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Chapter 19

Africa's Space Heritage: Inventory, Analysis, and Future Possibilities*

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Abstract

To date, published works on space history in Africa have almost invariably focused on one country, or on only one project in one country.

This chapter seeks to explore how a continental perspective may indicate niches where the African whole could become greater than the sum of its parts. It starts with an inventory of Africa's space heritage infrastructure. This notes the historic evolution of these from colonial-era projects in Africa, to projects by and for Africa. Next, it analyzes the current proliferation of African space-related institutions and initiatives, some with international partners such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Astronomical Union (IAU).

Last, it debates to what extent the African Resource Management Constellation (ARM) and Regional African Satellite Communication Organisation (RASCOM) may serve as differing models for future cooperation, and where they have encountered difficulties. The conclusion will discuss future possibilities, with a focus on where African space may achieve a critical mass. It also discusses how corporate and other nongovernment space participants will become increasingly important.

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Introduction

Published works on space history in Africa have with few exceptions[1] focused on one country, or on only one project in one country.

This chapter seeks to explore how a continental perspective may indicate niches where the African whole could become greater than the sum of its parts. It starts with an inventory of Africa's space heritage infrastructure. This notes the historic evolution of these from colonial-era projects in Africa, to projects by and for Africa. Next, it analyzes the current proliferation of African space-related institutions and initiatives, some with international partners such as UNESCO and the IAU.

Last, it debates to what extent the ARM and RASCOM may serve as differing models for future cooperation, and where they have encountered difficulties. The conclusion will discuss future possibilities, with a focus on where African space may achieve a critical mass. It also discusses how corporate and other nongovernment space participants will become increasingly important.

In developing countries, a realistic analysis needs to conceptualize both astronautics and astronomy as space activities. Compared to century ago, the digital revolution has brought them convergences and synergies in software and other technology that extend far beyond the launch of orbiting observatories. For example, today not only space launcher programs, but now astronomical observatories, have to negotiate with the U.S. authorities over International Traffic in Arms Regulations (ITAR) export restrictions upon lasers. But above all, the political drivers that bring government buy-in for astronautics and astronomy are the same in developing countries, and often involve a synergy of institutions and personnel.[2]

Inventory: Heritage Infrastructure

Africa's space heritage infrastructure ranges from astronomical observatories to missile and space launcher test stands, plus the ground stations necessary to consumers of space products and services. This includes not only the physical infrastructure, but also the skilled personnel and institutions that are a prerequisite to run remote sensing centers, and weather forecast software and predictions. These in turn make budget demands that compete against other priorities in developing countries.

Algeria

Set up during the colonial epoch, the *Centre Interarmees d'Essais d'Engins Speciaux* (CIEES) launched its first rocket on 24 April 1947 at Columb-Bechar (today Béchar). The French missile developers next started launching from Hammaguir from 20 May 1952 to 4 April 1967. On 26 November 1965 France launched the 42 kg satellite Asterix from Hammaguir into a 527 x 1,808 km orbit, the first satellite launched from Africa. The second was Diapason, launched on 17 February 1966 into a 502 x 2,740 km orbit. The third satellite launched from Africa was Diadème 1, 23 kg, into a 573 x 1,345 km orbit, on 8 February 1967, followed on 15 February 1967 by Diadème 2 into a 589 x 1,881 km orbit.[3] The Diamant rocket weighed 18 tons. The other 270 launches achieved a highest apogee of 280 km on 13 May 1961. This ground infrastructure still remains.[4]

Egypt

Egypt started a missile and rocket program in 1958, with static tests in 1961–1962. It recruited German expatriate rocket engineers, many who had worked in France. On 21 July 1962 it carried out test flights of two sounding rockets, the *Al Zafir* (the Victory), 7 x 1.2 m dimensions, and the *Al Kahir* (Conqueror) 12.2 x 1.22 m dimensions. Masses and apogees achieved are unknown. Dr. Hassan Marie (Eins-Shams University professor) chaired the Supreme Committee of Space Research, and announced they aimed at launching satellites of 5–10 kg mass.

