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MIDDLE EAST AND NORTH AFRICA SPACE CAPABILITIES & SECURITY CHALLENGES



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Abstract

More than five decades after the launch of the Sputnik and the race to the Moon, new spacefaring nations emerge and consolidate their ambitions including countries in Middle East and North Africa (MENA). Security interests, national prestige, the uses of space for climate and environmental research, alongside scientific, technological and economic purposes are the main drivers to space endeavours also in that region. Satellites and launch vehicles are associated with projection of power and extension of military capabilities, as well as with the international status of a certain country vis-à-vis both domestic public opinion and foreign actors.

Besides these traditional and recurrent drivers to space, the potentials of space investments attract public and private actors to get into the sector. The several possibilities unlocked by the exploitation of satellite data encourage investing in new capabilities and developing innovative solutions. In 2020, the global space economy reached the value of \$447 billion, according to annual estimations. The whole Middle East and Africa region is steadily increasing the space spending, with a 5 years Compound Annual Growth Rate (CAGR) of 5.6%. Specifically in the MENA region, the budgets doubled in the 2010-2020 period.

Led by the space investments of the United Arab Emirates (UAE), Saudi Arabia, Egypt, Israel and Iran, the whole of MENA countries surpasses the institutional spending of Latin America and Oceania. Notably, they register investments comparable to a number of member states of the European Space Agency (ESA). Indeed, MENA government space expenditures exceeded \$1.2B in 2018, while registering a minor decrease in 2020. The COVID-19 pandemic may well be a factor of this drop, alongside the sharp fall in oil prices, particularly relevant for these economies, experienced until 2020.

Indeed, MENA accounts for a large share of global oil production and not surprisingly in 2020 most economies of the region experienced their sharpest Gross Domestic Product (GDP) contractions in decades. These impacts hit the oil importer countries as well, exacerbating previous crises dating back to 2011 Arab Springs. Over the past years, security crisis and political instability contributed to a deterioration of the general economic outlook. The prospects of urbanisation pose numerous challenges, also concerning food availability, while greater exposure to the impacts of climate change is epitomized by desertification. In particular, food security is a crucial issue, considering that MENA states have some of the highest global rates of food import dependency and that prices have skyrocketed in many countries over the past months.

Overall, the overreliance on the energy sector highlights the persistent need to diversify the economy in order to achieve a more sustainable, resilient and stable GDP growth. In this context, the space sector cannot take the place of a commodity in generating large revenues. Nevertheless, space may help countries to build diversification outside a resource-based economy in various ways:

- i) It strengthens traditional economic sectors, from agriculture, farming and fisheries to oil and gas,
- ii) It facilitates the creation of an appealing business environment,
- iii) It favours quality education possibilities,
- iv) It sustains the employment rate, especially of the growing percentage of youth population,
- v) It supports digital transitions and technology transfers.

The MENA presents a diverse landscape in terms of space capabilities, as few states actively engaged in the sector coexist with other nations interested in developing national assets. More and more countries in the region have established space agencies and adopted strategies or policy documents. Engagement to regional and international cooperation is also rising. In terms of capabilities, many states have multiple satellites in orbit, in particular for Earth Observation (EO) and remote sensing applications but also for communication purposes. The interest to improve the overall capabilities is widespread. Furthermore, countries that

currently do not maintain assets in orbit are engaged to identify requirements, launch tenders or establish cooperation with experienced partners to externally procure or internally develop new satellites. All MENA countries present universities engaged in scientific and space research and often collaborate to design and manufacturing projects, thanks to the increasing access to space technology due to miniaturisation.

The investments in the sector can then be leveraged to develop targeted solutions for local issues, as EO, satellite navigation and telecommunication unlock a variety of applications. Earth Observation is indeed recognised as a game-changer component for socio-economic development, from climate and atmosphere applications to land, marine and emergency services. The pandemic also highlighted how satellites can support local authorities to plan logistics operations and assess the economic impacts of various contingencies. In this field, satellite imagery is a crucial component of risk mitigation and disaster recovery in the occasion of events such as earthquakes, forest fires, extreme weather, or sanitary crisis like pandemics.

While satellite navigation technology is less spread in the region, the applications for road traffic and delivery, complex maritime and aviation operations open the way to a larger utilisation also in MENA. This expansion may be significant given also the high rate of mobile phone subscriptions in the whole region, and the implementation of Global Navigation Satellite Systems (GNSS) receivers in most of present-day phones.

Finally, satellite communication and connectivity can be used for a number of different institutional, commercial, civil and military purposes. Some countries maintain many communication satellites only for broadcast services, but the exploitation of the technology is quite large, from services to oil and gas remote sites and platforms, to in-flight and cruises connectivity. Satellite communication also enables distance learning and tele-health solutions, particularly relevant in time of crisis and generally for rural areas and quality of education. The implementation of connectivity services for schools and hospitals could indeed allow reaching a broader public, especially if located in remote areas.

Beyond space's socio-economic applications, the growing interest by MENA countries in this field shall be considered in light of the regional security complex, with several challenges and tensions. The United States are in a process of detachment from the region, while China and Russia are increasing their influence and investments. Also, as a result of these shifts, MENA regional powers grow in terms of autonomy and assertiveness, and since 2011 resorted to the use of force – both covert and overt – in a more robust way than in the past twenty years. The regional security environment witnessed increasingly volatile, tactical and overlapping alliances among states, which may confront each other in one theatre and align in another against a common adversary. At the same time, religion inspired violence represent enduring, trans-national challenges for many countries in the region, while the deep roots of the 2011 unrests have not been properly addressed over the last decade. These trends then lead to more investments on counter terrorism and counter insurgency capabilities, as well as in some cases to an arms race with a view to high-end, multi-domain conflicts involving the support of regional and extra-region powers.

