; jointly organized by AAAF, AIAA and ESA focused on the complementary of ground based and space-based rescue systems and the importance of the response time to an emergency.

The Global Maritime Distress and Safety System (GMDSS) as an internationally agreed-upon set of safety procedures to rescue distressed ships, boats and aircraft. While the International Mobile Satellite Organization (INMARSAT) is a satellite system under the International Mobile Satellite Organization (IMSO) is an intergovernmental organization that oversees certain public satellite safety and security communication services provided via the satellites, see Figure 5 for the map of the member countries where more than 50% of African countries are yet to be members compared to other continents of the world.



Figure 5: Inmarsat Member States as at 2013
Source: International Mobile Satellite Organization.png

3.1. Remote Sensing Operation Missions Techniques

It will be necessary at this juncture to give a general view of the definition of Remote Sensing (RS) technology as “an act of observing and measuring an object or phenomenon by the use of electromagnetic sensors placed on a fixed or moving vehicle without physical contact. It operates with four components via: energy source, radiant interaction with the earth surface, interaction with the atmosphere and the final detection by the sensors” (Alexandre [4]) with this definition, the uniqueness of remote sensing technique in environmental issues like SAR includes the following:

- a) Real-time data-information collection;
- b) Potential for direct Electro-transmission to receiving stations and action areas;
- c) Comparatively low-cost of large area coverage;
- d) Ability to operate day and night via thermal infrared and microwave sensors.

Remote sensing application in SAR operation can be seen as space digital data technology assemblage. Sensors like the Scatterometer and Radiometer and even Radar series can be placed in special aircraft as done by companies like Motorola Inc or placed on space borne satellite launched by various countries space research centres like; Russian-COSMOS-1500, U.S-SKYLAB, GEOSAT, IKONOS, France-SPOT-5, QUIKBIRD and even the Nigeria-Sat-X etc. While SAR operation is an amalgamation of different but related professions’ technical knowhow like the Remote sensing scientist, Naval force, Air force, Police, Road safety, Red Cross, Fire service, etc. for disaster management and mitigations.

There are series of air space missions that are oriented to search and rescue activities. For instance, COSPAS/SARSAT is a joint international Search and Rescue Satellite Aided Tracking System established and operated in January 1986 (ESA [5]).

In the case of fire related search and rescue operation, the infrared scanning system can penetrate through smoke while the line scanner system can map fire and locate their hot spots. After the first hand notification, the smokejumper reaches the fire site by helicopter parachute as used in a fire incidence at Nezperce forest in Northern Idaho (Trevett [6]).

3.2. Operation on the High Sea

In the search and rescue operation on the high sea, remote-sensing technique has proved vital and indispensable for fruitful operation. Satellites such as Seasat, launched on 28 June 1978 were the first satellites with a scatterometer (after tests on Skylab). Seasat was also equipped with a Radar Altimeter and the Scanning Multichannel Microwave Radiometer (SMMR) (Dalati [7]). Microwave sensors generally have the ability to penetrate through the water bodies and reveal water bed materials. See Figure 6 and 7 for space based rivers and high sea search and rescue operations.

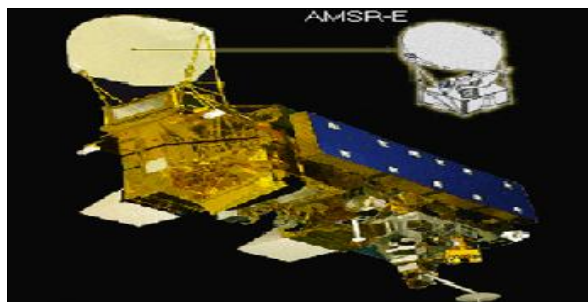


Figure 6: Satellite-based Flood Assessment
Source: Dartmouth Flood Observatory College



Figure 7: Danish Air Force S-61A with
Its Rescue Swimmer

4. Africa Initiatives in Rescue Operation Mission

African countries bordering the Atlantic and Indian Ocean have some MOU on maritime rescue regional grouping with major countries heading each group. The South Africa sub-regional group appears to be more organized and more pro-active than others like Nigeria sub-grouping, see Figure 8 for the maritime grouping.

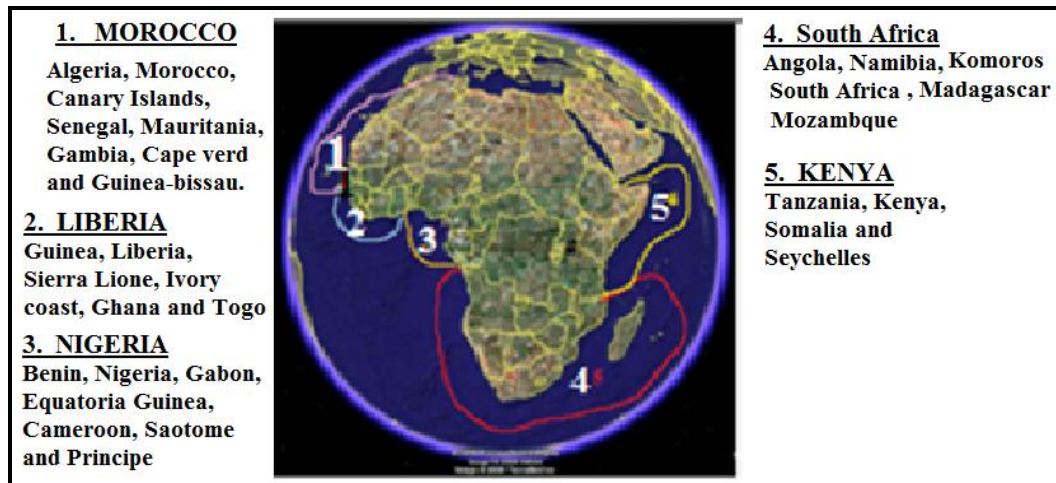


Figure 8: Regional Maritime Rescue Coordination Centre (MRCC) for Africa
Source: After Botes A. (Head of Maritime SAR operation)

4.1. South Africa Position

South Africa is the only country that has a relatively coordinated search and rescue organization called South Africa Search and Rescue Organization (SASAR). It is made up of representatives from government departments, commercial and voluntary organizations which are signatories to SASAR which are able to contribute service and facilities.

