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With the editorial team, I am pleased once again to invite you to learn about some developments in the world of scientific activity and remote sensing in Africa and around the world in this October 2019 edition of the AARSE Newsletter. Firstly, may I extend my congratulations to the team who were responsible for the upgrade of our website...p3

Important News: AARSE Membership Subscriptions

The new AARSE website is now active and the online subscription and membership platform is up and ready! As a limited opening special we will not charge any extra fees or penalties for new subscribers or lapsed subscriptions. We accept Visa and MasterCard payments through our PAYGATE portal, but also have a free Online Naira option available plus a direct EFT option...p2

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Focus on an African Personality in Space Science

Dr. Tidiane Ouattara was born in Côte-d'Ivoire where he started his academic career at the *Université de Cocody-Abidjan* where in 1993 he received a master's degree in Physical Geography. In 1996, he obtained another master's degree...p5



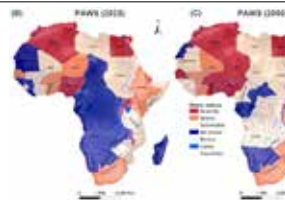
Discovery of an African Space Institution

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Africa could face a dangerous water scarcity crisis by 2050

By 2050, assuming no change in available water resources, we project that 19 countries in Africa will face water scarcity and another nine countries will be water-stressed. However, if climate change were to cause Africa's water resources...p8



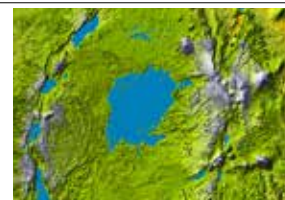
Southern African wetlands monitoring project still on track

The Southern African Wetlands Monitoring and Assessment (WeMAST) project, which will support the sustainable management of selected transboundary river basins namely the Cuvelai, Okavango River, Limpopo River, and Zambezi River Basins is still well on track...p11



African lakes threatened by global warming?

Eight African lakes are listed as under threat of intense lake phytoplankton blooms in a worldwide study of 72 freshwater lakes conducted by Jeff Ho and Anna Michalak from the Department of Global Ecology, Carnegie Institution for Science, Stanford...p12



From the Editor

Creeping desertification of the African continent is a measurable phenomenon where the accelerated pace of land degradation in fragile and semi-arid areas caused by greater numbers of people and livestock is quite obvious. This has been labelled as a monstrous challenge facing Africa in the domain of human health, food security and economic activity.

If this is not enough bad news we are now also receiving warnings from Earth Observation specialists that Africa might soon face a serious water scarcity crisis should climate projections for global warming realize.

A study recently published by four academics which we report on in this issues warns that some 85% of Africa's population will experience a dangerous water scarcity by 2050 should the population double as expected and climate change causes water resources to

decrease by as little as 10%. What's more is that these researchers did not only take data such as rainfall, rivers and lakes into account, but also underground aquifers some of which are currently not even accessible due to technical and economic limitations.

The deteriorating water quality of Africa's big freshwater lakes is another twist in this tale with global warming yet again the big bad brother. Researchers have now provided evidence that higher global temperature causes accelerated growth of toxin producing phytoplankton which can make water unsuitable for human consumption. Eight of Africa's biggest lakes are already included in this list of 72 vulnerable freshwater lakes worldwide.

So what is the solution? Clearly it has to with planning and for this we need information. Fortunately that information is flowing down in a steady stream from Earth observation vehicles, mostly satellites, while the sophistication and quality level of this are improving by the day.

Africa, however, is a big continent with a total of 55 countries. It will necessitate co-ordinated efforts as no-one can go it alone. What happens to your neighbour will happen to you.

Food and water are a human being's absolute first necessity. The rest, such as education and medical care only becomes doable if this first need is looked after. Africans have created several instruments to co-ordinate their efforts with the African Union leading the pack. Their Agenda 2063 is for transforming Africa into a future global powerhouse, we trust with enough food and water.

At least we have been forewarned. There are no excuses.

Anthony Penderis
Editor



Important News: AARSE Membership Subscriptions

The new AARSE website is now active and the online subscription and membership platform is up and ready! As a limited opening special we will not charge any extra fees or penalties for new subscribers or lapsed subscriptions. We accept Visa and MasterCard payments through our PAYGATE portal, but also have a free Online Naira option available plus a direct EFT option.

If you want to sign up or renew your membership follow this link and choose your option i.e. Student Member, Regular Member, Corporate Member, etc.
<http://africanremotesensing.org/join-us/>.

Those who have current active subscriptions must please send proof of their last payment to members@africanremotesensing.org so we can confirm it against our bank statements.

If you experience any problems with payments or need additional information regarding membership please send a message to members@africanremotesensing.org.

Membership Privileges: Reasons why you should join AARSE

1. You can make a bigger impact on remote sensing in Africa through the Association;
 2. You are joining a dynamic and respectable organization founded in 1994;
 3. Get exposure to many organizations, their publications and potential job opportunities;
 4. Be part of the important voice to address Africa's remote sensing policies and research;
 5. Attend biennial AARSE Conferences at a reduced rate or even get sponsored;
 6. Get the AARSE-IEEE/GRSS Travel Fellowship Award to attend their conferences;
 - 7 Join our Technical Program Committee and assist with workshops and training activities;
 8. Utilize our partner resources provided on remote sensing, GIS and ICT training;
 9. Join our national or regional members to sit in or collaborate with international fora;
 10. Get subsidized subscription to tour partner journals;
 - 11 Corporate Members get an 30% reduction on advertising fees in our bimonthly newsletter.
- See more at <http://www.africanremotesensing.org/Why-Join-AARSE>

AARSE Editorial Contact Details

The AARSE Newsletter is an official publication of the African Association of Remote Sensing of the Environment. During the year 2019 it will be published at least six times starting February 2019 and thereafter every second month until December 2019.

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Message from the President

Dear Readers

With the editorial team, I am pleased once again to invite you to learn about some developments in the world of scientific activity and remote sensing in Africa and around the world in this October 2019 edition of the AARSE Newsletter.

Firstly, may I extend my congratulations to the team who were responsible for the upgrade of our [website](#). It is indeed a pleasure to view and read the new-look content. We are also proud to be able to present it in our main working languages French and English, with even Dutch and Portuguese as extra options. I trust this will entice members old and new to subscribe to our organization.

This past month's meeting of AARSE Councillors and Trustees was indeed an uplifting and inspirational experience judged by the inputs we received from our various representatives all over Africa. Their concerns about and dedication to all the challenges we face on this continent of ours certainly shone through. I thank them all for their unselfish contributions.

Next year of course is our biennial milestone event the [AARSE 2020 Conference](#) which is set to take place from the 26th to 30th October 2020 in Kigali City, Rwanda. The 13th conference since the first one in 1996 in Harare, will once again be one the premier forums in Africa for the gathering of leading scholars, policy makers and entrepreneurs from the remote sensing and related communities to share their views on remote sensing technologies and geospatial

information science. Our best wishes to the Local Organizing Committee at the INES-Ruhengeri Institute for all the hard work that lies ahead.