The regional challenges have clear implications for space. First, state investments in this sector are part of a broader strategy aimed to enhanced national security and power projection. Second, several MENA countries are willing and able to join a space race as part of a soft power strategy aimed to strengthen the state posture both internally and externally. Third, applications for disaster management, risks mitigations, environment monitoring, support to agriculture and other economic sectors will be deeply influenced by the priority attached to military forces deemed necessary for the national security, and by the financial constraints brought by the price of energy exports. Finally, given the role of extra-region powers in the regional security context, MENA states competing against each other are likely to seek bilateral space cooperation as part of their overall strategy of tailored, overlapping alliances within and beyond the region.

1. Outlook of space capabilities in MENA countries

1.1 General introduction on the status of space capabilities in the region

The MENA region presents quite a diverse landscape in terms of space capabilities. Few states are actively engaged in space, with a long-established record of accomplishment and a full spectrum of domestically developed capabilities. At the same time, several young spacefaring nations are emerging, interested in exploiting the multiple applications of space technology in different domains, from security and defence to climate and economy. These emerging space nations may have significant ambitions but often limited domestic capabilities in terms of manufacturing. Yet, the trend is increasingly to combine external procurement for products and services with cooperation for the national development of capabilities.

In the last decade, the investments in space by MENA countries increased by roughly 50%, from approximately \$700 million to over \$1 billion. Beyond South Africa, Kenya and Nigeria, the four North African countries analysed in this paper engaged in the last years to expand their space capabilities. In the Middle East, the United Arab Emirates represents an exceptional case of a successful new spacefaring nation. The UAE is not alone in the trend of intensification of efforts, especially as Saudi Arabia plans to invest massively in this sector.

Country	GSE 2018	GSE 2020	Total
United Arab Emirates	383 M	148 M	531 M
Saudi Arabia	165 M	175 M	340 M
Iran	142 M	134 M	276 M
Egypt	177 M	90 M	267 M
Israel	77 M	164 M	241 M
Qatar	186 M	27 M	213 M
Algeria	75 M	22 M	97 M
Morocco	80 M	11 M	91 M
Oman	<10 M	23 M	>23 M
Tunisia	<10 M	11 M	>11 M
Others	<10 M	<10 M	/
Total	>1285 M	>805 M	>2090 M

Government space expenditures (GSE) in 2018 and 2020, in million (M). (Source: Euroconsult)

This chapter firstly focuses on policy and programmes, to identify the overall space governance responsible for implementing a strategy, if present, together with significant highlights. Furthermore, it includes the analysis of relevant technological and industrial capabilities, primarily regarding satellite manufacturing and launch vehicles. Not least, it comprises the main data on the national space economy. Each box then summarises the MENA countries' membership of regional and international formats,¹ as well as reports their engagement on international treaties governing space activities.²

¹ Membership to, in order: United Nations Committee on the Peaceful Uses of Outer Space (**UNCOPUOS**); African Space Agency (**AfSA**); Arab Space Cooperation Group; Gulf Cooperation Council (**GCC**); Regional Centre for Remote Sensing of North Africa States (**CRETAN**); Inter-Islamic Network on Space Sciences & Technology (**ISNET**); Arab Union for Astronomy and Space Sciences (**AUASS**); Asia-Pacific Space Cooperation Organisation (**APSCO**).

² Treaty status, in order: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (**OST**, 1967); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (**ARRA**, 1968); Convention on International Liability for Damage Caused by Space Objects (**LIAB**, 1972); Convention on Registration of Objects Launched into Outer Space (**REG**, 1975); Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (**MOON**, 1979); International Telecommunication Constitution and Convention (**ITU**, 1992).

1.2 Overview of national cases³

1.2.1 Middle East

Bahrain

Policy and Programmes. The Kingdom of Bahrain established the National Space Science Agency (NSSA) in 2014 and recently adopted



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a National Space Policy (NSP). The former highlights the major objectives in space and is based on the more general “Bahrain Economic Vision 2030”. The NSP further defines the role of the NSSA in pursuing specific goals, centred on: i) supporting sustainable development, and ii) creating a proper space sector, building domestic capabilities and a space infrastructure. Bahrain also aims to create an *ad hoc* space legislation and to attract investments through favourable regulations and incentives. The NSSA established relations with UAE and Russia for “joint projects” and “exchange of expertise”. In 2019, it signed a Memorandum of Understanding (MoU) with India for the development of domestic capabilities. In 2020, the NSSA and the Italian Space Agency signed a MoU to establish cooperation. Finally, the NSSA is also engaged in advancing Science, Technology, Engineering and Mathematics (STEM) opportunities and contribute to space scientific research.

Industry and Economy. Currently, Bahrain has no satellites in orbit. According to NSSA representatives, Bahrain has a high-demand of satellite imagery and recently identified a requirement for a national Earth Observation satellite, “on hold due to the drop in oil prices”.

Jordan

Policy and Programmes. Jordan does not have a structured space governance nor agency devoted to space matters. Notwithstanding, the



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country’s interest for space is centred on the Royal Jordanian Geographic Centre, established in 1975, and the Jordan Meteorological Department, operative since 1951. Notably, Amman hosts the Arab Union for Astronomy and Space Sciences (AUASS) and the Regional Centre for Space Science and Technology Education for Western Asia. Inaugurated in 2012, this Centre is an initiative of the UN Office for Outer Space Affairs (UNOOSA) for education in Arabic and aims to develop national efforts in space science and technology.

Industry and Economy. Jordan has successfully launched one satellite in orbit for technology demonstration in 2018, onboard a SpaceX Falcon 9 rideshare mission. The Jordan University of Science and Technology (JUST), a cornerstone for national scientific research, led the satellite project JY1-SAT together with the Dutch company ISISPACE. JUST students and engineers collaborated on the CubeSat’s manufacturing process in order to acquire a certain level of expertise.

³ Colour code. green: member/treaty ratified; red: not member/part; grey: treaty signed but not ratified.

