The Political Dimension of Space Exploration

Andreea I. Mosila
American Public University

Abstract

Space exploration is essential for global security and technological development, yet political leaders often disregard its importance. This policy paper demonstrates the role of space exploration in global security and technological development and the necessity for political support, as space exploration is costly, relying primarily on federal funding. Political support is motivated by political circumstances. When winning the space race was an important demonstration of power, political support was at its highest. However, political interest in spacefaring faded after the Cold War ended, and funding decreased. Political disinterest has global consequences. Space hazards constitute a severe global threat to planetary defense and come in different forms, such as space rocks, artificial space debris, and space weaponization. These hazards threaten satellites in orbit with a significant role in global operations, including communications, surveillance, and navigation. Additionally, near-Earth objects such as asteroids or comets seriously threaten global security. A catastrophic impact of a near-Earth object could threaten life on Earth and even become an extinction event. The national space program also plays an important role in mitigating climate change, a significant current threat to global security. Therefore, setting the right direction for the space program and ensuring sufficient funding for spacefaring is essential to global security. Using qualitative secondary analysis and the causal explanation method, this policy paper analyzes political support by comparing NASA's budget and national space policies over several decades and how funding affects technological advances and development. The paper concludes by generating policy recommendations to establish the optimal conditions for a national space program to thrive and fulfill its role in maintaining global security.

Keywords: spacefaring, NASA, space exploration, Cold War, global security

La dimensión política de la exploración espacial

Resumen

La exploración espacial es esencial para la seguridad global y el desarrollo tecnológico, pero los líderes políticos a menudo ignoran su importancia. Este documento de política demuestra el papel de la exploración espacial en la seguridad mundial y el desarrollo tecnológico y la necesidad de apoyo político, ya que la exploración espacial es costosa y depende principalmente de la financiación federal. El apoyo político está motivado por las circunstancias políticas. Cuando ganar la carrera espacial era una importante demostración de poder, el apoyo político estaba en su punto más alto. Sin embargo, el interés político en la navegación espacial se desvaneció después de que terminó la Guerra Fría y disminuyó la financiación. El desinterés político tiene consecuencias globales. Los peligros espaciales constituyen una grave amenaza global para la defensa planetaria y se presentan en diferentes formas, como rocas espaciales, desechos espaciales artificiales y armamento espacial. Estos peligros amenazan a los satélites en órbita con un papel importante en las operaciones globales, incluidas las comunicaciones, la vigilancia y la navegación. Además, los objetos cercanos a la Tierra, como asteroides o cometas, amenazan gravemente la seguridad mundial. Un impacto catastrófico de un objeto cercano a la Tierra podría amenazar la vida en la Tierra e incluso convertirse en un evento de extinción. El programa espacial nacional también juega un papel importante en la mitigación del cambio climático, una importante amenaza actual para la seguridad global. Por lo tanto, establecer la dirección correcta para el programa espacial y garantizar una financiación suficiente para la navegación espacial es esencial para la seguridad mundial. Utilizando un análisis secundario cualitativo y el método de explicación causal, este documento de política analiza el apoyo político comparando el presupuesto de la NASA y las políticas espaciales nacionales durante varias décadas y cómo la financiación afecta los avances tecnológicos y el desarrollo. El documento concluye generando recomendaciones de política para establecer las condiciones óptimas para que un programa espacial nacional prospere y cumpla su función de mantener la seguridad mundial.

Palabras clave: navegación espacial, NASA, exploración espacial, Guerra Fría, seguridad global

太空探索的政治维度

摘要

太空探索对于全球安全和技术发展至关重要，但政治领导人往往忽视其重要性。本篇政策论文展示了太空探索在全球安全和技术发展中的作用以及政治支持的必要性，因为太空探索成本高昂并主要依赖联邦资金。政治支持是由政治环境推动的。当赢得太空竞赛是权力的重要证明时，政治支持是最高的。不过，冷战结束后，对太空探索的政治兴趣逐渐消失并且资金减少。政治冷漠会产生全球性的后果。太空危害对行星防御构成严重的全球威胁，并以不同形式出现，例如太空岩石、人造太空垃圾和太空武器化。这些危害威胁着轨道卫星，后者在全球操作中发挥着重要作用，包括通信、监视和导航。此外，小行星或彗星等近地天体严重威胁着全球安全。近地天体的灾难性撞击可能威胁地球上的生命，甚至演变成灭绝事件。国家太空计划在缓解气候变化方面也发挥着重要作用，气候变化是当前全球安全面临的重大威胁。因此，为太空计划设定正确的方向并确保为太空探索提供足够的资金一事对于全球安全而言至关重要。本篇政策论文使用定性二次分析和因果解释方法，通过比较“NASA几十年来的预算和国家空间政策”与“资金如何影响技术进步和发展”，进而分析了政治支持。本文最后提出一系列政策建议，用于为“国家太空计划的蓬勃发展和履行其在维护全球安全方面的作用”一事创造最佳条件。

关键词：航天，美国国家航空航天局，太空探索，冷战，全球安全

“*As goes the future of NASA so too does the future of this nation.*”

~Neil deGrasse Tyson

Introduction

July 20, 1969 is one of the most memorable dates in human history. For anyone alive then, witnessing live on television the first human being walking on the moon was an experience to remember for the rest of their lives. The achievements of NASA's Project Apollo are unique in the scope of human history. Besides the magnitude of the accomplishment, this program's technological, scientific, economic, and political development was game-changing (Mosila, 2015, 8). The famous movie *Apollo 13* credits James Arthur Lovell,

the Commander of the Apollo 13 mission, with these words while witnessing the first man on the moon: "From now on, we live in a world where man has walked on the moon. It is not a miracle. We just decided to go" (Howard, 1995, n.a.). There is no doubt that living in a world where humans can visit and walk on a foreign celestial body is an unprecedented accomplishment in science, engineering, and technology. However, the space program had more merit than meets the eye (Mosila, 2015, 8). It became a powerful political tool—a means to national and global security and a display of soft power. Soft power is the ability to use other means than military, in this case, spacefaring, to display force in a non-coercive manner.

