

Space technologies, smart cities, and national security: a smart(er) state synergy

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Abstract

In the Smart(er) State era, the dynamic synergy between space technologies, smart cities, and national security takes center stage, guided by practical examples that vividly illustrate the profound impact of this convergence. Space technologies, including Earth observation satellites facilitating urban planning, satellite-based communication networks empowering connectivity, and advanced navigation systems optimizing transportation, are at the forefront of reshaping urban landscapes and driving sustainability in smart cities. Practical examples spotlight the intricate interplay between smart cities and national security, shedding light on real-world cyber threats that challenge city infrastructure, vulnerabilities that jeopardize essential services, and the ethical concerns surrounding data privacy in urban surveillance. This paper goes further to showcase how space technologies actively enhance smart city security. Tangible instances include the use of satellite-based emergency services for swift disaster response, Earth monitoring systems for proactive disaster management, and space-based navigation for robust transportation security. In addressing the challenges and ethical considerations posed by this interplay, we emphasize the need for cross-sector collaboration, underpinned by rigorous governance and policy frameworks. This collaborative effort serves as the cornerstone for achieving a secure and resilient urban future. Finally, this paper casts its gaze toward the horizon, anticipating future trends that will be driven by space-based technologies, such as predictive policing and sustainability initiatives within smart cities. It concludes by offering actionable recommendations for building smart cities that are not only secure but also sustainable and resilient in the face of emerging challenges.

Keywords: infrastructure vulnerabilities, cyber threats, complex governance, resilience, predictive policy.

1. Introduction

In the dawning era of the Smart(er) State, the fusion of advanced technologies with urban development and national security strategies marks a transformative epoch. This new era is characterized by an unprecedented integration of space technologies into the fabric of urban life, reshaping how cities evolve, function, and protect their inhabitants.

The role of space technologies in urban development has seen a paradigm shift in recent years. Earth Observation satellites, once primarily tools for scientific exploration, have now become integral in urban planning and management. These satellites provide critical data for monitoring environmental changes, urban sprawl, and resource distribution, offering a bird's-eye view that is indispensable for sustainable urban development. For instance, the Copernicus program [1], initiated by the European Union, stands as a testament to how satellite imagery can be leveraged for urban planning and environmental monitoring.

Moreover, the proliferation of satellite-based communication networks has bridged significant gaps in urban connectivity. In regions where terrestrial networks are unfeasible or unreliable, satellite communications have provided a lifeline, ensuring seamless connectivity. An illustrative example of this is the Galileo [2] program, which aims to deliver high-speed internet across Europe, including remote urban areas.

The integration of space technologies into smart cities also plays a pivotal role in enhancing national security. Advanced navigation systems, such as the American Global Positioning System (GPS), are not just tools for wayfinding but also critical components in urban security infrastructure. These systems enable precise tracking and rapid deployment of emergency services, bolstering the resilience of cities against threats and disasters. Furthermore, the use of satellite technology in surveillance and communication aids law enforcement and security agencies in safeguarding urban areas against various threats, ranging from cyber-attacks to physical assaults.

As we venture further into the Smart(er) State era, the confluence of space technologies with urban development presents both opportunities and challenges. It is imperative to navigate this landscape with a keen eye on ethical considerations, particularly concerning surveillance and data privacy, while harnessing these technologies for the greater good of urban societies and national security.

Additionally, it's insightful to consider the historical evolution of space technologies in urban contexts. Initially, the utilization of these technologies was largely dominated by governmental and military entities. However, over the past few decades, there has been a significant shift towards civilian and commercial applications, largely driven by advancements in satellite technology and data analytics. This evolution has democratized access to space-derived data, enabling city planners, businesses, and public services to make more informed decisions [3].

Looking forward, the potential of space technologies in urban development is immense. The emerging concept of 'smart urbanism,' which envisions cities where technology and data are seamlessly integrated to enhance living conditions, is becoming increasingly feasible. For instance, predictive analytics derived from satellite data can play a pivotal role in urban planning, traffic management, and environmental monitoring, making cities more efficient and sustainable.

The integration of space technologies into smart cities also opens up new frontiers in national security. The ability to monitor urban spaces in real-time provides invaluable insights for emergency response and crisis management. This integration not only enhances the physical security of urban areas but also fortifies them against emerging cyber threats, which are increasingly becoming a concern for modern cities.