Kuwait

Policy and Programmes. Kuwait does not have a space governance or strategic policy.



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Although it ratified all relevant space

treaties, Kuwait applied to the membership of UNCOPUOS only in September 2021, affirming that it is in the process of building national space capabilities and launching a national satellite. The country historically had in place a ground segment, composed of the satellite station *Um Alaish*, built in 1966 and expanded in the '80s, that had been destroyed during the First Gulf War.

Industry and Economy. Kuwait currently has one satellite in orbit, launched in June 2021 on a SpaceX Falcon 9 rideshare mission. The QMR-KWT nanosatellite is the outcome of a private initiative, led by the nationally-based Orbital Space company. Established in 2018, Orbital Space focuses on CubeSats and aims to raise awareness on the relevance of space technology. The company is also engaged in re-establishing the *Um Alaish* ground segment and building a station to serve CubeSats. Another private initiative regards the development of a small vehicle for suborbital launches that since 2019 has completed all the preparatory phases, led by the research group Kuwait Space Rocket. Besides private organisations, Kuwait can count on a number of scientific institutions and research centres, namely the Kuwait University, the Kuwait Foundation for the Advancement of Science, the Kuwait Institute for Scientific Research (KISR), active in space-related matters and in cooperation with some projects launched by NASA.

Iran

Policy and Programmes. Iran established in 2003 the Iranian Space Agency (ISA) under the responsibilities of the Space Supreme



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Council (SSC) and the Ministry of Communications and Information Technology. ISA is tasked with implementing the space programme within the perimeter defined by the SSC, headed by the President of the Islamic Republic of Iran. ISA also maintains relations with the several universities, involved in space research activities and often engaged in the satellite manufacturing process. The Iran University of Science and Technology, the Amir Kabir University of Technology and the Malek Ashtar University all contributed to the development of small satellite projects.

Besides the civilian programme, the existence of a military space programme emerged over the years. This programme is led by the Islamic Revolutionary Guard Corps (IRGC), which also rebranded in 2009 their Air Force to Aerospace Force. After few unsuccessful attempts, in April 2020 the IRGC launched in orbit the satellite Noor-1 from the Shahroud Missile Test Centre onboard the newly developed Qased, a three-stage rocket with both liquid and solid propellants. Already in 2019, the United States imposed sanctions on ISA for covering, under the civilian space programmes, military developments in the fields of ballistic missiles, whose technology is considered "virtually identical and interchangeable" with space launch vehicles. These developments would be in defiance of provisions from the Joint Comprehensive Plan of Action and the UN Security Council Resolution 2231.

Industry and Economy. Iran is the 9th country in the world to have acquired full orbital launch capability, launching its own payload with a domestic vehicle from a national base. Indeed, in 2009 Teheran launched the Omid satellite onboard the domestic rocket Safir, from the Semnan Satellite Launch Centre (Imam Khomeini Spaceport). Already in 2005, Iran produced its first satellite Sina-1 in cooperation with Russia, which operated the launch. Iran launched five satellites and supposedly still maintains three assets in orbit, although data are uncertain also due to several unconfirmed failures, involving both rockets and satellites. Overall, Iran developed four different rockets - Safir, Simourgh, Zoljanah and Qased - maturing during years a higher degree of technology associated with more powerful vehicles but also new solutions concerning the launch bases (e.g., mobile platforms). The rockets reportedly benefitted from knowledge used for the Shahab ballistic missile and from transfers of technology by Russia and North Korea. Iran is equipped with non-kinetic counterspace weapons, such as electronic and cyber capabilities to disturb and confuse (jamming and spoofing) satellite transmissions and GPS signals. On the contrary, Iran is not believed to be in the process of achieving kinetic weapons, especially direct ascent Anti-Satellite (ASAT) capabilities, although the status of existing and future developments of the military space programme is uncertain. The country also operates at least one satellite tracking centre.

Iraq

Policy and Programmes. Iraq does not have a defined approach on space, lacking both an agency and a strategic policy. During the 1980s, Iraq kicked-off the development of a space launch vehicle, Al-Abid, through the national Space Research Corporation (SRC), together with the manufacturing of two experimental satellites. However, efforts did not produce any results, and the programme was cancelled, also because of the prolonged successive war periods. The Al-Ta'ir satellites still exist and are stored by the Ministry of Science and Technology.



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Industry and Economy. Iraq has no satellite in orbit. The only minor effort has been in cooperation with the School of Aerospace Engineering of University La Sapienza in Rome and the Italian Ministry of Foreign Affairs (MFA): Iraqi students contributed to the development of the educational CubeSat TigriSat to study dust storms. The satellite is officially registered in Italy and was launched in June 2014, on a Russian Dnepr rocket.

Israel

Policy and Programmes. Created in 1983, the Israel Space Agency (ISA) leads the national space programme. ISA supports scientific and



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space research, it promotes educational initiatives and established over years cooperation with several entities. ISA developed the Venus satellite together with the French Space Agency (CNES), as part of an Earth Observation mission for scientific and environmental purposes. Moreover, ISA and the Italian Space Agency (ASI) are jointly developing the SHALOM mission, for a hyperspectral and multipurpose satellite yet to be launched. Although ending in tragedy, the country also counts its first Israeli in space, Ilan Ramon, who participated in 2003 in the STS-107 mission of the Space Shuttle Columbia, destroyed upon re-entry from orbit. Notably, Israel is the first MENA country to have launched an interplanetary and lunar mission. Developed by the private company SpaceIL, the Beresheet mission launched in 2019 a lunar lander that successfully inserted in the Moon's orbit but eventually crashed on its surface. Beresheet is being renewed by SpaceIL for a second Moon landing attempt, which could reportedly see the cooperation of the UAE Space Agency. Beresheet-2 is also developed together with the Israel Aerospace Industries (IAI), as well as with the support of ISA and the Ministry of Science and Education.