While Commander Lovell's words in 1969 were historic, President Nixon's words, uttered in 1972 as the last of the Apollo missions left the moon to return home, were premonitory: "This may be the last time in this century that men will walk on the moon" (Logsdon, 2014, 1). As the goal to win the space race and, ultimately, the Cold War was accomplished, human spaceflight no longer returned to the moon, and it refocused its goals to the low earth orbit instead. Nixon canceled Project Apollo, put plans for a crewed mission to Mars on the back burner, and directed NASA to develop the Space Transportation System, better known as the space shuttle, and focus on low earth orbit exploration. The immediate consequence of this decision was a drastic cut in NASA funding, to never again return to the funding levels of Project Apollo. While perhaps not immediately and publicly visible, this decision had significant consequences. Witnessing humans walking on the moon allowed humanity to dream big. People envisioned moon colonization, landing on Mars, and further solar system exploration. Six decades later, not only is there no further progress along these lines, but with the space shuttle program cancellation in 2011, NASA lost human spaceflight capabilities and relied on Russia to fly astronauts to the International Space Station (Mosila, 2015, 9).

As a publicly funded endeavor, the national space program seemingly depends on political support (Mosila, 2015, 9). The positive correlation between political support and funding of the national space agency means that politics must be considered when planning space missions. As a political tool, the national space program depends a great deal on the political trends of the moment. It is essential to understand what factors make space exploration politically significant, as the level of importance determines the level of funding, which is consequential in sustaining a thriving national space program. In the 20th century, space exploration was politically crucial for winning the Cold War. In the 21st century, an essential political role of spacefaring is national and global security.

The Purpose and Importance of This Research

Defining the political importance of space exploration has been a struggle for several de-

cades. The brilliant success of Project Apollo was so blinding that envisioning a new path for NASA was no easy task. There have been no moon colonies or Mars crewed missions, but NASA continued to explore space within the limit of a significantly lower funding level. Success stories such as the Mars exploration rovers Curiosity and Perseverance, the Mars helicopter Ingenuity, and the James Webb Space Telescope continue to captivate the public. However, NASA's human spaceflight program has been at a crossroads since the space shuttle program was canceled in 2011. For an entire decade after the cancellation, the United States depended on the Russian Soyuz to transport astronauts to and from the International Space Station. Furthermore, political friction between the U.S. and Russia jeopardizes human spaceflight cooperation. Since 2020, NASA has successfully launched and delivered the first astronauts to the International Space Station from U.S. soil on the SpaceX Crew missions to reduce and eliminate the dependence on the Soyuz. In recent years, global instability and tensions with the other leading spacefaring nations, Russia and China, have been worrisome for human spaceflight endeavors. Additionally, the commercialization of human spaceflight in the U.S. led to tensions within the spacefaring community caused by the division between those favoring the allocation of federal funds to private companies and voices advocating for the U.S. government to lead human spaceflight rather than outsourcing the activity to private companies.

This policy paper comes at a decisive moment in spacefaring. The transition from the NASA crewed spaceflight vehicle to a private sector one began with the allocation of federal funds to private companies, primarily SpaceX, for developing a new spaceflight system that could carry astronauts has been controversial. This allocation of federal funds was praised, but those advocating for a commercial space program were criticized by those favoring a national human spaceflight program claiming that commercialization would end the American human spaceflight program altogether (Mosila, 2015, 10). Despite influential voices strongly advocating against the commercialization of space (first man on the moon, Neil Armstrong, astronaut Gene Cernan, former NASA administrator Michael Griffin, and director of Hayden Planetarium, Neil DeGrasse Tyson), a decade later, it is impossible not to acknowledge the successes of spaceflight commercialization. SpaceX has launched missions to resupply the International Space Station and even successfully delivered astronauts to low earth orbit. In February 2023, Boeing plans to launch the Crew Flight Test of the CST-100 Starliner commercial crew vehicle and have the first official Starliner flight in the fall of 2023 (Smith, 2022, para.1). The successful spaceflight endeavor of the private sector could not have come at a better time. Political tensions with Russia are currently jeopardizing NASA's collaboration with Roscosmos on human spaceflight, and the dependency on the Soyuz to fly astronauts to the International Space Station must end.

Launching the first Artemis mission to the moon is also a significant moment in space exploration, marking NASA's return to crewed deep space missions.

Additionally, spacefaring plays an essential role in global security, particularly in mitigating space hazards that constitute a severe global threat to planetary defense and come in different forms, such as space rocks, artificial space debris, and space weaponization. These hazards threaten satellites in orbit with a significant role in global operations, including communications, surveillance, and navigation. Near-earth objects such as asteroids or comets seriously threaten global security. A catastrophic impact of a near-earth object could threaten life on Earth and even become an extinction event.

Methodology

Using qualitative secondary analysis and the causal explanation method, this policy paper analyzes political support by comparing NASA's budget and national space policies over several decades and how funding affects technological advances and development. The policy paper focuses on the political dimension of space exploration and the causes that led to creating a national space program, its success, and its decline. Comparing and contrasting the different decades in space exploration reveals causes and lessons learned and emphasize today's attempts to regain sufficient political support for a return to the moon and a crewed mission to Mars.

The main research limitation is that there is no clear consensus on solving the disconnect between NASA directives and the space agency's funding. The paper concludes by suggesting policy recommendations to establish the optimal conditions for a national space program to thrive and fulfill its role in maintaining global security.

