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MENA SPACE CAPABILITIES & SECURITY CHALLENGES

NSD-S HUB STUDY DAY

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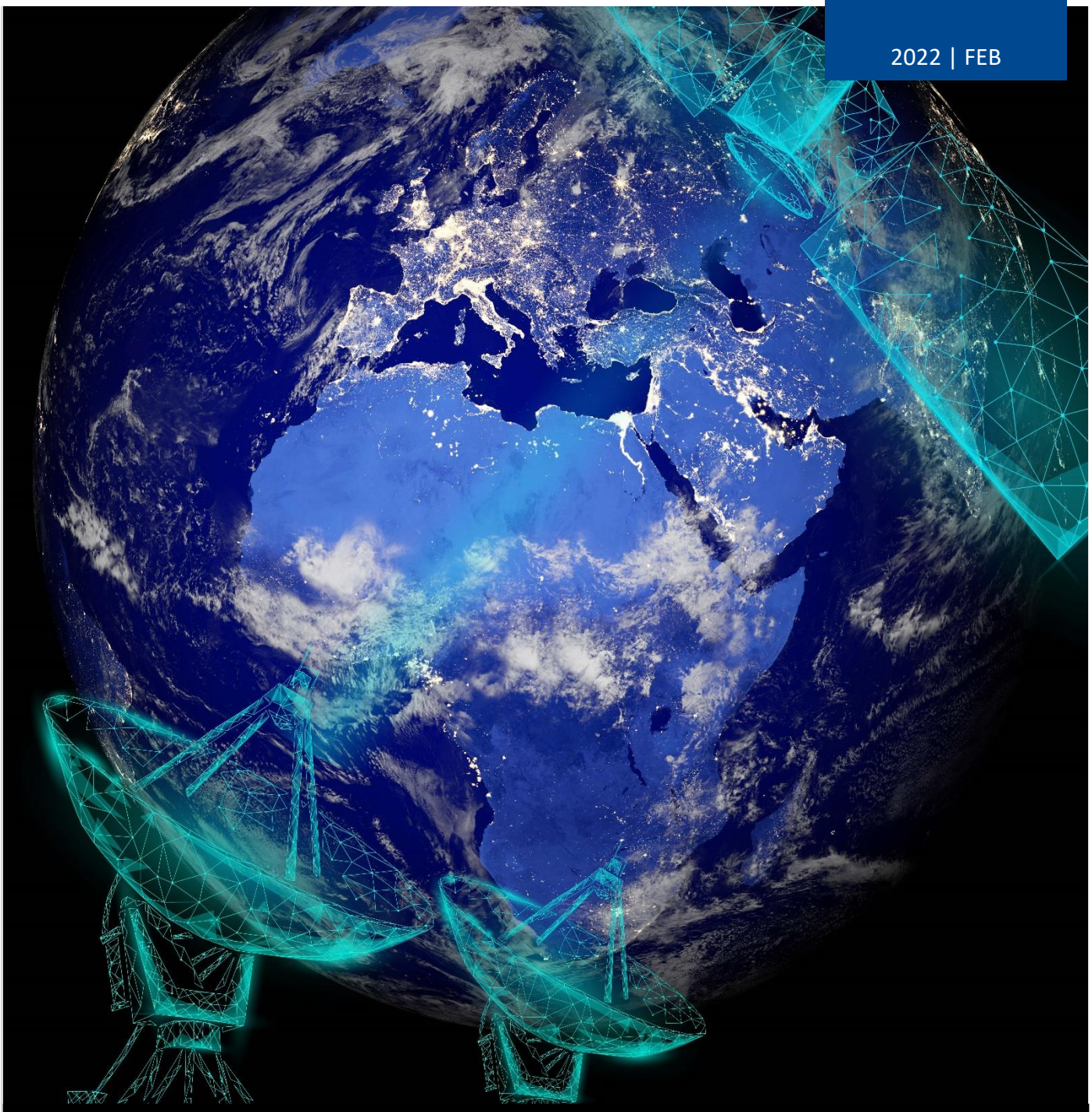

A REPORT BY
THE NATO STRATEGIC DIRECTION SOUTH HUB WITH THE SUPPORT OF Istituto Affari Internazionali

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NSD-S Hub Study Day

The Middle East and North Africa (MENA) Space Capabilities and Security Challenges Study Day was organised by the NATO Strategic Direction South (NSD-S) Hub and Allied Command Transformation (ACT) on the 27th and 28th of October 2021. This intricate and specific project was aimed at enhancing NATO's understanding of space and security challenges in the region, at the same time, shedding more light on the developing capabilities of MENA countries in not only the space domain, but also assessing political, military, economic and societal issues.

Unlike the space race of the 1960s, space is no longer an area where only a few countries operate. In recent decades, there has been a surge of interests and participants in space activities. Therefore, space has become an important resource for security and prosperity on the planet. The Middle East, like Africa, has steadily accelerated the space race in recent decades. These two regions have similar development motives and development models, but there are also differences.

This Study Day was made possible by a collective effort through a network of distinguished experts/speakers, trusted partners and multiple agencies; the Istituto Affari Internazionali (IAI), Prague Security Studies Institute (PSSI), NATO Instanbul Cooperation Initiative (ICI), Space Generation Advisory Council (SGAC), Mohammed bin Rashid Space Centre (MBRSC), International Space University (ISU), European Space Agency (ESA), International Business and Space Law and the Saudi Youth Space Association.

The 2-day Study Day was divided into three panels dealing with the topics of:

1. The general outlook of the existing space capabilities in North Africa and the Middle East, dissecting the national priorities and strategic goals;
2. The relevance of space capabilities for the economic development (with a proper distinction between the Middle East and North Africa, if deemed appropriate), including the analysis of educational requirement for the concerned countries;
3. The (regional) geo-strategic competition in the space sector, with the projection out to the medium to long term (5 to 10 years).

Summary

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 the 2011 Arab Spring. 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.

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 growing interest for scientific and space research and often collaborate to design and manufacture 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 (SATNAV) 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 SATNAV 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 (SATCOM) and connectivity can be used for a number of different institutional, commercial, civil and military purposes. Some countries maintain many communication satellites (COMSATs) 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. SATCOM 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 have 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 enhance 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 at strengthening 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. Socio-economic landscape of Middle East and North Africa countries

1.1 The economies of the MENA region

The MENA region accounts for a large share of global oil production, of extreme relevance for the world economy, also given its role in logistics and maritime lanes, as shown by the impact of the Suez blockade in March 2021. Cultural, linguistic, and historical elements may portray the region as an area characterised by a significant degree of homogeneity and coherence. However, looking at it from an economic and social perspective, the picture is different, where fragmentation and diversity instead characterise an area that varies substantially in terms of living standards, demographics and geographical size.[1] On top of structural differences, the region is also characterised by a low degree of economic integration.[2] Intra-regional trade remains low, even in the Gulf area that implemented a formal integration. Trade in goods and services remain limited. Labour flows are still relevant, although political and security dynamics may impact them. Quite significant are investment flows as well, often used as tools of political influence, particularly from the Gulf countries.[3]

The trends of the Human Development Index (HDI), measuring countries' achievements in health, knowledge and standard of living, identify a significant correlation between political stability and the general development context [Table 1].[4] Data for Syria, Libya and Yemen show almost no improvement in the 1990-2019 period, while the rest of the countries in MENA show signs of progress. Particularly notable is the case of Iran, whose HDI grew on average by 1.13% in the period, and by an even more remarkable 1.54% in 1990-2000 when the country tried to open more to the world. Morocco and Tunisia also respectively achieved a remarkable 1.41% and 0.92% in the 1990-2019 period, although the Tunisian HDI grew by only 0.37% in the last decade, against 1.30% and 0.96% in the twenty years before.

The HDI of the Gulf countries continues to grow. Yet, security volatility and political dynamics over the past fifteen years have contributed to a deterioration of the economic outlook for the entire region. In 2020, most economies in the MENA region experienced their sharpest Gross Domestic Product (GDP) contractions in decades amid the direct impacts of the pandemic, from sanitary challenges to restrictions and lockdowns, and the indirect consequences of the COVID-19 global outbreak, ranging from a sharp decline in global demand for oil to logistic disruptions.

However, the pandemic broke out after a decade characterised by a number of other crises that severely impacted the social and economic stability of many MENA countries.[5] As a result, a large part of the region has witnessed a gradual deterioration of their physical and human capital, although the actual impact of

[1] Marcus Noland and Howard Pack (2007), *The Arab Economies in a Changing World* (Washington D.C.: Peterson Institute for International Economy).
[2] Mustapha Rouis and Steven R. Tabor (2013), '*Regional Economic Integration in the Middle East and North Africa: Beyond Trade Reform'* (Washington, DC: World Bank). Available at: https://doi.org/10.1596/978-0-8213-9726-8.
[3] İsmail Numan Telci and Gökhan Ereli (2021), *'Investments as Foreign Policy Instruments: The Cases of Saudi Arabia, The UAE and Qatar'* (ORSAM Center for Middle Eastern Studies). Available at: https://www.orsam.org.tr/en/investments-as-foreign-policy-instruments-the-cases-of-saudi-arabia-the-uae-and-qatar/.
[4] United Nations Development Programme website, '*Human Development Report. 2020'*, accessed 10 September 2021. Available at: http://hdr.undp.org/en/composite/HDI.
[5] Eckart Woertz (2020), '*COVID-19 in the Middle East and North Africa: Reactions, Vulnerabilities, -Prospects'*, *GIGA Focus Nahost*, no. 02.

these dynamics is yet to be quantified. The COVID-19 crisis came after years in which other problems undermined regional economies, such as the 2008 financial crisis, which directly hurt some countries in the Gulf, and the Arab Spring revolutions of 2011.[6] The rise of terrorism, particularly after the so-called Islamic State (IS) emerged in Syria and Iraq and spread across the region,[7] heavily affected the economies of a number of countries, such as Tunisia, Egypt and many others.[8]

Against this backdrop, other crises may unfold. For instance, the current tension between Egypt and Ethiopia over the Nile is possibly the most significant challenge Cairo has experienced so far, as the Nile remains crucial for Egypt's social and economic needs.[9] As mentioned in the opening paragraph, the region's oil is still of particular relevance for the global energy market, despite the developments of the shale industry and the advancements in the field of renewable energy sources.[10] MENA oil exporters managed to prop up their reserves thanks to the gains made in the first decade of the 21st century. Many used this wealth to finance ambitious programs of external political, economic and military projection, with direct or indirect implications also on the development of space policies and capabilities. However, this unique, positive energy cycle ended one decade ago and put the financial capacities of many Middle Eastern countries under strain.