Industry and Economy. Israel is the 8th country in the world to have developed orbital launch capabilities. In 1988, it successfully orbited the nationally manufactured Ofeq-1 satellite with the indigenous launch vehicle Shavit, from the Palmachim Air Force Base on the Mediterranean coast. The Shavit rocket was based on the Jericho missile technology and then evolved to a first and second generation of space vehicles, now engineered with three solid fuel stages. The Palmachim spaceport presents a particular feature, as the country geographic position impose Israel to launch on a retrograde direction, contrary to Earth's spinning and demanding more propellant. From the end of the 1990s to 2020, Israel launched ten Ofeq satellites, for military reconnaissance and Earth Observation services. Furthermore, through the satellite operator Spacecom (a public company since 2005) Israel launched five satellites of the AMOS fleet, for broadcast and communication services. In 2020, the Israeli government procured a new satellite, Dror-1, for institutional communication. The main national industrial actor and prime contractor of satellites and launcher vehicles is the IAI, active since 1953. In synergy with institutional and military developments, Israel presents a dynamic space business environment, populated by many private start-ups such as Spacell, NSLComms, Spacepharma, Satixfy and Effective Space Solutions. The latter has expertise in the field of In-Orbit Servicing and has been recently acquired by the Japanese-U.S. company Astroscale.

Lebanon

Policy and Programmes.

Lebanon does not have a space agency, but rather a National Space Committee composed of academics and public and private sectors' experts. In 1995, the National Council for Scientific Research (CNRS-L) established the Remote Sensing Centre (RSC) which provides basic satellite imagery services to institutions and cooperates with space agencies on bilateral projects. From 2011 to 2016, the RSC had in place a cooperation project with Italy, financed also by the Italian MFA, to strengthen scientific research activities.



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Industry and Economy. Lebanon does not have assets in orbit. In 2019, the country started a project in cooperation with the EU to develop and launch the first national satellite. The project sees the involvement of a number of Lebanese universities and the Ministry for Administrative Reform.

Oman

Policy and Programmes. The space governance of the Sultanate of Oman is centred on the Space Communications Technology



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(SCT). The SCT acts as a sort of agency for the implementation of a National Satellite Programme together with the Ministry of Transport, Communications and Information Technology. According to sources, the government is in the process of preparing a national space policy. In 2020, the SCT signed a MoU with the Sultan Qaboos University for the development of domestic space capabilities.

Industry and Economy. In 2021, the SCT published a tender for the development of a communication satellite, aiming to launch the first national space asset by 2024. The SCT cooperates with the national ground network company Omantel for the management and provision of communication services, also through the national Al Amerat ground station.

Qatar

Policy and Programmes. Qatar does not have a space agency in place. The national interest for space is centred on satellite communication



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for commercial services but also for institutional and defence requirements. Moreover, the communication satellite programme allowed the country to fulfil the commitments related to broadcasting services for the FIFA World Cup 2022.

Industry and Economy. Established in 2010, Es'hailSat is the national satellite services provider. It operates two satellites, Es'hailSat-1 and 2, launched respectively in 2013 on an Ariane 5, and in 2018 on a SpaceX Falcon 9. The two satellites were built by Maxar and Mitsubishi Electric, yet Qatar participated in the manufacturing of Es'hailSat-1 in order to acquire elementary domestic capabilities.

Saudi Arabia

Policy and Programmes. The Saudi space governance is traditionally centred on the King Abdulaziz City for Science and Technology



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(KACST). Established in 1977, KACST is the main actor involved in space technology and projects, coordinating and absorbing most of the national efforts to develop satellites. Yet, the creation of the Saudi Space Commission (SSC) in 2018 brings the management of a proper space strategy under the new body, chaired by the Prince Sultan bin Salman Al-Saud. Among its projects, the SSC is in the process of establishing a national space company and defining regulations and legislations for the space sector. Furthermore, it coordinates the space affairs within the framework of the Saudi Vision 2030 and in light of national security and socio-economic goals. During its 2020 presidency of the G20, Saudi Arabia organised the first Space Economy Leaders Meeting. Notably, the chairman of the SSC, Prince Sultan bin Salman Al-Saud, became the first Arab in space in 1985 during the STS-51G Discovery mission. As a payload specialist of the mission, Prince Salman oversaw the deployment of the Arabsat-1B.

Industry and Economy. Saudi Arabia launched over thirteen satellites in space, with a central role of KACST in the manufacturing process and the involvement also of other academic and research centres, such as the King Saud University (KSU). The country launched the first two national satellites in 2000 for basic communication services and for technology demonstration, on a Dnepr rocket from the Baikonur cosmodrome. Since then, seven SaudicomSat followed between 2004 and 2007. In 2018, the country launched two satellites for reconnaissance and Earth Observation, Saudisat 5A and 5B, onboard a Long March 2-D Chinese rocket from the Jiuquan Satellite Launch Centre. Finally in 2021, Saudi Arabia launched Najim-1 (or Shaheen Sat), a satellite for maritime traffic monitoring, together with a KSU-developed CubeSat. The Kingdom of Saudi Arabia plans to invest over \$2 billion in space by 2030, to create a dynamic space sector and a favourable business environment. Besides national satellites and capabilities, Riyadh hosts the headquarter of Arabsat. Fostered by the Arab League, twenty-one countries established the company in 1976 with the goal of providing communication and broadcast services to the MENA region. Saudi Arabia remains the main shareholder of the company with a 37% stake. Since 1985, Arabsat launched over fifteen satellites, with a close involvement of Airbus Defence and Space and Thales Alenia Space as prime contractors for the assets' manufacturing. In 2013, Arabsat acquired for \$280 million the Greek operator Hellas-Sat, now a subsidiary of the Riyadh-based company.

