



The Importance and Social Impacts of Space Studies in the Context of International Relations in the Post-pandemic Period

Lokman Kuzu

Prof. Lokman Kuzu

He received a B.Sc degree in Electrical and Electronics Engineering from Middle East Technical University (METU) in 1997. He obtained his M.Sc. and Ph.D. degrees from Syracuse University, in 2003 and 2006, respectively. Dr. Kuzu worked as the Director of the Space Technologies Research Institute of TUBITAK between 2014-2019. He worked on satellite projects such as TURKSAT 6A, the first domestic communications satellite of Turkey and high resolution observation satellite İMECE. He is an expert on RF/Microwave. He is a faculty member of the Electrical and Electronics Engineering department at Karabuk University and also he is the board member of Turkish Space Agency.

The Importance and Social Impacts of Space Studies in the Context of International Relations in the Post-pandemic Period¹

Lokman Kuzu

Turkey Space Agency Board Member

lokman.kuzu@tua.gov.tr

Abstract

Driven by Cold War tensions between the US and the Soviet Union, the space race began in the late 1950s. As satellite technologies have become an integral part of our daily lives, they have profoundly influenced the course of human civilization for more than 60 years. These technologies have provided humanity with many remarkable insights the world over. For example, observation satellites provide a continuous view of our planet for effective monitoring of the environment. There are clear turning points in history when things changed and new courses were plotted. The space community is experiencing such a point today. In this paper, we briefed the space sector and we tried to give some information regarding the impacts of the COVID-19 outbreak to this sector. We also highlighted the importance of working together to find solutions to the problems that humanity is now facing. In this new era, only the cooperative approach to space can ensure that all countries and peoples can benefit from what space activities have to offer.

Keywords

Astronomy, COVID-19, Satellite Technologies, Space

¹ This study is a translation and updated version of the paper previously published in the book titled "Küresel Salgının Anatomisi: İnsan ve Toplumun Geleceği" by TÜBA in June 2020.

Introduction

The novel Coronavirus COVID-19 (technically named as SARS CoV-2), which emerged in Wuhan, China in December 2019, has quickly spread to many countries and caused government agencies to take drastic measures in order to contain spreading. The pandemic had an impact on almost every sector one way or another. The way people work has changed, their awareness of hygiene has increased. By virtue of the fact that the virus is not known exactly, each country has made its own decisions in its own way. Some enforced isolation, some partial isolation. Others preferred the herd immunity method.

The World Health Organization (WHO) first underestimated the incident, considered the virus epidemic, and then declared a pandemic on March 11 when it noticed that the virus spread rapidly to 6 continents and more than 100 countries. WHO had concluded this decision late, primarily in order not to cause anxiety. The virus continued to spread rapidly throughout the world (Que, 2020). The fact that the virus spreads quickly brought the question of “is it a modified virus?” to the agenda. At this stage, almost all countries had to return to the practice of isolation. They even decided to act together in order to struggle with COVID-19. In addition, countries have started to introduce economic packages to overcome the crisis. Some of the projects excluding the urgent ones have been stopped or postponed.

Travel bans were imposed. International flights and even intercity trips were banned. Short-term curfews were announced. People started to work from their homes. As a matter of fact, they even started to conduct social meetings through applications that allow video calls. From young to elderly, people have learned to shop online and meet via the internet. Schools and universities have set up infrastructures for online classes and started to have online classes. In this way, they try to complete their education. Some universities even transferred their promotions to digital media.

All these developments have deeply influenced social and economic life. In order to prevent the spread of the COVID-19 virus, most people had to stay in isolation, thus digital media became more and more used. Attacks on applications used on computers, tablets and mobile phones have increased, and fake mobile applications have emerged under the mask of the coronavirus theme. (Intel Probe, 2020). In the internet environment, information full of mistakes began to spread rapidly and the concept of infodemic, which expresses the rapid circulation of dirty information, came into our lives.

In the pandemic period, especially the production, transportation and aviation became the sectors that were negatively affected. There were some developments in the healthcare and pharmaceutical industry. Specialists have made great efforts in order to develop the vaccine. There were also some positive changes regarding the environment (Resilience of the Space Sector to the COVID-19 Crisis , 2020).