As the pandemic broke out, with its almost immediate impact on global energy demand, it soon became clear for many of these countries that one of the lessons to be learned concerns the vulnerability and risks of overreliance on a single economic sector and the need to diversify the economy in order to achieve a more sustainable, resilient and stable GDP growth, even if the oil prices will rise again in a meaningful way. The problems in oil exporters impacted almost immediately the situation in non-oil producers as well. Oil-importing economies witnessed a sharp GDP contraction as investments dry up, while the pandemic also took a hard toll on private consumption, a significant driver of the GDP of those countries that cannot rely on natural rents more. The general halt to global trade adversely affected the logistics industry, with sectors such as automotive and textiles suffering substantially. Tourism also remained subdued. It has to be seen when, how and how much the ongoing economic recovery in Europe and North America will impact the MENA economies, for instance, in terms of demand for energy resources – with the related prices' increase – and relaunch of global trade and tourism.[11]

1.2 Overview of the social context

The pandemic thus contributed to worsen the economic conditions across the entire region, adding to the problems that already emerged over the past fifteen years. While the specific consequences are likely to differ from country to country depending on its pre-COVID-19 situation, the economic and social structure and the measures taken to cope with the outbreak remain similar. Unemployment increased. Sanitary

[6] Shanta Devarajan and Lili Mottaghi (2017), '*The Economics of Post-Conflict Reconstruction in MENA*', Middle East and North Africa Economic Monitor (Washington D.C.: The World Bank).
[7] Brynjar Lia (2016), 'Jihadism in the Arab World after 2011: Explaining Its Expansion', *Middle East Policy* 23, no. 4: 74–91. Available at: http://onlinelibrary.wiley.com/doi/10.1111/mepo.12234/full.
[8] Harrison Bardwell and Mohib Iqbal (2021), '*The Economic Impact of Terrorism from 2000 to 2018*', *Peace Economics, Peace Science and Public Policy* 27, no. 2: 227–61. Available at: https://doi.org/10.1515/peps-2020-0031.
[9] Olivier Caslin and Hossam Rabie, '*Is a War between Egypt and Ethiopia Brewing on the Nile*?', *The Africa Report*, 6 May 2021. Available at: https://www.theafricareport.com/85672/is-a-war-between-egypt-and-ethiopia-brewing-on-the-nile/.
[10] Emanuela Menichetti et al. (2018), '*The MENA Region in the Global Energy Markets*', MENARA Working Papers.
[11] Paul Rivlin (2021), '*The Impact of Covid-19 and Conflict on Middle Eastern Economies*', *Iqtisadi: Middle East Economy* 11, no. 1. Available at: https://dayan.org/content/impact-covid-19-and-conflict-middle-eastern-economies.

restrictions and lockdowns adversely affected informal workers and respective households, who do not have the same protections as public employees or people formally employed in the private sector and for whom teleworking was not a real option.

Mounting fiscal deficits and rising debt-to-GDP-ratios reduced room for expansionary fiscal policy and thus required painful cuts to subsidies and other forms of public support to the economy. Remittances from abroad declined, adversely affecting many households depending on them. The performance of almost all the MENA countries in 2019 was worse compared to the HDI 2018 [Table 2].[12] This trend is likely to continue in 2020 as the setbacks of the pandemic and the collapse in oil prices weigh in. The data for life expectancy, expected years of schooling and mean years of schooling are not so different across the region. In this field, Israel, UAE, Jordan, Iran and Saudi Arabia lead the statistics, with lowest averages in Morocco, Tunisia and Kuwait. The difference in Gross National Income (GNI) per capita is instead striking, showing the existence of a structural difference between the Gulf countries and Israel and the rest of the region.

The socio-economic issues rising from the past years show the persistent need for diversification, expected to become more and more significant in the coming years. Still, many of these countries will need to move ahead on the process of economic diversification in a context of declining fiscal revenues, mounting unemployment and escalating environmental challenges related to food security and climate change. These challenges must be also interpreted in the context of specific demographic and job markets features [Table 3].[13] In many energy-dependent countries such as Iran, Saudi Arabia, Algeria and Iraq, the 15-64 years of age population represents between 57.2% and 23% respectively and usually the segment 15-30 years is particularly relevant. If these economies are unable to keep with the creation of jobs and opportunities, the risks of mounting discontent among people in their '20s and '30s may be significant. Moreover, in many of these countries the fertility rate is above 2.1, assuring a stable population. This means many of these countries have still decades ahead before they complete a demographic transition. Furthermore, besides from the Gulf countries, there is a medium to high percentage of youth not in school or employment to be considered, especially in Iraq, Iran, Jordan and Egypt. These issues remain a concern for political and social stability, particularly in the context of sluggish economic development. Moreover, in some of the MENA states, such as Egypt and Syria, urbanisation is overall not widespread, which pose challenges concerning the future prospects of greater urbanisation and the impacts of climate change, desertification, food availability and quality of life.

Over the past ten years, the trends have shown a sharp improvement concerning literacy rates [Table 4].[14] Data for people aged 15-24 shows favourable conditions and countries such as Egypt, Tunisia and Morocco managed to catch up and bridge the gap with others. However, many of these countries, particularly in North Africa, still lag behind in regard to the population with at least some secondary education and tertiary enrolment. While numbers are high in Saudi Arabia, Iran and Israel, the percentage of population in tertiary education is lowest in Qatar, Tunisia, Jordan and Morocco. Many MENA countries present then a low ratio of high skilled workers, even those countries in the Gulf whose economies are based on services. In North Africa, there is still a significant rate of the population employed in the agricultural sector, with peaks in Morocco and Egypt – the country in which urbanisation is least developed [Table 5]. Relevant data

[12] United Nations Development Programme, *'Human Development Report. 2020'*.
[13] Ibidem
[14] Ibidem

also concern the mobile phone subscriptions, which identifies overall a high penetration rate in the MENA region, and the percentage of schools with access to internet, which reflects the regional diversity as few countries reports high quality of education while the majority would require more investments and technological catch-up.

Food security is becoming of particular concern in the region, and it will likely be a crucial issue to be tackled through technology. According to the Food and Agriculture Organisation (FAO), as of September 2021 the global food prices increased 33% over the last 12 months, with basic staples such as vegetable oil, grains and meat showing some of the highest increases.[15] MENA states import most of their food and, in some cases, prices have skyrocketed over the past months. Lebanon represents an emblematic case: food inflation rose to 400 percent last year due to several reasons.[16] While the Lebanese case is rather unique and somehow extreme, all of the MENA region faces rising prices and mounting food insecurity.[17] Food security is also a concern for many high-income countries in the region, such as Bahrain, Qatar, the UAE, and Kuwait, as they face the highest global rates of food import dependency.

The data [Table 6, 7, 8] from the Economist Intelligence Unit (EUI) Global Food Security Index[18] shows that the situation of "affordability, availability and quality and safety" is somehow acceptable. However, the situation of "natural resources and resilience", assessing the exposure to the impacts of climate change, the susceptibility to natural resource risks and how the country is adapting to these risks is concerning, leaving open opportunities for technology and space-based applications.

[15] Alastair Smith (2021), '*Why Global Food Prices Are Higher Today than for Most of Modern History*', *The Conversation*, Available at: http://theconversation.com/why-global-food-prices-are-higher-today-than-for-most-of-modern-history-168210.
[16] Bloomberg (2021), '*Lebanese Inflation Hits Record High as Food Prices Soar 400%*'. Available at: https://www.bloomberg.com/news/articles/2021-02-11/lebanese-inflation-hits-record-high-as-food-prices-soar-400.
[17] Ferid Belhaj and Ayat Soliman, '*MENA Has a Food Security Problem, But There Are Ways to Address It*', *World Bank*, 25 September 2021. Available at: https://www.worldbank.org/en/news/opinion/2021/09/24/mena-has-a-food-security-problem-but-there-are-ways-to-address-it.
[18] Food Security Index website (2021), '*Global Food Security Index (GFSI)*' (Economist Intelligence Unit, EUI), accessed 08 December 2021, Available at: http://foodsecurityindex.eiu.com/.

Table 1 MENA Region Human Development Index trends, 1990-2019

		Human Development Index (HDI)								Change in HDI rank	Average annual HDI growth			
		Value									(%)			
HDI rank	Country	1990	2000	2010	2014	2015	2017	2018	2019	2014-2019[a]	1990-2000	2000-2010	2010-2019	1990-2019
	VERY HIGH HUMAN DEVELOPMENT													
19	Israel	0.801	0.861	0.895	0.909	0.910	0.913	0.916	0.919	1	0.72	0.39	0.29	0.48
31	United Arab Emirates	0.723	0.782	0.820	0.847	0.859	0.881	0.889	0.890	6	0.79	0.48	0.91	0.72
40	Saudi Arabia	0.697	0.743	0.809	0.852	0.859	0.852	0.854	0.854	-4	0.64	0.85	0.60	0.70
42	Bahrain	0.749	0.795	0.800	0.820	0.848	0.854	0.852	0.852	6	0.60	0.06	0.70	0.45
45	Qatar	0.750	0.816	0.834	0.835	0.839	0.848	0.845	0.848	0	0.85	0.22	0.19	0.42
60	Oman	..	0.693	0.782	0.802	0.814	0.819	0.813	0.813	-3	..	1.22	0.43	..
64	Kuwait	0.705	0.781	0.788	0.796	0.801	0.805	0.807	0.806	-5	1.03	0.09	0.25	0.46
	HIGH HUMAN DEVELOPMENT													
70	Iran (Islamic Republic of)	0.565	0.658	0.742	0.774	0.774	0.787	0.785	0.783	1	1.54	1.21	0.60	1.13
91	Algeria	0.572	0.637	0.721	0.736	0.740	0.745	0.746	0.748	0	1.08	1.25	0.41	0.93
92	Lebanon	..	..	0.766	0.748	0.744	0.748	0.747	0.744	-6	..	..	-0.32	..
95	Tunisia	0.567	0.651	0.716	0.726	0.729	0.734	0.738	0.740	7	1.39	0.96	0.37	0.92
102	Jordan	0.625	0.711	0.737	0.729	0.730	0.726	0.728	0.729	-3	1.30	0.36	-0.12	0.53
105	Libya	0.724	0.780	0.798	0.728	0.697	0.714	0.721	0.724	-4	0.75	0.23	-1.08	0.00
115	Palestine, State of	..	..	0.684	0.697	0.701	0.706	0.708	0.708	-6	..	..	0.38	..
116	Egypt	0.548	0.613	0.668	0.685	0.691	0.698	0.701	0.707	1	1.13	0.86	0.63	0.88
	MEDIUM HUMAN DEVELOPMENT													
121	Morocco	0.457	0.529	0.616	0.652	0.658	0.673	0.680	0.686	2	1.47	1.53	1.20	1.41
123	Iraq	0.560	0.595	0.636	0.645	0.649	0.667	0.671	0.674	4	0.61	0.67	0.65	0.64
151	Syrian Arab Republic	0.550	0.600	0.672	0.556	0.537	0.564	0.563	0.567	-2	0.87	1.14	-1.87	0.11
	LOW HUMAN DEVELOPMENT													
157	Mauritania	0.397	0.464	0.505	0.531	0.536	0.540	0.542	0.546	-2	1.57	0.85	0.87	1.10
179	Yemen	0.401	0.444	0.506	0.502	0.483	0.467	0.468	0.470	-16	1.02	1.32	-0.82	0.55