Literature Review

The literature on the topic gravitates towards the importance of a national, publicly sponsored space program and its benefits to the nation and the world, as well as the role of the private sector in this endeavor. Because space exploration is costly, there has been an ongoing debate about relying primarily on or only on a publicly sponsored space program to continue space exploration of the magnitude of Project Apollo or outsourcing the endeavor to private companies. There is also the idea that space should be explored for the benefit of all rather than for private investors. Valerie Neal writes in the book *Spaceflight in the Shuttle Era and Beyond: Redefining Humanity's Purpose in Space* that the public and private sectors are not mutually exclusive. Collaboration between the two sectors occurred since the dawn of the space program and flourished during the space shuttle era. A significant example of such cooperation is the services offered by NASA's space shuttle to carry payloads for private entities into orbit (Neal, 2018, 54). Despite this successful collaboration, the space shuttle program remained costly for NASA,

and the agency struggled with funding and public support (Tribbe, 2019, 449). On the opposite spectrum, in the book *The Long Space Age: The Economic Origins of Space Exploration from Colonial America to the Cold War,* Alexander MacDonald advocates for the privatization of space by claiming space exploration has always been a private endeavor, and it only became publicly funded in the Sixties as a tool to win the Cold War (MacDonald, 2018, 2). MacDonald refers to private funding and personal initiatives of explorers throughout American history that performed telescopic observations using their own funding, including Robert Goddard's self-funding of his rocket experiments (MacDonald, 2018, 5). While this idea is valid, it is essential to note the difference in magnitude between ground telescoping observations and actual space travel and the political consequences of the latter (Tribbe, 2019, 446). The ability to go into space changed the world's power dynamics. It brought significant economic and political developments, from space sovereignty, weaponization, and space warfare, to property rights and profits generated by space endeavors, including the mining of celestial bodies (Tribbe, 2019, 448).

Background

Technological revolutions usually originate in wars, and the Cold War was an excellent opportunity. The launch of the first artificial satellite Sputnik in October 1957 marked the beginning of the space race, the most expensive technological war in history, and a new type of world power (Mosila, 2015, 16). During the space race, it became evident that the nation that masters space would also master the world (Gillespie & Weller, 2008, 8). To win the space race and, ultimately, the Cold War, the United States and the Soviet Union used any resources and spared no expense. Sputnik turned the Soviet Union into the first spacefaring nation in the world, a position solidified in 1961 when Yuri Gagarin became the first human to journey into space (Mosila, 2015, 16). The United States lost the race to launch the first artificial object into space and the first human into orbit. However, it ultimately won the most spectacular space endeavor: landing a human on the moon. As a political tool used to win the Cold War, deep space crewed exploration was shelved and preserved when the war was over (Mosila, 2015, 16). NASA switched focus from crewed missions into deep space to low earth orbit and robotic and uncrewed missions. The concept of deep space crewed exploration was not entirely abandoned, as with each new administration, new ideas were put forth. The Bush Administration, for example, proposed a return to the moon under the Constellation program, scrapped and replaced with a mission proposal to an asteroid by the Obama Administration, and scrapped again and replaced with a return to the moon by Trump and Biden Administrations. The retirement of the space shuttle in 2011 made things even worse. The U.S. lost its human spaceflight capability for the first time in its spacefaring history. Politically speak-

ing, contracting the Russian Soyuz to transport American astronauts to the International Space Station for an entire decade and at a high financial cost was a risky proposition, considering the instability of the relationship between the United States and Russia under the leadership of Vladimir Putin (Mosila, 2015, 17).

While NASA continued the advancement of science through the robotic exploration of the solar system, the political engine of the national space program is fueled by human spaceflight (Mosila, 2015, 17). No robotic exploration, including a flagship mission, has the same political, economic, and societal impact as human spaceflight. No matter the popularity of the Mars rovers or the Hubble and James Webb space telescopes, there has never been a ticker tape parade for a machine (Mosila, 2015, 17). The human factor is the most spectacular aspect of the space program. Spacefaring is a form of soft power (Gillespie & Weller, 2008, 8). Therefore, abandoning human spaceflight signals weakness. Depending on a rival spacefaring nation for human spaceflight results in the erosion of the American international image.

Paying to Go to the Moon

Following President Kennedy's directive to land a man on the moon by the end of the decade, the NASA budget almost doubled, from 524 million in 1960, a 0.5 percent of the total federal expenditures, to 964 million, 0.9 percent of the total federal spending in 1961, and continued to grow exponentially for the following years, reaching a record of 5.2 billion, 4.4 percent of the total federal expenditures in 1965 (Office of Management and Budget, 2022, n.a.). Given the political importance of the national space program at that time, it is understandable that the space agency's funding reached its highest level during Project Apollo, to decrease significantly following the cancellation of the program and the accomplishment of President Kennedy's goal. Soon after, NASA's budget declined to 4.9 billion in 1967 and 4.5 billion when Richard Nixon won the Presidency in 1968. After the lunar landings were completed, beginning in 1970, the NASA budget decreased significantly, reaching an all-time low record of 3 billion in 1974 (Office of Management and Budget, 2022, n.a.). To better understand the funding levels as compared throughout the different decades, this policy paper will use FY20 dollars going forward. The equivalent in FY20 dollars of the funding levels mentioned above are 1960 funding level – 3.6 billion; 1961 funding level – 6.5 billion; 1965 funding level – 34 billion; 1967 funding level – 30.5 billion; 1968 funding level – 27.3 billion.

The Policy-Budget Relationship

The disconnect between the mission and the budget is a significant issue for NASA. With every new White House administration, a new mission for the space agency is usually drafted, an audacious plan involving human spaceflight. However, the budget remained roughly the same

throughout the years. Setting an agenda for the space agency and failing to allocate sufficient funding to execute said agenda erodes NASA's public image and fails to contribute to the advancement of human spaceflight. A look at the NASA directives and budget by decade demonstrates the statement above.