Along with the pandemic, the way companies work has begun to change. We now have online meetings. Digital programs entered our lives more in this period. Online barbers who describe hair cutting and direct the customer for a certain fee have appeared (You Probably Need a Haircut, 2020). Virtual babysitters started to serve (SitterStream, 2020). Video calling programs started to be benefitted for marketing and sales. For instance, farmers started to sell their products through these platforms.

Space and astronomy studies have inevitably been affected in this isolation period. Although some projects are delayed and some companies have gone bankrupt, it is observed that the works are still ongoing. However, services received from orbiting satellites did not decrease but rather increased. This once again demonstrated the importance of space technologies during the pandemic.

A Brief History of Space-Age

Human beings have been watching outer space and celestial bodies for thousands of years. In 1609, Galileo used a telescope for the first time for space observations. Since that day, thoughts for space changed as telescopes developed. Since the inception of the space age, human beings began to place and use space telescopes in earth orbit. The Hubble space telescope is the most known. As science and technology progressed, models for the world and the universe evolved and changed over time.

The year 1957 was appointed the International Geophysical Year. It started on 1 July 1957 and ended on 31 December 1958. There was almost no scientific sharing between East and West during the cold war period. Countries that could not meet agreed to carry out scientific work together in this 18 months. This project has put an end to this period. The Russians reported that they

would put a satellite into orbit in 1955. Two years later, on 4 October 1957, they placed the Sputnik-1 satellite into orbit. This incident made a tremendous impact on American media. The fact that the party who gave a start to this race was Russians after the World War II caused panic among Americans. The space-age has begun.

Following this date, developed countries, particularly within the scope of the projects of the two countries, placed hundreds of satellites into orbits of the earth and other celestial bodies. Space was deemed as a military supremacy as well as a prestige race. Many accidents and failures have occurred. However, no country has given up on its goal.

Mankind first went into space in 1961 when Russian cosmonaut Yuri Gagarin entered orbit. A person stepped on the moon for the first time in 1969. Although the space race seemed to be over, the race actually slowed down a little, but the sector continued its growth trend.

The utilization of satellites in the war took place in 1967 during the Vietnam War. On one hand, satellites were launched for civilian applications and scientific studies, on the other hand, military satellites were launched. Navigation satellites were introduced as a military project, and over time these services came into the civilian service.

As of today, we can handle the satellite industry basically in four parts: the production of satellite and satellite components, the production of ground segment equipments, the production of launchers and satellite services. Pursuant to the predictions for the end of 2021, the space sector refers to a sector of 370 billion dollars. It achieves growth every year. This sector is expected to exceed 600 billion dollars in the 2030s and 1 trillion dollars in the 2040s (Viens, 2019).

Space economics refers to the utilization of all the activities or resources that produce value and benefit to people during exploring, research, understanding, management and use of space. It has entered into our social life in many fields such as space technologies, agricultural planning, disaster management, medicine, cultivation, transportation and urban planning. It has been the driving force of economic development and innovation in many sectors from agricultural food products to healthcare, from the environment to communication in developed countries.

Space projects are much more difficult than the designs of the systems that will be operated on earth. Human beings have found the answers to many engineering problems while manufacturing equipment that will work in space conditions. So the outcomes of the project are not just limited to space. More often than not, technologies used in daily and professional life are also developed. There are many technologies NASA has developed in this regard. NASA publishes the Spin-off list every year. There are many products presented

for the benefit of humanity in many fields from healthcare to consumer goods, from transportation to information technologies (NASA, 2020a).

Distinguishing features of this sector are that states are involved and projects and investments take too long. Sometimes projects can be long enough to cover the entire engineering life of a person, and sometimes even exceed his/her life. For example, the Voyager-1 and Voyager-2 projects of NASA were commenced in the 70s and are still ongoing projects. Therefore, most of the time, projects have been developed by the states. However, space shows itself to be the field of activity of civil companies in the late 1990s. SpaceX, Blue Origin and Virgin Galactic companies can be mentioned as the best examples for this.