Table 2 MENA Region Human Development Index

HDI rank	Country	Human Development Index (HDI)	Life expectancy at birth	Expected years of schooling	Mean years of schooling	Gross national income (GNI) per capita	GNI per capita rank minus HDI rank	HDI rank
		Value	(years)	(years)	(years)	(2017 PPP $)		
		2019	2019	2019 [a]	2019 [a]	2019	2019	2018
	VERY HIGH HUMAN DEVELOPMENT							
19	Israel	0.919	83.0	16.2	13.0	40,187	14	21
31	United Arab Emirates	0.890	78.0	14.3	12.1	67,462	-24	30
40	Saudi Arabia	0.854	75.1	16.1	10.2	47,495	-16	40
42	Bahrain	0.852	77.3	16.3	9.5	42,522	-12	41
45	Qatar	0.848	80.2	12.0	9.7	92,418 [d]	-43	45
60	Oman	0.813	77.9	14.2	9.7 [j]	25,944	-5	56
64	Kuwait	0.806	75.5	14.2	7.3	58,590	-51	62
	HIGH HUMAN DEVELOPMENT							
70	Iran (Islamic Republic of)	0.783	76.7	14.8	10.3	12,447	26	70
91	Algeria	0.748	76.9	14.6	8.0 [m]	11,174	13	91
92	Lebanon	0.744	78.9	11.3	8.7 [n]	14,655	-11	90
95	Tunisia	0.740	76.7	15.1	7.2	10,414	14	94
102	Jordan	0.729	74.5	11.4 [p]	10.5 [f]	9,858	8	103
105	Libya	0.724	72.9	12.9 [n]	7.6 [o]	15,688	-29	106
115	Palestine, State of	0.708	74.1	13.4	9.2	6,417	12	114
116	Egypt	0.707	72.0	13.3	7.4 [f]	11,466	-14	117
	MEDIUM HUMAN DEVELOPMENT							
121	Morocco	0.686	76.7	13.7	5.6 [f]	7,368	1	121
123	Iraq	0.674	70.6	11.3 [m]	7.3 [j]	10,801	-16	123
151	Syrian Arab Republic	0.567	72.7	8.9 [j]	5.1 [n]	3,613 [t]	2	152
	LOW HUMAN DEVELOPMENT							
157	Mauritania	0.546	64.9	8.6	4.7 [f]	5,135	-21	157
179	Yemen	0.470	66.1	8.8 [j]	3.2 [f]	1,594 [t]	2	179

Table 3 MENA region population trends

HDI rank	Country	Population: Total (millions) 2019	Total (millions) 2030	Average annual growth (%) 2005/2010	Average annual growth (%) 2015/2020	Urban (%) 2019	Under age 5 (millions) 2019	Ages 15–64 (millions) 2019	Ages 65 and older (millions) 2019	Median age (years) 2020	Dependency ratio (per 100 people ages 15–64): Young age (0–14) 2019	Dependency ratio: Old age (65 and older) 2019	Total fertility rate (births per woman) 2005/2010	Total fertility rate (births per woman) 2015/2020
	Very high human development													
19	Israel	8.5	10.0	2.4	1.6	92.5	0.8	5.1	1.0	30.5	46.5	20.4	2.9	3.0
31	United Arab Emirates	9.8	10.7	12.4	1.3	86.8	0.5	8.2	0.1	32.6	17.5	1.4	2.0	1.4
40	Saudi Arabia	34.3	39.3	2.8	1.9	84.1	3.0	24.6	1.2	31.8	34.7	4.8	3.2	2.3
42	Bahrain	1.6	2.0	6.7	4.3	89.4	0.1	1.3	0.0	32.5	23.7	3.2	2.3	2.0
45	Qatar	2.8	3.3	15.3	2.3	99.2	0.1	2.4	0.0	32.3	16.0	1.8	2.2	1.9
60	Oman	5.0	5.9	3.8	3.6	85.4	0.5	3.7	0.1	30.6	29.8	3.3	2.9	2.9
64	Kuwait	4.2	4.7	5.5	2.1	100.0	0.3	3.2	0.1	36.8	28.5	3.7	2.4	2.1
	High human development													
70	Iran (Islamic Republic of)	82.9	92.7	1.1	1.4	75.4	7.6	57.2	5.3	32.0	35.7	9.2	1.8	2.2
91	Algeria	43.1	50.4	1.6	2.0	73.2	5.0	27.1	2.8	28.5	48.6	10.4	2.7	3.1
92	Lebanon	6.9	6.2	1.1	0.9	88.8	0.6	4.6	0.5	29.6	38.1	10.8	1.9	2.1
95	Tunisia	11.7	12.8	1.0	1.1	69.3	1.0	7.9	1.0	32.8	36.1	12.8	2.0	2.2
102	Jordan	10.1	10.7	4.6	1.9	91.2	1.1	6.3	0.4	23.8	53.7	6.2	3.8	2.8
105	Libya	6.8	7.6	1.3	1.4	80.4	0.6	4.6	0.3	28.8	41.6	6.6	2.5	2.3
115	Palestine, State of	5.0	6.3	2.5	2.4	76.4	0.7	2.9	0.2	20.8	66.4	5.5	4.6	3.7
116	Egypt	100.4	120.8	1.8	2.0	42.7	12.8	61.1	5.3	24.6	55.6	8.7	3.0	3.3
	Medium human development													
121	Morocco	36.5	40.9	1.2	1.3	63.0	3.4	24.0	2.7	29.5	41.0	11.1	2.5	2.4
123	Iraq	39.3	50.2	2.0	2.5	70.7	5.4	23.0	1.3	21.0	64.9	5.8	4.4	3.7
151	Syrian Arab Republic	17.1	26.7	3.0	-0.6	54.8	1.8	11.0	0.8	25.6	48.3	7.3	3.7	2.8
	Low human development													
157	Mauritania	4.5	6.0	2.9	2.8	54.5	0.7	2.6	0.1	20.1	70.0	5.5	5.1	4.6
179	Yemen	29.2	36.4	2.8	2.4	37.3	4.1	16.9	0.8	20.2	67.8	5.0	5.0	3.8

Table 4 MENA region education achievements

		Literacy rate				Gross enrolment ratio						
		Adult (% ages 15 and older)	Youth (% ages 15–24)		Population with at least some secondary education	Pre-primary	Primary	Secondary	Tertiary	Primary school dropout rate	Survival rate to the last grade of lower secondary general education	Government expenditure on education
HDI rank	Country		Female	Male	(% ages 25 and older)	(% of preschool-age children)	(% of primary school-age population)	(% of secondary school-age population)	(% of tertiary school-age population)	(% of primary school cohort)	(%)	(% of GDP)
		2008-2018 [a]	2008-2018 [a]	2008-2018 [a]	2015-2019 [a]	2014-2019 [a]	2014-2019 [a]	2014-2019 [a]	2014-2019 [a]	2008-2018 [a]	2008-2018 [a]	2013-2018 [a]
	VERY HIGH HUMAN DEVELOPMENT											
19	Israel	..	..	..	89.3	111	105	105	63	1.4	98	5.8
31	United Arab Emirates	93.2	99.1	99.6	78.9	78	108	105	..	8.0	97	..
40	Saudi Arabia	95.3	99.3	99.3	68.8	21	100	110	68	30.4	81	..
42	Bahrain	97.5	99.3	100.0	72.3	54	99	99	50	2.8	98	2.3
45	Qatar	93.5	96.1	94.1	68.2	60	104	..	18	3.8	97	2.9
60	Oman	95.7	99.0	98.4	66.6	52	103	107	38	1.9	98	5.0
64	Kuwait	96.1	99.5	98.8	51.5	62	92	98	54	7.2	94	..
	HIGH HUMAN DEVELOPMENT											
70	Iran (Islamic Republic of)	85.5	97.9	98.3	70.2	54	111	86	68	4.0	94	4.0
91	Algeria	81.4	97.3	97.6	38.9 [d]	..	110	..	51	3.7	77	..
92	Lebanon	95.1	99.8	99.7	54.9 [g]	..	..	..	..	14.5	83	2.4
95	Tunisia	79.0	95.8	96.6	44.9	45	115	93	32	5.8	79	6.6
102	Jordan	98.2	99.5	99.2	84.2 [c]	27	81	63	34	4.1	86	3.6
105	Libya	..	..	..	57.5 [e]	..	..	..	..	..	..	..
115	Palestine, State of	97.2	99.4	99.3	64.2	56	99	89	44	1.1	85	5.3
116	Egypt	71.2	86.8	89.5	73.0 [c]	29	106	88	35	3.0	92	..
	MEDIUM HUMAN DEVELOPMENT											
121	Morocco	73.8	97.4	98.0	32.4 [c]	51	114	80	36	7.0	79	..
123	Iraq	85.6	92.1	94.9	48.0	..	..	..	..	..	..	..
151	Syrian Arab Republic	..	..	..	41.0 [c]	..	..	..	40	6.8	10	..
	LOW HUMAN DEVELOPMENT											
157	Mauritania	53.5	56.8	70.9	19.0 [c]	10	100	37	5	35.1	72	2.6
179	Yemen	..	..	..	28.0 [c]	2	94	52	..	30.5	85	..