The Reagan administration announced an increase in NASA's budget by more than 20% to continue the space shuttle program (Leary, 1988, para 2.). Following the space shuttle Challenger disaster and the grounding of the space shuttle fleet, NASA's human spaceflight program was at a crossroads again. To save the program, President Reagan signed a new national space policy in 1988, directing NASA to focus on developing a crewed lunar base and a future mission to Mars (Leary, 1988, para 3.). During the Reagan administration, the budget went from 14 million in 1981 to 22 million in 1987, then back to a lower 17 million in 1988 (see Fig. 1). Following the release of the new space policy, in the last year of Reagan's presidency, NASA's budget returned to 20 million (Roberts & Harrison, 2022, n.a.).

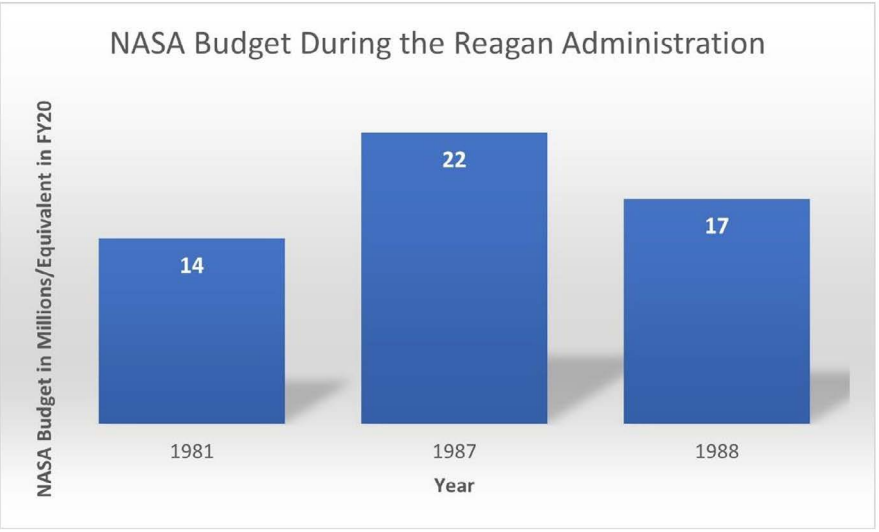

Figure 1: *NASA Budget During the Reagan Administration*

Note: NASA Budget During the Reagan Administration (Office of Management and Budget, 2022).

Under the directives of President Bill Clinton, the National Space Policy of 1996 directed NASA to "develop and operate the International Space Station" (U.S. Geological Survey, 1996, 2). The NASA allocated funding for the following years of the Clinton presidency (1996-2000) fluctuated (see Fig. 2) between 20-21 billion dollars (Roberts & Harrison, 2022, n.a.).

President George W. Bush's National Space Policy of 2006 directed

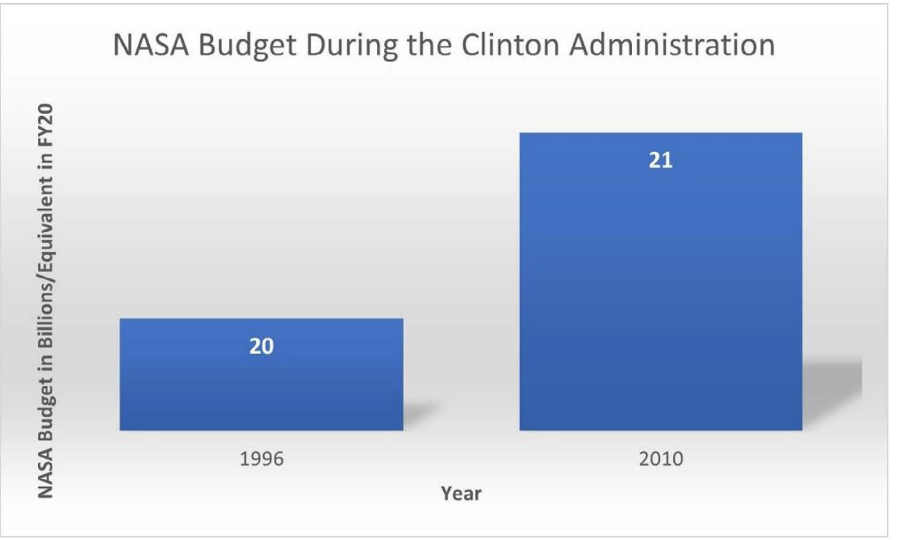

Figure 2: *NASA Budget During the Clinton Administration*

Note: NASA Budget During the Clinton Administration (Office of Management and Budget, 2022).

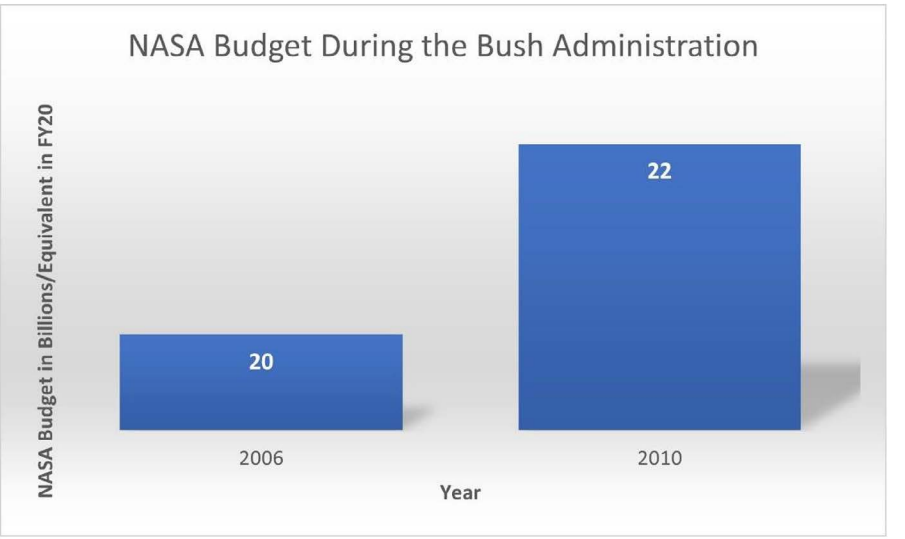

Figure 3: *NASA Budget During the Bush Administration*

Note: NASA Budget During the Bush Administration (Office of Management and Budget, 2022).