Space projects can also be too big-budget and risky to undertake for civil initiatives. Therefore, such projects are carried out thanks to the collaborative approaches of the states. While doing these, the priorities of the state were determined and budget was transferred to such projects. The International Space Station (ISS) is one of the best projects that countries collaborate with. Even in periods of escalated tension between countries, the project was not affected.

Social Impacts of Space Technologies

Perhaps the most profound impact of space technologies on societies is to create an informed and socially interacted society, and as a result, to form a global village (Joseph A. Angelo, 2003). Satellite TV broadcasts were first used in the Tokyo Olympics in 1964. This publication was performed by INTELSAT. In so far as the system is expensive, satellite TV broadcasts hardly became widespread in the 1980s. It has become widespread in Turkey in the late 1990s.

Taking into account that the language of scientific articles produced in the world is, to a large extent, in English, this situation is thought to destroy cultures and eliminate differences. There are 17 sustainable development goals contemplated for the world before the UN. In this context, in case of disaster, they have very important goals such as acting in a collaborative manner and following up on the global climate in order to minimize losses (United Nations Department of Economic and Social Affairs, 2020).

Satellites serve in many areas. Among them, these can be mentioned: communication, disaster follow-up, mapping, agriculture, weather, security, and intelligence. It is of vital importance for humanity to predict and take precautions before disaster comes. In 2011, there was a tsunami in the Sendai earthquake and Japan used satellites to detect and prevent disasters.

Impact of COVID-19 on the Space Industry

Global Satellite Services Industry

When we assumed that the entire satellite industry is about \$ 370 billion, the sale of satellite observation data consists of \$ 3 billion of this amount. The growth in this sector is expected to be around 7% this year. Besides its use in defense and intelligence, such satellites provide very useful information in terms of agriculture and preventing and delivering services against natural disasters.

Recently, interest in small satellites has increased and small companies that have become advantageous in this sector have emerged. Moreover, the information obtained with the Copernicus and Landsat programs is now processed using artificial intelligence (AI). Thanks to this, capturing and interpreting the changes became easier. For example, images from satellites immediately show the fact that the car manufacturing plants are not working full. The course of ship transport and the density of the ports can also be determined immediately thanks to the observation satellites.

Food security is one of the most important issues in corona days. The way to follow this strictly is through the data received from observation satellites. In the images obtained from the planting areas, yield estimation can be made. This information has become very significant for the policies to be developed on food.

Pursuing the aviation industry has also become very easy thanks to satellites. Through the radar satellites, the number of aircraft in the air is determined. After the COVID-19 pandemic, there has been a great decrease in flights. Both business and holiday travel stopped and some airline companies have gone bankrupt.

Observation satellites have offered very substantial advantages in monitoring the borders of countries and in developing border policies. Furthermore, satellites are used in order to reveal the industrial and environmental impacts of the COVID-19 pandemic.

Satellite operators that offer TV and radio services such as Turksat and Intelsat have a 60% share in the satellite industry. While the ground sector is about 28%, launchers refer to 3%, and satellite manufacturing refers to about 9%. Operators switched to remote operation during the COVID-19 period. Much as launching new satellites became a problem, existing satellites in orbit continue to serve. However, due to the problems in the supply chain, there are problems in the installation and completion of the newly launched satellite ground stations. In addition, TV content producers experienced a decrease in advertisement revenues because they could not produce content such as movies and series. Due to the fact that the local and regional TV channels take a small share from advertisement, they encountered greater financial

difficulties during this period. Business plans of satellite operators serving worldwide have also changed and their revenues decreased (Satellite Today).

Environmental Impacts

As industrial activities mostly stopped, the COVID-19 pandemic has positive impacts on the environment. With the help of the sensors on the satellites, polluting substances such as ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide and methane can be detected. Copernicus Sentinel-5P satellite currently mapped air pollution over Europe and China and detected a significant decrease in Nitrogen Dioxide intensity (G-Nous).

