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BUILDING UP NATIONAL SPACE CAPABILITIES FOR DISASTER MANAGEMENT: ANALYSIS OF A TREND IN EMERGING SPACE NATIONS AND DEVELOPING COUNTRIES

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For the past decades, new space nations have emerged worldwide. Developed as well as developing countries have started to gain national space capabilities and this trend has obviously increased during the last ten years. Space applications are assessed to contribute and foster the achievement of the United Nation's Millennium Development Goals. Civil security, quality of life and disaster management are thus the main rationale presented by countries to develop their own space capabilities, often with the support of space-faring nations through capacity building or technology transfer.

Despite having different political structures and economic background, numbers of these countries acquiring national space-borne technologies follow a similar approach in the development and implementation of these capabilities.

The space-based technologies relevant for disaster management and used for early warning, vulnerability assessment, emergency preparedness, disaster mitigation and adaptive response, are remote sensing, satellite communications, navigation systems and meteorological satellites. This paper will therefore present how political and economic decision makers in countries with recent space capabilities underline the role of these space applications for disaster management, principally telecommunications and earth observation, and the policies induced by their strategies.

In this approach, countries often emphasise in official public documents the need for them to acquire these technologies in order to independently ensure national civil security. The paper will analyse the concept of "self-reliance" and its implications.

Nevertheless, space-borne technologies intended for civil use can be of great interest for defence or intelligence applications and some countries can be tempted to follow a second agenda. Despite this risk, in some cases, the rationale of civil security could increase the worldwide acceptance for space technologies development and for capacity building.

To serve efficiently the public needs in disaster management, space-borne applications have to be supported by sectorial policies. This paper aims to analyse political strategies and policies' implementation to develop space technologies for disaster management in emerging space nations. This study, taking into account the historical path and the stakeholders involved, is supported by official documents (i.a. laws and budgets), statistics and relevant academic literature. Some concrete examples, provided as case studies, illustrate the overall process. The following research aims to distinguish homogeneous and heterogeneous trends in the development of space technologies for disaster management in emerging space nations.

Abbreviations and Acronyms

DM	Disaster Management
EO	Earth Observation
GEO	Group on Earth Observations
ICT	Information and Communication Technologies
UN	United Nations

I. GENERAL OVERVIEW

Since the 1990's, various developed and emerging countries have been drawing up their own national space plan. From 2001 to 2011, the number of nations with space programmes has grown exponentially from 26 to 49[*]. According to the common definition provided by dictionaries, a "spacefaring nation" is a country capable of independently building and launching a

[*] Euroconsult, 2012, Profiles of Government Space Programs.

spacecraft into space. Nevertheless, it is sometimes admitted that countries without launch capabilities can be considered as "space faring" if they already have strong capabilities in spacecraft manufacturing. On the other hand, "emerging space nations" are defined as countries on the way to acquire space-based capabilities.

In the field of disaster management, these new entrants underline the socio-economic benefits provided by space technology, enhancing the need for them to be able to protect independently their population and to improve their capabilities. Thus far, only very few emerging space nations do not mention disaster mitigation in their space strategy. The Nigerian Space Policy, released in 2001, illustrates this outlook:

"Nigeria is not located within the zones of the world that are known to be highly prone to natural disasters […]. However cases of floods, landslides, tidal waves, coastal erosion, sand-storms, dust-storms, locust/other insect infestations, oil spillage and other man-made disasters have been recorded in the country. […] All [this] need[s] space technology to be effective. Nigeria shall endeavour to use space technology for disaster prediction, warning and mitigation."†

Pakistan presents the same motive for the development of space technology in the country:

"Like other developing countries, [Pakistan] faces a number of socioeconomic problems such as poverty, hunger, over-population, illiteracy, healthcare, and energy and water shortage. [...] some additional problems include poor telecommunication, rail and road infrastructure and rugged and inaccessible terrain. Finding solutions for all these problems through conventional methods is difficult, if not impossible. [...] The competence and capabilities in relevant areas of space science and technology for space exploration could help attain sustainable socio-economic development and improve the quality of life of the people of Pakistan."‡

Space technology is assessed to contribute and foster the achievement of the United Nation's Development Goals for emerging countries. Enhancing the population's quality of life, disaster mitigation or even civil security are the main arguments presented by these countries to develop their own national space capabilities, usually with the support of established space nations.