Next month I have the pleasure to attend the UN-GGIM: Africa in Rwanda where I intend to meet some of my AARSE councillors as well. Please feel free to look me up should you also attend the meeting.



Good reading.

Prof. Kamal Labbassi
AARSE President
2018 - 2022



An invitation to advertise in the December 2019 issue of the AARSE Newsletter

The bimonthly newsletter of the African Association of Remote Sensing of the Environment (AARSE) offers an ideal opportunity to those who wish to expand their African footprint in the arena of Earth Observation Systems and Geo-information Technology. The newsletter is distributed electronically to a select audience of some 5 000 recipients who include inter alia most African national space agencies, governmental space research institutes, and space technology companies. It is also published on the AARSE website <http://africanremotesensing.org/current-newsletters/> and the Facebook Page Space News Africa <https://www.facebook.com/spaceneWSafrica/>.

The A4 newsletter covers a minimum of 16 pages with content normally divided as follows: AARSE News (25%); Africa Space News (50%); International Space News (25%).

Rates: Please contact the editor for standard rates and sizes at newsletter@africanremotesensing.org.

Discounts : 15% discount on 3 or more placements; 30% discount per placement for AARSE Corporate Members.

Invoicing: This will be generated within a few days after a booking has been received.

Payments: Per EFT prior to placement on Materials Deadline Day.

Material Specs: Advertising material to be supplied in high resolution jpeg of pdf format.

Layout Service: AARSE's editorial team can assist with layout and editing of Advertorials.

Deadlines for the December 2019 Newsletter:

Booking Deadline: Friday 22 November 2019
Materials & Payments Deadline: Friday 29 November 2019
Publishing Deadline: Friday 6 December 2019

See samples of previous newsletters here:
<http://africanremotesensing.org/current-newsletters/>
See more detail on AARSE Advertising here:
<http://africanremotesensing.org/advertising-options/>
Please contact the editor here: newsletter@africanremotesensing.org for more information.

Members of AARSE Council (2018 - 2022)

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Mahamadou Keita	Secretary General
Dr. Abel Ramoelo	Treasurer
Dr. Souleye Wade	Communications
Mahamadou Keita	Councillor for West Africa
Prof. Islam Abou El-Magd	Councillor for North Africa
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Message from the Chairman: AARSE2020 Conference

Dear AARSE Family

Warm greetings from the Land of a Thousand Hills. On behalf of the Local Organising Committee, I would like to deeply express my appreciation to the African Association of Remote Sensing of the Environment (AARSE) for giving us the opportunity to organize our AARSE2020 Conference in Kigali, Rwanda. With a record number of participants expected next year, we are delighted to see that this, your 13th biennial conference is becoming larger and more substantial.

I am equally excited about the record number of sessions, and wide variety of ideas that scholars and practitioners will bring into our fold. The exciting academic, scientific research and policy brief conference under the theme “Space and Geospatial Technologies for the Africa We Want” will be a major event in the African and international community of Earth observation and geo-spatial information science in 2020. This conference will be organized by AARSE and the Institut d’Enseignement Supérieur de Ruhengeri (INES-Ruhengeri).

The main objective of AARSE2020 is to bring together scholars and professionals from the African and international community to present their latest achievements, discuss challenges and share experiences in space



Dr. Fr. Fabien HAGENIMANA, Vice-Chancellor Ines-Ruhengeri and Chair of the AARSE2020 Conference

and geospatial technologies. The conference program will feature keynote speeches delivered by leading policy makers, scholars, technical sessions with reports of the latest research outcomes, discussion sessions on operational topics such as capacity building, Spatial Data Infrastructure (SDI), space policy, programmes and projects, as well as commercial exhibitions showing the latest products and services in remote sensing and geospatial information technologies.

Rwanda is a country where remote sensing is used to manage natural resources, register land and increase people’s land tenure security, reduce land and natural resources

conflicts, and increase environment protection. This conference will therefore be a good platform to share experiences and learn from our sister African countries but also to share Rwanda’s experiences. We therefore call upon everybody and all familiar with remote sensing not to miss this great event.

The hosting of this conference would not have been possible without tremendous work and efforts of Mr. Jossam Potel and his team. I am therefore very grateful and thank the conference organizing committee members for the work they are continuing to do for the successful organization of the AARSE2020 Conference.

I call upon all well-wishers, remote sensing organizations and families to lend us a hand through moral and financial support for the better preparation of this conference.

All in all, I would like to thank you, the participants for enriching this biennial event by your presence. As is a tradition with AARSE conferences, I hope you will enjoy the content, renew old friendships, make new friends, get new ideas, and above all, have a good time in Rwanda.

Dr. Fr. Fabien Hagenimana
Vice-Chancellor Ines-Ruhengeri
Chair of the AARSE2020 Conference

AARSE2020 Conference
Kigali, Rwanda
26 – 30 October 2020
<http://www.aarse2020.org>

The African Association of Remote Sensing of the Environment’s 13th biennial conference AARSE2020 on Earth Observations and Geospatial Science in service of Sustainable Development Goals will be held in Kigali, Rwanda, organized by Ines-Ruhengeri from 26th to 30th of October, 2020.

Conference Theme
Space and geospatial technologies for the Africa we want.

Conference Sub-Themes

1. Remote sensing for natural resource management.

2. EO and geospatial information for sustainable human security.
3. Geospatial information for smart city development.
4. Space and geospatial technologies for land administration and management.
5. Space technology for environmental monitoring and sustainability.
6. Space technology in natural hazard and disaster management.
7. Integrated geospatial technologies in agriculture and food security.
8. Remote sensing climate change adaptation and mitigation strategies.
9. African Space Development under the African Space Agency:
 - a. Space Capacity building and utilization
 - b. Innovative space technologies

10. Big Data analysis and Spatial Data Infrastructures.
- Important dates**
1. Deadline of submission of abstract 27th March 2020 at 00:00 GMT
 2. Notification of acceptance: 22nd May 2020 at 00:00 GMT
 3. Deadline for full paper 31st July 2020 at 00:00 GMT
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Focus on an African Personality in Space Science and Technology



Dr. Tidiane Ouattara

An unmistakable leader who sets the pace for innovation in space policies, science and technology on the African continent is but one way to describe the dynamic dr. Tidiane Ouattara our choice for this month's African Personality in Space Science and Technology. In this article we cover only some of his background and achievements thus far - Editor

Dr. Tidiane Ouattara was born in Côte-d'Ivoire where he started his academic career at the *Université de Cocody-Abidjan* where in 1993 he received a master’s degree in Physical Geography. In 1996, he obtained another master’s degree and in 2001 a PhD, both in Remote Sensing and Geographical Information Systems (GIS) from Sherbrooke University, Canada.

His working career commenced in Canada as lecturer from 1996 to 2001 at Sherbrooke University where he taught not only scientific, but also courses on African geopolitics and sociocultural issues.

After a brief stint with the private sector in Montreal, in 2002, Dr. Ouattara joined the federal government of Canada where he worked in various capacities and received top-leadership training for executive level officials. In these positions he gained extensive experience in international relations and business development, research and development, strategic policy development and program management issues related to the environment, outer space, natural resources, science and technology.