In conclusion, the synergy between space technologies, smart cities, and national security heralds a new era of urban development. The Smart(er) State era is not just about technological advancement; it's about reimagining how cities operate, protect, and serve their inhabitants. The subsequent sections of this paper will delve deeper into specific technologies, case studies, and strategic considerations, painting a comprehensive picture of this dynamic and rapidly evolving field.

2. The Role of Space Technologies in Urban Development

Space technologies, particularly those developed for Earth observation, satellite communication, and navigation, play a transformative role in urban development. Their

applications in urban planning, connectivity, and transportation have become indispensable in the era of smart cities, where efficient, sustainable, and secure urban environments are paramount.

Earth observation satellites offer a vantage point that is pivotal for modern urban planning. These satellites provide detailed, up-to-date imagery and data that are essential for various aspects of city planning, including land use analysis, environmental monitoring, and disaster management. For example, the Copernicus program, operated by the European Space Agency, offers a wealth of data used in urban growth analysis, helping city planners to make informed decisions about sustainable land use. The program's Sentinel satellites provide high-resolution images that can be used to monitor urban sprawl, assess the impact of urbanization on the environment, and plan infrastructural development in an eco-friendly manner.

Satellite-based communication networks have a profound impact on urban connectivity, especially in bridging the digital divide. These networks ensure reliable, high-speed internet access, essential for the digital infrastructure of smart cities. An example of this is the Starlink project by SpaceX, which aims to provide global broadband coverage through a constellation of satellites. This technology is especially beneficial for remote or underserved urban areas, where traditional broadband infrastructure is lacking. By facilitating seamless connectivity, these satellite networks enable various smart city applications, including IoT (Internet of Things) integration, smart grid management, and real-time data exchange for municipal services.

Advanced navigation systems, primarily those driven by satellite technology like the Global Positioning System (GPS), significantly optimize urban transportation. They enable efficient traffic management, route optimization for public transit, and facilitate emerging technologies such as autonomous vehicles. For instance, cities like Singapore utilize GPS-based systems to optimize bus routes and schedules, reducing wait times and improving the overall public transit experience. Furthermore, GPS technology is integral to ride-sharing services, which have transformed urban mobility by providing convenient, on-demand transportation options.

Geographic Information Systems (GIS), powered by satellite data, are instrumental in urban management and planning. GIS technology integrates spatial data with demographic and infrastructural information, providing city planners with comprehensive tools for urban design, resource management, and public service deployment. For example, the city of Los Angeles uses GIS for urban planning, environmental monitoring, and emergency response coordination, enhancing the city's ability to manage its resources effectively and respond to crises.

Space technologies play a crucial role in monitoring environmental factors such as air quality, water resources, and green spaces within urban settings. Satellites like NASA's Landsat or the European Space Agency's Sentinel-5P are critical in tracking urban pollution, water quality, and vegetation cover. This data is vital for cities aiming to improve environmental sustainability and mitigate the effects of climate change. For instance, the European Environment Agency

utilizes satellite data to monitor air quality across Europe, helping cities to implement targeted measures to reduce pollution and improve public health.

In the context of increasing urbanization and climate change, the ability to effectively manage and respond to disasters is paramount. Satellite technologies offer real-time data critical for disaster management and resilience planning in urban areas. For instance, satellite imagery was crucial in assessing the damage and coordinating response efforts in the aftermath of natural disasters like the 2011 Japan earthquake and tsunami. Urban centers are increasingly relying on such technologies for risk assessment, early warning systems, and post-disaster recovery planning.

The integration of space technologies into urban development processes marks a significant leap towards smarter, more sustainable cities. From the strategic use of Earth observation data in urban planning to leveraging satellite communications for enhanced connectivity, and harnessing advanced navigation systems for improved transportation, these technologies are at the heart of the smart city revolution. As urban areas continue to expand and evolve, the reliance on space technologies will only increase, paving the way for more innovative, efficient, and secure urban environments. The inclusion of GIS in urban planning, the use of space technology in environmental monitoring, and the application of satellite data in disaster management underscore the multi-faceted impact of space technologies in shaping the future of smart cities. These technologies not only enhance the efficiency and connectivity of urban areas but also play a pivotal role in ensuring their sustainability, resilience, and safety.