† Republic of Nigeria, 2001, Nigerian Space Policy and Programmes
‡ Pakistan, 2011, Space Development Program 2040

The following paper aims to explore the motives formulated in the space strategies by emerging countries, acknowledging the criticism regarding dual-use capabilities and expensive space programmes seen as potential waste of investment. Dual-use capabilities will be defined as "technologies normally used for civilian purposes but which may have military applications"§ and will not be limited to a shared investment by the defence and public sectors in a space project. This research compared official texts to actual implementation of space applications for disaster management, especially in countries that developed their strategy mainly in the last decade, defined as "third tier space nations" by Robert Harding**.

II. WHY SPACE TECHNOLOGIES FOR DISASTER MANAGEMENT?

Disaster management is defined by UN-SPIDER as: "The complete set of phases related to disasters and their management (prevention, mitigation, preparedness, response, rehabilitation, reconstruction and recovery)."††

The interrelation of these different phases is usually represented in a diagram as the one shown below:

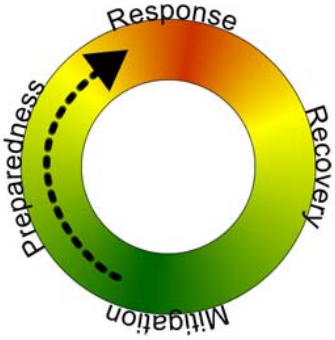

Figure 1: Disaster Management Cycle‡‡

At all these different phases, space technologies provide a value-adding contribution compared to ground or aerial systems and this is acknowledged in the United Nations' resolution. Indeed, "convinced that the use of existing space technology, such as Earth observation and meteorological satellites, communications satellites and satellite navigation and positioning systems, and

§ European Commission, Directorate General TRADE
** Harding R. C., 2013, Space Policy in developing countries, The search for security and development of the final frontier.
†† UN-SPIDER Glossary, website retrieved on August 20, 2013 (http://www.un-spider.org/glossary/term/6016)
‡‡Image from the Institute for Building Technology and Safety Disaster Management Group. http://webapps.icma.org/pm/9102/images/cover1_fig1.jpg

their applications, can play a vital role in supporting disaster management by providing accurate and timely information for decision making and re-establishing communication in case of disasters,"[§§] the United Nations General Assembly established in 2006 the "United Nations Platform for Space-based Information for Disaster Management and Emergency Response - UN-SPIDER" with the following mission statement: "Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle".

As mentioned before, the space-borne technologies relevant for disaster management are remote sensing, satellite communications, navigation systems and meteorological satellites and all are used for early warning, vulnerability assessment, emergency preparedness, disaster mitigation and adaptive response. The following chapter will briefly present the use and role of space technologies, focusing on telecommunications and remote sensing, taking into account that space capabilities intended to support disaster monitoring and mitigation are not only used for this purpose. These technologies are not only dedicated to disaster management and therefore, dedicated statistics space budgets for disaster management do not exist. It is only possible to analyse the budget share for technologies relevant for disaster management, such as telecommunications or Earth observation.

II.I. Telecommunications

Satellite Communications offer a great asset in disasters and emergency situations. These space-based wireless communications infrastructures are indeed the only capabilities able to ensure communications after the destruction of terrestrial facilities. Among others, UN-SPIDER case studies[***] show potential uses of space-based telecommunications.