Ghana Position

The Ghana Maritime Authority (GMA) is mandated to coordinate maritime Search and Rescue activities in collaboration with other relevant agencies. National Maritime SAR Coordinating Centre at Tema is to be linked to the Regional Maritime SAR Coordinating Centre in Monrovia, Liberia to provide effective search and rescue coverage for the countries in the sub region. The GMA has concluded bilateral arrangements with the United Kingdom Hydrographic Office (UKHO) to publish hydrographic and safety information covering the Ghanaian coast on navigational charts for dissemination to ships (GMA [8]).

The country is to establish a Vessel Traffic Management Information System (VTMIS). The Contract Agreement for the project was signed on February 9, 2011 between the Ghana Maritime Authority/Ministry of Transport and ELTEL Networks Corporation of Finland. The VTMIS consists of the following among other things:

- a. An integrated system comprising of eight (8) Remote Sensor Sites to be sited along the entire coast of Ghana from Keta to Half Assini.
- b. Three (3) Remote Base Stations (RBS) along the Volta Lake (for the inland waterways).

4.2. Nigeria Position

Nigeria that is often referred to as the giant of Africa is yet to fully organize a well-coordinated space technology based search and rescue operation. For instance, how can one explain the episode of the Bellview Airlines crash on Saturday at about 20.45 (19.45 GMT) on its way to Abuja from Lagos that was first reported found on Sunday morning by a police helicopter search team near Kishi, Oyo state, 400 km (320 miles) from Lagos; was later found at Lissa in Ogun state, about 50 km (30 miles) from Lagos. According to (Yusuf and Ikechiji [9]) a vast country like Nigeria has only one search and rescue helicopter that is parked in the "Office of the Presidency".

It was after much air mishaps in the country that the Federal Airport Authority (FAA) began to talk of the establishment of search and rescue service in the country. Some of the facilities in the country lack proper coordination, see Figure 9 for an air crash simulation exercise undertaken by NEMA and other relevant agencies at the Murtala Muhammed airport Abuja, but after display what next?



Figure 9: Air Craft Hazard Simulated with NEMA Helicopter at Abuja, Nigeria

The question is how many underwater breathing apparatus (SCUBA, surface-supplied air, re-breathers, etc.) are available for water divers in the country? In fact, it just in the year 2013 that the Nigerian Air Force (NAF) signed a Memorandum of Understanding (MOU) with the Nigerian Maritime Administration and Safety Agency (NIMASA) in the fight against crime in the nation's coastal waters (Nigercom Network [10]; National Concord [11, 12]; Ronald [13]; NEMA [14]).

5. Conclusion

From the ongoing discussion on search and rescue operation and the billions of naira been lost in various hazards and mishaps due to improper coordination of agencies and lack of up-to-date space technology equipments in most African countries SAR, the policy makers need to be fully sensitized on the need to fund and enhance the capacity building of the relevant rescue agencies.

5.1. The Way Forward

A functional SAR is not unachievable if there is a political will. Although political instability quagmire is a major monster against the progress of African countries, the following recommendations are some of the panacea to the ailing SAR operation in the continent:

- a. A budgetary allocation should be established at all level to finance the activities of those agencies and units.

- b. The National Emergency Management Agency (NEMA) at the central level should be the coordinator and the superior commander of the allied agencies through special signal networking.
- c. NEMA should have a legislative power to call upon allied agencies and departments that are signatory to SAR mission when their support services are required.
- d. There should be hierarchical regional, states, local government and municipal disaster emergency coordinating units with relatively up-to-date Radar system and communication equipments to respond to issue within their jurisdiction or send distress call to NEMA.
- e. The Unified Command structure should issues operation orders and mission assignments to activate responses based on the scope and magnitude of the threat or incident as indicated in the proposed organizational structure (see Figure 10). The coordinating centre is to establish communication links with support agencies and regional coordinators which will provide the relevant agency and other stakeholders with Situation Status (SITSTAT) and Resource Status (RESTAT) as required, (COES, 1999).

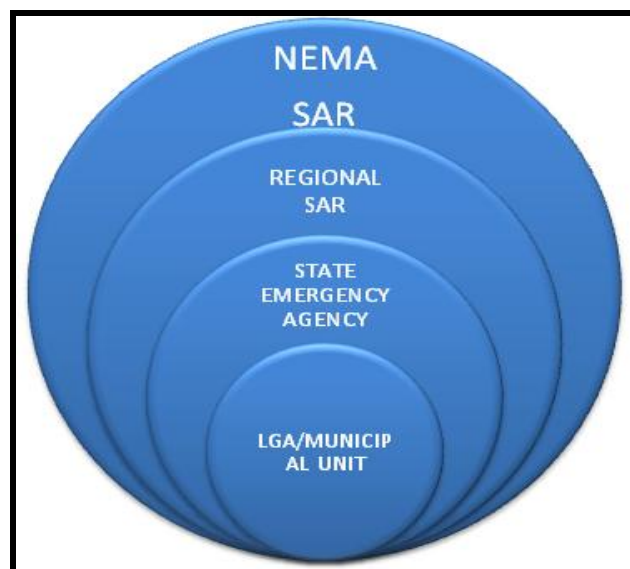


Figure 10: Organizational Structure of National SAR

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