He was amongst others appointed *Senior International Relations Manager* at the Canadian Space Agency in charge of Africa, Central and South America and the United Nations. In this position he covered Earth Observation, Navigation and Positioning, Robotics and Space Sciences portfolios. At the Canadian Wildlife Service Branch of the Department of Environment and Climate Change he served as manager of the Geospatial Data Management Unit and head of the Landscape and Ecosystem Assessment Planning and Coordination Section. He was also appointed as *Senior Science and Policy Advisor* for the Assistant Deputy Minister, and *Chief Scientist* as well as *Head of Knowledge Management, Bilateral and Multilateral Strategies Section*

at the Department of Natural Resources of Canada. In the same department, Dr. Ouattara held the coveted position of manager of the Canadian Digital Elevation Model Program and *Researcher and International Relations Officer* in geomatics (Earth Observation, mapping, GPS and Geographical Information Systems).

During this period he notched up a number of personal feats such as the development of an expert system for landslide monitoring, and a methodology using remote sensing and GIS for rapid change detection. He also developed the Canadian Space Agency (CSA) inaugural Earth Observation Strategy Framework for Africa, the Department of Natural Resources inaugural geomatics strategy for Africa as well as the Canadian Wildlife Services’ data publishing and sensitive data policies. He led, as head of the Canadian delegation for two years, the participation of Canada in the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) discussion on space governance, security, law, policy and science.

Dr. Tidiane Ouattara currently holds the position of Space Science Expert in charge of developing and implementing the African Outer Space Programme for the African Union and is also the Coordinator of the Global Monitoring for the Environment and Security and Africa (GMES and Africa) programme at the African Union Commission.

He introduced, for the first time in Africa, the idea of consortia in implementing an Earth Observation program. With this idea, a group of institutions from at least five different countries, among which one would be an academic institution, will band together to implement EO programs. Under his inventive leadership the broadest coverage of the African continent by an EO program was

occasioned. Through his drive and direction, GMES and Africa requires the mandatory involvement, for the first time, of the African private sector in the implementation of a continental EO program, as well as the sponsorship of at least 2 students at master’s and PhD level by the end of the project.

Dr. Ouattara’s led and coordinated the development of the African Space Agency statute and the proposal of the structural and financial implications of the African Space Agency. He commissioned several baselines studies including the Comprehensive Survey of Earth Observation and Geospatial & Allied Technologies’ Private Sector in Africa, and the Survey and Gap Analysis on Satellite Navigation and Positioning Infrastructure and Technologies in Africa. Thanks to his drive and stimulus, the African Space Agency is on the verge of being fully operationalized.

His expertise in bilateral, multilateral and international relations engendered positive yields in negotiations involving several partnership agreements with private sector, academia, national institutions and international organizations in Africa and beyond. He is a prolific motivational speaker who has delivered several keynote speeches on space, science and technology at various forums worldwide. He has granted technical and policy interviews on space and sustainable development matters to a wide range of African and international media.

Dr. Ouattara won several honors and accolades, among them, the Prize of the President of the Canadian Space Agency; the Prize of Merit of the Ministry of Natural Resources of the Federal Government of Canada; and the medal of ‘*Chevalier de l’ordre académique*’ of Burkina Faso.

In our series Discovery of an African Space Institution, in this issue, we focus on the Center for Ecological Monitoring (CSE) based in Dakar, Senegal. See more at www.cse.sn.

Discovery of an African Space Institution

Text supplied by the CSE



Driven by the international community a project for monitoring and understanding Sahelian pastoral eco-systems exposed to cycles of drought was set up in Senegal in 1986 by the United Nations Sahelian Office.

Over a period of 10 years this resulted in the development of new skills and expertise relying on Earth observations as well as scientific methodologies for monitoring natural resources. This progressively evolved into broader and integrated ecological monitoring and better understanding of the mechanisms and dynamics of the environment and natural resources in Senegal.

At the end of this exercise and considering the strategic contribution of the project in the light of economic, social and environmental policy, the government of Senegal opted for its institutionalization. Thus, the Ecological Monitoring Center was created in 1993 with the status of a public utility association. It is placed under the technical supervision of the Ministry in charge of the environment of Senegal and endowed with a moral personality allowing for an administrative and financial autonomy.

The main mission assigned to CSE is “to contribute to the knowledge and sustainable management of natural resources and the environment, through the production and dissemination of decisions on support products and services, in particular for the Government, local authorities, the private sector, the civil society, research and development institutions, producer organizations and development partners”.

The CSE’s human resources currently include about forty professionals (PhD, Masters, Engineers and Technicians) in various disciplines. More than a third are women.



CSE interventions cover diverse areas including support for land-use planning, urban, coastal, bushfires, rangeland, forest and sustainable land management, agricultural yield production, environmental and social assessment, mapping and monitoring of basic social services, climate change vulnerability assessment, monitoring of SDG indicators, etc

Professedly, CSE interventions have extended beyond Senegal’s borders, covering many countries in Africa. In this regard, CSE is among the pioneers and leader organizations in Africa in the promotion and use of geomatics and geo-spatial data for environmental monitoring. CSE is a member of several regional or international initiatives, including the Executive Committee of GEO (Group of Earth Observations) and AfriGEO. In Senegal, CSE is a founding member of



Regional Workshop in Dakar, September 13, 2018. Launching GDZHAO project (Gestion Durable des Zones Humides d'Afrique de l'Ouest), a GMES & Africa project

the Inter-institutional Group in charge of conducting Senegal’s National Geomatics Plan.

Certified ISO 9001 in 2015, CSE was accredited as an implementing entity by the Adaptation Fund in 2010 and by the Green Climate Fund in 2015. As such, CSE activities are expanding, covering now administration of financial resources and overseeing the implementation of large-scale projects and programs on adaptation and/or mitigation of climate change impacts.

National Workshop in Dakar, 23 October, 2018. Launching of the Dionewar Project financed by the Adaptation Fund.

Current CSE flagship activities at the regional level include:

- The project **West African Coastal Zone Observation Mission** (Mission d’Observation du Littoral Ouest Africain, MOLOA) entrusted by UEMOA to CSE in 2011.
- The project **Monitoring coastal risks and soft solutions in Benin, Togo and Senegal** financed by the French Global Environment Facility (FFEM).
- The project **WACA (West Africa Coastal Areas Resilience Investment Project)** under the World Bank, to work on the establishment of a Regional Observatory on coastal risks in West Africa.
- Under the **Global Monitoring for Environment and Security and Africa (GMES & Africa)**, CSE coordinates one of the 13 funded consortia to implement a project on wetlands management in 8 West African countries.
- CSE is active in the establishment of the **Regional Observatory of the Program for Biodiversity and Management of Protected Areas (BIOPAMA)** funded by the European Union and jointly implemented by IUCN and the European Commission.
- Under the **SERVIR-West Africa**, funded by USAID and NASA in collaboration with the Agrhyment Center and partner institutions, CSE is in charge of the development of a satellite data-based service for monitoring ephemeral water bodies in the Ferlo Region (Senegal).
- CSE is an active partner of the **NEPAD Land Governance Program**, providing support for the promotion of geospatial data and information for strengthening good land governance in Africa.