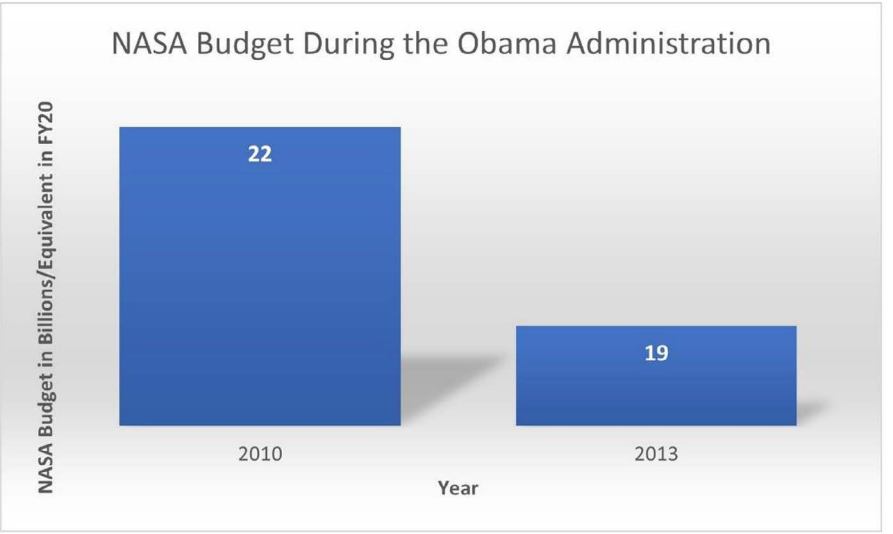

Figure 4: *NASA Budget During the Obama Administration*

Note: NASA Budget During the Obama Administration (Office of Management and Budget, 2022).

NASA to return the Space Shuttle to flight following the space shuttle Columbia disaster of 2001 to complete the activity at the International Space Station by 2010. The space shuttle program was also to retire by 2010. In parallel with the preparation to retire the space shuttle and end activities at the International Space Station, President Bush directed NASA to develop a new vehicle by 2008, the Crew Exploration Vehicle, capable of transporting astronauts to the International Space Station following the space shuttle retirement but having deep space flight as its primary purpose, specifically a return to the moon by 2020 (National Aeronautics and Space Administration, 2004, para.16). This was the Constellation program. In his speech to NASA Headquarters in Washington D.C. announcing the new space policy, President Bush also touched on the necessity to increase NASA's budget. However, most of the funding needed to cover the new directives was based on reallocating funding within the existing NASA budget. As such, (see Fig. 3) NASA's allocations for the following years remained within 20-22 billion dollars per year (Roberts & Harrison, 2022, n.a.).

President Barack Obama announced his National Space Policy in 2010, canceled the Constellation program and the plans to return to the moon because "we have been there before," and directed NASA to design a spacecraft for deep space travel to an asteroid instead and eventually to orbit Mars by mid-2030s (National Aeronautics and Space Administration, 2010, para.30). Following the new National Space Policy announcement, NASA's funding decreased from 22 billion in 2010 to 19 billion in 2013, to increase

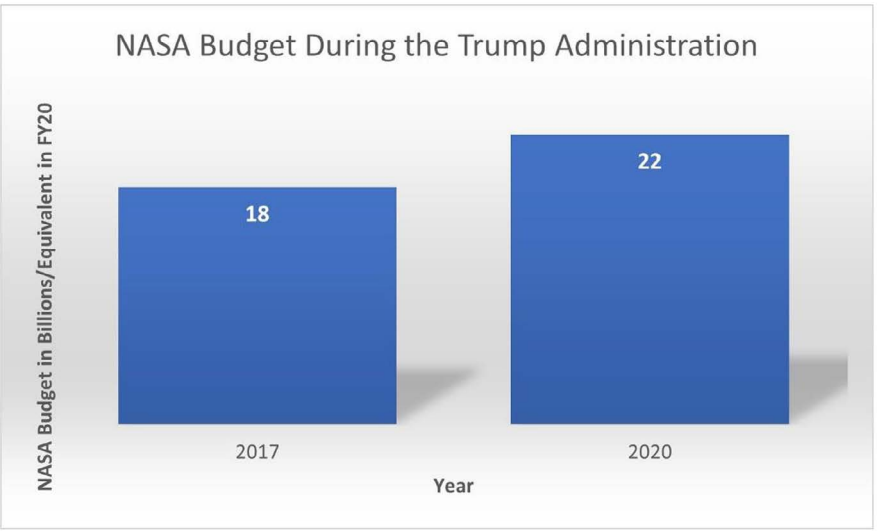

Figure 5: *NASA Budget During the Trump Administration*

Note: NASA Budget During the Trump Administration (Office of Management and Budget, 2022).