The Israeli government launched a two-pronged campaign to terminate Egypt's rocketry research and development (R&D). Its secret services posted letter bombs to kill and injure the German expatriate engineers in Egypt, while its diplomats got the German government to pressure the surviving engineers to resign and return to Germany. The Egyptian government had hoped to acquire national prestige through its rocket program, and exhibited in 1965 a two-stage liquid-propellant rocket *Al Ared* (the Pioneer). We now know that this latter rocket was merely a wooden mock-up. Egyptian engineers failed to develop guidance systems, and the missile project was abandoned by the 1967 war.[5]

Ground infrastructure appears to be at most only a launch pad for a sounding rocket. The half-century old Factory 333 missile plant at Heliopolis and other facilities, if they still stand, would have long since converted for other manufacturing.

Democratic Republic of Congo (Then Zaire)

The German company OTRAG was founded in 1974 to R&D cheap mass-produced rocket modules. It first negotiated with President Mobutu a lease and erected a runway and launch pad at Kapani Tonneo adjacent to Lake Tanganyika. Its first launch on 18 May 1977 reached a 15 km apogee (Pirard and the *Encyclopedia Astronautica* give differing dates and apogees). Its 19 May 1978 test reached 150 km altitude, but its third test was a failure on 15 June 1978. Under diplomatic pressure, in 1979 Mobutu canceled OTRAG's lease. The literature makes the unconvincing claim that Mobutu did this under Soviet, Angolan, and East German diplomatic pressure.[6] Because Mobutu was an anticommunist U.S. ally, this is unlikely as the origin of the diplomatic pressure on Mobutu. The literature does not indicate what infrastructure remains in 2011.

Libya

After its eviction from Zaire, OTRAG next signed a lease with Gaddafi in Libya. Its 1 March 1981 test flight from Tawiwa reached a 150 km apogee. It conducted a further 27 test flights until 9 December 1982. When the German government signed the MTCR in 1982 it ordered OTRAG to end any further operations in Libya. The company lost all told $200 million. Gaddafi sequestrated OTRAG assets in Libya, but lacked the skilled personnel to succeed in carrying on its development, abandoning the project within a decade.[7] The literature does not indicate what infrastructure remains.

Kenya

Following a NASA–University of Rome Agreement, they started the Luigi Broglio Space Centre. They towed into place an offshore launch pad into Kenyan waters. Between 25 March 1964 and 25 March 1988 this San Marco facility carried out 27 launches. These included the fifth satellite launched from African territory on 26 April 1967, when a Scout rocket placed a 129 kg satellite into a 219 x 741 km orbit. All told San Marco launched nine satellites, the last in 1988.[8] The San Marco launch platform, deactivated in 1988, is today severely corroded, and would require major renovation to bring back into operation.

South Africa

Amateurs started launching rockets in Johannesburg from 1947, including a liquid propellant two-stage rocket in November 1959. They and other rocketeer groups in Durban and Port Elizabeth continued launches until 1962, reaching a highest apogee of 40 km. South Africa started manufacturing military tactical

missiles in 1963. By 1987 the Overberg Toetsbaan (OTB), today renamed Overberg Test Range (OTR), had construction completed.

The RSA-3 space launcher program achieved three test flights between 1 June 1989 and 19 November 1990, reaching an apogee of 300 km. The OTR ground infrastructure is maintained,[9] though severely underutilized. The Houwteq facilities for satellite testing and integration remain[10] and were used to validate the Sumbandila satellite.

With help from UN agencies, Africa has also built up a plethora of regional and national centers for processing remote sensing data, plus ground stations to receive comsats, too numerous to list in this chapter. They have set up the African Association for the Remote Sensing of the Environment.[11] The South African government alone spends as a consumer of space services an estimated 500 million ZAR per year to acquire Earth observation related data from international sources.[12] Its SABC spends 33 million ZAR on transponders yearly.[13]

Africa's major astronomical observatories include Egypt's premier astronomical instrument, the 1.88-meter Kottamia telescope; the Mauritius radio telescope; Morocco has a 51 cm telescope at Rabat, plus the Observatory of Caddi Ayyad University. Namibia's HESS is Africa's major gamma-ray detector, while South Africa operates the 9 meter Southern African Large Telescope (SALT). Today, the exponential growth of the Internet and computer memory gives virtual observatories rising importance, enabling African astronomers to access cached data for research. Of professional societies, the premier is the century-old Astronomical Association of Southern Africa, and the newest is the African Astronomical Association, AfAS.[14] The year 2011 saw the founding of the IAU Global Office of Astronomy for Development in Cape Town. The South African Space Association, founded in 2009[15] will doubtlessly be followed in other African countries by many more nongovernmental organizations.