Beijing, the capital of China, is one of the metropolises that have the most polluted air in the world. Based on the information obtained from observation satellites, the air was cleared in February and March of this year. But, when the isolation was relieved, the factories started to work again and the air started to resume its former condition.

A Canadian firm plans to launch a satellite fleet to perform studies on such air pollution (Space News, 2019b). Last year Europe called for cooperation with America, Japan and other countries on satellites which will be developed to monitor greenhouse gases (Space News, 2019a).

Bartolomeo, Europe's first commercial external platform to be built on ISS, went to ISS on March 7th with a SpaceX rocket. This platform is designed for commercial use of ISS. Companies and research institutions will use this platform in order to carry out their experiments in space conditions.

Impacts of COVID-19 on Satellite Projects

On the one hand, some space agencies announced a delay in their projects, on the other hand, others never mentioned. Institutions have developed projects to keep people at home. The "NASA at Home" project came to existence as a result of such an intention. It organizes events to introduce space to people of all ages, to enable them to experience enjoyable activities, and to make them watch. The rules of isolation should be followed so that the spread of the virus can be controlled.

Of the 560 astronauts who went to outer space, only eight went as tourists. The first tourist who went to outer space is American businessman Dennis Tito. In 2001 he went to the International Space Station with the Russian spacecraft. In 2020, space tourists would go to space with a 90-minute flight for 250 thousand dollars. However, COVID-19 brought these projects to a standstill.

During the COVID-19 pandemic, NASA has identified a four-stage framework for work and has switched to remote work as far as possible in all its facilities. It continues its projects with minimum personnel. It announced that it will close the Stennis Space Center in Mississippi and the Michoud Assembly Facility in New Orleans. This means the delay of the SLS launch and the Orion capsule

to be used for Artemis projects. Moreover, summer internships will be re-evaluated. (NASA Artemis Mission Coronavirus, 2020).

NASA has assumed other tasks in this struggle. Engineers working in the Jet Propulsion Laboratory (JPL) lab have designed a fan for COVID-19 patients. NASA also opened calls and motivated its engineers to implement the obtained ideas. Another center of NASA has initiated a study in order to eliminate the lack of critical medical equipment. They have also triggered off studies to develop joint projects with some companies (NASA Press-Release). It is said that some of the NASA and UAE Space Agency projects still prosper. However, we do not have satisfactory information about the projects of the Chinese Space Agency (CNSA).

The European Space Agency (ESA) announced on March 31th that it allocated a budget of 10 million Euros for distance education and health. More than 120 project proposals came in three weeks. When the proposals and ideas were considered to be of good quality, the budget was doubled (ESA Website). ESA's project called Mars rover, Rosalind Franklin, was having trouble with the parachute system. The pandemic further extended the delay and is now planned to be launched in 2022 (Space Astronomy). The second ExoMars mission developed by ESA with Roscosmos was also postponed to 2022. Both sides decided to re-perform hardware and software tests on this spacecraft. They do not want any margin of error in a module that will go to Mars. The mission of BEPiColombo, which is a co-production of ESA and JAXA, achieved its close transition to the world as of April 10th. It is now heading towards the planet Mercury. Some of the ESA employees work remotely, while others pay attention to social distance.

As it is known, Turkey Space Agency was established by Presidential decree No. 23 on December 13th, 2018. When we examine the calls opened during the COVID-19 period, there was an opportunity to give the response to countries seeking cooperation. We have the infrastructure and human resources to utilize these opportunities (Turkish Policy). When we look at the satellite project developed in Turkey, two projects are noteworthy. Turksat 6A communication and IMECE observation satellite projects developed at TUBITAK Space Technologies Research Institute. Satellite tests at the TUSAS AIT (Assembly, Integration and Test) center are ongoing. However, due to the COVID-19 pandemic, flexible work was applied and some people stopped working on projects because of health reasons. Turksat 5A and 5B communication satellite projects developed by Airbus are ongoing in England and France. Even though they have been affected by this process, satellites will be ready to launch in 2021.