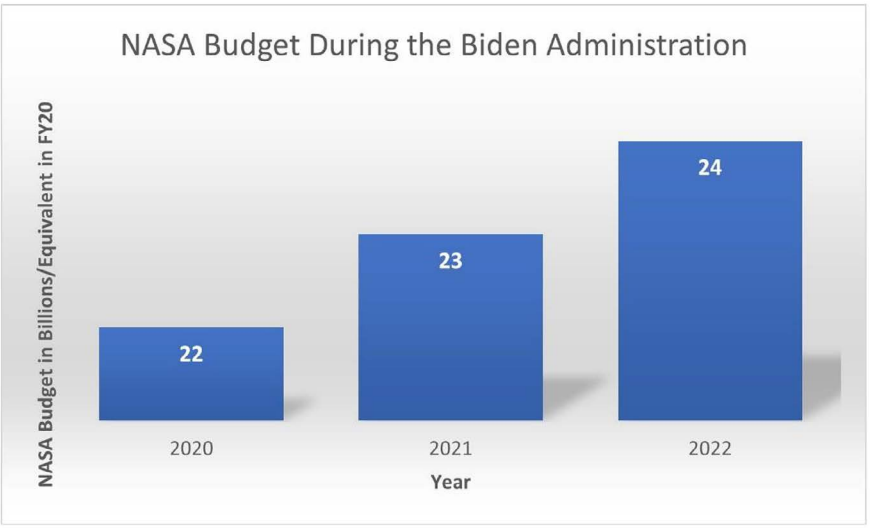

Figure 6: *NASA Budget During the Biden Administration*

Note: NASA Budget During the Biden Administration (Office of Management and Budget, 2022).

slightly to 20 billion by 2016 (see Fig. 4), the last year of the Obama presidency (Roberts & Harrison, 2022, n.a.).

President Trump's new space policy was announced in 2020 and proposed a return to the Moon under the Artemis program, the establishment of a lunar space station and a lunar-based colony, as well as a close collaboration between NASA and the newly created armed forces branch, the Space Force to ensure national security and protect American interests in space (National Archives and Records Administration, 2020, para.2). NASA's budget (see Fig. 5) in 2017 was 18 billion, to increase to 22 billion in 2020 (Roberts & Harrison, 2022, n.a.).

The Biden administration carried many priorities for NASA from his predecessor, confirming in 2021 that NASA would continue with the Artemis program and return to the moon (Harris, 2021). NASA's budget (see Fig. 6) in 2020 was 22 billion, and 23 billion in 2021 (Roberts & Harrison, 2022, n.a.). Fortunately, with the creation of the Space Force in 2019, spacefaring began receiving more funding. For example, in the fiscal year 2022, NASA received a budget of almost 24 billion, and Space Force received 18 billion (Smith, 2022, para.1). For the fiscal year 2023, however, the presidential budget has requested a significant increase in Space Force's funding to 24.5 billion and for NASA to almost 26 billion (National Aeronautics and Space Administration, 2022, 9). The increase in the spacefaring federal budget is promising.

Over the past several decades, every White House administration proposed a new space policy, setting bold directives for the space agency to pursue crewed missions into deep space. The tendency to maintain a high standard for NASA's missions remained prevalent. What was different was the budget. Whereas in the Sixties the bold directives were supported by significant funding, as soon as winning the space race was no longer a priority, the budget decreased, while the directives remained. This may be a reasonable explanation for the fact that NASA has not been able to accomplish any new deep-space human spaceflight missions since the end of the Apollo program. Funds reallocation within the agency led to some progress, but it is insignificant. If the Artemis program succeeds, it will be the first endeavor of this magnitude accomplished with a lower budget. However, there is criticism about the slow pace of Artemis, revised schedules, long gaps between missions, and ongoing delays. This could mean that NASA may need an entire decade to finalize building a space station in orbit around the moon (Berger, 2022, para. 3). There is no doubt that space exploration is an expensive endeavor. However, despite its costs, the national space program accounted for 4.4 percent of the total federal expenditures in 1965, the peak of NASA's budget (Office of Management and Budget, 2022, n.a.). Since then, NASA's budget has averaged half a percentage of the federal budget.

Federal funding allocation has been revolutionized during the Covid-

19 pandemic, and by these newly set standards, a yearly budget of 24 billion is no longer a lot of money. Covid relief spending reached a total obligation of 4.5 trillion dollars (USASpending, 2022, n.a.). Extensive fiscal support to stimulate the economy is rare. President Roosevelt's 1933 New Deal was similar. However, the New Deal federal spending was 41.7 billion in then-dollars, the equivalent of 793 billion in FY20 dollars (Dupor, 2021, para.12). As a percentage of GDP, the two relief spendings look more similar. While the New Deal accounted for 40.1% of the GDP in 1929, the entire Covid relief spending accounted for 43.2% of the GDP in 2019 (Dupor, 2021, para.15). A more recent example is the fiscal stimulus response to the Great Recession. While this was the first relief package to reach trillions (1.8 trillion), the fiscal stimulus response to the Great Recession was distributed over four years, from 2008 to 2012, as opposed to the Covid relief package, which was more sudden and spread over a brief period (Committee for a Responsible Federal Budget, 2020, para.5). Covid relief spending recalibrated the notion of "a lot of money" from billions to trillions. The T-word (trillion) has not been used before in this context. Considering the societal impact of NASA, it is fair to say that NASA could request and receive more money.

Why is this important? The foreign perspective on the U.S. space program is crucial for the country's image. NASA is known, respected, and admired around the world. Together with Hollywood and Silicon Valley, NASA is one of the best ambassadors of the U.S. The space agency has always played a positive role in representing the United States. In many corners of the world, the U.S. is seen as an imperialist power with a negative connotation. It is the American space program that continues to receive positive support across the globe. Space exploration is undoubtedly a display of power, capabilities and a source of wonder and joy. The national space program is the epitome of American ingenuity, science, engineering, and technology.

Spacefaring and Global Security

Spacefaring plays an essential role in global security, particularly in mitigating space hazards that constitute a severe global threat to planetary defense and come in different forms, such as space rocks, artificial space debris, and space weaponization. NASA also plays a significant role in helping with the climate crisis, considered by the United Nations as the most significant threat to global security in current times (Parry, 2007, para. 1).