As outlined above, CSE has positioned itself as a well-established resource center and continues to maintain its institutional position by providing high quality products and services while diversifying its partners and networks. In this regard, CSE as active member of the GEO community is contributing to increase the wide use of Earth observations for strategic decision-making and its impact at all levels of decision.

Regional Workshop in Abidjan, November 08, 2018. Launching the West African Coastal Area Project (WACA)



Signing of a partnership agreement between CSE and the Agricultural Bank of Senegal in Dakar on January 8, 2019. In the front row second from left is the DG of CSE and to his right the DG of the Bank.

The organization chart of CSE is structured around five major programs:

Environmental Monitoring and Food Security;
Natural Resources Management and Local Development Support;
Environmental Assessment and Risk Management;
Socio-Economics of the Environment;
Research and Development.

These programs are supported by the following service units:

Geomatics;
Information-Training-Documentation;
IT and ICT;
External Relations and Marketing;
Climate Finance - Reference Bureau on Climate Change.

Data and information are collected at several levels, satellite (remote sensing), aerial (systematic reconnaissance flights, aerial photographs, drones) and terrestrial (surveys, sampling, inventories). In-house infrastructure and equipment include satellite image reception antennas, servers and state-of-the-art software constantly being updated offer undeniable comparative advantages.



Africa could face a dangerous water scarcity crisis by 2050

“By 2050, assuming no change in available water resources, we project that 19 countries in Africa will face water scarcity and another nine countries will be water-stressed. However, if climate change were to cause Africa’s water resources to decrease by 10%, which is within the range of several climate projections for some African countries, then approximately 85% of Africa’s population will experience a dangerous water scarcity situation.”

This is the disturbing conclusion four authors Emad Hasan, Aondover Tarhule, Yang Hong and Berrien Moore III came to in their peer-reviewed article with the title “Assessment of Physical Water Scarcity in Africa Using GRACE and TRMM Satellite Data” recently published in the MDPI Open Access Journal for Remote Sensing.

This is the first in our series of publishing well-researched articles in which the tools of remote sensing applicable to the African continent are demonstrated. All information used on this page is with permission from the authors.

Editor

Links: <https://www.mdpi.com> <https://theconversation.com> <http://www.terradaily.com>

We use satellites to measure water scarcity

Article by Aondover Tarhule; Published in The Conversation Africa Edition

Today, more than 700 million people around the world drink water from unsafe or untreated sources, such as wells, springs and surface water.

About half of these people live in sub-Saharan Africa. In fact, in more than 30 African countries, fewer than 20% of the people have access to safe drinking water.

Climate change is likely to worsen the situation by making water less available in some locations and by changing the amounts and timing when water is available.

Determining whether a region has sufficient water to satisfy the needs of people who live there is a complicated and imperfect process. Our research team has developed a new approach to measure water scarcity by using satellites hundreds of miles up in space.

How to measure water scarcity

To estimate water scarcity, hydrologists, the people who study the science of water, build what they call a “water budget.”

They estimate all of the water entering the country – from rivers, rainfall, groundwater and man-made sources – and then subtract all of the water exiting the country. This produces an estimate of the available water in the country or region.

By dividing the available water by the population in the region, hydrologists can tell whether there is sufficient water to meet people’s needs.

Generally, in the U.S., the average person uses between 300 and 400 liters of water per day for basic needs – like drinking, sanitation, bathing and food preparation.

Globally, a country is said to experience a serious water scarcity problem if it has less than 500,000 liters of water per person per year, to meet both their daily needs and agricultural needs.

This water budget process works if accurate data are available for each source of water. However, in many developing regions, such as Africa, the data required to calculate water budgets are not available.

Yet Africa critically needs accurate information on its water scarcity status. As the second most populated continent, Africa is projected to have a population of 2.4 billion by 2050, approximately double the current estimated population. Such rapid population growth will exert considerable stress on the continent’s available water resources, worsening the already acute water scarcity situation.

So, assessing the potentially available water resources is essential for the future.

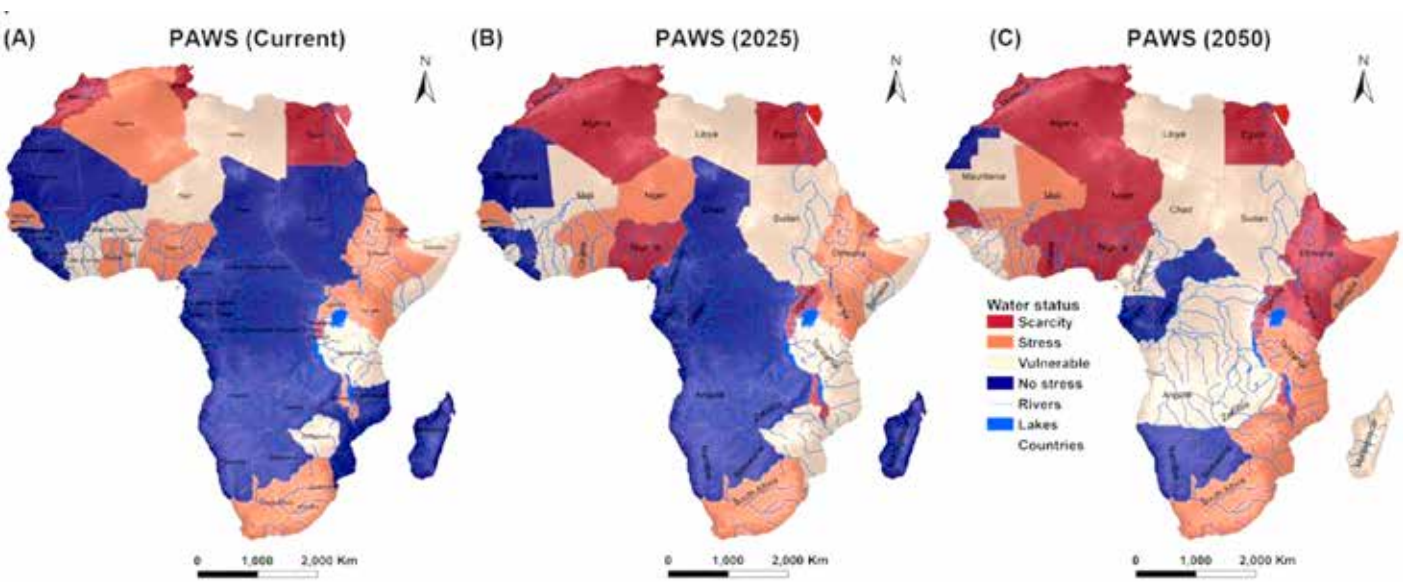
Look to the skies

Our study takes a new approach to assessing water scarcity.

We used data from two satellite systems. The first is called the Tropical Rainfall Measuring mission, operated since 1997 by the U.S. and Japan. The Tropical Rainfall Measuring mission uses several instruments – including a precipitation radar, microwave imager, visible and infrared scanner – to estimate rainfall. Getting the rainfall estimate right is critical, because this is the most important source of water for human use.