United Arab Emirates

Policy and Programmes. UAE is among the fast-developing space nations at global level, with a full governance in place. The UAE Space Agency



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(UAESA) was established only in 2014 and is chaired by the Minister of State for Advanced Technology - an office currently held by a woman. UAESA is responsible for the implementation of the national space strategy, coordinating with the Mohammed Bin Rashid Space Centre (MBRSC). The MBRSC represents the operative and technological arm of the national policy in this domain, and was founded already in 2006. The Emirates introduced in 2016 a federal space law, in order to create the conditions to support and encourage the formation of an industrial sector, and launched the following year the national space programme. Moreover, Dubai established in 2021 the Courts of Space, an initiative meant to host and solve commercial legal disputes in this field. In 2020, UAESA signed an agreement with UNOOSA to create a space international hub in the Emirates to focus on space and sustainable development. The first Emirati astronaut, Hazza al-Mansouri, was launched to the ISS with a NASA mission in September 2019. Following further cooperation with NASA Johnson Space Center, in 2021 the country announced a second batch of astronauts to be trained and the first female Emirate astronaut to participate in a mission. UAE is also the only MENA country to have signed the Artemis Accords, a set of principles fostered by NASA and negotiated with partner agencies for the next missions to the Moon. Most notably, in 2020 UAE became the fifth country to have successfully launched a mission to Mars, the Emirates Mars Mission (EMM) – also known as Al-Amal or HOPE, the name of the orbiter probe. Developed with domestic capabilities at the MBRSC and in cooperation with the United States, the EMM is studying the Martian atmosphere within the larger scope of the Mars 2117 national scientific programme. Furthermore, in October 2020 UAE announced plans for an Emirates Lunar Mission (EML) to land the Rashid rover on the Moon by 2022. In this framework, MBRSC signed an agreement with the Japanese ispace company for the production of a lander to carry the Emirati rover to the lunar surface. At regional level, the UAE envisioned the creation of a pan-Arab space agency already in 2008. The country eventually fostered the creation of the Arab Space Coordination Group. Since its inception, the group focuses on the development of a climate monitoring satellite, named 813, a cooperation project between twelve MENA countries. Finally, the country features several universities, academic and research centres relevant for space and often involved in the sector's activities. These include the American University of Sharjah (AUS), the Masdar Institute of Science and Technology, the Khalifa University of Science and Technology (KUST), the American University of Ras Al-Khaimah (AURAK).

Industry and Economy. UAE launched sixteen satellites in orbit, including five for telecommunications operated by the companies Yahsat and Thuraya, owned by the Abu Dhabi sovereign investor Mubadala Investment Company. In particular, Thuraya-1 is the first national satellite launched into space in 2000, onboard a Russian Zenit rocket. UAE also maintains three satellites (DubaiSat) for Earth Observation, manufactured in cooperation with the South Korean Satrec Initiative company with an incremental involvement of national engineers and capabilities. In 2018, the Emirates procured from Airbus and Thales Alenia Space a military reconnaissance satellite, the Falcon Eye-1, but it suffered a failure at the Vega rocket and never reached space. The Falcon Eye-2 replacement satellite was successfully put in orbit by a Soyuz rocket in 2021. UAESA is developing a project for a constellation of CubeSats to provide satellite navigation services at regional level. The Global Navigation Satellite Systems – Augmentation System (GNSSaS) programme aims to improve the signals of GPS or Galileo SatNav constellations and is developed by the National Space Science and Technology Centre (NSSTC) and the United Arab Emirates University (UAEU). The country is increasingly investing in the space sector and aims to create a regional hub for related business. In this perspective, Krypto Labs and UAESA cooperate to attract New Space companies and incubate or accelerate innovative start-ups. Actually, UAE already hosts several commercial space companies that also

profited from acceleration programmes. Amongst others, Stratign and Farmin stand out for scope and level of innovation, dealing respectively with the defence and security field and geospatial intelligence.

1.2.2 North Africa

Algeria

Policy and Programmes. Algeria has a full space governance in place, with the Algerian Space Agency (ASAL) established in 2002, a national space programme (Horizon 2006-2020) and a space law adopted in 2019. The national agency reflects a whole-of-government approach in its Administrative Board and is engaged in a number of projects based on the national assets in orbit. ASAL also has four operational entities, focused on technological capabilities: i) the Center of Space Techniques (CTS), ii) the Space Applications Center (SAC), iii) the Satellite Development Center (SDC), and iv) the Telecommunications Systems Operating Center (TSOC). ASAL interacts with several other space agencies and hosts the Regional Support Office for MENA and Sahel of the UN Platform for Space-based Information for Disaster Management and Emergency Response (UN SPIDER). Finally, ASAL offers advanced educational programmes in space-related technologies, including a Doctoral School.



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Industry and Economy. Algeria has six satellites in orbit, including five active and one retired. Three satellites provide Earth Observation services. The first national satellite Alsat-1 is in orbit since 2002, launched from Russia. It was replaced in 2016 by Alsat 1B, built in cooperation with Surrey Satellite Technology (SST). Alsat 2A and 2B form a constellation and were launched respectively in 2010 and 2016 from India. Airbus manufactured this constellation of satellites, with close involvement of the Algerian expertise for the integration phases of Alsat 2B, which took place at the SDC located in Oran. Alsat 1N is a nanosatellite also supplied from SST, co-financed by the UK Space Agency. This technology demonstrator asset also saw the participation of ASAL for the final assembly and integration and was launched in 2016. Finally, Algeria operates a geostationary communication satellite, Alcomsat-1, for broadcast as well as governmental services. Alcomsat-1 was built and launched in 2017 by China, which also provided training to ASAL and contributed to the creation of two ground stations in Médéa and Ouargla.