In order to get the maximum benefits of these technologies, their implementation is often more strategic than their acquisition. Indeed, if these technologies can be used in emergency situations, they can also be tactical resources in the long run. When both civil and military needs are addressed at the same time, it is concrete case of dual-use. The company in charge of the operations and exploitation of the Nigerian satellite, NigComSat-1R, also expressed this idea:

"NigComSat-1R […] is a critical ICT backbone infrastructure to drive the National ICT revolution in […] offering cost effective solution and affordable access to meet Nigeria's telecommunications, broadcast, aviation, maritime, defence and security needs."[†††]

In 2011, countries dedicated a $8.4 billion budget[‡‡‡] for space-based telecommunications, i.e. 14% of the civil and defence non-classified global budget. Nevertheless, if we subtract the official defence-only budget, we come to US$ 2 billion, to which we still have to deduce the budget of the main established space nations such as the United States, Russia, Europe or Japan. We could consider the dedicated budget as limited, compared to other public budgets.

Additionally, satellite telecommunications are a mature technology and this allows the countries to acquire or purchase this technology faster and at a lower cost. For this reason, telecommunications are usually the first space-based capability acquired or developed by emerging space nations.

II.II. Earth observation and remote sensing

Whereas satellite telecommunications has already achieved a mature stage and reached commercial markets, the situation is different for Earth observation. Undeniably, and not only in developing countries, Earth observation remains a public initiative intended for direct socio-economic benefits for the country.

In many emerging space nations, Earth observation is expected to become a budget driver in the coming years. For instance, in 2011, US$9 billion[§§§] (i.e. 15% of global budget) were dedicated worldwide for Earth observation & meteorology, showing a +16% expansion over 2010. Remote sensing is used for various applications such as mapping or change detection, of great use for disaster mitigation. It can be also used for defence purposes and numerous observers expressed criticisms and concerns regarding the development of these space capabilities and their dual-use potential.

III. THE POTENTIAL AMBIVALENCE OF CIVIL SECURITY

III.I. The UN Millennium Development Goals

As seen previously, space-based technologies are established with the intention to support economic development policies. One major initiative is the

[§§] Resolution 61/110 of 14 December 2006 the United Nations General Assembly

[***] UN-SPIDER website, http://www.un-spider.org/space-application-matrix, retrieved August 30, 2013.

[†††] Nigcomsat website: http://nigcomsat.com/, retrieved July 30, 2013

[‡‡‡] Euroconsult, 2012, Profiles of Government Space Programs.

[§§§] Euroconsult, 2012, Profiles of Government Space Programs.

Millennium Development Goals defined by United Nations in 2000, to which the space technologies can definitely contribute.

The UN are a major actor in this context and is "desirous of enhancing international coordination at the global level in disaster management and emergency response through greater access to and use of space based services for all countries and facilitating capacity-building and institutional strengthening for disaster management, in particular in developing countries"[****]

International cooperation and capacity building is a clear strategy advocated by the UN. Following these statements, emerging nations claim the right to develop and acquire their own capabilities, in cooperation with space faring countries. Despite the fact that space strategies and public policies differ worldwide, each nation follows a similar approach in the development and implementation of civil use space-borne technologies[††††].

"The common progression of space activity begins with societal interest, often from government, in developing space capabilities that have a positive impact on a nation's security, economy, society, and technology base. The inception of space activity is usually government-led, with legislative efforts that develop a space strategy, supporting laws and policies, and provide upfront governmental investment in space."[‡‡‡‡]

The tendency shows that an emerging space nation regularly starts to purchase a satellite from an established space nation public or private space industry. Sooner or later, the country develops its own capabilities thanks to capacity building and technology transfer. The usual strategy starts with telecommunications, moves then towards remote sensing and finally launchers – due obviously to the investment required for their development.

Additionally, developing countries are looking for the support of countries with established space capabilities to obtain the required capabilities. Following the principles of the UN, this support contributes to development policies and leads emerging space nations not only to order satellites, but also to acquire nationally the know-how: capacity building and know-how transfer are part of this strategy. On this point, Pakistan Space Agency mission is clearly stated: "Strive to achieve self-reliance in space technology and applications for national security, economy and society."[§§§§]

III.II Self-reliance

In this framework, "self-reliance" is a key word. "Relying" being a synonym of "dependency", developing countries do not wish to rely on foreign space-based resources for disaster management activities that require high reactivity. In order to become independent in a long-term perspective, they decide to invest not only in the applications but also in the hardware capabilities and the manpower:

"The Nigerian Space Policy serves as the road map to the attainment of self-reliance, particularly in the areas of an indigenous critical mass of trained space engineers and scientists and the utilisation of space-derived data for national development"[*****]

This cooperation is undertaken in a context of sometimes harsh discussion about the high investment required to acquire such technologies. For instance, in August 2013, a debate started in the United Kingdom about the national development aid allocated to Nigeria, this payment being seen as "sponsoring" the space programme instead of contributing effectively to the socio-economic development of the country. In other words, according to the general public, the funding should go directly to development policies instead to go to a space programme whose usefulness is questioned.