The second type of satellite data is from the Gravity Recovery and Climate Experiment, a joint mission between the U.S. and Germany. First launched in 2002, the Gravity Recovery and Climate Experiment is a twin satellite mission that uses the changes in the Earth’s gravitational fields to infer changes in the global water resources, from the Earth’s surface to the deepest groundwater aquifers.

We combined data from these two satellite systems to calculate the monthly potential available water from all sources of water for each country in Africa from 2002 to 2016. By dividing this value by the population in each country, we obtained a new measurement of available water storage per capita. Because the Gravity Recovery and Climate



This graphic of Potential Available Water Storage (PAWS) clearly illustrates what the combined potential effect of population growth and climate growth could be on the water availability for the African continent by 2050. The authors claim that all in all “approximately 85% of Africa’s population will experience a dangerous water scarcity situation” within three decades from now. Image by permission from the authors.

Experiment satellite data also estimates water in deep groundwater aquifers, which may not be accessible due to technical or economic limitations, we refer to this new estimate as potential available water storage.

Measuring water faster

We compared our results with the data currently used by the United Nations Food and Agricultural Organization. Their method relies on conventional water budget accounting to estimate the total renewable water resources in a country. It then classifies each country into one of four categories: water-sufficient, vulnerable, water-stressed or water-scarce. Of the 48 African countries studied, our

method classified 26 in the same category as the U.N.’s method; 12 were classified as having more water than indicated and 10 as less.

These differences are not surprising. Our estimate includes also water in aquifers deep underground that the U.N.’s method does not account for. Their method likely underestimates the total available water for countries that have substantial groundwater reserves.

On the other hand, the accuracy of our method can be affected by the size of a country. Countries smaller than the Gravity Recovery and Climate Experiment footprint – the approximately 200,000 square kilometer

blocks that the Gravity Recovery and Climate Experiment estimates can be made with confidence – are much more likely to be in error.

By 2050, assuming no change in available water resources, we project that 19 countries in Africa will face water scarcity and another nine countries will be water-stressed. However, if climate change were to cause Africa’s water resources to decrease by 10%, which is within the range of several climate projections for some African countries, then approximately 85% of Africa’s population will experience a dangerous water scarcity situation.

In general, we think that our method has several advantages over existing methods. It circumvents many of the limitations related to data unavailability and reliability in Africa. The data are more temporally and spatially continuous, as well as easier for researchers to access. As a result, estimates of water scarcity can be carried out much more rapidly for the entire continent.

Satellites will gather new data in the coming years. We plan to take advantage of such data improvements as they become available to refine our method in terms of accuracy and water scarcity assessment at the sub-country level, not only in Africa but globally.

“Assessment of Physical Water Scarcity in Africa Using GRACE and TRMM Satellite Data”

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Abstract

The critical role of water in enabling or constraining human well-being and socio-economic activities has led to an interest in quantitatively establishing the status of water (in)sufficiency over space and time. Falkenmark introduced the first widely accepted measure of water status, the Water Scarcity Index (WSI), which expressed the status of the availability of water resources in terms of vulnerability, stress, and scarcity.

Since then, numerous indicators have been introduced, but nearly all adopt the same basic formulation; water status is a function of “available water” resource—by the demand or use. However, the accurate assessment of “available water” is difficult, especially in data-scarce regions, such as Africa.

In this paper, therefore, we introduce a satellite-based Potential Available Water Storage indicator, PAWS. The method integrates GRACE (Gravity Recovery and Climate Experiment) satellite Total Water Storage (TWS) measurements with the Tropical Rainfall Measuring Mission (TRMM) precipitation estimates between 2002 and 2016.

First, we derived the countries’ Internal Water Storage (IWS) using GRACE and TRMM precipitation data. Then, the IWS was divided by the population density to derive the PAWS per capita. Following the Falkenmark thresholds, 54% of countries are classified in the same water vulnerability status as the AQUASTAT

Internal Renewable Water Resources (IRWR) method. Of the remaining countries, PAWS index leads to one or two categories shift (left or right) of water status.

The PAWS index shows that 14% (~160 million people) of Africa’s population currently live under water scarcity status. With respect to future projections, PAWS index suggests that a 10% decrease in future water resources would affect ~37% of Africa’s 2025 population (~600 million people), and 57% for 2050 projections (~1.4-billion people).

The proposed approach largely overcomes the constraints related to the data needed to rapidly and robustly estimate available water resources by incorporating all stocks of water within the country, as well as underscores the recent water storage dynamics. However, the estimates obtained concern potential available water resources, which may not be utilizable for practical, economic, and technological issues.

See full article at:
<https://www.mdpi.com/2072-4292/11/8/904>



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Southern African wetlands monitoring project still on track

The Southern African Wetlands Monitoring and Assessment (WeMAST) project, which will support the sustainable management of selected transboundary river basins namely the Cuvelai, Okavango River, Limpopo River, and Zambezi River Basins is still well on track.



In a recent announcement WeMast confirmed that they are in the process of developing tools to implement a sustainable wetland management system, by drawing on the experiences of consortiums led by the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) and other key regional, national and local institutions stakeholders.

WeMAST is a GMES and Africa initiative who after a competitive call for proposal on 28 November 2017 awarded 13 consortia over all African economic regions with grants to support the project. The awardees represent 45 African countries and 122 African institutions.

The 13 recipients were Agence Gabonaise d’Etudes et Observations Spatiales (AGEOS) – Libreville, Gabon; Commission Internationale du Bassin Congo-Oubangui-Sangha (CICOS) – Kinshasa, RDC; Centre de Suivi Ecologique (CSE) – Dakar, Sénégal; Centre for Space Science and Technology Education (CSSTE)

– Ile Ife, Nigeria; IGAD Climate Prediction & Applications Centre (ICPAC) – Nairobi, Kenya; Observatoire du Sahara et du Sahel (OSS) – Tunis, Tunisia; Regional Centre for Mapping of Resources for Development (RCMRD) – Nairobi, Kenya; SADC Climate Services Centre (SADC-CSC) – Gaborone, Botswana; Southern Africa Service Centre for Climate Change and Adaptive Land Management (SASSCAL), Windhoek, Namibia; Council for Scientific and Industrial Research (CSIR) – Pretoria, South Africa; Mauritius Oceanography Institute (MOI) – Port Louis, Mauritius; National Authority for Remote Sensing and Space Science (NARSS) – Cairo, Egypt; University of Ghana (UoG)– Legon, Ghana

The SASSCAL-led consortium includes the University of Botswana, University of Zambia, Cape Peninsula University of Technology, University of the Western Cape, Midlands State University, the South African National Space Agency (SANSA) and the National Remote Sensing Centre (NRSC) of Zambia.

In addition to the African partners, SASSCAL invited two institutions from Europe to take part as associates.

Wetlands in Southern Africa are highly productive and biologically diverse ecosystems that contribute significantly to livelihood and economic development. However, they are under immense pressure from both human activities and natural phenomena, including agriculture, land cover and land-use change, human settlements, water harvesting, invasive species infestation, climate change and unsustainable development practices.