Analysis: Current Programs and Institutions

As mentioned in the introduction, the political drivers that bring government buy-in for astronautics and astronomy are the same in developing countries, and often involve a synergy of institutions and personnel. For example, the chair of the regulatory South African Council for Space Affairs is Dr. Peter Martinez, an astronomer whose doctorate was on astereoseismology.[16] Dr. Sandile Malinga, the first CEO of the South African National Space Agency (SANSA), is a space physicist, whose doctorate was on meteor physics.[17]

Synergies are clear. Knowledge of meteor physics is relevant to reentry vehicles. Also, South Africa is bidding to host the Square Kilometer Array

(SKA). The SKA could interrupt its scheduled program to receive radio signals from a space probe whose high-gain antenna has failed to point correctly and can now be received only through its low-gain antenna. If equipment breakdown meant that astronauts on the Moon or Mars could only transmit from their space-suit backpacks, the SKA has the sensitivity to receive their voices loud and clear.

Similarly, Nigeria's National Space Research and Development Agency (NASRDA) has astronomy as one of its centers, equal to its Centre for Space Transport and Propulsion, plus a planetarium for astronomy outreach. Its National Space Council is chaired by the Nigerian president,[18] compared to NASA falling under the vice president's portfolio.

Both astronautics and astronomy are politically viewed as projecting cutting-edge modernity, and so enhancing that country's soft power in foreign policy. One small but typical example: the South African Astronomical Observatory got a supplementary grant to restore its historic buildings and instruments in 2011 only due to a visit from the G8 Ministers of Science and Technology.

On the continental scale, the African Union formally endorsed the South African bid to host the SKA on the African continent,[19] welcomed the establishment of the African Resource Management satellite constellation between Algeria, Kenya, Nigeria, and South Africa, and "calls upon member states to develop bilateral and multilateral cooperation in the area of Space Technologies in order to speed up their development."[20] Another unstated motivation is that governments perceive participation in astronautical and astronomical mega-projects as debunking western stereotypes of Africa as a backward continent.

Training high-level human capital is another priority in developing countries. Algeria sent more than thirty researchers to France,[21] and Nigeria to the United Kingdom for training in building a microsatellite. In South Africa, both Stellenbosch University and the Cape Peninsula University of Technology run satellite engineering masters' programs, the CPUT course with French aid.[22] A consortium of universities started the National Space Science and Physics program (NASSP) in 2003 to accelerate the number of graduates qualifying for enrollment as doctoral candidates.

Africa's first space agencies are Nigeria's National Space Research and Development Agency (NASRDA) founded in 1998, followed by Algeria's *Agence Spatiale Algérienne* (ASAL) founded in 2002,[23] and the South African National Space Agency launched in 2010. Operationally, we must add Egypt's National Authority for Remote Sensing and Space Sciences (NARSSS), who outsourced building a satellite to the Ukraine, and Kenya's Regional Centre for mapping Resources for Development (RCMRD), a partner in the ARMC.

Africa's Space Corporate Sector

The corporate sector is a growing African player in space products and services, with assets and resources that outstrip some public sector institutions. South Africa's Multichoice company from 1992, and Egypt's Nilesat Company,[24] established in 1996, are early leaders in providing satellite TV to the continent. It is also a sign of the new trend that the continental parastatal RASCOM has set up a hybrid public-private company, registered in Mauritius, to operate its phone and Internet services via comsats.[25] Convergence Partners hired Arianespace to launch in 2011 its 3-tonne *New Dawn* satellite with 30 transponders.[26]

Sunspace, founded 1999, is the first African company to manufacture microsatellites.[27] Space Advisory Company is a new consultancy.[28] The defunct parastatal space launcher programs of the last century are now replaced by the first African private sector space launcher company, founded in 2002, seeking capital to develop its proposed two-stage liquid-propellant satellite launcher.[29]