Table 5
MENA region work and employment

		Employment				Unemployment			Work that is a risk to human development				Skill-level employment	Employment-related social security
		Employment to population ratio [a]	Labour force participation rate [a]	Employment in agriculture [a]	Employment in services [a]	Total [a]	Youth [a]	Youth not in school or employment	Child labour	Working poor at PPP$3.20 a day [a]	Proportion of informal employment in nonagricultural employment		High-skill to low-skill ratio	Old-age pension recipients [b]
												Female		
HDI rank	Country	(% ages 15 and older)		(% of total employment)		(% of labour force)	(% ages 15-24)		(% ages 5-17)	(% of total employment)	(% of total employment in nonagriculture)		(employment ratio)	(% of statutory pension age population)
		2019	2019	2019	2019	2019	2019	2019 [c]	2010-2019 [c]	2019	2011-2019 [c]	2011-2019 [c]	2009-2019 [c]	2014-2019 [c]
	Very high human development													
19	Israel	61.6	64.0	0.9	82.1	3.9	7.3	15.2	..	..	..	..	9.38	100.0
31	United Arab Emirates	80.2	82.1	1.4	64.2	2.3	7.3	11.2	..	0.4	..	..	1.86	27.0
40	Saudi Arabia	52.6	55.9	2.4	72.9	5.9	28.6	16.0	..	0.1	..	..	..	5.1
42	Bahrain	72.8	73.4	1.0	63.8	0.7	4.6	18.0	..	..	..	..	0.61	..
45	Qatar	86.7	86.8	1.2	44.4	0.1	0.4	10.5	..	0.1	..	..	0.96	13.1
60	Oman	70.4	72.4	4.6	62.7	2.7	13.2	19.8	..	0.2	..	..	..	..
64	Kuwait	71.9	73.5	2.0	73.6	2.2	15.8	27.0	..	0.6	..	..	0.82	41.9
	High human development													
70	Iran (Islamic Republic of)	39.6	44.7	17.9	51.5	11.4	27.4	28.0	..	0.7	..	..	1.47	35.6
91	Algeria	36.3	41.2	9.9	59.4	11.7	29.5	21.1	4.3	1.3	..	..	0.84	..
92	Lebanon	44.1	47.0	13.6	63.9	6.2	17.6	25.5	..	0.2	..	..	..	..
95	Tunisia	38.7	46.1	13.0	54.4	16.0	36.3	24.8	2.3	0.9	..	..	0.95	54.0
102	Jordan	33.5	39.3	3.1	72.4	14.7	35.0	32.5	1.7	1.4	..	..	..	46.6
105	Libya	40.5	49.7	18.9	59.2	18.6	50.5	31.8	..	0.4	..	..	..	..
115	Palestine, State of	32.4	43.8	6.1	62.3	26.2	42.0	33.8	9.4	1.4	50.6	39.2	1.40	31.0
116	Egypt	41.4	46.4	23.8	48.5	10.8	31.1	27.7	4.8	11.9	54.2	41.1	3.68	37.5
	Medium human development													
121	Morocco	41.2	45.3	34.7	43.6	9.0	22.1	22.1	..	5.0	..	..	0.45	..
123	Iraq	37.5	43.0	18.1	59.6	12.8	25.1	44.6	4.5	6.8	..	..	1.30	..
151	Syrian Arab Republic	40.4	44.1	10.7	62.7	8.4	20.9	33.4	..	53.8	..	..	1.64	..
	Low human development													
157	Mauritania	41.5	45.9	51.3	35.8	9.5	14.8	39.9	14.0	15.9	89.4	90.8	9.95	..
179	Yemen	33.1	38.0	29.0	61.0	12.9	24.0	44.8	..	85.1	68.4	63.4	1.53	7.0

Table 6 MENA region global food security index

Regional ranking	Country	Overall score	Affordability	Availability	Quality and Safety	Natural Resources and Resilence
1st	Israel	78.0	90.6	75.2	90.7	47.6
2nd	Qatar	73.6	83.8	74.4	83.5	43.4
3rd	Kuwait	72.2	80.1	72.3	86.4	43.0
4th	United Arab Emirates	71.0	75.9	71.3	88.8	43.6
5th	Oman	70.0	88.8	57.3	83.8	45.2
6th	Bahrain	68.5	79.2	67.5	79.9	39.1
7th	Saudi Arabia	68.1	75.0	67.8	79.8	44.3
8th	Turkey	65.1	67.6	61.6	75.8	56.4
9th	Jordan	64.6	80.4	55.2	63.5	54.2
10th	Algeria	63.9	77.9	58.0	62.0	50.7
11th	Tunisia	62.7	74.4	54.0	72.1	47.6
12th	Morocco	62.5	75.1	51.8	72.3	49.0
13th	Egypt	60.8	66.5	60.0	60.7	52.0
14th	Syria	37.8	34.0	30.1	53.2	43.3
15th	Yemen	35.7	39.3	27.6	37.4	42.1

Table 7 MENA region global food security index trends

Regional ranking	Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Last 10 Year change
1st	Israel	72.6	0.9	-0.1	3.0	1.1	-1.2	2.3	-0.4	-0.1	-0.1	+5.4
2nd	Qatar	66.2	3.0	3.2	0.1	-0.5	2.5	-1.4	1.7	-1.1	-0.1	+7.4
3rd	Kuwait	68.9	1.6	0.0	-2.9	-1.3	1.7	1.7	1.6	1.6	-0.7	+3.3
4th	United Arab Emirates	61.4	-1.1	1.2	2.3	-0.7	2.7	4.3	0.0	1.3	-0.4	+9.6
5th	Oman	58.1	1.0	6.9	0.1	2.8	1.4	0.6	-1.0	0.6	-0.5	+11.9
6th	Bahrain	63.2	1.7	2.2	-1.7	0.4	1.3	0.7	0.4	0.2	0.1	+5.3
7th	Saudi Arabia	63.6	2.1	0.9	2.0	-1.0	1.7	0.9	-1.5	2.8	-3.4	+4.5
8th	Turkey	64.0	-0.5	1.5	-1.0	0.5	1.4	-1.9	-0.5	-2.3	3.9	+1.1
9th	Jordan	65.0	-0.3	-2.8	2.3	0.1	0.3	-0.4	-0.8	1.5	-0.3	-0.4
10th	Algeria	53.2	-1.9	6.1	0.8	4.7	0.6	-0.2	0.4	-2.1	2.3	+10.7
11th	Tunisia	60.0	-2.3	0.7	0.8	0.6	3.4	-1.0	-0.4	-1.6	2.5	+2.7
12th	Morocco	54.1	0.7	0.9	2.7	-0.6	0.4	3.8	-2.8	2.9	0.4	+8.4
13th	Egypt	58.9	-0.4	1.0	2.9	-2.6	-1.8	-1.0	4.3	-1.5	1.0	+1.9
14th	Syria	41.2	-3.1	4.9	-0.2	-0.3	-3.2	1.0	5.1	-5.9	-1.7	-3.4
15th	Yemen	35.7	-0.5	-0.3	5.3	-3.8	-0.4	-1.3	0.5	0.0	0.5	0.0

Table 8 MENA region global food security index trends

Regional ranking	Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Last 10 Year change
1st	Israel	72.6	73.5	73.4	76.4	77.5	76.3	78.6	78.2	78.1	78.0	+5.4
2nd	Qatar	66.2	69.2	72.4	72.5	72.0	74.5	73.1	74.8	73.7	73.6	+7.4
3rd	Kuwait	68.9	70.5	70.5	67.6	66.3	68.0	69.7	71.3	72.9	72.2	+3.3
4th	United Arab Emirates	61.4	60.3	61.5	63.8	63.1	65.8	70.1	70.1	71.4	71.0	+9.6
5th	Oman	58.1	59.1	66.0	66.1	68.9	70.3	70.9	69.9	70.5	70.0	+11.9
6th	Bahrain	63.2	64.9	67.1	65.4	65.8	67.1	67.8	68.2	68.4	68.5	+5.3
7th	Saudi Arabia	63.6	65.7	66.6	68.6	67.6	69.3	70.2	68.7	71.5	68.1	+4.5
8th	Turkey	64.0	63.5	65.0	64.0	64.5	65.9	64.0	63.5	61.2	65.1	+1.1
9th	Jordan	65.0	64.7	61.9	64.2	64.3	64.6	64.2	63.4	64.9	64.6	-0.4
10th	Algeria	53.2	51.3	57.4	58.2	62.9	63.5	63.3	63.7	61.6	63.9	+10.7
11th	Tunisia	60.0	57.7	58.4	59.2	59.8	63.2	62.2	61.8	60.2	62.7	+2.7
12th	Morocco	54.1	54.8	55.7	58.4	57.8	58.2	62.0	59.2	62.1	62.5	+8.4
13th	Egypt	58.9	58.5	59.5	62.4	59.8	58.0	57.0	61.3	59.8	60.8	+1.9
14th	Syria	41.2	38.1	43.0	42.8	42.5	39.3	40.3	45.4	39.5	37.8	-3.4
15th	Yemen	35.7	35.2	34.9	40.2	36.4	36.0	34.7	35.2	35.2	35.7	0.0

2. Outlook of space capabilities in MENA countries

2.1 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 increasing 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.[19] 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.[20] 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.[21]

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*

Table 9 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

[19] Dario Sabaghi (2021), *"Investment and ambition: A history of Middle Eastern space exploration"*, *Middle East Eye*. Available at https://www.middleeasteye.net/news/uae-mars-middle-east-space-exploration-history.
[20] Simon Seminari (2019), "A Euroconsult Analysis: Examining government space budget", *SatMagazine*. Available at http://www.satmagazine.com/story.php?number=289878940. See also: Euroconsult's Government Space Programs 2018, 2019 and 2020 reports.
[21] Charles W. Dunne (2021), *Arab Space Programs Level Up*, Arab Center Washington DC. Available at https://arabcenterdc.org/resource/arab-space-programs-level-up/.

summarises the MENA countries' membership of regional and international formats,[22] as well as reports their engagement on international treaties governing space activities.[23]

2.2 Overview of national cases [24]

2.2.1 Middle East

Bahrain

Member *UNCOPUOS* ✓ *AfSA* ✗ *Arab Space Cooperation Group* ✓ *GCC* ✓ *CRTEAN* ✗ *ISNET* ✗ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✗ *LIAB* ✓ *REG* ✗ *MOON* ✗ *ITU* ✓

Policy and Programmes. The Kingdom of Bahrain established the National Space Science Agency (NSSA) in 2014 and recently adopted a National Space Policy (NSP).[25] 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".[26] In 2019, it signed a Memorandum of Understanding (MoU) with India for the development of domestic capabilities.[27] In 2020, the NSSA and the Italian Space Agency signed a MoU to establish cooperation.[28] Finally, the NSSA is also engaged in advancing Science, Technology, Engineering and Mathematics (STEM) opportunities and contribute to space scientific research.[29]

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".[30]

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[22] 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**).

[23] 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).

[24] **Colour code.** ***green*: *member/treaty ratified*; *red: not member/part*; *grey: treaty signed but not ratified*.**

[25] Bahraini National Space Science Agency - NSSA (2020), *Space Policy of the Kingdom of Bahrain and Strategic Plan 2019-2023*. Available at https://www.nssa.gov.bh/policy-booklet/english/NSSA_Brochure_English.html.