Additionally, countries have the opportunity to purchase data or capacity from other countries or private suppliers. Emerging countries can rely on free data made available, as promoted by organisations like Group on Earth Observations (GEO). As analysed by Harris and Miller[†††††], Earth observation data, especially in digital format, could be considered as non-rivalrous and non-excludable public goods and therefore could be accessed by anybody. However, in most of the cases, data policies and intellectual property rights do not offer this freedom[‡‡‡‡‡]. Additionally, lack of data, limited coverage, or even limited access to the data, over some regions are common concerns. A dedicated national service might then be the only solution for serving the

[****] Resolution 61/110 of 14 December 2006 the United Nations General Assembly.

[††††] Wood D., Weigel A., 2010, Building technological capability within satellite programs in developing countries, IAC-10-B4.1.

[‡‡‡‡] Futron, 2011, Innovative Strategies for Space Competitiveness: Assessing the SpaceIsle's Policy and Results, p10.

[§§§§] Pakistan, 2011, Space Development Program 2040

[*****] Boroffice R. A., 2008, NASDRA, *The Nigerian Space Programme: An Update*, African Skies / Cieux Africains.

[†††††] Harris R., Miller L., 2011, *Earth Observation and the public good*, Space Policy 27.

[‡‡‡‡‡] Williamson R.A., Antoniou N., 2012, Data Policies in support of Climate Change and Disaster Management Applications, IAC- 12-E.3.1.1

population needs. In this situation, countries with an insufficient demand or with no demonstrated cost-benefit analysis often raise criticisms worldwide regarding their investment in a satellite or a space programme.

For this reason, it is relevant to discuss other national motives for the acquisition of space technologies. These are not necessarily presented as official rationales but well and truly exist; we analyse here two of them: dual-use capabilities and national prestige.

III.III. Dual-use and national prestige

Not only socio-economic benefits but also geopolitical issues are drivers for the development of space capabilities. Regional conflicts, border monitoring, terrorism or even warmongering behaviour can be the true drivers. In addition, national institutions responsible for space programmes can belong to the military sector.

Technologies like telecommunications or Earth observation have multiple applications in the defence sector. As civil security and disaster management increase the worldwide acceptance for emerging countries to gain space capabilities, legitimate questions can be raised when nations – particularly dictatorships – tend to emphasise civil security as a goal. However, the various international space treaties mention the basic principle of "non-aggressive use of outer space" and not the non-military use: dual-use capabilities for security applications do not mean an aggressive behaviour, especially when the only national organisations empowered in critical times, such as disasters, are military institutions. This is the case in many countries and not only in the developing world.

Moreover, funding is an important element to develop dual-use capabilities in order to establish synergies. As an example, in its Strategic Plan for Space[§§§§§], Kazakhstan mentions dual-use as a countermeasure to avoid financial drawbacks from low market demand due to the financial crisis.

All these interconnections, even if they are factual, are difficult to assess. One solution to analyse the real purposes of space programmes is to assess the public policies related to the implementation of these space-based technologies like geographic information systems, precise agriculture or tele-education. The two following case studies show how countries choose to implement space applications through public policies and potentially to link space capabilities to the military sector.

III.IV. Case Studies

a) Nigeria

Nigeria founded a space agency NASRDA in 1999 and approved a space strategy in 2001. The first Nigerian satellite NigeriaSat-1, built by Surrey Satellite Technology Ltd (SSTL), was launched in 2003 and, since then, the country pursues the development of space capabilities in various areas, mainly satellite communications and remote sensing (77% of the budget dedicated to space)[******].