Egypt

Policy and Programmes. Since 1991, the Egyptian space governance revolves around the National Authority for Remote Sensing and



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Space Sciences (NARSS). Created under the Ministry of Scientific Research, it conducts several research and cooperation activities. Yet, in 2019 the government established the Egyptian Space Agency (EgSA), taking over most of the programmatic responsibilities. Nevertheless, NARSS continues to exist, given also its long-established experience in satellite development and wide network of relations with other space agencies, institutions and private companies. Besides, Egypt can count on a number of universities and academic centres with space-related educational programmes, which cooperate with both EgSA and NARSS. In addition, Egypt will host the African Space Agency headquarter. Finally, EgSA and Roscosmos are currently defining an agreement for the training process of an Egyptian cosmonaut.

Industry and Economy. Egypt launched in orbit nine satellites, two of which have been lost for malfunctions and one is now retired. Overall, Egypt launched four satellites for Earth Observation, establishing a partnership with Russia and RKK Energia for joint development of assets. Three other satellites are operated on lease from Eutelsat for regional communication services. Two more satellites are currently under development (one for EO, one for SatCom) and expected to be launched by 2022. Concerning satellite communication, Egypt can claim to be the first African country to have launched a national broadcast TV satellite, as a result of the establishment in 1996 of Nilesat, which still operates the satellites and recently ordered a new one. Concerning SatCom, Egypt always procured satellites with European companies, namely Airbus and Thales Alenia Space France and Italy. Egypt also procured a military communication satellite to Thales Alenia Space and Airbus, the Tiba-1, launched in 2019 onboard an Ariane 5. Recently, China established cooperation with Egypt, offering grants for \$140 million for space research activities.

Morocco

Policy and Programmes. The Royal Centre for Remote Sensing (CRST) is the main space actor in Morocco. Created in 1989, it acts as an



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agency and main coordinator of space related activities, in cooperation with public institutions. Morocco also hosts the Regional Centres for Space Science and Technology Education for French language, established already in 1998 in partnership with UNOOSA to develop local capabilities for space research and applications.

Industry and Economy. Morocco counts three satellites in orbit. The first satellite is Maroc-TUBSAT, developed by CRST in partnership with the Technical University of Berlin and launched in 2001 from Russia. The two others are Mohammed VI-A and VI-B, respectively launched in 2017 and 2018 onboard a Vega rocket. Thales Alenia Space and Airbus manufactured these two dual-use remote sensing satellites, which present high resolution and revisit time capabilities, intended for Earth Observation services as well as military reconnaissance.

Tunisia

Policy and Programmes. The National Commission of Outer Space (CNEEA) represents Tunisia's main space entity, since its creation



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in 1984, together with the National Centre of Cartography and Remote Sensing established in 1988. In 2018, the country begun a process to define a proper space strategy. Since 2016, Tunisia hosts a BeiDou centre and in 2018 it hosted the 2nd China-Arab forum on the use of the Chinese satellite navigation system. In August 2021, through the company Telnet, the country signed an agreement with Roscosmos to train a female Tunisian cosmonaut possibly for an expedition to the ISS.

Industry and Economy. Tunisia has one satellite in orbit, the Challenge One launched in March 2021 on a Soyuz rocket and developed with domestic capabilities by Telnet. The Sfax Technopole also has sectorial capabilities and, apart from offering educational programmes relevant for space, in 2013 started developing the ERPSat-1 CubeSat, whose status is currently unknown.

2. Space applications for socio-economic development: opportunities for MENA countries

In recent years the MENA region has experienced a serious decrease in GDP and suffered from the direct and indirect impacts of the COVID-19 outbreak. The pandemic has exacerbated previous crises and vulnerabilities related to the precariousness of development and the uncertainty in the energy sector. Environmental and climate challenges also intensified, from droughts to desertification and land degradation, affecting the primary sector with ripple effects on food security, standard of living, etc. In some cases, vulnerabilities at socio-economic and environmental level can also evolve into serious emergencies and disasters, requiring an effective and efficient management. The increased urbanisation in the region is likely to put further pressure to the socio-economic context. At the same time, the mobile phone penetration reached high rates in last years and the demand of connectivity grows both in urban and rural areas.

In this context, space applications – categorised in Earth Observation, satellite navigation and satellite communication – provide solutions and unlock opportunities for socio-economic development, given also the growing interest and investments of MENA states in the sector.

2.1 Earth Observation

Remote sensing and satellite imagery are one of the main drivers for MENA states to invest in space capabilities. Beyond the defence and security sector, Earth Observation is recognised as a game-changer component for socio-economic development, from climate and atmosphere applications to land, marine and emergency services. Indeed, satellite imagery is experiencing a sharp increase in number and variety of applications, at both institutional and commercial levels. The pandemic highlighted how satellites can contribute to manage crisis by supporting local authorities to plan logistics operations, measuring the effects of lockdown on the environment, assessing the economic impacts and preparing the recovery phase. New and more advanced missions are launched every year by space actors to deepen scientific research or improve observation capabilities.

In the MENA region, the first project of the Arab Space Coordination Group is an EO satellite, named 813, that will focus on land erosion, crop condition, water quality and geological exploration for natural resources. In terms of resources, Algeria also collects imagery from its assets in orbit to better exploit fisheries and monitor agriculture or wildfires in the Saharan region. Kuwaiti Universities collaborate with NASA to study and validate soil moisture measurements, essential to allow researches on desertification. The CRTEAN organisation also launched a project to monitor droughts and receive early warning from satellite data, relevant for agriculture and farming stakeholders. This project also focuses on the optimisation of water resources, to improve irrigation and reduce unnecessary withdrawals. ISNET also developed technical projects to map land use and degradation, study water management for better efficiency and enhance food security among the network's member states through the combination of satellite and meteorological data applied to agriculture. Bahrain developed a project to react in the event of oil spills to monitor the involvement of the incidents and allow efficient recovery operations and increase the transparency of such episodes.