The future of these wetlands is therefore dependent on effective assessment and monitoring initiatives that can inform policy and decision makers to promote sustainable management. Inadequate human and institutional capacity and traditional data sources, as well as the lack of suitable and applicable spatial data, constrain effective wetland management efforts.

The WeMAST project’s ultimate aim is to facilitate sustainability and an exploitation plan to preserve these ecosystems for future generations.

Sources:
<http://wemast.sasscal.org>
<https://gmes4africa.blogspot.com>

EO Clinic open to assist African Development Professionals



The European Space Agency (ESA) has launched the EO Clinic (Earth Observation Clinic), a rapid-response mechanism for small-scale and exploratory uses of satellite EO information in support of a wide range of projects and activities specific to international development. The EO Clinic consists of “on-call” technically pre-qualified teams of EO service suppliers and satellite remote sensing experts in ESA member states. They are ready to help development projects with a com-

prehensive range of skills and experience in terms of geospatial product generation and analysis, based on a large variety of satellite data.

African development professionals can also tap into this resource as the European Commission and the African Union Commission are pursuing EO activities in a number of areas of common interest and cooperate in the framework of the GMES and Africa partnership.

The EO Clinic is open for assistance for the next two years with support teams ready to meet the short delivery timescales often required by the development sector, targeting a maximum of 3 months from

request to solution.

This activity is also an opportunity to explore more innovative EO products related to developing or improving methodologies for deriving socio-economic and environmental parameters and indicators. This is an ideal support tool for users in managing land, marine and environmental resources in Africa.

Development professionals requiring support can send them a message to register and also fill in the standard questionnaire on their website listed below.

Source:
https://eo4society.esa.int/eo_clinic/

African lakes threatened by global warming?

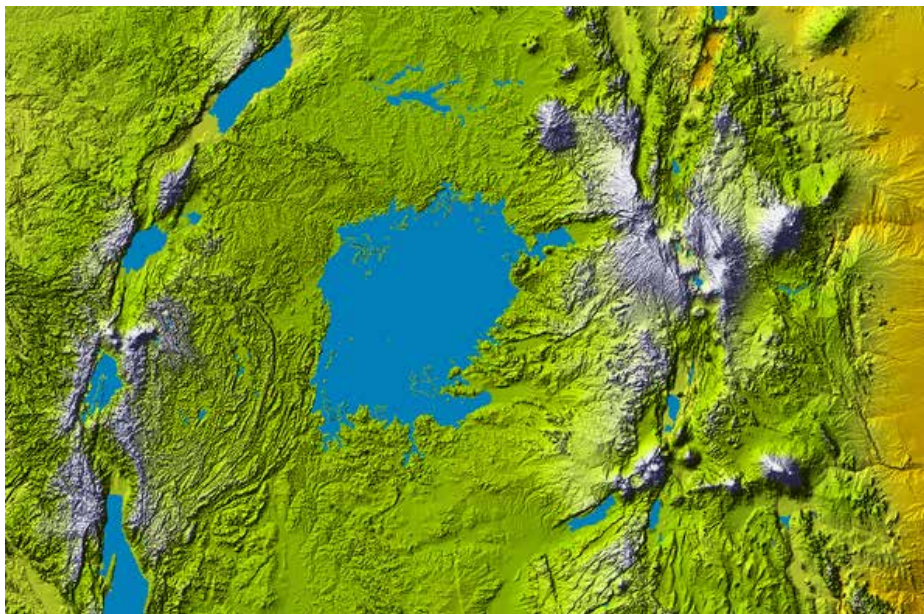
Eight African lakes are listed as under threat of intense lake phytoplankton blooms in a worldwide study of 72 freshwater lakes conducted by Jeff Ho and Anna Michalak from the Department of Global Ecology, Carnegie Institution for Science, Stanford, and NASA's Nima Pahlevan and published by Nature this month.

Freshwater phytoplankton blooms in high intensity and can produce toxins with harmful effects on drinking water quality, aquatic food production, recreation and tourism.

The researchers used three decades of high-resolution Landsat 5 imagery to investigate the long-term trends in intense summertime near-surface blooms and found that 68% of these lakes reveal an exacerbation globally of bloom conditions. Only 8% of the lakes studied showed a decrease in bloom conditions.

The research paper states that the reasons for this increase is unclear at this stage as "temporal trends do not track consistently with temperature, precipitation, fertilizer-use trends, or other previously hypothesized drivers".

The authors do however suggest that there is a correlation with lake warming and suggests that water-quality management in the affected areas



should be stepped up to find the interaction between climate change and local hydrological conditions.

The eight African lakes listed in the study with the countries adjoining them are Cahora Bassa (Mozambique, Zimbabwe); Kariba (Zimbabwe, Zambia); Victoria (Tanzania, Uganda, Kenya); Nasser (Egypt, Sudan); Turkana (Kenya, Ethiopia); Edward (Zaire, Uganda); Albert (Uganda, Zaire).

Satellite image of Lake Victoria, which is adjoined by three countries Tanzania, Uganda and Kenya. Global warming may affect water quality, food production, tourism and recreation dependent on this water source. Image: mappery.com

Sources:
<https://www.nature.com>
<http://www.terradaily.com/reports>

GMES and Africa Forum Report

The first GMES and Africa Forum Report held in Libreville, Gabon, from 19 to 23 November 2018 is now available online. The forum brought together more than 400 Earth Observation service and data providers, grass-roots level users, decision makers, academia, the private sector, research institutions from Africa and all over the world with the aim of addressing how to unlock the potential of Earth Observation services for the socio-economic transformation for the achievement of the "Africa We Want", as articulated in the Agenda 2063.

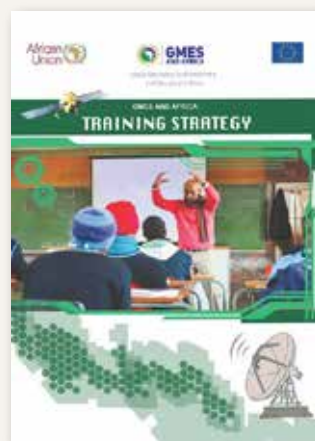
See download link at <https://au.int/en/documents>



GMES and Africa Training Strategy

"The GMES and Africa Training Strategy addresses the need to develop skills and expertise in EO applications, strengthen space-based and in-situ infrastructural capacities of technical institutions in Africa, develop user-centric EO services, and foster communication to ensure effective use of services and products that maximizes EO benefits. It also captures the intensification of research clouds at the regional level to strengthen data exploitation skills, and capacity utilization to harness the intellectual capital of trained experts," says H.E. Sarah Anyang Agbor, Commissioner for Human Resources, Science and Technology.

See download link at <https://gmes4africa.blogspot.com>



International Space Conference Diary

We have assembled the details of the most important international and African conferences in the arena of remote sensing, satellites and geotechnical applications scheduled for the next few months. Please visit their individual websites for more information on submission criteria for papers, deadlines for registration, etc.