[26] The Daily Tribune (2021), "*Bahraini Space Scientists Gain Mission-Critical Experience From UAE*". Available at https://www.newsofbahrain.com/bahrain/73305.html ; The Daily Tribune (2021), *"Bahrain Links Up With Russian Space Science"*. Available at https://www.newsofbahrain.com/bahrain/72198.html.

[27] Hindustan Times (2021), "*India, Bahrain agree to bolster defence and security cooperation".* Available at https://www.hindustantimes.com/india-news/india-bahrain-agree-to-bolster-defence-and-security-cooperation-101617818189266.html.

[28] Agenzia Spaziali Italiana - ASI (2020), "*ASI-Bahrein, al Via la Collaborazione Spaziale*". Available at https://www.asi.it/2020/02/asi-bahrein-al-via-la-collaborazione-spaziale/.

[29] The Daily Tribune (2021), "*Bahrain Shapes The Future of Space Science*". Available at https://www.newsofbahrain.com/bahrain/70722.html; The Daily Tribune (2021), "*Bahrain's National Space Science Agency to Host Women in STEM Virtual Event*". Available at https://www.newsofbahrain.com/bahrain/71254.html.

[30] SpaceWatch.global (2018), *"Arab Space Leaders Commit to Regional Cooperation, Provide Update on Programmes"*. Available at https://spacewatch.global/2018/05/arab-space-leaders-commit-regional-cooperation-provide-update-programmes/.

Jordan

Member *UNCOPUOS* ✓ *AfSA* ✗ *Arab Space Cooperation Group* ✓
GCC ✗ *CRTEAN* ✗ *ISNET* ✓ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✗ *MOON* ✗ *ITU* ✓

Policy and Programmes. Jordan does not have a structured space governance nor agency devoted to space matters. Notwithstanding, the 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 United Nation Office for Outer Space Affairs (UNOOSA) for education in Arabic and aims to develop national efforts in space science and technology.[31]

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.[32]

Kuwait

Member *UNCOPUOS* ✗ *AfSA* ✗ *Arab Space Cooperation Group* ✓
GCC ✓ *CRTEAN* ✗ *ISNET* ✗ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✓ *MOON* ✓ *ITU* ✓

Policy and Programmes. Kuwait does not have a space governance or strategic policy. Although it ratified all relevant space treaties, Kuwait applied to the membership of UNCOPUOS (UN Committee on the Peaceful Uses of Outer Space) only in September 2021, affirming that it is in the process of building national space capabilities and launching a national satellite.[33] The country historically had in place a ground segment, composed of the satellite station *Um Alaish*, built in 1966 and expanded in the 1980s, that had been destroyed during the First Gulf War.[34]

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.[35] 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.[36] Another private initiative regards the development of a small vehicle for suborbital launches that since 2019 has completed all the

[31] United Nations Office for Outer Space Affairs - UNOOSA (2012), *The Royal Jordanian Geographic Center*. Available at: https://www.unoosa.org/pdf/pres/stsc2012/tech-04E.pdf.

[32] Jordan University of Science and Technology – JUST, *First Jordanian Satellite Programme*. Available at: https://www.just.edu.jo/pages/satellite.aspx; Andra Gentea (2017), *"Jordan's first satellite – JY1-SAT supported for the final integration by His Royal Highness Crown Prince Al Hussein bin Abdullah II"*, *ISISPACE*. Available at: https://www.isispace.nl/news/jordans-first-satellite-jy1-sat/.

[33] UNOOSA website (2021), *Application for Membership of the Committee on the Peaceful Uses of Outer Space: Kuwait.* Available at: https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_1052021crp/aac_1052021crp_19_0_html/AC105_2021_CRP19E.pdf.

[34] Sophie Smith, *"The Emerging Space Industry in Kuwait"*, The Euro-Gulf Information Centre (EGIC). Available at: https://www.egic.info/emerging-space-industry-kuwait.

[35] Orbital Space, *"QMR – KWT Mission"*. Available at: https://www.orbitalspace.org/qmr-kwt.

[36] SatelliteProme.com (2019), "Exploring a new space opportunity in Kuwait with Orbital Space". Available at: https://satelliteprome.com/tech-features/exploring-a-new-space-opportunity-in-kuwait-with-orbital-space/.

preparatory phases, led by the research group Kuwait Space Rocket.[37] 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.[38]

Iran

Member *UNCOPUOS* ✓ *AfSA* ✗ *Arab Space Cooperation Group* ✗ *GCC* ✗ *CRTEAN* ✗ *ISNET* ✓ *AUASS* ✗ *APSCO* ✓

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✓ *MOON* ✗ *ITU* ✓

Policy and Programmes. Iran established in 2003 the Iranian Space Agency (ISA) under the responsibilities of the Space Supreme 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.[39] 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.[40] 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.[41] 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. In 2009, Teheran launched the Omid satellite onboard the domestic rocket Safir, from the Semnan Satellite Launch Centre (Imam Khomeini Spaceport). In 2005, Iran produced its first satellite, the 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 due to several unconfirmed failures, involving both rockets and satellites. Overall, Iran developed four different rockets - Safir, Simourgh, Zoljanah and Qased - maturing over 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 counter-space weapons, such as electronic and cyber capabilities to disturb and confuse (jamming and spoofing) satellite transmissions and GPS signals.[42] Iran is not believed to be in the process of

[37] Kuwait & International website. Available at: https://www.kuwaitrocket.com/.
[38] Ahmad Al-Hamily (2017), "*Kuwait Space Agency… a pipedream or reality?*", *Kuwait News Agency* – KUNA. Available at: https://www.kuna.net.kw/ArticleDetails.aspx?id=2595274&Language=en.
[39] Aerospace website, *Statute of the Iranian Space Agency*. Available at: https://aerospace.org/sites/default/files/policy_archives/Iran%20Space%20Agency%20statute%20unofficial%20translation.pdf.
[40] Maziar Motamedi (2021), "*Iran Completes Satellite-Carrying Rocket Launch*", *AlJazeera*. Available at: https://www.aljazeera.com/news/2021/2/1/iran-completes-satellite-launch-test-with-new-rocket.
[41] U.S. Department of State website (2019), "*New Sanctions Designation on Iran's Space Program*". Available at: https://2017-2021.state.gov/new-sanctions-designations-on-irans-space-program/index.html.
[42] Dana Goward (2020), *"GPS circle spoofing discovered in Iran"*, *GPS World.* Available at: https://www.gpsworld.com/gps-circle-spoofing-discovered-in-iran/.

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.[43]

Iraq

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GCC ✗ *CRTEAN* ✗ *ISNET* ✓ *AUASS* ✗ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✗ *MOON* ✗ *ITU* ✓

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.

Industry and Economy. Iraq currently 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.[44] The satellite is officially registered in Italy and was launched in June 2014, on a Russian Dnepr rocket.

Israel

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Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✗ *MOON* ✗ *ITU* ✓

Policy and Programmes. Created in 1983, the Israel Space Agency (ISA) leads the national space programme. ISA supports scientific and space research, it promotes educational initiatives and over the years has established cooperation with several entities.[45] ISA developed the Venμs 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

[43] On Iran capabilities, see: Todd Harrison, Kaitlyn Johnson and Makena Young (2021), *Space Threat Assessment 2021*, Center for Strategic & International Studies (CSIS). Available at: https://www.csis.org/analysis/space-threat-assessment-2021; Andrew Hanna (2021), "*Iran's Ambitious Space Program*", *The Iran Primer.* Available at: https://iranprimer.usip.org/blog/2020/jun/23/iran%E2%80%99s-ambitious-space-program; Zhanna Malekos Smith (2020), "Iran's Space Program and the Wall Between Peaceful Purposes", Center for Strategic & International Studies. Available at: https://www.csis.org/blogs/technology-policy-blog/irans-space-program-and-wall-between-peaceful-purposes.

[44] Paride Testani, Paolo Teofilatto, Augusto Nascetti et ali (2013), "A Nadir-Pointing Magnetic Attitude Control System for Tigrisat Nanosatellite", International Astronautical Federation – IAF. Available at: https://iafastro.directory/iac/archive/browse/IAC-13/C1/1/18370/.

[45] Israel Space Agency website. Available at: https://www.space.gov.il/en/about.

UAE Space Agency.[46] 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 cost.[47] 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 rotation and demanding more propellant. From the end of the 1990s to 2020, Israel launched ten Ofeq satellites, for military reconnaissance and Earth Observation services.[48] 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 SpaceIL, 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

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Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✓ *MOON* ✓ *ITU* ✓

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.[49] 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 Ministry of Foreign Affairs (MFA), to strengthen scientific research activities.[50]

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

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GCC ✓ *CRTEAN* ✗ *ISNET* ✗ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✗ *ARRA* ✗ *LIAB* ✓ *REG* ✗ *MOON* ✗ *ITU* ✓

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

[46] Ricky Ben-David (2021), "*Israel, UAE to launch joint space projects, including Beresheet 2 Moon mission*", *The Times of Israel*. Available at: https://www.timesofisrael.com/israel-uae-to-launch-joint-space-projects-including-beresheet-2-moon-mission/.
[47] IsraelDefense website (2020), *"IAI Satellites - leading in space development".* Available at: https://www.israeldefense.co.il/en/node/47346.
[48] The New Arab website, "*Israel Launches New Spy Satellite as Iran Tensions Continue".* Available at: https://english.alaraby.co.uk/news/israel-launches-new-spy-satellite-iran-tensions-continue.
[49] UNOOSA website (1996), *Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space*. Available at: https://www.unoosa.org/pdf/reports/ac105/AC105_614Add3E.pdf.
[50] National Council for Scientific Research - CNRS website, "*Regional Research Programmes* CNR/CNRS-L". Available at: http://www.cnrs.edu.lb/english/fellowship-and-awards/research-programs-and-funding/regional-research-programmes/euro-mediterranean-cooperation-through.

the Space Communications Technology (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.[51]

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.[52] 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.[53]

Qatar

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GCC ✓ *CRTEAN* ✗ *ISNET* ✗ *AUASS* ✗ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✓ *MOON* ✗ *ITU* ✓

Policy and Programmes. Qatar does not have a space agency in place. The national interest for space is centred on satellite communication 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.[54]

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.[55]

Saudi Arabia

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Treaty Status *OST* ✓ *ARRA* ✗ *LIAB* ✓ *REG* ✓ *MOON* ✓ *ITU* ✓

Policy and Programmes. The Saudi space governance is traditionally centred on the King Abdulaziz City for Science and Technology (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.[56] 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

[51] Space Communications Technologies website (2020), "*Space Communications Technologies and Sultan Qaboos University signed a Memorandum".* Available at: https://omansat.com/omansat-squ-sign/.
[52] Times of Oman website (2021), "*Oman to Get Its First Satellite by 2024".* Available at: https://timesofoman.com/article/103325-oman-to-get-its-first-satellite-by-2024;
Satelliteprome.com website (2020), *"Oman to Launch Country's First Space Satellite in 2024"*. Available at: https://satelliteprome.com/news/oman-to-launch-countrys-first-space-satellite-in-2024/.
[53] Space Communications Technologies website (2021), "*SCT and Omantel Entering into an Agreement for Satellite Services"*. Available at: https://omansat.com/sct-and-omantel-entering-into-an-agreement-for-satellite-services/.
[54] Omani Ministry of Transport website, *Satellite Program*. Available at: https://www.motc.gov.qa/en/national-programs/ict-infrastructure/satellite-program.
[55] Qatar Satellite Company website (2013), *" Qatar Enters Space Age with Launch of Es'Hail 1"*. Available at: https://eshailsat.qa/en/Posts/view/48/12/qatar-enters-space-age-with-launch-of-eshail-1.
[56] Saudi Press Agency website (2021), "*Saudi Arabia is on the Verge of New Phase in Space Industry, With Its Global Investments are Estimated at More Than $350 Billion".* Available at: https://www.spa.gov.sa/viewfullstory.php?lang=en&newsid=2204535.