As stated in the Nigerian space strategy, the objective of the implementation plan is the "attainment of space capabilities as an essential tool for its socio-economic development and the enhancement of quality of life of its people"[††††††]. Nigeria is also "in pursuance of the national policy on ICT, launched a communication satellite to provide a backbone for the ICT services particularly in the areas of e-learning, e-commerce, e-government, telemedicine, tele-education, rural telephony, etc.".[‡‡‡‡‡]

The budget dedicated to space in Nigeria, US $84 million of investment in 2011, is considered as a fully civil budget, the major part being for the telecommunications satellite Nigcomsat 1R. Nevertheless, the dual-use of these technologies is stated in the official publications such as the Space Strategy. National security purposes, such as the fight against terrorism, location identification, training of military personnel or border control, are mentioned as motives.[§§§§§§]

Disaster management takes a great place in the space plan. Remote sensing imagery is aimed to serve as a catalyst to the development of Nigeria's National Geospatial Data Infrastructure programme, in perspective of the attainment of the MDGs (Millennium Development Goals) and the 7-Point Agenda of the Nigerian Government, including among others food security. Additionally, Nigeria makes its remote sensing data from NigeriaSat-2 available to the Disaster Monitoring Constellation (DMC) consortium.

§§§§§ Kazakhstan, National Strategic Plan for Space 2010-2014.

****** Euroconsult, 2012, Profiles of Government Space Programs.

†††††† Republic of Nigeria, 2001, Nigerian Space Policy and Programmes

‡‡‡‡‡ Boroffice R. A., 2008, NASDRA, The Nigerian Space Programme: An Update, African Skies / Cieux Africains.

§§§§§§ eoPortal Directory, retrieved on August 31 : https://directory.eoportal.org/web/eoportal/satellite-missions/n/nigeriasat-2

Since 1998, Nigeria also hosts the African Regional Centre for Space Science and Technology Education - in English Language (ARCSSTE-E) of the United Nations. This centre aims at providing education programmes to university educators and scientists in space science and technology fields contributing to sustainable development, such as remote sensing and geographic information systems, meteorological satellite applications or satellite communications.

In the country, the space sector is strongly linked to other agencies and public departments related to the space applications implementation, making Nigeria an interesting example for civil implementation of space-based technologies.

b) Pakistan

Even if Pakistan started to undertake space activities in 1965, the nation has seen a renewal of its commitment over the last a decade and achieved an estimated investment for civil space programmes of US$ 106 million in 2011[*******], mainly driven by satellite telecommunications. In 2011, Pakistan published a "Space Development Program 2040" aiming at monitoring natural disasters and developing tools to utilise space technology applications for socio-economic development.

In Pakistan, the National Command Authority (NCA) is the organisation responsible for joint-space operations, information operations, missile defence, and combating weapons of mass destruction. This organisation is also in charge of the space agency, the Space & Upper Atmosphere Research Commission (SUPARCO). The space field is strongly linked to national security purposes and to military applications.

In parallel to the statements related to disaster mitigation and the protection of the population, one goal of the space programme is clearly stated: "In the context of nuclear security, space technology could help in promoting transparency, verification regimes and early warning"[†††††††]

On the other hand, SUPARCO "works towards developing indigenous capabilities in space technology and promoting space applications for socio-economic uplift of the country." [‡‡‡‡‡‡] In 2010, SUPARCO and the United Nations Office of Outer Space Affairs (UNOOSA) signed in 2010 a cooperation agreement to establish a UN-SPIDER Regional Support Office in the country, in the field of remote sensing, geo-informatics and geo-information systems.

CONCLUSION

This research analysed the general acceptance of the development of space capabilities in emerging countries for the purpose of disaster management. This analysis questioned the political rationales, behind the expression of interest to acquire own space capabilities for space emerging nations, and how they are perceived internationally.

The various motives of a space programme are certainly difficult to assess and to distinguish but several elements, like an appropriate implementation of public policies towards socio-economic benefits, are good indications that the population takes full advantage of the investment in space technologies.

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