3. Smart Cities and National Security: A Complex Interplay

In the contemporary urban landscape, the nexus between smart cities and national security is increasingly complex and critical. This complexity is primarily driven by the digitalization of city infrastructures and the consequent rise in cyber threats targeting these sophisticated systems. The sophistication of cyber threats targeting smart cities is rapidly evolving. These threats not only disrupt municipal services but also pose risks to critical data and citizen safety.

An example is the 2017 WannaCry ransomware attack, which impacted over 150 countries, including disruptions in the UK's National Health Service. The attack underscored the global reach of cyber threats and the necessity for international cooperation in cybersecurity efforts [4]. Another notable instance of such threats was the Atlanta ransomware attack in 2018. The city's computer networks were crippled, affecting municipal operations ranging from bill payments to court proceedings. This incident highlighted the vulnerability of smart city infrastructures to cyberattacks and the need for robust cybersecurity measures [5]. One more significant example is the 2015 cyberattack on the Ukrainian power grid, which left over 230,000 residents without electricity. This attack, attributed to sophisticated malware, underscored how critical infrastructure, often integrated with smart city technologies, can be targeted by national and international actors [6].

Smart cities, with their interconnected infrastructures, present unique vulnerabilities. Essential services such as water supply, electricity, and transportation systems rely heavily on internet-connected devices and sensors. The integration of Internet of Things (IoT)

devices in these services, while enhancing efficiency, also exposes them to potential breaches. The Mirai botnet attack in 2016, which turned a multitude of IoT devices into a massive botnet, disrupting internet services across the United States, serves as a stark reminder of these vulnerabilities [7].

The interconnected nature of smart city technologies means that a breach in one system can lead to cascading failures across multiple services. The concept of “cyber-physical systems” is at the heart of this challenge, where a cyberattack can have tangible physical consequences. For instance, a breach in traffic control systems can lead to widespread transportation chaos, emphasizing the need for resilient and redundant systems in smart city infrastructures [8].

Alongside security concerns, the increasing use of surveillance technologies in smart cities raises significant ethical issues, particularly regarding data privacy. The deployment of CCTV cameras, facial recognition technologies, and predictive policing tools have been met with concerns over privacy infringements and potential biases in surveillance practices.

For instance, the use of facial recognition technology by law enforcement in London has sparked debates about the balance between security and individual privacy rights. Critics argue that such technologies can lead to unwarranted intrusions into personal privacy and may disproportionately impact certain groups, leading to civil liberties concerns [9].

The ethical concerns regarding surveillance in smart cities extend beyond privacy to encompass issues of consent, transparency, and accountability. The deployment of “smart” technologies often occurs without explicit consent from citizens, raising questions about the balance between collective security and individual rights. Moreover, the potential for mass data collection by urban surveillance tools necessitates stringent data governance policies to prevent misuse and ensure accountability.

For example, in Toronto’s Quayside smart city project, initially led by Sidewalk Labs (a subsidiary of Alphabet Inc.), there were significant public concerns about how data would be collected, used, and shared. The project sparked a broader debate about public space data governance and the role of private companies in smart city development [10].

In conclusion, the interplay between smart cities and national security is fraught with challenges ranging from cybersecurity threats to ethical dilemmas surrounding surveillance. Addressing these issues requires a multifaceted approach involving robust cybersecurity protocols, transparent governance, and ethical frameworks guiding the deployment of surveillance technologies.

To mitigate these challenges, it is imperative to adopt a proactive stance. Recommendations include the development of robust cybersecurity frameworks tailored to smart city contexts, increased investment in cybersecurity talent and technologies, and fostering public-private partnerships for better security solutions. Furthermore, establishing clear ethical guidelines and ensuring public involvement in decision-making processes are crucial for maintaining trust and legitimacy in the surveillance practices of smart cities.

4. Enhancing Smart City Security through Space Technologies

The incorporation of space technologies into the fabric of urban management is a significant leap forward in enhancing the security infrastructure of smart cities [11]. This integration not only provides immediate solutions to existing challenges but also paves the way for innovative approaches to urban resilience and sustainability. In this context, satellite-based emergency services, Earth monitoring systems, and space-based navigation emerge as key components in the strategic toolkit for smart city security.