The Impact of COVID-19 on the Astronomy World

The pandemic also affected astronomical activities worldwide. Besides many conferences and activities in all subjects have been affected, conferences held by the astronomy community were postponed to a later date or canceled. Some

conferences and seminars started to be held in the form of webinars in a virtual environment (Space Agenda). The activities may start after the travel bans are lifted, but this situation is expected to extend to this summer.

The International Astronomy Congress (IAC), which was commenced in 1950 and is recognized as one of the most important conferences on space, would be held in Dubai. Due to the COVID-19 pandemic, it will be held online in October this year. The congress to be held next year will be held in Dubai between 25-29 October 2021. Other delays and suspensions due to the outbreak can be listed as follows:

- *Studies at the Mauna Kea Observatory in Hawaii were suspended pursuant to the governor's decision to stay home.*
- *LIGO (Laser Interferometer Gravitational wave Observatory) laboratory in the USA also suspended its third observation study.*
- *The astronomy observation facility on the Canary Islands was closed following the decision taken by Spain.*
- *The SOFIA project, which NASA developed together with the German Space Agency DLR, was also suspended. Its budget was canceled for 2021.*

The Annular eclipse, which will take place on June 21th, will be observed from Africa and South Asia. Since the flights are banned, some scientists will be able to go to the observation with special permits. For the amateur astronomy community, this permit will be a little more difficult. TÜBİTAK National Observatory (TUG) is an observatory located in the Taurus Mountains, Saklıkent, west of Antalya. The telescopes built in partnership with Russia and Turkey continue its activities. For the maintenance and service of these telescopes, technical personnel work 24/7. Scientists work remotely due to travel bans. For instance, scientists who could not come from Russia connect remotely from Moscow and Kazan cities and make their observations. Within the scope of the Eastern Anatolian Observatory (DAG) project carried out by the Astrophysics Research and Application Center (ATASAM) within the Erzurum Ataturk University, Turkey's first and largest infrared telescope (in the region of up to 3 microns) is established. DAG observatory is established at an altitude of 3170 m and the infrastructure is completed except asphalt road. 90% of the telescope building and 70% of the dome are completed and all factory tests of the telescope have been finalized in Italy. Grinding and polishing process of 4 m primary mirror has been completed and is now in Russia for coatings, will be brought to Turkey in 2021. Due to the COVID-19 pandemic, the arrival of the dome and telescope components from Italy and Belgium and the arrival of the foreign team are delayed. In total, there is a 4-month delay in the project.

COVID-19 and Launch Industry

While launching for satellite projects took place almost every week, the frequency of launch has also decreased due to the pandemic. Argentina's

SAOCOM 1B radar observation satellite was to be launched in late March, but its launch from Florida was delayed due to travel restrictions. The GPS satellite to be operated by the United States Space Forces would be launched on April 29th, but it was announced that there would be a 2-month delay.

The US and UK joint venture OneWeb satellite firm was already experiencing financial difficulties before the pandemic. It launched 34 satellites on March 21st and filed for bankruptcy in early April. It currently has 74 satellites in orbit. It had an intention to provide internet services in Ku-band frequency with 648 satellites in total. All initiatives like the Iridium project have resulted in bankruptcy in the past.

SpaceX has put 362 Starlink satellites in orbit so far. The coronavirus test was positive in 6 of its employees. Nevertheless, since the projects are critical, the work was not interrupted. 60 of these satellites were launched in April. SpaceX aims to serve the world by placing more than 1500 satellites in total in LEO orbit. Moreover, the design and testing of reusable rockets are ongoing. Manned space flights will begin in the next few years.

Due to the pandemic, NASA's project called Artemis to go the Moon and Mars, and the space telescope project James Webb (JWST) will probably be delayed. Excluding the urgent ones, works have been suspended. The mirror alignment test of the James Webb telescope was successfully completed in early March. Currently, the last checks are being performed. This project is conducted together with NASA, ESA and the Canadian Space Agency. In 2021, it will be launched into space via the Ariane-5 rocket from French Guyana. On April 15th, Russia conducted the trial of the DA-ASAT (Direct-Ascent Antisatellite Weapon) gun in space. However, it hit no major low earth orbit satellite (<https://g-nous.com/article/9/how-is-the-space-sector-doing-during-COVID-19>).