Continental and Other Multilateral Space Initiatives

The Regional African Satellite Communication Organization was the first Pan-African space initiative, founded in 1992. Today it has grown to forty-five African states as members. It runs through a biennial Assembly of Parties, with the usual Director's Board meeting quarterly. Its secretariat is in Abidjan (Côte d'Ivoire), with operation centers in Gharyan (Libya), and Douala (Cameroon) for phone, radio, TV, and Internet services. Its resilience is indicated by its survival with two of those three locations being affected by civil wars.

RASCOM took two decades to become fully operational, which gives us a realistic time frame to anticipate in future pan-African space initiatives. This was due primarily to delays in intergovernmental negotiations, and implementing long-promised commitments. Further delay arose from technical failures: its first satellite RASCOM QAF 1, launched in 2007, soon broke down, with the replacement RASCOM-QAF 1R only launched in 2010. Its twenty transponders have linked 150,000 villages to telecommunications.[30]

The second multilateral initiative is the African Resource Management satellite constellation (ARMS). Negotiations that started in 2003 took until 2009 to successfully complete. The ARMC starts as a data-sharing agreement between Algeria, Kenya, Nigeria, and South Africa to pool their satellite imagery.[31]

Such initiatives now receive political support from the top. The AU set up in 2003 the African Ministerial Conference on Science and Technology (AMCOST) with a Bureau and Steering Committee in Pretoria, which identified Space Science Technologies as a Flagship program.[32]

Below the apex level of heads of government, space professionals meet in the biennial African Leadership Conferences for Space Science and Technology for Sustainable Development (ALC). These have rotated between Abuja, Nigeria (2005), Pretoria, South Africa (2007), Algiers, Algeria (2009), and Mombasa, Kenya (2011). One of the proposals discussed is for an African Institute of Space Science. The proposed Institute would promote and coordinate crosscutting multidisciplinary research and applications in space science and technology to address the development needs of the region.[33]

Conclusions: Future Possibilities and Recommendations

The RASCOM organization and ARM MOU raise the obvious issue. The far wealthier European countries recognized half a century ago that their budgets and other resources were much too limited to afford the national space programs of world powers such as the United States, Russia, and today China, and India. Alongside their national space agencies, they founded the European Launch Development Organisation (ELDO) in 1962 and the European Space Research Organisation (ESRO) in 1964. Budget realities made these in turn rationalize by merging to form the European Space Agency (ESA) in 1975. Even ESA itself has to work with the United States and Russia to participate in human spaceflight and the International Space Station (ISS).

Clearly, the scarce resources available to any individual African national space agency present compelling reasons to cooperate over space projects.[34]

First, it is overdue that Africa, in the position of a late-entering space player, negotiates as a whole for the allocation of scarce spectrum and geosynchronous orbit slots.[35]

The second GSO-related argument flows from spherical geometry. Africa, more than any other continent, divides into halves on each side of the equator. It is best served through cooperative projects of comsats.

Third, only through African national space agencies pooling together part of their budgets will they be able to participate as partners in projects whose costs are beyond any individual country agency.[36]

Fourth, the rationalization of sharing imagery and other remote sensing data prevents expensive replication of satellites or purchase in foreign exchange of such data.

The fifth argument is that a continental space agency will be able to bargain with vendors constructing comsats, and vendors offering space launch services for optimal deals over pricing, launch dates, and preferred orbits.

Sixth, democracies can only launch satellites from coastal spaceports. Even Russia (after paying pollution damages to Kazakhstan) and China (after several farmers were killed by debris from a launch failure) are both now building major coastal launch sites. But even the West African coast from the Cape Verde republic to Nigeria is limited to launching into polar orbits only, unless they pay the same one-third of payload mass penalty as Israel to launch into retrograde orbits. This argues that Africa's eastern seaboard, from Cape Agulhas to Somalia, should be designated as a continental asset for spacefaring. The Overberg Test Range and the Luigi Broglio launch pads should be renovated and optimized as the future preferred continental satellite launch facilities.