The utilization of satellite-based emergency services in urban disaster management exemplifies a paradigm shift from traditional, ground-based communication systems. These services offer a robust platform for emergency communication, particularly in scenarios where terrestrial networks fail. Theoretical frameworks in disaster management, such as the “Resilience Theory,” highlight the importance of adaptive and responsive systems in the face of crises. Satellites play a crucial role in this respect, as evidenced by their deployment during the Haiti earthquake in 2010, where they provided critical information for rescue and relief efforts [12]. This example underscores the transition towards more resilient urban systems, capable of adapting to and recovering from disaster scenarios.

Earth monitoring systems represent a proactive approach to urban disaster management, aligning with the principles of “Predictive Analytics” in urban planning. These systems harness satellite imagery and advanced analytics to monitor environmental changes, predict potential disasters, and enable timely interventions. The Copernicus program’s contribution during the 2019 Amazon wildfires serves as a testament to the power of these technologies in managing complex urban environmental emergencies [13]. The strategic use of Earth monitoring data not only enhances disaster preparedness but also contributes to sustainable urban development by facilitating informed decision-making.

In the domain of urban transportation, space-based navigation systems like GPS introduce an unprecedented level of precision and efficiency. The application of these systems in urban mobility aligns with the “Smart Mobility” concept, which advocates for technologically advanced, efficient, and sustainable transportation solutions. GPS technology’s role in optimizing traffic flow and enabling autonomous vehicle technologies marks a significant step towards smarter, safer, and more sustainable urban transportation networks. This advancement is indicative of a broader trend towards integrating digital technologies in urban infrastructure to enhance efficiency and security.

In summary, the integration of space technologies in smart cities presents a multifaceted approach to enhancing urban security and resilience. From enabling robust emergency responses to facilitating proactive disaster management and advancing smart mobility, these technologies are at the forefront of driving sustainable urban development. Theoretical underpinnings, such as Resilience Theory and Predictive Analytics, provide a framework for understanding the transformative impact of these technologies on urban landscapes. As smart cities continue to evolve, the strategic application of space technologies will undoubtedly play a pivotal role in shaping secure, resilient, and sustainable urban futures.

5. Addressing Challenges and Ethical Considerations

The integration of space technologies into the fabric of smart cities, while beneficial, presents a unique set of challenges and ethical considerations, particularly in the realms of national security, surveillance, and data management.

5.1 Challenges in Integrating Space Technologies with Smart Cities

The synergy between space technologies and smart cities, though promising, is fraught with complexities. One primary challenge lies in the technical integration and interoperability of space-based systems with terrestrial urban infrastructures. For instance, aligning satellite communication networks with ground-based systems requires substantial coordination and technological harmonization.

Furthermore, the reliance on space technologies for critical infrastructure poses risks, such as vulnerability to space weather or satellite malfunction. A notable example was the 1998 Galaxy IV satellite failure, which disrupted pagers and broadcast services across the United States, illustrating the potential impact on essential urban services.

Integrating space technologies into smart cities introduces complex challenges, straddling technical, legal, and operational domains. Technically, achieving interoperability between space-based and terrestrial systems demands sophisticated engineering solutions. For example, ensuring real-time data transmission from satellites to urban infrastructure requires overcoming latency issues, as seen in advanced telemetry systems.

Legally, the deployment of space technologies in urban settings intersects with international space law. The Outer Space Treaty of 1967, for instance, provides a legal framework but may not fully address the nuances of modern urban applications of space technology.

Operational challenges also emerge, particularly in maintaining the reliability and security of satellite communications. The incident of the Galaxy IV satellite malfunction, as noted by the Federal Communications Commission, underscores the criticality of contingency planning in space-dependent urban infrastructures.

5.2 Ethical Considerations in Surveillance and Data Management

The use of space technologies in urban surveillance raises significant ethical concerns, especially regarding citizen privacy and data protection. The European Union's General Data Protection Regulation (GDPR) offers a framework for balancing technological advances with privacy rights. However, the global nature of satellite data collection often transcends national jurisdictions, complicating regulatory compliance.

An ethical dilemma also arises from the potential for surveillance overreach. The case of the Chinese city of Rongcheng, which implemented a social credit system partially reliant on surveillance technologies, underscores the fine line between security and individual freedoms. Such systems, while enhancing security, can lead to invasive monitoring, raising concerns about civil liberties.