The UAE Space Agency is manufacturing the Mezsatsat satellite, to study Greenhouse Gases (GHG) concentration in the atmosphere and monitor the emissions, for climate research as well as potential industrial applications in the oil and gas sector. Further applications also concern the so-called blue economy, especially for monitoring changes in the marine environment, such as the algal blooms which can be harmful to fisheries and water quality. A peculiar use of Earth Observation data then regards archaeology and the potential advantage of radar satellite imagery for the identification of buried cultural sites.

In this perspective, satellite imagery is a crucial component of risk mitigation and disaster recovery. EO data and images converted into Geographical Information System (GIS) are utilised from civil and defence authorities in the occasion of floods, earthquakes, forest fires or sanitary crisis, to coordinate actions and have a clear picture of the capabilities on the ground. Notably, in 2021 the Iranian Space Agency organised together with UNOOSA a workshop on satellite applications for emergency response.



Figure 1 Copernicus EMS reconstruction monitoring in Beirut

The most advanced resource for this application is the Copernicus Emergency Management Service (EMS), developed by the European Union and delivered by a consortium led by the Italian company e-Geos. The Copernicus EMS is composed of the Rapid Mapping and the Risk and Recovery services, which collect data from the Sentinel satellites and combine it with other GIS. The Service distributes maps of specific locations in support of municipalities, civil protection authorities or scientific entities to assess the damages and ensure informed decisions. The Copernicus EMS already delivered solutions in the MENA region, thanks to activation by the EU Commission (EC), European national delegations and UN-Habitat. Indeed, in August 2020, the EC activated the service after the explosion at the port of Beirut instituting the Reform, Recovery and Reconstruction Framework (3RF) to assess the damages and assist in the recovery. Activations concerned as well Syria, Libya, Yemen and the Gaza strip, for post-conflict damage assessment and logistic coordination for refugees. The Iranian Space Agency also requested the service in 2020 to analyse the impacts of an unprecedented wildfire to several areas and land classes. Copernicus even contributed to manage the Ebola outbreak in West Africa in 2014, helping to identify the environmentally hazardous areas and support emergency preparedness.

Overall, Earth Observation can deliver measurements of the sea level, water salinity, sea and land temperatures. Satellites are then employed also to inform about several atmospheric and marine indicators – from air quality to solar radiations and ship pollution – as well as security applications for border or maritime surveillance also relevant for law enforcement. MENA states have several opportunities to take from this pool of applications and from initiatives at international level.



Figure 2 Ship throughput in Suez

One example is the analysis of the shipping through in the Nile during and after the pandemic, provided by a joint dashboard of NASA, ESA and Japan Aerospace Exploration Agency (JAXA) to assess the economic impacts of the crisis. The dashboard informs about the shipping activity in the Suez Canal, offering insights about logistics and cargo activity. Other insights and economic intelligence from satellite imagery concerned the oil supply crisis that occurred in spring 2020 and the status of refinery sites, analysed for instance in Saudi Arabia to get

information on the storage capacities and volatility in the commodity market, particularly relevant for Gulf countries.

Finally, ESA and the Food and Agriculture Organization (FAO) launched a joint initiative for food security called World Cereal to create an open-source global crop mapping platform to monitor the status of plantations.

Satellite imagery is progressively acquiring relevance for new markets and applications, since these often entail improved efficiency and reduced costs. Earth Observation then creates opportunities for institutions and start-ups to develop targeted solutions to local issues.

2.2 Satellite Navigation

Positioning, Navigation and Timing (PNT) are commonly recognised as critical elements

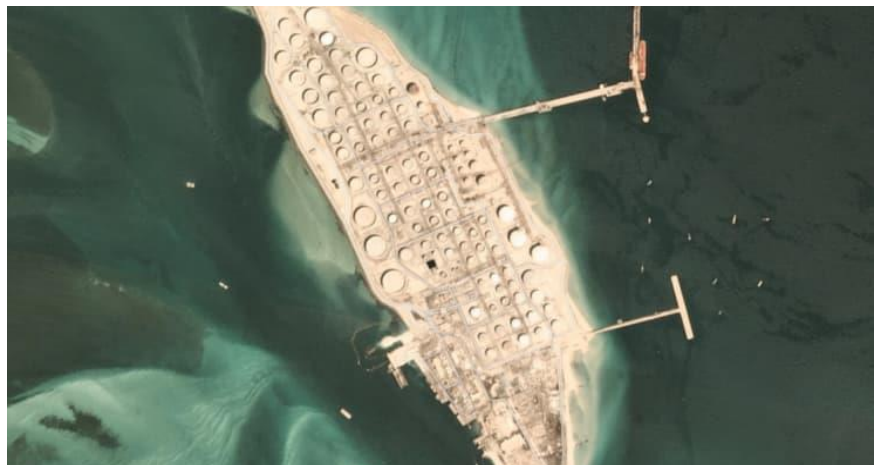


Figure 3 Saudi Aramco crude oil storage

and pre-requisites for a number of applications, from financial services to defence and security operations. The deployment of Global Navigation Satellite Systems (GNSS) such as GPS, Galileo, the Russian GLONASS, the Chinese BeiDou or the Japanese Quasi-Zenith, is considered as a strategic advantage. A satellite navigation system is usually composed of constellation of dozens of satellites launched in Medium Earth Orbit (MEO). It enables services based on accurate positioning, from maritime navigation to precision agriculture and farming or autonomous driving of cars and drones. In Europe, the European Geostationary navigation Overlay Service (EGNOS) signal augmentation system of Galileo is used by first responders, helicopters and rescue operators. Overall, satellite navigation became essential for aviation, road and rail transport sectors. During the pandemic, the European Commission (EC) launched the Galileo Green Line platform to track logistics of critical goods and reduce road traffic at the borders.