DC5G 2019

November 4 - 5, 2019
Arlington, Virginia, USA
<https://2019.dc5g.com>

Launched in 2017 at the request of the community and after two successful years the organizers are forging ahead to find objective, problem-solving discussions tackling 5G infrastructure. The aim of the event is to outline realistic steps for organizations to build and implement next-generation wireless services.



CyberSat Summit

November 7 - 8, 2019
Reston, Virginia, USA
<https://2019.cybersatsummit.com>

CyberSat Summit is the only satellite security event in the world that fuses satellite, space, cyber and government to discuss cyber-specific threats that could be made against satellites and ground infrastructure. How does the mind of a hacker work that targets your infrastructure? The Summit is preceded by a Classified Day on 6 November.



AfricaGIS 2019

November 18 - 22, 2019
Kigali, Rwanda
www.eis.africa/africagis-2019

The largest Geospatial, Science and Technology conference on the African Continent held every two years. It explores the role of innovations in geospatial information and its implication in addressing the 17 targets of the Sustainable Development Goals for Africa.

African Space Leadership Congress

December 2 - 4, 2019
Addis Ababa, Ethiopia
<http://aslc.essti.gov.et>



The 8th African Space Leadership Congress (ASLC) will be hosted by the Ethiopian Space Science and Technology Institute. The main focus areas are: assessment of space programs in Africa; space research and development; space policy, strategy, implementation and participation of youth and women in aerospace.



GRSG 30th Anniversary & AGM

December 10 - 12, 2019
Frascati, Italy
<http://www.grsg.org.uk/agm30th>

"Exploring New Frontiers" is the title of 2019 special event featuring both the GRSG (Geological Remote Sensing Group) 30th anniversary and Annual Conference, looking at past and future geologic remote sensing, especially focusing on both longwave infrared and radar / InSAR applications. Tickets to the event can be purchased online.

CIEDG 2019

December 15 - 16, 2019
Arzew, Algeria
<http://asal.dz>



This first International Conference on the Exploitation of Geospatial Data (CIEDG) will be hosted by the Algerian Space Agency Centre for Space Technology. It will bring together experts in the field of Earth observation, geomatics and space geodesy to discuss inter alia geospatial data analysis, methods, tools and big data exploration, Earth's gravity field issues, geodesic networks, etc. Paper submissions have closed. Contact info-ciedg2019@cts.asal.dz for more info.



SmallSat Symposium

February 3 - 6, 2020
Silicon Valley, San Francisco, USA
<https://2019.smallsatshow.com>

Hosted by Satnews Publishers since 1983, it focuses on new technologies and the business environment shaping the implementation of smallsat constellations, launchers, the challenges facing the smallsat developer and actors and the benefits of these advanced technologies to our world. More than 100 speakers will attend.



Satellite 2020

March 9 - 12, 2020
Washington DC, USA
<https://2020.satshow.com>

Touted as the most important annual satellite and space event in the world the Conference and Exhibition features more than 15,000 attendees from 100+ countries, along with the latest products and newest innovations from more than 340 companies and 300 experts speaking at the event. A wide spectrum of satellite application possibilities are covered.

AARSE 2020

October 26 - 30, 2020
Kigali, Rwanda
www.aarse2020.org



The 13th AARSE International Conference, AARSE 2020 will be held in Kigali, Rwanda, organized by the Institut d'Enseignement Supérieur de Ruhengeri (Ines-Ruhengeri). It is the premier forum in Africa for research on remote sensing technologies and geospatial information science, gathering leading scholars from the remote sensing and related communities to discuss challenges in space and geospatial technologies.

Space Snippets

The space industry is not called “burgeoning” for nothing. There is so much happening that it’s difficult to keep track of all the new developments all the time. In this issue we bring you once again a number of the most interesting announcements we could find.

Juno avoids Jupiter’s sun-starved shadow

NASA’s Juno mission to Jupiter successfully executed a 10.5-hour propulsive maneuver started September 30 and ending on October 1 to evade a mission-ending shadow cast by Jupiter on the spacecraft during its next close flyby of the planet on Nov. 3, 2019.

Using the spacecraft’s reaction-control thrusters, the propulsive maneuver lasted five times longer than any previous use of that system. It changed Juno’s orbital velocity by 126 mph (203 kph) and consumed about 160 pounds (73 kilograms) of fuel. Without this maneuver, Juno would have spent 12 hours in transit across Jupiter’s shadow — more than enough time to drain the spacecraft’s batteries. Without power, and with spacecraft temperatures plummeting, Juno would likely succumb to the cold and be unable to awaken upon exit.

Juno has been navigating in deep space since 2011. It entered an initial 53-day orbit around Jupiter on July 4, 2016. Originally, the mission planned to reduce the size of its orbit a few months later to decrease the period between science flybys of the gas giant to every 14 days. But the project team recommended to NASA to forgo the main engine burn due to concerns about the spacecraft’s fuel delivery system. Juno’s 53-day orbit provides all the science as originally planned; it just takes longer to do so. The spacecraft’s longer life at Jupiter is what led to the need to avoid the gas giant’s shadow.



This color-enhanced image of Jupiter and two of its largest moons – Io and Europa – was captured by NASA’s Juno spacecraft as it performed its eighth flyby of the gas giant planet. The image was taken on Sept. 1, 2017 at 3:14 p.m. PDT (6:14 p.m. EDT). At the time the image was taken, the spacecraft was about 17,098 miles (27,516 kilometers) from the tops of the clouds of the planet at a latitude of minus 49.372 degrees. Closer to the planet, the Galilean moon of Io can be seen at an altitude of 298,880 miles (481,000 kilometers). In the distance (to the left), another one of Jupiter’s Galilean moons, Europa, is visible at an altitude of 453,601 miles (730,000 kilometers). Image credit: NASA/JPL-Caltech/SwRI/MSSS/Roman Tkachenko Source: <https://www.nasa.gov>



Boeing’s Starliner prototype capsule getting its finishing touches before testing is about to begin. Image: www.floridatoday.com

Starliner

NASA confirmed target dates on which Boeing will conduct test on its Starliner space capsule program destined to take humans into outer space. The target dates announced are:

- Boeing Pad Abort Test: Nov. 4, 2019 at White Sands Missile Range in New Mexico;
- Boeing Orbital Flight Test: Dec. 17, 2019 at Space Launch Complex 41 on Cape Canaveral Air Force Station in Florida.

NASA’s Commercial Crew Program has worked with several American aerospace industry companies to facilitate the development of U.S. human spaceflight systems since 2010. The goal is to have safe, reliable and cost-effective access to and from the International Space Station and foster commercial access to other potential low-Earth orbit destinations.

NASA selected Boeing and SpaceX in September 2014 to transport crew to the International Space Station from the United States. These integrated spacecraft, rockets and associated systems will carry up to four astronauts on NASA missions, maintaining a space station crew of seven to maximize time dedicated to scientific research on the orbiting laboratory.

Source: <https://blogs.nasa.gov/commercialcrew/2019/10/>

First Arab astronaut visits ISS

Hazza Al Mansouri the UAE’s first astronaut returned to the country on Saturday, 12 October 2019 after becoming the first Arab to visit the International Space Station (ISS) for a stay of 8 days orbiting Earth 128 times and covering a distance of 4.9 million kilometres in space.