Ethically, the deployment of space technologies in urban surveillance walks a tightrope between public security and individual privacy rights. The GDPR in the EU sets a precedent in privacy protection but navigating compliance across different jurisdictions remains a challenge. The dilemma intensifies when considering global satellite networks that collect data across borders.

Moreover, philosophical and ethical debates surface around the extent of surveillance. Foucault's theory of 'panopticism,' as applied to modern surveillance, questions the balance between societal safety and personal freedom. The social credit system in Rongcheng, China, while an extreme example, highlights how surveillance can permeate daily life, potentially leading to societal control mechanisms that conflict with democratic values.

5.3 The Imperative for Cross-Sector Collaboration and Governance

To navigate these challenges and ethical quandaries, robust cross-sector collaboration and sound governance are essential. This involves a multi-stakeholder approach, engaging government agencies, technology providers, urban planners, and civil society. For example, the Smart City initiative in Singapore demonstrates effective cross-sector collaboration, where the government, industry partners, and academic institutions work together to develop sustainable and secure urban solutions.

Effective governance frameworks must also be established to oversee the deployment and operation of space technologies in urban environments. The United States' National Space Policy serves as an example, providing guidelines for space activities, including commercial and national security considerations.

Addressing these challenges necessitates a multi-faceted approach. Collaboration across sectors – government, private sector, academia, and civil society – is pivotal. Singapore's Smart City initiative exemplifies this, involving diverse stakeholders in shaping a technologically advanced yet socially responsible urban ecosystem.

Governance frameworks need to evolve alongside technological advancements. The U.S. National Space Policy provides a comprehensive approach, yet further refinement is needed to address the specificities of space technology applications in urban settings. Scholars like Sassen and Castells have emphasized the need for governance models that account for the digital and physical convergence in urban spaces.

6. Future Trends and Predictive Policies

In the realm of space-based technologies and smart cities, the future holds transformative potential. Emerging trends and innovations are poised to redefine urban living and governance, particularly in the areas of predictive policing and sustainability initiatives.

The evolution of space technologies is set to offer unprecedented capabilities in urban management. Advancements in satellite imagery and analytics, for example, will enable more accurate and real-time monitoring of urban developments. Projects like the European Space Agency's Copernicus program are already providing critical data for urban planning and environmental monitoring. Furthermore, advancements in satellite communication

technologies, such as those led by SpaceX's Starlink project, promise to deliver high-speed internet connectivity even in the most remote urban areas, bridging the digital divide and fostering inclusivity in smart city services.

Predictive policing, an approach that utilizes data analytics to forecast potential criminal activities, is gaining traction in smart cities. This method leverages various data sources, including space-based technologies, to predict and prevent crime. A real-world example is the Los Angeles Police Department's (LAPD) use of PredPol, a predictive policing software that analyzes historical crime data to forecast crime hotspots. While promising in enhancing urban security, this approach raises significant ethical and privacy concerns, necessitating robust governance frameworks to ensure responsible use of data and technology.

Space technologies are increasingly central to sustainability initiatives in urban contexts. Satellite data is instrumental in monitoring environmental changes, enabling cities to respond to challenges like air pollution, deforestation, and climate change effectively. The European Union's Earth observation program, Copernicus, provides valuable data used in monitoring air quality, which cities like Copenhagen utilize to develop cleaner transportation solutions. Additionally, space technology is pivotal in solar energy advancements, with projects like the International Space Station's Solar Array Wings demonstrating the potential of space-based solar power as a sustainable energy source for smart cities.

In conclusion, the future trajectory of space technologies in smart cities is marked by exciting opportunities and complex challenges. As these technologies evolve, they will play a pivotal role in shaping urban landscapes, from predictive policing to sustainability. However, this progress must be underpinned by careful consideration of ethical implications and a commitment to sustainable development.

7. Conclusions and Recommendations

As we delve into the intricate synergy between space technologies, smart cities, and national security, several key insights emerge. Firstly, space technologies like Earth observation satellites, satellite-based communication networks, and advanced navigation systems are revolutionizing urban landscapes. They are not only enhancing the efficiency of urban planning and connectivity but are also playing a pivotal role in addressing sustainability challenges within smart cities.

The integration of space technology in urban development has also highlighted complex cybersecurity threats and infrastructure vulnerabilities. For instance, the use of satellite imagery in urban planning, as seen in the European Union's Copernicus program, has greatly enhanced environmental monitoring and urban sprawl management. However, it also raises concerns about data privacy and surveillance ethics.