No country in MENA has yet implemented a regional satellite navigation programme. However, the UAE is currently developing the GNSSaS, composed of small satellites to be launched in LEO improving the signals of larger constellation. The programme openly aims to create better market conditions for the utilisation of

satellite navigation applications. Moreover, there has been a growing influence of China in the MENA region on space issues, through agreements with countries such as Tunisia to employ the BeiDou system and open ground centres for training and operations expanding the so-called “Space Silk Road”. Finally, the EU as well tested its own system in Africa, verifying the use of satellites in the aviation and agriculture sectors and deploying temporary or permanent stations in some parts of the continent.

The application of satellite from basic services, such as road traffic and delivery, to complex maritime and aviation operations opens the way to increasingly larger utilisation. This expansion may be significant given also the high rate of mobile phone subscriptions in the whole region and the implementation of GNSS receivers in most of present-day phones.

2.3 Satellite Communication

Satellite-based communications can be considered together with remote sensing a primary need for MENA states’ approach to space. As Earth Observation and navigation, satellite communication and connectivity unlock a variety of services and solutions, both institutional and commercial, civil and military. The most advanced spacefaring nations in the MENA region operate or have operated multiple satellites for communications. It is the case of Saudi Arabia, UAE and Egypt which still maintains a number of assets for broadcast services, a common and remunerative use of the technology. Arabsat, Yahsat, Thuraya and Nilesat are all recognised and successful operators, members of the Europe, Middle-East and Africa Satellite Operators Association (ESOA). Potential applications concern also the oil and gas sector to bring services to remote sites and platforms, as it is already done for in-flight connectivity and cruises.

Besides commercial perspectives, satellite communication enables remote learning and tele-health solutions which could be particularly relevant in time of crisis, in rural areas and to generally improve the standards of living and access to education. The implementation of connectivity services for schools and hospitals could indeed allow to reach a broader public, especially if located in remote areas. For instance, Oman is developing a project to bring connectivity to rural villages, schools and health centres and contribute to close the digital divide. This sector offers wide opportunities, as large companies such as SpaceX and OneWeb are launching programmes to connect remote areas in the worlds and offer institutional and commercial services, especially where ground networks may be extremely expensive to build, operate and maintain.

3. Security implications for space programmes and capabilities

The growing interest by MENA countries in space programmes and capabilities and their possible applications for socio-economic development shall be considered in light of the regional security complex.

Such a complex stretches from Morocco to Iran, as well as from the Mediterranean basin to the Sahel, and it is marked by fragmentation, competition and instability. In this context, seven regional trends are particularly relevant as they entail a number of implications for the MENA countries approaches to the space domain.

3.1 Four implications for space policies and capabilities

These trends entail a number of important implications for the space policies and capabilities addressed by previous chapters:



Figure 2 Israel, launch of the Ofek satellite

First, states investments on space will be part of a broader strategy aimed to enhance national security and power projection. Indeed, Israel and Iran are the only two MENA states with full orbital capability, having developed domestic technology for space rocket vehicles and successfully launching from their national territories after the most active space actors (Soviet Union, U.S., France, Japan, China, UK and India). Furthermore, EO will be increasingly important for intelligence purposes, while improved satellite communications are a key element for more effective and joint capabilities fit for multi-domain warfare. This is particularly true for countries like Iran, Israel and Saudi Arabia, but also UAE, Morocco and Egypt. Obviously, their capabilities to operate in the space domain remains extremely limited in comparison with space powers such as US, Russia or China, yet their assets are likely to be progressively integrated within military Command, Control and Communication (C3) framework, thus gaining strategic relevance.



Figure 3 Iran, launch of the Noor satellite

Beyond hard power, several MENA countries are willing and able to join a space race as part of a soft power strategy aimed to strengthen the state posture both internally and externally. On the domestic front, achievements for example towards the Moon and Mars, or the launch of the first astronaut, would have an appeal towards the nationalistic sectors of the society. At regional level, they contribute to a status of regional power which does matters in influencing the perception by counterparts across the region, including both states and non-states actors.

A third implication of the aforementioned trends concerns the space applications for disaster management, risks mitigations, environment monitoring, support to agriculture and other economic sectors. Considering the dire socio-economic conditions in the region, advantages to be brought by space assets and technologies would be welcome to support economic recovery and societal resilience. Yet the size and timing of space investments by MENA states will be deeply influenced by two kinds of factors. One the one hand, the priority attached to military and security forces deemed necessary for the state very same survival. On the other

hand, the financial constraints brought by relatively low oil prices which directly harms the oil producer countries. Therefore, MENA states are likely to plan different levels and types of investments in space, reflecting the national priorities and the diversity and fragmentation within the region, but considering that programmes in the sector require long-term development and are potentially less influenced or affected by the economic temporary contingencies.

A fourth implication regards the international dimension of space activities. As underlined previously, MENA countries have partnered with Russian companies and cosmodromes, have procured satellites and technologies from Russian suppliers, have undertaken cooperation activities with NASA, ESA, ASI and other space agencies, UN bodies, as well as American and European private companies. Moreover, as mentioned before, Egypt aims to host the African Space Agency headquarter and this may pave the way for further bilateral, mini-lateral and multi-lateral cooperation within and beyond Africa. All these cooperation initiatives have an increasingly strategic character exactly because of the aforementioned trends.

The U.S., Russia and China will factor space cooperation in the struggle for influence in the region, and European countries may do the same albeit on a smaller scale. While the Russian and Chinese influences in the region are based on direct investments, push of own technology and more recently also on human spaceflight training, the European space sector often leads in terms of satellite manufacturing and launch services. Airbus and Thales Alenia Space together with Arianespace cover a relevant part respectively of the manufacturing and the launch services demand. In turn, MENA states fiercely competing against each other are likely to seek space cooperation as part of their overall strategy of tailored, overlapping alliances beyond the region. The recent creation of the Arab Space Cooperation Group sees the pivot of the UAE, which in turn is also reported to cooperate with Israel on the next Beresheet Moon mission, confirming the significant role science and space diplomacy may have in regional and international context.

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