Seventh, Africa as a whole has already had to negotiate a Pan-African MOU with India on the Enetwork linking thirty-six African countries. While the Pan-African Parliament has stepped in to facilitate, a continental space agency will be better placed to negotiate international cooperation in space. Clearly, the budgetary magnitude of human spaceflight and RLV projects will of necessity have Africa partnering with either IBSA or BRICS space powers.[37]

The cautionary notes so far sounded relate to not the principle of a continental space agency, but the timing and modalities.

First, until considerably more than one or two African countries have substantial national space budgets and other facilities, there will not be significant gains in setting up an additional institution.

Second, it can be argued that developing countries are especially prone to set up top-heavy bureaucratic structures, whose prime function is political patronage to ruling party clientele. This would divert scarce budgets away from science and engineering into parasitic salaries.

Third, founding intergovernmental agencies requires learning multilateral ways of thinking and doing. Issues of negotiating inter-operationality with software, hardware, and agencies are protracted. As RASCOM and ARM show, this realistically requires one to two decades to operationalize.

A balanced and rational solution is to propose that an African continental space agency should grow organically out of agreements such as the ARM and institutions such as the ALC. Individual countries can be incrementally added to the ARMS and similar MOUs. Additional functions can be incrementally added to RASCOM.

Name or Locality	Country or Organization	Facility
6th October City (nr. Cairo)	eg, Nilesat	Satellite Operations Centre
Al-Hammam (nr. Alexandra)	eg, Nilesat	Satellite Operations Centre
Béchar	dz	Sounding rocket launch site
Douala	cm, Rascom	Satellite Operations Centre
Gharyan	ly, Rascom	Satellite Operations Centre
Hammaguir	dz	Rocket launch site
High Energy Stereoscopic System (Gamsberg)	**na**	**Gamma ray telescope**
ISSA – Houwteq (nr Grabouw)	za	Satellite testing facility; Ground station
Kapani Tonneo	cd	Sounding rocket launch site; airstrip
Kottamia Observatory	**eg**	**1.9 meter telescope**
Luigi Broglio Space Centre (nr. Malindi)	ke	Orbital Launchpad; plus ground station
Mauritius Radio Telescope (Bras d'Eau)	**mu**	**Low frequency radio-telescope**
Overberg Test Range (nr Arniston)	za	Orbital Launchpad; ground station
Satellite Applications Centre (nr. Hartebeeshoek)	za	ground station
Southern African Large Telescope (Sutherland)	**za**	**9 meter telescope**
Square Kilometer Array bid	**za plus 8 African countries**	**Radio telescope**
Tawiwa	ly	Sounding rocket launch site

Bold font indicates Astronomical Observatories.

Table 19–1: Africa's Ground Infrastructure.

Name	Country or Organization	Launched
Alsat-1	Dz	2002
Alsat-2A	Dz	2010
Egyptsat 1	Eg	2007
New Dawn	Za	2011
NigComSat	Ng	2007
NigeriaSat-1	Ng	2001
NigeriaSat-2	Ng	2011
NigeriaSat-X	Ng	2011
Nilesat 101	Eg	1998
Nilesat 102	Eg	2003
Nilesat 103 (Hot Bird 4, 10)	Eg	2005
Nilesat 201	Eg	2010
Rascom-QAF1 RQ1	Rascom	2007
Rascom-QAF1R RQ1R	Rascom	2010
Shuttleworth astronaut	Za	2002
Sumbandila	Za	2009
Sunsat	Za	1999

(Table excludes four French satellites launched from Hammaguir, and nine Italian satellites launched from San Marco platform, Kenya).

Table 19–2: African Satellites Built, or Bought, or Borrowed.

Endnotes

[1] The exceptions include Danielle Wood, 2008, "The Use of Satellite-Based Technology in Developing Countries." MIT S.M. dissertation. http://hdl.handle.net/1721.1/46371 (viewed 9 September 2011); also Danielle Wood and Annalise Weigel, "Building Technology Capability within Satellite Programs in Developing Countries," *Acta Astronautica*, Vol. 69, No. 11–12 (2011), pp. 1110–1122. Doi 10/1016/j.actaastro.2011.06.008 (viewed 7 August 2011).

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