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.[57] 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.[58] Besides national satellites and capabilities, Riyad 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 Riyad-based company.

United Arab Emirates

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Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✓ *MOON* ✗ *ITU* ✓

Policy and Programmes. UAE is among the fast-developing space nations at global level, with a full governance in place.[59] The UAE Space Agency (UAESA) was established only in 2014 and is currently being chaired by Her Excellency Sarah bint Yousef Al Amiri, the UAE Minister of State for Advanced Technology. UAESA is responsible for organising, regulating, and supporting the space sector. UAESA is also responsible for the implementation of the national space strategy and Space Science and Technology Policy (SSTP Mohammed Bin Rashid Space Centre - MBRSC) represents the R&D, operative and technological arm of the national policy in this domain, and was founded in 2006. UAESA 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.[60] In 2020, UAESA signed an agreement with UNOOSA (UN Office for Outer Space Affairs) to create a space international hub in the Emirates to focus on space

[57] Arab News website (2021), "*Saudi Arabia Launches Two Locally Made Satellites*". Available at: https://www.arabnews.com/node/1829601/saudi-arabia; Times Aerospace website, "*Double Satellite Joy for Saudi Arabia*". Available at: https://www.arabianaerospace.aero/double-satellite-joy-for-saudi-arabia.html.

[58] Marwa Rashad, *"Saudi Arabia Plans $2 Billion Boost for Space Programme by 2030"*, *Reuters*. Available at: https://www.reuters.com/article/us-saudi-economy-space/saudi-arabia-plans-2-billion-boost-for-space-programme-by-2030-idUSKBN27D1ZH.

[59] UAE Space Agency website, *National Space Strategy 2030 (Summary)*. Available at: https://www.space.gov.ae/Documents/PublicationPDFFiles/2030-National-Strategy-Summary-EN.pdf; UAE Ministry of Justice website, *On The Regulation of the Space Sector*. Available at: https://www.moj.gov.ae/assets/2020/Federal%20Law%20No%2012%20of%202019%20on%20THE%20REGULATION%20OF%20THE%20SPACE%20SECTOR.pdf.aspx.

[60] Arab News website, "*Dubai Launches New Court to Rule on Commercial Disputes in Space".* Available at: https://www.arabnews.com/node/1801831/business-economy.

and sustainable development.[61] The first Emirati astronaut, Hazza al-Mansouri, was launched to the ISS on board the Soyuz MS-15 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 Arab astronaut, Noora Al Matrooshi, to participate in a mission.[62] 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.[63]

The Emirates Mars Mission and the Hope probe are the culmination of an international collaboration, knowledge transfer and development effort. It will contribute to providing knowledge and expertise to the scientific community through a trove of scientific data; providing full access to a holistic view of the Martian atmosphere at different times of the day, through different seasons. Example of recent data sample is the first global images of Mars in the far-ultraviolet, capturing unique global snapshots of the discrete aurora of Mars. Furthermore, in October 2020, UAE announced plans for an Emirates Lunar Mission (EML) to land the Rashid rover on the Moon by 2022.[64]

The Arab Space Cooperation Group was formed in 2019 by the UAE. It aims to enhance the exchange of knowledge, technical expertise, experiences, and information, as well encourage the development of scientific research and innovation to develop advanced space capabilities. It promotes the harmonisation of international laws and regulations and seeks to unify them as much as possible in line with global best practices. The Group aims to provide an ecosystem to develop regional skills and competencies to work on advanced projects, and sponsor initiatives and programs to prepare the next generation of space innovators in the region. Since its inception, the group focuses on the development of a climate monitoring satellite, named 813, a cooperation project between twelve MENA countries.[65] 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 seventeen 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 1 & 2) for Earth Observation, which play a major role in the knowledge development journey of local expertise, manufactured in

[61] UNOOSA website (2020), "*UNOOSA and UAE Space Agency Announce agreement to advance space sustainability".* Available at: https://www.unoosa.org/oosa/en/informationfor/media/2020-unis-os-532.html.
[62] Times Aerospace website (2021), "*UAE Names World's First Female Arab Astronaut"*. Available at: https://www.arabianaerospace.aero/uae-names-world-s-first-female-arab-astronaut.html.
[63] Mohammed Soliman (2021), "*The Geopolitics of Space: Why Did the UAE Send a Probe to Mars"*, Middle East Institute. Available at: https://www.mei.edu/publications/geopolitics-space-why-did-uae-send-probe-mars; Arnold Koka, *"HOPE: The UAE's Vision for Space Affairs",* The Euro-Gulf Information Centre. Available at: https://www.egic.info/hope-uae-vision-for-space.
[64] The New Arab website (2021), "*UAE to Send Rover to the Moon in 2022"*. Available at: https://english.alaraby.co.uk/news/uae-send-rover-moon-2022.; Mike Wall (2021), "*Japanese Ispace Lander to Carry UAE Moon Rover to Lunar Surface in 2022"*, *Space.com.* Available at: https://www.space.com/uae-moon-mission-ispace-lander-2022.
[65] Saudi Space Commission website (2020), *"Saudi Arabia Signs Charter of Arab Space Cooperation Group"*. Available at*:* https://saudispace.gov.sa/en/news/saudi-arabia-signs-charter-of-arab-space-cooperation-group/; Sam Bridge (2019), *"UAE-Led Arab Space Group Reveals 813 Satellite Project Plan"*, *Arabian Business*. Available at: https://www.arabianbusiness.com/technology/415968-uae-led-arab-space-group-reveals-813-satellite-project-plan; Connie Lee (2020), "*Middle East Allies Look to Expand Space Capabilities", National Defense*. Available at: https://www.nationaldefensemagazine.org/articles/2020/2/3/middle-east-allies-look-to-expand-space-capabilities.

cooperation with the South Korean Satrec Initiative company with an incremental involvement of national engineers and capabilities. 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).[66] The country is increasingly investing in the space sector and aims to create a regional hub for related business and activities. 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.

2.2.2 North Africa

Algeria

Member *UNCOPUOS* ✓ *AfSA* ✓ *Arab Space Cooperation Group* ✓ *GCC* ✗ *CRTEAN* ✓ *ISNET* ✗ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✗ *LIAB* ✓ *REG* ✓ *MOON* ✗ *ITU* ✓

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.[67] 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.[68] 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 Sahelof the UN Platform for Space-based Information for Disaster Management and Emergency Respons (UN SPIDER). Finally, ASAL offers advanced educational programmes in space-related technologies, including a Doctoral School.

Industry and Economy. Algeria has six satellites in orbit, including five active and one retired.[69] 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 United Kingdom 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

[66] UAE Space Agency website, *Global Navigation Satellite Systems - Augmentation System* (GNSSAS). Available at: https://www.space.gov.ae/Page/20121/20252/Global-Navigation-Satellite-Systems-%e2%80%93-Augmentation-System-(GNSSaS.
[67] Agence Spatiale Algerienne website (2019), "*Loi n° 19-06 du 14 Dhou El Kaâda 1440 correspondant au 17 juillet 2019 relative aux activités spatiales*", *Journal Officiel De La Republique Algerienne*, No. 47. Available at: https://asal.dz/wp-content/uploads/2020/12/Loi-spatiale-nationale.pdf.
[68] Agence Spatiale Algerienne website, *"Mission"*. Available at: https://asal.dz/?page_id=50 .
[69] Statement of Algerian Delegation (2018), 2nd International Space Forum, The African Chapter. Available at: https://www.iafastro.org/assets/files/events/isf/2017/statement-of-algeria-asal-2nd-isf.pdf.

Member *UNCOPUOS* ✓ *AfSA* ✓ *Arab Space Cooperation Group* ✓ *GCC* ✗ *CRTEAN* ✓ *ISNET* ✓ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✗ *MOON* ✗ *ITU* ✓

Policy and Programmes. Since 1991, the Egyptian space governance revolves around the National Authority for Remote Sensing and Space Sciences (NARSS). Created under the Ministry of Scientific Research, it conducts several research and cooperation activities.[70] 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. 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.[71]

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 are 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.[72]

Morocco

Member *UNCOPUOS* ✓ *AfSA* ✓ *Arab Space Cooperation Group* ✓ *GCC* ✗ *CRTEAN* ✓ *ISNET* ✓ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✓ *MOON* ✓ *ITU* ✓

Policy and Programmes. The Royal Centre for Remote Sensing (CRST) is the main space actor in Morocco. Created in 1989, it acts as an agency and main coordinator of space related activities, in cooperation with public institutions.[73] Morocco also hosts the Regional Centres for Space Science and Technology Education for French language, established 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 the 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

[70] National Authority for Remote Sensing & Space Sciences - NARSS, *"NARSS Cooperations"*. Available at: http://www.narss.sci.eg/cooperations.

[71] Mustapha Iderawumi (2021), "*Egyptian Space Agency Deliberates on Roscosmos Proposal to Train the Nation's First Cosmonaut", Space in Africa.* Available at: https://africanews.space/egyptian-space-agency-deliberates-on-roscosmos-proposal-to-train-the-nations-first-cosmonaut/.

[72] SpaceWatch.global website, "*Egypt Receives $72 million Grant from China for Egyptsat-2 Project"*. Available at: https://spacewatch.global/2019/01/egypt-receives-72-million-grant-from-china-for-egyptsat-2-project/.