Impactor

Near-Earth objects such as asteroids or comets seriously threaten global security. A catastrophic impact of a near-Earth object could threaten life on Earth and even become an extinction event. Planetary defense policies have been focused on detecting and mitigating impactors similar in size to the Tunguska event object with the potential for regional destruction (Marks, 2022, 6). While these objects represent

a significant risk and must be prioritized in the risk assessment of an Earth impact, larger-size impactors closer to the Chicxulub event object should not be disregarded. An impact with a 10 km diameter or larger object would be an extinction-level event and could mean the end of human civilization or even extinction.

In 1980, Alvarez hypothesized that a giant size asteroid impacted the Earth around 65 million resulting in the extinction of many species, including the dinosaurs (Alvarez et al., 1980, 1095). At that time, Alvarez's hypothesis was met with reticence by paleontologists. While in his paper, Alvarez expressed the desire to find the impact crater and offered three possibilities of craters that would match the size of such a giant impactor, the location of the impact crater was confirmed in 1995 by Hildreband et al. at the Chicxulub crater under the Yucatán Peninsula in Mexico (Hildebrand et al., 1991, 867). These discoveries changed the narrative about the possibility of such an impact. However, if it happened before, it could happen again. Following the confirmation of the Alvarez hypothesis, Congressional hearings mandated NASA to search for near-earth objects 1 km or larger in diameter and identify and map 90% of these space rocks (Morrison, 1992, 103). As the survey did not identify any large space rocks on a collision course with Earth, at least for the foreseeable future, it put to rest the idea that space impactors could be a severe threat to global security (Marks, 2022, 2). However without prior planning, it is risky to assume that there will be a sufficient window of opportunity to plan and prepare a deflection if any such threat may occur. Marks (2022) argues that, given the possibility of such an extinction-level event happening again, it would make sense to come up with a planetary defense policy based on a risk assessment that would include both the Tunguska and Chicxulub size impactor and that could justify allocation of a significantly higher budget for this purpose (Marks, 2022, 1).

Lubin and Cohen (2022) argue that, with preparation ahead of time, current capabilities could successfully deflect a Chicxulub size impactor (Lubin & Cohen, 2022, 1). Their policy paper on a hypothetical impact scenario of a 10-km diameter asteroid or a comet with a six-month warning shows that a defense using an array of nuclear penetrators launched five months before the impact could deflect the object and result in a successful planetary defense (Lubin & Cohen, 2022, 10). However, the discovery of the Neowise comet in 2020 with only four months' warning ahead of its closest Earth approach (103 million km) shows that a sufficient lead time for action should not be automatically assumed. NASA's DART - Double Asteroid Redirection Test is the first mission designed to deflect an asteroid using kinetic impactor technology. It involves impacting the object sufficiently to change the course of its trajectory. This plan has been the domain of science fiction until DART. Its mission is to impact the binary asteroid system Didymos (Double Asteroid Redirection Test, 2022, para. 1). The

success of DART could determine the course of future mission planning for planetary defense.

There is no doubt that sooner or later, a space rock will find itself on a collision course with Earth, creating havoc and concern for global security. It could also be an extinction-size object. Unfortunately, the timing of such an object being detectable is unpredictable. A Chicxulub size object could not be observable before being as close to the sun as Jupiter (Marks, 2022, 2), which might not be early enough for the current deflection capabilities. Waiting for the detection and developing a deflection plan might be too late.

Space Debris

Spacefaring may have started as a show of power with a political purpose, but it soon developed into a significant economic, educational, research, and development tool. Some of Earth's most important human activities depend on satellites in orbit. Any threat to these satellites can seriously affect human life and activity. However, the increased activity in orbit, from satellites to space launches, the presence of the International Space Station, as well as intentional and unintentional "accidents" such as anti-satellite demonstrations or satellite collisions led to the pollution of Earth's orbit, primarily the low earth orbit, with non-functional artificial objects known as space debris or space waste (Migaud, 2020, 1). After more than six decades of spacefaring, space governance is facing the urgent necessity to manage, minimize, and mitigate space debris in Earth's orbit. While more than 60 nations are involved in space activities in different forms, 93% of the current space debris has been produced by the U.S., Russia, and China alone (Migaud, 2020, 3). In 1978, NASA astrophysicist and head of the Orbital Debris Program Office, Donald Kessler, postulated a hypothesis that came to be known as the Kessler Syndrome. According to the Kessler Syndrome, at some point, the process of creating new space debris will lead to a "cascade effect" that will increase the quantity of debris exponentially, as new debris will create more debris and so on, leading to the incapacitation of the low earth orbit, making the zone entirely unusable (Hermer-Frie, 2019, 260). This cascade effect will be devastating, destroying all satellites in orbit and leading to a severe global crisis in communication, surveillance, navigation, etc. This will impact both the public and private sectors.

Space debris management is regulated nationally through legislation and policies and internationally through treaties and agreements (Migaud, 2020, 1). At the national level, space debris mitigation has been included in the President's National Space Policy beginning with Ronald Reagan in 1988. NASA is involved in the development of the Orbital Debris Mitigation Standard Practices (ODMSP), a 2001 policy designed to control the release of orbital debris during space activities, minimize accidents that lead to space debris, ensure space hardware is safe, and enforce the retirement of space hardware at the end of

the operation (Migaud, 2020, 2). At the international level, space activities and the mitigation of space debris are regulated by the Outer Space Treaty and the Convention on Liability. Hermer-Frie (2019) suggests that these may not be enough to stop the Kessler Syndrome from happening because they do not stipulate legal consequences for space debris generator activities, and argues that a legal solution is required to prevent Kessler Syndrome from happening (Hermer-Frie, 2019, 268).