International Space Station (ISS) and Experiments

The International Space Station is a giant space laboratory, in which 15 countries execute collaborative works and operate at an altitude of 350 km in low earth orbit (LEO). It has been operating since 1998. It is an extraordinary example of cooperation between Russia and the west. 6 astronauts work at the station at any time. Various scientific experiments are carried out and studies are ongoing without being affected by the pandemic.

Two cosmonauts and one astronaut from the new crew were enforced the two-week quarantine and went to the ISS on April 9th from the Baikonur space base with the Soyuz launch vehicle. After 6 hours, they reached ISS on April 10th. So, the COVID-19 pandemic changed the launch protocol. Quarantine is applied to astronauts who go to ISS and come from there. Now the quarantine process has begun to be enforced earlier to those who go. Also, astronauts could not see their families lastly. After this launch, Yevgeny Mikrin, the Russian director responsible for manned flights, was diagnosed with corona. Mikrin died on

May 5th. On April 17th, the crew of 3, who served at ISS for a long time, returned to a world of corona with the Soyuz spacecraft. SpaceX firm took two American astronauts to ISS with the Falcon 9 rocket and Dragon Crew spacecraft on May 30th. It had successfully passed ground tests. Studies were not suspended during the pandemic period. After 2011, America had retired space shuttles since they are expensive and dangerous. Russians' Soyuz vehicle had been used to go to and return from the space station for 9 years. These two were the achievement of SpaceX firm that the first time a civilian company went to ISS and the station was reached again from the American soil. This situation is expected to open the way for space tourism. The International Space Station is planned to serve for another 7 to 10 years. The preparations for a second space station began to prevent the scientific experiments from being stopped when its expiry date came. Turkey's involvement in this new project will bring huge benefits in terms of our scientific community.

Conclusion

Space technologies play an important role in modern life and have greatly influenced the course of civilization. Data obtained from observation satellites are processed using Artificial Intelligence (A.I.) and world trade is monitored consistently. Satellites are essential in preventing and responding to disasters. States that had worked together in space projects in the past continue these associations in some civil projects today.

It can be suggested that COVID-19 developed the remote work culture because of the constraints it brought. Satellite operators providing satellite services seem to resolve the crisis by working remotely. There was no interruption in communication, satellite observation and navigation services. These services are already needed to monitor a global crisis.

Consumer behavior also changed in the pandemic. Meetings, family reunions, ways of working have mostly switched to the internet. Online orders have increased. The variety of applications has increased. However, applications that abuse this have also emerged. During the pandemic, user experience has started to be utilized more for software used for video conferencing. In the light of these experiences, the software updated itself based on the needs. Security issues were handled. In addition, people started to use the internet more frequently during this period, and in so far as the traffic increased, problems emerged. Countries have also tested their internet infrastructure.

When mankind was isolated from life, the air quickly refreshed itself such that some invisible distances began to be visible clearly. It was seen that the dolphins reached up to the Bosphorus. Carbon dioxide emission decreased. As if the world started to recover itself. COVID-19 pandemic provided an opportunity for those who make environmental policies. With the new data obtained, it will be possible to work on climate change in a rational way

and policies will be developed accordingly. The Paris Climate Agreement signed in Paris under the United Nations Framework Convention on Climate Change entered into force at the end of 2015. It includes provisions on reducing greenhouse gas emissions, adaptation and finance. The COVID-19 pandemic presented a new calculation opportunity regarding the policies mentioned in this agreement (Paris Climate Agreement, 2015). The impact of the pandemic can be analyzed more clearly by combining information obtained from satellites and information from other sources, and countries and institutions can act together in order to resolve problems quicker and more effectively. COVID-19 once again tells us that the world is the only habitable place and that we must protect it and act together.