[73] Centre Royal de Télédétection Spatiale - CRTS website, https://www.crts.gov.ma/; CRTS website, *Earth Observation to Support Socio-Economic Development,* Royal Center for Remote Sensing. Available at: https://crts.gov.ma/sites/default/files/CRTSPLAQUETTEAng.pdf.

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.[74]

Tunisia

Member *UNCOPUOS* ✓ *AfSA* ✓ *Arab Space Cooperation Group* ✓ *GCC* ✗ *CRTEAN* ✓ *ISNET* ✓ *AUASS* ✓ *APSCO* ✗

Treaty Status *OST* ✓ *ARRA* ✓ *LIAB* ✓ *REG* ✗ *MOON* ✗ *ITU* ✓

Policy and Programmes. The National Commission of Outer Space (CNEEA) represents Tunisia's main space entity, since its creation in 1984, together with the National Centre of Cartography and Remote Sensing established in 1988.[75] In 2018, the country began 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.[76] 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.[77]

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.[78] 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.

[74] Ghalia Kadiri (2017), *"Morocco's Secret Launch of a Powerful Observation Satellite Puts Neighbouring countries on Alert", France24.* Available at: https://www.france24.com/en/20171120-morocco-secret-launch-powerful-observation-satellite-puts-neighbouring-countries-alert; Shaul Shay, *"Morocco Seeks Space Edge Over Algeria and Spain", IsraelDefense.* Available at: https://www.israeldefense.co.il/en/node/32980.

[75] UNOOSA website, *Space Activities in Tunisia*, Centre de la Cartographie et de la Télédétection - CNCT. Available at: https://www.unoosa.org/pdf/pres/stsc2010/tech-05.pdf.

[76] Space in Africa website (2018), "*BeiDou Navigation Satellite System Centre Opens in Tunisia".* Available at: https://africanews.space/beidou-navigation-satellite-system-centre-opens-in-tunisia/.

[77] Telnet website (2021), *"Signature of an Agreement between TELNET Group and the Russian Space Corporation "ROSCOSMOS" for the Selection of a Tunisian Astronaut",* https://www.groupe-telnet.com/En/2021/08/13/signature-dun-accord-entre-telnet-et-lagence-spatiale-russe-roscosmos-pour-la-selection-dune-astronaute-tunisienne/.

[78] The New Arab website (2021), *"Tunisia Makes History With First Satellite in Space".* Available at: https://english.alaraby.co.uk/news/tunisia-makes-history-first-satellite-space.

3. 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 the socio-economic and environmental level can also evolve into serious emergencies and disasters, requiring 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, mobile phone penetration reached high rates in the last years and the demand of connectivity grows both in urban and rural areas.

In this context, space applications – categorised in multi-sensor 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.

3.1 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.[79] 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 (Regional Center for Remote Sensing of North Africa) also launched a project to monitor droughts and receive early warning from satellite data, relevant for agriculture and farming stakeholders.[80] 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.[81] Bahrain

[79] European Space Policy Institute website (2020), *"ESPI Special Report - COVID-19 and the European Space Sector", in ESPI Report.* Available at: https://espi.or.at/publications/espi-public-reports/send/2-public-espi-reports/516-covid-19-and-the-european-space-sector.
[80] The Regional Center For Remote Sensing of North Africa States website. Available at: http://www.crtean.org.tn/en/index.php/projects/ldas.
[81] http://www.isnet.org.pk/pages/technical-projects.asp.

developed a project to react in the event of oil spills to monitor the evolvement of the incidents and allow efficient recovery operations and increase the transparency of such episodes.[82]

The UAE Space Agency is manufacturing the Meznsat 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.[83]

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.[84]

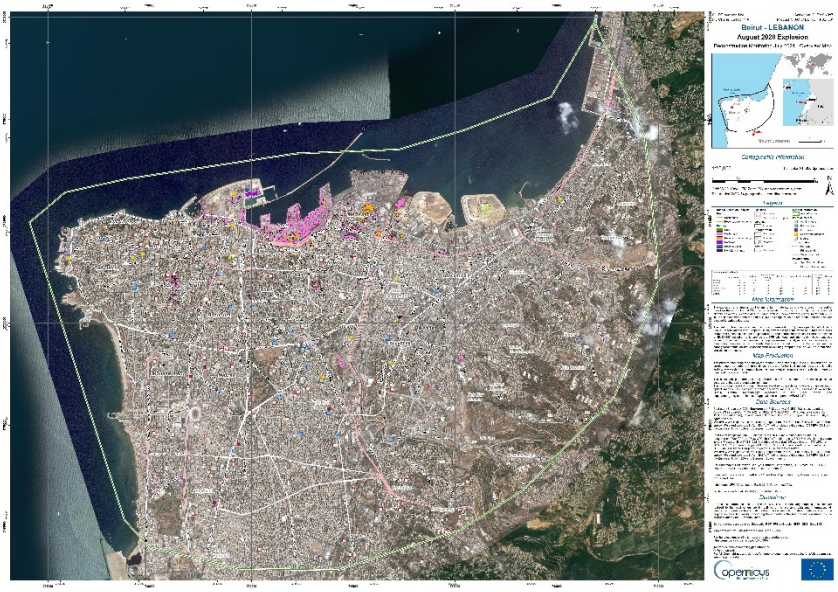

Figure 2 Copernicus EMS reconstruction monitoring in Beirut

[82] The Daily Tribune (2021), "*Bahrain Polytechnic Student Develops Unique Project to Detect and Monitor Oil Spills from Naval Vessels"*. Available at: https://www.newsofbahrain.com/bahrain/74559.html.
[83] C. Stewart. (2020), SAR for Archaeological Prospection in Europe and in the Middle East, in D. G. Hadjimitsis et al. (eds.), Remote Sensing for Archaeology and Cultural Landscapes, Springer Remote Sensing/Photogrammetry.
[84] UN-SPIDER Knowledge Portal website (2021), "*Workshop on the Space Technology Applications for Drought, Flood and Water Resource Management"*. Available at: https://un-spider.org/news-and-events/events/united-nationsislamic-republic-iran-workshop-space-technology-applications.

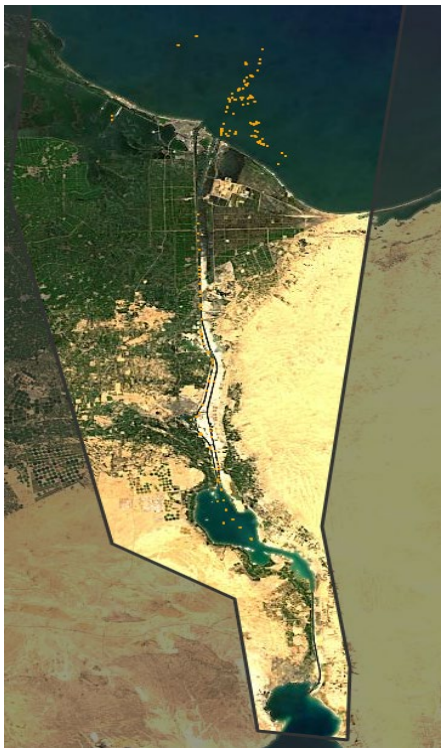

Figure 3 Shipping activity through Suez (activity shown in orange)

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.[85] Activations concerned as well Syria, Libya, Yemen and the Gaza strip, for post-conflict damage assessment and logistic coordination for refugees.[86] The Iranian Space Agency also requested the service in 2020 to analyse the impacts of an unprecedented wildfire to several areas and land classes.[87] Copernicus even contributed to manage the Ebola outbreak in West Africa in 2014, helping to identify the environmentally hazardous areas and support emergency preparedness.[88]

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.

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.[89] Other insights and economic intelligence from satellite imagery

[85] Copernicus Emergency Management Service website (2021), *"EMSN087: Reconstruction monitoring in Beirut, Lebanon, Following August 2020 Explosion, for the Reform, Recovery and Reconstruction Framework (3RF)*. Available at: [illegible]list-of-components/EMSN087.
ce website (2021), "*EMSN096: Damage assessment and reconstruction Monitoring of Urban Areas in Syria*". Available at: [illegible]emergency.copernicus.eu/mapping/list-of-components/EMSN096; Copernicus Emergency Management Service website (2017), *"EMSN033: Satellite Based Conflit Damage Assessment of Two Selected Cities in Libya"*. Available at: https://emergency.copernicus.eu/mapping/list-of-components/EMSN033; Copernicus Emergency Management Service website (2018), "*EMSN058: Satellite-Based Conflict Damage Assessment of Two Selected Cities in Yemen"*. Available at: https://emergency.copernicus.eu/mapping/list-of-components/EMSN058; Copernicus Emergency Management Service website (2014), *"EMSR103: Agriculture Assessment in the Gaza Strip"*. Available at: https://emergency.copernicus.eu/mapping/list-of-components/EMSR103 .

[87] Copernicus Emergency Management Service website (2020), *"EMSN079: Post-Disaster Assessment After Wildfire Events in the South and Southwestern Regions of Iran"*. Available at: https://emergency.copernicus.eu/mapping/list-of-components/EMSN079

[88] Copernicus website (2014), *"Tracking the Outbreak of Ebola: How Copernicus Supports Emergency Response"*, in *ISSUE 47*. Available at: https://www.copernicus.eu/sites/default/files/documents/Copernicus_Briefs/Copernicus_Brief_Issue47_Ebola_October2014.pdf

[89] Earth Observing Dashboard website (2020), *Suez, Ports: Ship Throughput.* Available at: https://eodashboard.org/?country=EG&poi=EG01-E13c

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.[90]

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.

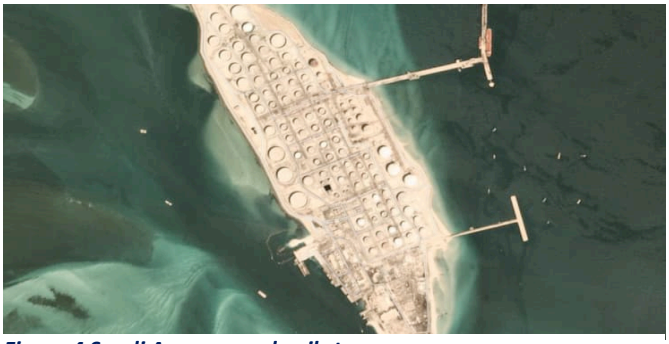

Figure 4 Saudi Aramco crude oil storage

3.2 Satellite Navigation

Positioning, Navigation and Timing (PNT) are commonly recognised as critical elements 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 GPS and Galileo is used by first responders, helicopters and rescue operators. Overall, satellite navigation became essential for aviation, road, naval 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.[91]

No country in MENA has yet implemented a regional satellite navigation programme. However, the UAE is currently developing the GNSSaS (Glbal Navigation Satellite Augmentation System), composed of small satellites to be launched in LEO improving the signals of larger constellation.[92] 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.