An exciting policy paper by Adilov et al. (2022) compares the orbital debris crisis with the climate crisis on Earth. From an economic and social costs perspective, the space debris cascade effect proposed by the Kessler Syndrome is analogous to the carbon dioxide effect (Adilov et al., 2022, 1). Additionally, both problems have been accelerated by the failure of global governance to unite nations and develop international agreements to mitigate the hazards. Adilov et al. suggest that because of the evident connection between orbital space and the environment, space debris, the topic should be included in climate negotiations (Adilov et al., 2022, 1). The ability of federal agencies such as NASA and NOAA to continue monitoring the climate crisis from space using satellites will also be jeopardized if a space debris cascade effect occurs.

NASA's role in combating the climate crisis cannot be neglected. As a global leader in the policy paper of climate change, NASA maintains a significant satellite fleet in orbit in charge of policy papering and monitoring the different aspects of Earth's system and climate, including land, oceans, atmosphere, biosphere, etc. (National Aeronautics and Space Administration, 2022, n.a.). Following the recommendations of the 2017 Earth Science Decadal Survey, NASA is focused on the Earth System Observatory to create a 3D view of the entire planet, from bedrock to the atmosphere, how they work together and how they work together change (National Aeronautics and Space Administration, 2022, para.2). This is significant in finding solutions to many aspects of the climate crisis, including managing food and water resources, predicting natural disasters, rising sea levels, and the impact on coastal communities and city heat islands (National Aeronautics and Space Administration, 2022, para 1).

Space threats to global security must be an international concern and should be addressed by international cooperation. While the United States remains a leader in spacefaring, international collaboration can further support space operations and the development of space capabilities (Toyoma, 2021, 1). International cooperation has been successful throughout the history of space exploration, and the International Space Station is an excellent example of it. However, to mitigate future space threats, international cooperation must take place in the development of such mitigation plans. A joint mission between all space agencies and other actors is a must.

Policy Recommendations

1. Advocacy:

Going into space has always been more about politics, power, and money than science, exploration, or technological advancement. The National Space Program is driven by two critical factors: national security and economic profit (Mosila, 2015, 31). In the 21st century, advocating for an encompassing space program must include attractive points to convince Congress and the White House that investing in spacefaring has the proper return on investment (Mosila, 2015, 31). Space competition for its own virtues and benefits is no longer a compelling consideration (Mosila, 2015, 31). An important lesson learned from the past six decades of space exploration is that the factors that led to Project Apollo were so unique that a repeat is almost impossible. Attempting for decades to engage politicians similarly has resulted in bitter disappointment in the space community (Mosila, 2015, 31).

2. Partnership:

NASA has been the spacefaring leader both nationally and globally. However, in the past decade, the success of space commercialization in human spaceflight demonstrates that commercial companies can be an excellent ally to NASA and its endeavors. Additionally, creating the sixth armed forces branch, the Space Force to ensure national security and protect American interests in space is an excellent addition to spacefaring. A thriving space program capable of fulfilling its role in maintaining global security must include all three components: NASA, commercial space, and Space Force.

There is no doubt that NASA possesses the scientific, engineering, and technological expertise to provide solutions to any of the significant space threats discussed above. The participation of commercial companies is essential because it can bring fresh ideas to the table and execute important missions for NASA. The Space Force may undoubtedly play an important role in implementing the measures proposed for space hazard mitigation. The National Space Policy (NSP) must incorporate the role of each of these parties. The increase in the fiscal year 2023 presidential budget request for both NASA (26 billion) and Space Force (24.5 billion) is a step in the right direction.

3. Global Security:

The NSP must focus on the role of space exploration in national and global security and direct the parties involved to design mitigation plans for space debris and space impactors. It should also acknowledge the importance of space exploration in mitigating the climate crisis. The most recent space policy is the first to include a climate crisis component. NASA's capabilities to collect and analyze Earth's systems data cannot be ignored. NASA joined President Biden's Climate Task Force and is actively involved in the fight against climate change (The White House, 2021, n.a.). There should also be a clear relationship

between mission directives and budget. A directive that addresses space hazard mitigation and plays a significant role in combating climate change must be supported by sufficient funding. A repeat of NASA directives unsupported by adequate funding will continue to result in unaccomplished goals that change with every administration in the White House. Future administrations must carry on a national space policy with a long-term goal supported by sufficient funding to ensure success. The Biden Administration's commitment to carry on with the NASA directives from the previous administration is an example of good practice.

4. International Cooperation:

International cooperation in mitigating space hazards is vital since these space hazards threaten the security of the entire planet. International cooperation in space exploration has been met with many obstacles, primarily because of the ongoing tensions between the major spacefaring nations, the U.S., Russia, and China. Most recently, the tensions with Russia created issues for astronauts flying to and from the International Space Station. The manager of the NASA International Space Station program, Joel Montalbano, pointed out, however, that "when you're in space, there are no borders. You don't see country lines or state lines" (Gorman, 2022, para. 2).

Conclusion

This policy paper aimed to demonstrate the role of space exploration in global security and technological development and the necessity for political support, as space exploration is costly, relying primarily on federal funding. Space exploration is essential for global security and technological development and depends significantly on political support. Political support is motivated by political circumstances, while political disinterest has global consequences. Space hazards such as space rocks, artificial space debris, and space weaponization threaten global security. Space debris threatens satellites in orbit with a substantial role in global operations, including communications, surveillance, and navigation. A catastrophic impact of a near-Earth object could threaten life on Earth and even become an extinction event. The national space program is also essential in mitigating the climate crisis, the most significant threat to global security in current times, according to the United Nations. Therefore, setting the right direction for the space program and ensuring sufficient funding for spacefaring is essential to global security. This policy paper analyzed levels of political support by comparing NASA's budget and national space policies over several decades and how funding affects technological advances and development and offered policy recommendations to establish the optimal conditions for a national space program to thrive and fulfill its role in maintaining global security.

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The author declares to have no known competing financial interests or personal relationships that could have influenced the content of this paper.

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