In light of these insights, the following actionable recommendations are proposed for building secure, sustainable, and resilient smart cities:

- **Robust Cybersecurity Frameworks:** Implementing comprehensive cybersecurity measures is essential to protect smart city infrastructure from cyber threats. Cities

like Singapore, with their Smart Nation initiative, have set benchmarks in creating resilient urban digital infrastructure.

- **Ethical Use of Surveillance and Data:** As cities like London and Tokyo expand their use of urban surveillance systems, there is a pressing need to balance security with citizens' privacy rights. Developing ethical guidelines and transparent data policies is crucial.
- **Leveraging Space Technology for Disaster Management:** Incorporating satellite-based systems for early warning and disaster response can significantly enhance urban resilience. The use of NASA's Earth-observing satellites in disaster management across various U.S. cities serves as a model.
- **Collaborative Governance:** Establishing collaborative frameworks involving government, industry, and academia can foster innovation and ensure the sustainable development of smart cities. The partnership approach in Amsterdam's Smart City initiative is a prime example of this.
- **Sustainability-Driven Urban Planning:** Integrating space technology in urban planning for environmental monitoring and resource management, as seen in the European Space Agency's initiatives, can aid in sustainable urban development.

Looking toward the future, the trajectory of space technologies in urban development is poised to be transformative. With advancements in satellite technology and the increasing accessibility of space data, cities will have unprecedented capabilities in urban management and security. Future trends like predictive policing, powered by space-based data analytics, and sustainability initiatives leveraging Earth observation technologies, are set to redefine the smart city landscape.

In conclusion, the fusion of space technologies with smart city development presents both challenges and opportunities. As we navigate this terrain, a focus on ethical, collaborative, and sustainable approaches will be key to unlocking the full potential of this synergy, paving the way for a smarter and more secure urban future.

References

- [1] "Copernicus Program," 4 December 2023. [Online]. Available: <https://www.copernicus.eu/en>.
- [2] EUSPA, "Galileo is the European global satellite-based navigation system," [Online]. Available: <https://www.euspa.europa.eu/european-space/galileo/What-Galileo>. [Accessed 4 December 2023].
- [3] U. Botezatu, "The Small Businesses of Smart Cities," *FAIMA – Business and Management Journal*, vol. 8, no. 4, p. 44 – 5, 2020.
- [4] (. C. United States Computer Emergency Readiness Team, "WannaCry fact sheet," 2017. [Online]. Available: <https://www.cisa.gov/news-events/alerts/2017/05/17/ics-cert-releases-wannacry-fact-sheet>. [Accessed 4 December 2023].
- [5] A. Blinder and N. Perlroth, "A Cyberattack Hobbles Atlanta, and Security Experts Shudder," *The New York Times*, 27 March 2018.
- [6] "Power grid cyberattack in Ukraine," 2015. [Online]. Available: [https://cyberlaw.ccdcoe.org/wiki/Power_grid_cyberattack_in_Ukraine_\(2015\)](https://cyberlaw.ccdcoe.org/wiki/Power_grid_cyberattack_in_Ukraine_(2015)). [Accessed 4 December 2023].
- [7] C. Koliass, G. Kambourakis, A. Stavrou and J. Voas, "DDoS in the IoT: Mirai and other botnets," *Computer*, vol. 50, pp. 80-84, 2017.
- [8] A. Humayed, J. Lin, F. Li and B. Luo, "Cyber-Physical Systems Security—A Survey," vol. 4, no. 6, pp. 1802-1831, 2017.

- [9] P. Fussey and D. Murray, "Independent report on the London Metropolitan Police Service's trial of live facial recognition technology," University of Essex Human Rights Centre, 2019.
- [10] O. Gassmann, J. Böhm and M. Palmié, *Smart Cities: Introducing Digital Innovation to Cities*, Emerald Publishing Limited, 2019.
- [11] U. Botezatu and O. Bucovetchi, "Space as integrator: from horizontal to vertical urban planning," in *Smart Cities International Conference (SCIC) Proceedings*, 2021.
- [12] ESA, "The International Charter 'Space and Major Disasters'," 2019.
- [13] EU COM, "OBSERVER: 2019 fire season through the eyes of Copernicus," 2019.