References

- Angelo, J. A. (2003). *Space technology*. Greenwood Publishing Group.
- Dickinson, D. (2020). Space and Astronomy in the Time of COVID-19. Sky & Telescope. Retrieved from: <https://skyandtelescope.org/astronomy-blogs/astronomy-space-david-dickinson/space-astronomy-covid19> (01.06.2020)
- ESA. (2020). Funds increase for space in response to COVID-19. Retrieved from: https://www.esa.int/Applications/Telecommunications_Integrated_Applications/Funds_increase_for_space_in_response_to_COVID-19 (01.06.2020)
- G-nous. (2020). How is the space sector doing COVID-19. Retrieved from: <https://g-nous.com/article/9/how-is-the-space-sector-doing-during-covid-19> (15.05.2020)
- Holmes, M. (2020). Satellite Operators Adjust as COVID-19 Sweeps Normal Life Away. Via Satellit. Retrieved from: <http://interactive.satellitetoday.com/via/june-2020/satellite-operators-adjust-as-covid-19-sweeps-normal-life-away/> (01.06.2020)
- Intel Probe. (2020). Corona/COVID-19 Mobil Tehdit Raporu. Retrieved from: <http://intelprobe.com.tr/uploads/1586531760-IP-DigitalCovid19-Mobile-IntReport.pdf> (20.05.2020)
- Leman, J. (2020). NASA's Artemis Mission Hits Another Snag: The Coronavirus. Popular Mechanics. Retrieved from: <https://www.popularmechanics.com/space/rockets/a31797824/nasa-artemis-mission-coronavirus/> (01.06.2020)
- NASA. (2020a). Spinoff. Retrieved from: <https://spinoff.nasa.gov/Spinoff2020/pdf/Spinoff2020.pdf> (01.06.2020)
- NASA. (2020b). NASA Contributes Expertise, Ingenuity to COVID-19 Fight. Retrieved from: <https://www.nasa.gov/press-release/nasa-contributes-expertise-ingenuity-to-covid-19-fight/> (01.06.2020)
- Que, C. (2020) Answers to Your Coronavirus Questions. The New York Times Report. Retrieved from: <https://static01.nyt.com/files/2020/ebooks/corona-virus-questions/nyt-coronavirus-answers.pdf> (20.05.2020)
- Scatteia, L., & Perrot, Y. (2020). Resilience of the Space Sector to the COVID-19 Crisis. Retrieved from: <https://www.pwc.fr/fr/assets/files/pdf/2020/05/fr-france-en-resilience-of-the-space-sector-to-the-covid-19-crisis.pdf> (20.05.2020)
- Space Agenda. (2020). Retrieved from: <http://www.spaceagenda.com/> (01.06.2020)
- Viens, A. (2019). Visualized: The Race to Invest in the Space Economy. Visual Capitalist. Retrieved from: <https://www.visualcapitalist.com/visualized-the-race-to-invest-in-the-space-economy/> (15.05.2020)
- You Probably Need a Haircut. (2020). Retrieved from: <https://www.youprobablyneedahaircut.com/> (01.06.2020)

- SitterStream. (2020) Retrieved from: <https://www.thesitterstream.com/> (01.06.2020)
- Turkish Policy. (2019). The Global Space Economy: A Short Overview of the New Space Race. Retrieved from: <http://turkishpolicy.com/blog/42/the-global-space-economy-a-short-overview-of-the-new-space-race> (01.06.2020)
- United Nations Climate Changes. (2015). Paris Climate Agreement. Retrieved from: https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (01.06.2020)
- United Nations Department of Economic and Social Affairs. (2020). #Envision2030: 17 goals to transform the world for persons with disabilities. United Nations. Retrieved from: <https://www.un.org/development/desa/disabilities/envision2030.html> (01.06.2020)
- Werner, D. (2019a). GHGSat, International focus on greenhouse gas monitoring satellites, sensors. *Space News*. Retrieved from: <https://spacenews.com/greenhouse-gas-satellites-ams/> (01.05.2020)
- Werner, D. (2019b). GHGSat, Canadian Foundation plan emissions monitoring campaign. *Space News*. Retrieved from: <https://spacenews.com/ghgsat-sustainable-technology-development-canada/> (01.05.2020)