Al Mansoori, 35, and his backup UAE astronaut Sultan Al Neyadi, 38, as well as the team from the Mohammed Bin Rashid Space Centre were received to a hero’s welcome at Abu Dhabi’s Al Bateen airport by Abu Dhabi Crown Prince Sheikh Mohamed bin Zayed Al Nahyan.

Some of the milestones of Hazzaa’s eight days in space were inter alia:

- Hazzaa and his colleagues, Russian commander Oleg Skripochka and Nasa astronaut Jessica Meir, blasted off to space at 5.57pm on September 25. It was a flawless docking and the new crew, including Hazzaa entered the ISS at 2.12am, UAE time.

- On his second day in space, Hazzaa made his first live space-to-Earth video call with Dubai speaking to His Highness Sheikh Mohammed Bin Rashid Al Maktoum, UAE Vice President and Prime Minister and Ruler of Dubai;
- He conducted a total of four live video sessions and one radio call with students, along with one radio call with heads of UAE media organisations.

- Hazzaa conducted a total of 16 experiments, with many focusing the effects of zero gravity on his body. These experiments include Brain DTI, Osteology, motor control, time perception in microgravity, Fluidics (fluid dynamics in space), and DNAm-Age.

- While in space, Hazzaa took advantage of the opportunity to take snaps of the Earth. He shared photos of the UAE, specifically the coastlines of Abu Dhabi and Dubai, a photo of Mecca, and other parts of the world.

While on board, the former military pilot donned Emirati dress and treated crew members to local snacks. He returned to Earth on October 3.



His Highness Sheikh Mohamed Bin Zayed Al Nahyan, Abu Dhabi Crown Prince and Deputy Supreme Commander of the UAE Armed Forces, received Hazzaa on his arrival at Al Bateen Executive Airport in Abu Dhabi. Image Credit: Twitter

Source: www.gulfnews.com
[www.twitter.com](https://twitter.com)
<https://www.msn.com/>

Rosalind Franklin Mars Rover almost ready for launch

The European Space Agency’s ExoMars Rover now named after Rosalind Franklin the English chemist and DNA pioneer is nearing completion in readiness for its launch from Earth in July 2020 and eventual touchdown on Mars in March 2021.

According to a media release by the UK Space Agency the “Rosalind Franklin, which is the result of cutting edge work from UK, European and Canadian scientists and engineers will now be shipped from the Airbus factory in Stevenage, Hertfordshire to Toulouse in France for testing to ensure it survives its launch from Earth next summer and the freezing conditions of Mars when it lands on the planet in March 2021.”

Dr Graham Turnock, CEO of the UK Space Agency, said: “This is a major milestone for this exciting project which demonstrates the UK’s leading capabilities in robotics, space engineering and exploration, as well as our ongoing commitment to the European Space Agency. As we hand the rover over to France for final testing, we should celebrate the huge efforts of the hundreds of people across the UK who have been involved in the design and

build of the rover and its instruments, which will look for life on Mars.”

ExoMars is an ESA program in cooperation with Russian Space Agency Roscosmos with contribution of NASA. The UK Space Agency is the second largest European contributor to the ESA-Roscosmos ExoMars mission, having



invested £287 million in the mission and £14 million on the instruments. This, in addition to successful negotiations with ESA, secured key mission contracts for the UK space sector.

Once landed and operational on Mars the solar-powered rover will embark on seven-month journey in search of past and present life on the red planet.

Sources: <https://www.gov.uk/government/news>
www.history.com

Rosalind Franklin after which the ESA rover for Mars is named, is strictly speaking the discoverer of the double helix DNA and should have received the Nobel Prize for her work in this field. Unfortunately she died of ovarian cancer in 1958 at the age of 37 and Nobel Prizes are not awarded posthumously. The honour eventually went to James Watson, Francis Crick and Maurice Wilkins who shared the 1962 Nobel Prize in Physiology or Medicine for their discoveries concerning the molecular structure of DNA. Watson did however suggest that she deserved at least the Nobel Prize in Chemistry for her work in this field.

Image: www.history.com

Stratolaunch gets a new owner



On April 13, 2019 Stratolaunch successfully completed the first flight as the world's largest all-composite aircraft. With a dual fuselage design and wingspan greater than the length of an American football field, the Stratolaunch aircraft took flight at 0658 PDT from the Mojave Air and Space Port in California. During the test flight it achieved a maximum speed of 189 miles per hour and flew for 2.5 hours over the Mojave Desert at altitudes up to 17,000 feet. As part of the initial flight, the pilots evaluated aircraft performance and handling qualities before landing successfully back at the Mojave Air and Space Port.

Source: www.stratolaunch.com

This doubled fuselage gigantic aircraft with a wingspan longer than a football field (385 feet/117 metres) intended as a mobile launch platform for small satellites has acquired a new owner possibly a group of investors after it's founder Paul Allen died last year.

The latest statement issued on their website stratolaunch.com states the following: "Stratolaunch LLC has transitioned ownership and is continuing regular operations. Our near-term launch vehicle development strategy focuses on providing customizable, reusable, and affordable rocket-powered testbed vehicles and associated flight services. As we continue on our mission, Stratolaunch will bring the carrier aircraft test and operations program fully in-house. We thank Vulcan Inc and Scaled Composites for turning an ambitious idea into a flight-proven aircraft."

Although no details are yet available about the new owners they also advertised 10 new jobs on LinkedIn for the project which include test pilot, safety engineer and quality manager.

The late Paul Allen who founded Microsoft with Bill Gates unveiled the Stratolaunch project in 2011 as an air-launch platform for satellites. His motivations were inter alia that it would give customers more flexibility to escape bad weather conditions which often hamper launches and also make it possible to launch closer to the equator with access to more orbital inclinations. In Allen's opinion popular launch sites such as Vandenberg Air Force Base in California and Kennedy Space Centre in Florida were also getting crowded.

Stratolaunch made its first successful test flight on April 13 this year from the Mojave Air and Space Port in California.



CAPSTONE

The Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment (CAPSTONE) is expected to be the first spacecraft to operate in a near rectilinear halo orbit around the Moon. NASA has awarded a \$13.7 million contract to Advanced Space of Boulder, Colorado, to develop and operate a CubeSat mission to the same lunar orbit targeted for Gateway – an orbiting outpost which astronauts will visit before descending to the surface of the Moon in a landing system as part of NASA's Artemis program.

In this unique orbit, the CubeSat will rotate together with the Moon as it orbits Earth and will pass as close as 1,000 miles and as far as 43,500 miles from the lunar surface. The 12-unit CubeSat is about the size of a small microwave oven. Onboard is a communications system capable of determining how far CAPSTONE is from NASA's Lunar Reconnaissance Orbiter and how fast the distance between the two spacecraft is changing. The inter-spacecraft information will be used to demonstrate software for autonomous navigation, allowing future missions to determine their location without having to rely exclusively on tracking from Earth. The launch could be as early as December 2020.

Source:

<https://www.nasa.gov/press-release/nasa-funds-cubesat-pathfinder-mission-to-unique-lunar-orbit>