[90] World Cereal website. Available at: https://esa-worldcereal.org/en
[91] Galileo Green Lane website. Available at: https://galileogreenlane.eu/about.php
[92] UAE Space Agency website, *“Global Navigation Satellite System – Augmentation System* (GNSSAS)*”*. Available at: https://www.space.gov.ae/Page/20121/20252/Global-Navigation-Satellite-Systems-%e2%80%93-Augmentation-System-(GNSSaS)

3.3 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.[93] 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.

[93] Fiber Connect Council Mena and North Africa website (2021), *"Oman Broadband Adapts a New Technology for Rural Areas (USO Project) Broadband Coverage"*, in *Members News*. Available at: https://www.fiberconnectmena.org/index.php/en/members-news/1213-oman-broadband-adapts-a-new-technology-for-rural-areas-uso-project-broadband-coverage

4. 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.[94]

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[95], despite some opportunities for de-escalation and cooperation.[96] 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.

4.1 Four implications for space policies and capabilities

Figure 5, Israel launch of Ofek satellite

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

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 (Russia, 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.

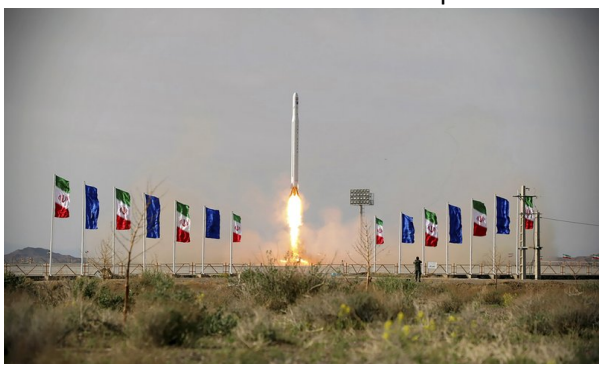

Figure 6, Iran launch of Noor satellite

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.

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[94] For a seminal theorization of what is a regional security complex see: Barry Buzan and Ole Wæver (2003), *"Regions and Powers. The Structure of International Security*" (Cambridge: Cambridge University Press). Available at: https://www.cambridge.org/core/books/regions-and-powers/9E0B611D4C01CECD704651B273646E1D

[95] See in this regard, among others: Sonia Lucarelli, Alessandro Marrone, Francesco Moro (eds.) (2017), "*Projecting Stability in an Unstable World*", NATO HQ. Available at: https://www.iai.it/en/pubblicazioni/projecting-stability-unstable-world

[96] On a positive agenda for de-escalation, dialogue and confidence building see: Silvia Colombo and Andrea Dessì (2020), *"Fostering a New Security Architecture in the Middle East",* Foundation for European Progressive Studies (FEPS) and Istituto Affari Internazionali (IAI). https://www.iai.it/en/pubblicazioni/fostering-new-security-architecture-middle-east

A third implication of the aforementioned trend 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[97] and China[98] will factor space cooperation in the struggle for influence in the region, and European countries may do the same albeit on a smaller scale[99]. 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.

[97] For an in-depth assessment of Russia's role in NATO southern neighbourhood see: Vice-Admiral (ret.) Pascal Ausseur et ali (2021), *"*Russia in NATO's South*: Expansionist Strategy or Defensive Posture?",* Edited by Chloé Berger and Cynthia Salloum*,* NDC Research Paper No. 16.

[98] On China engagement in Africa and Middle East see: NATO Strategic Direction South Hub (2021), *"China's engagement in Africa and the Middle East"*. Available at: https://thesouthernhub.org/publications/nsds-hub-publications/china-engagement-in-africa-and-the-middle-east.

[99] For a comprehensive analysis of US and Europe's involvement in MENA see: Nathalie Tocci et ali (2021), *"From Tectonic Shifts to Winds of Change in North Africa and the Middle East: Europe's Role", IAI Papers* 21-12. Available at: https://www.iai.it/en/pubblicazioni/tectonic-shifts-winds-change-north-africa-and-middle-east-europes-role

5. Key Findings

5.1 Space is a catalyst for regional cooperation

In the wide and diverse landscape of the MENA region, space is an essential resource for security and prosperity. Power projection and regional ambition certainly are strong factors to engage in the space sector. This remains true for a region which is often perceived as instable and fragmented. Nevertheless, ongoing developments demonstrate that MENA countries do not often identify with the idea of a space race, but rather value cooperation to achieve common goals and overcome different views. In this sense, the MENA region also offers a fresh perspective compared to the international one, more dominated by the recurrent concept of race and competition. Indeed, working together in space requires trust and transparency, emphasizing the significant role of space and science diplomacy to tie, restart, or consolidate relations between countries. The African Space Agency, the Arab Space Cooperation Group, satellites projects as well as Martian and Lunar missions are all examples that set the right direction to be pursued to go further and together. Space can provide an ideal platform as an icebreaker to connect different entities and allow to build dialogue and possibly move forward on other issues.

5.2 Space education and STEM engagement are strategic

Young people are more than 100 million in the MENA region. It is then critical and strategic to provide them opportunities for jobs and education. In this sense, it has been remarked that science and space can represent a social stabilizer to younger generations. A high demand of education needs to be met by a quality education offer within the countries and the region at large. STEM (Science Technology Engineering Mathematics) matters can indeed represent an optimal solution, allowing to enrich countries with professionals and scientists. Moreover, quality opportunities would create favourable conditions to build a solid national space sector, possibly covering the whole space value chain. In this sense, satellites and probe missions can be instrumental in raising awareness to the youth on the importance of science and STEM. Nonetheless, the role of governments and public institutions is critical to cultivate human resources and assure education and training opportunities. Universities have a crucial role to assure the education offer and the development of capabilities. As societies become more globalized, so are the opportunities, and some MENA countries should be aware of the risk of losing parts of their national know-how matured with engineers and scientists, who may travel abroad in search of better jobs. Moreover, education provides room for cooperation between universities, countries, and people. In this sense, partnerships and further commitments from countries and involved entities would be ideal to create more opportunities for growth and cooperation.

5.3 Institutional setting is key

Space agencies are critical entities that act as a transmission belt, connecting different bodies and institutional requirements. The creation of proper agencies and a legislation framework is often a fundamental building block that ensures the existence of strong relations with partners and facilitates the emergence of a space sector. Space agencies can also be an essential distributor of education and training opportunities. A robust institutional setting could indeed facilitate to understand the local priorities and dynamics, raise awareness directly to the governments and decision-makers when required, and accelerate the creation of a network across different bodies, nations, and generations. The role of youth associations should be highlighted and reinforced as positive and often spontaneous element that connects people and

informs about opportunities. Besides space agencies and associations, external or neutral organisations are also deemed important to achieve a high level of coordination and governance. Therefore, a balance between top-down and bottom-up approaches should be explored. In addition, the distinction of civil space programs, procurement, and goals from military ones may be considered important to assure trust among regional actors. Indeed, the security context of the MENA region could impose to some actors to separate civil and military efforts and activities.

5.4 Growing domestic capabilities

Currently, there is in MENA countries a pattern to develop domestic competences in the space sector while acquiring satellites and space capabilities. In the previous decades, governments often procured the overall missions to external companies. More recently, the trend shows an increasing participation of the procuring countries and institutions in the manufacturing process as well as in the final tests, assembly and integration phases. Cooperation among universities and/or research centres is also essential to allow rapid developments in the know-how. Human and financial resources are the prerequisite of flourishing space sectors in the MENA region. While winning over policymakers may represent one of the biggest challenges for the advancement of science and technology, there could be a momentum at global level – due to thriving space economy and popular endeavours also by private companies – that is favourable to raise awareness at the political level on the importance of space. Investments in space are very long-term and would be relevant also to enable technology transfers in other sectors, including medical research that can benefit from space-developed know-how and materials.

5.5 Influence of New Space

The evolution and high pace of development of the space sector – often channelled in the “New Space” idea – have a strong influence also on the MENA region. Nanosatellites and CubeSats technology are key examples, as assets are increasingly cheaper and easier to produce thanks to Commercial Off-The-Shelf (COTS) components the miniaturisation of technology. In certain states, these technological advancements are at the basis of the domestic approach to space and allow institutions and/or research centres to develop and launch national capabilities at limited costs. As is true for big powers, the MENA countries as well need to keep the pace of the rapid developments in space and acquire and adjust also the legislative and regulatory frameworks, including the insurance one, to facilitate the emergence of start-ups and favour the business environment.

5.6 Space for development

MENA is among the world driest regions and is one of the most impacted ones from climate changes, coupled with destabilising demographic trends, increasing urbanisation and limited availability of water resources. Droughts, desertification, deforestation, erosion of lands, coastal damages are examples of climate change acting a threat multiplier. Space contributes significantly to socio-economic development as well as risk and disaster mitigation, environmental and climate analyses. In this light, climate change could represent an opportunity multiplier thanks to the applications of Earth Observation data that can enable proper and targeted responses to specific threats, analysing local challenges and rebooting agriculture and other economic opportunities.

5.7 Influence of the international context on the security outlook

Space exploration and space law were born in the Cold War security environment. Today, the environment is still competitive and contested, and space is growingly essential not only for the functioning of military capabilities but also for the new Multi Domain Operations. Assets (including the ground segment) are considered critical infrastructures, facing increasing threats from direct-ascent and co-orbital weapons, as well as cyber, electronic and laser weapons. The international context influences the countries in this area and the medium to long-term strategic outlook of the whole region, as Russia and China are often partners to MENA states, also through direct investments in space capabilities, facilities and training opportunities. For instance, China has provided grants to some states and has pushed the acquisition of its technology, trying to enlarge its influence in the region. Moreover, the MENA region will have to face the increasing technologically advanced nature of threats, from Artificial Intelligence (AI) to cyber and quantum, fast developing at the international level.

The MENA region is actively participating in the global space community. There are good prospects for forthcoming developments thanks to the consolidation of the institutional setting across the involved countries and multilaterally. The multiple applications of space already contribute to socio-economic development, but there are many further opportunities which need to be further supported. The region thus offers large margins of growth in space, in terms of cooperation and development of capabilities, which in turn re-emphasise the role of external bodies to connect, understand and learn the dynamics and challenges, and monitor future progress, given the MENA relevance and operational need at the global level with a rapidly evolving paradigm shift in the space sector.

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