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About E-magazine

“Earth Root” is an open access e-magazine in the discipline of Environmental sciences published by Earth Root Foundation. The aim of the e-magazine is to provide information and upgradation of knowledge about environmental issues on wider scale and to share ideas and resources to the readers. Using essential knowledge people can lead a healthy life, which is more sustainable and can connect with ongoing efforts for stopping catastrophically the climate change. E-magazine caters to all related environmental aspects ranging from big issues like climate change, renewable energy and pollutants in the atmosphere to the health of human and living beings on Earth. We also take topics of water resources and efforts and measurement to provide optimum use of it; including large scale atmospheric circulation linked with oceans and ecology.

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SPACE, GRIT, AND GRACE: THE SUNITA WILLIAMS STORY

-Prof. S K Dhaka,
Rajdhani College
University of Delhi

Sunita Williams, the trailblazing astronaut of Indian-Slovenian descent, continues to be a beacon of inspiration for aspiring space travelers around the world. With a legacy already etched in the history of space exploration, she recently added another extraordinary chapter by embarking on her latest mission aboard Boeing's Starliner spacecraft in 2024. This mission was not just another trip to space—it was historic, filled with suspense, and tested the limits of human endurance and engineering resilience.

Having already made a name for herself with previous missions aboard the International Space Station, including setting records for the longest spacewalks by a woman, Sunita's return to orbit after more than a decade was a moment of pride and excitement. She, along with fellow astronaut Barry "Butch" Wilmore, was part of the first crewed test flight of the new Starliner capsule—NASA and Boeing's next-generation spacecraft designed for future low-Earth orbit missions.

The journey, however, was not without its hurdles. Shortly after docking with the International Space Station, the mission encountered a series of technical glitches that delayed the planned return to Earth. Issues such as helium leaks and concerns with the spacecraft's propulsion system meant the return had to be postponed multiple times, stretching the astronauts' stay far beyond initial expectations. For Sunita and her crewmate, it was a test of patience, resilience, and trust in their training and team.

Throughout the extended mission, Sunita remained composed and active, assisting with experiments aboard the station and regularly communicating updates to the ground crew. Her ability to stay calm in the face of uncertainty is a testament to her years of experience and mental fortitude. While millions on Earth followed the story with bated breath, Sunita maintained her signature optimism and dedication to duty.

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After weeks of problem-solving, ground engineers and the crew finally worked through the technical challenges, ensuring a safe trajectory back home. The reentry and landing were closely monitored, and when the capsule touched down safely, it was not just a victory for NASA and Boeing—it was a triumphant moment for space exploration, marked by determination and human courage.

Sunita Williams' journey to this moment began long before the Starliner launch. Born in Euclid, Ohio, she always had a fascination with flying. Her father, originally from Gujarat, India, and her mother, of Slovenian descent, instilled in her a strong work ethic and a sense of cultural pride. After completing her education in physical science from the United States Naval Academy, she went on to become a helicopter pilot and later a naval test pilot. These roles played a crucial part in shaping her career as an astronaut.

She was selected by NASA in 1998, and her first space mission took place in 2006 aboard the Space Shuttle Discovery. It was a moment of immense pride not just for the United States, but also for millions in India who saw a reflection of their aspirations in her. During her time on the International Space Station, Sunita set records for the longest spaceflight by a woman and completed more than 50 hours of spacewalks—another milestone that demonstrated her exceptional skills and determination.

Her time in space was not just about scientific experiments and technical duties. Sunita often shared her experiences with school children back on Earth, beaming videos of her floating in zero gravity, performing yoga, and even running a marathon on a treadmill in space. Her ability to connect with people, especially young minds, made her not only a scientist but also a storyteller, educator, and motivator.

Even after returning from her earlier missions, she continued to contribute to the space program and inspire the next generation of explorers. Her involvement in NASA’s Artemis program and other commercial crew missions has solidified her place among the most accomplished astronauts in history.

Sunita's latest mission has further cemented her reputation as one of the most esteemed figures in the realm of space science. Her remarkable ability to adapt, persevere, and excel under pressure exemplifies the traits that define astronauts as contemporary explorers in every regard. Sunita's journey is a testament to the enduring spirit of exploration, showcasing her ability to navigate and overcome the myriad challenges that accompany space travel.

Throughout her mission, Sunita showed remarkable dedication and resilience. Despite the challenges of a long stay in space, she returned with the same grace and wonder that define her journey. Her time in space deepened her appreciation for the universe and inspired others to look beyond our planet.

Sunita's narrative is about breaking boundaries and shattering glass ceilings—through spacewalks, leading missions, or groundbreaking test flights. She inspires many by proving that it's the human spirit that propels us toward the stars. Her story is a reminder of the courage and passion that drive exploration. With each mission, Sunita paves the way for future generations, encouraging young people to pursue careers in science, technology, engineering, and mathematics. Her legacy shows that dreams are attainable with hard work and dedication.

As an advocate for space exploration, Sunita engages in educational outreach, speaking at schools and universities worldwide. Her enthusiasm ignites young minds, fostering curiosity and ambition. Through her work, she has advanced human knowledge and fostered a global community united in discovering new frontiers.

In an era where collaboration and innovation unlock cosmic secrets, Sunita Williams exemplifies the pioneering spirit needed for exploration. Her influence will inspire the next wave of astronauts and scientists to push the boundaries of possibility and enrich our understanding of the universe.

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FRESH APPROACHES TO TACKLING CLIMATE CHANGE

-Dr. Vivek Panwar,
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The challenge of climate change is evolving, and so must our solutions. While global efforts have long focused on reducing emissions, enhancing renewable energy, and improving conservation strategies, new and unconventional ideas are emerging to address the crisis in innovative ways. These fresh perspectives go beyond the traditional methods and explore transformative approaches to mitigating climate impacts while fostering sustainability.

One promising idea is direct air capture (DAC) technology, which aims to remove carbon dioxide from the atmosphere. Unlike traditional carbon sequestration that relies on forests and soil, DAC systems use chemical processes to extract CO_2 from the air, storing it underground or converting it into useful materials. Companies are now exploring ways to scale up DAC economically, integrating it into industrial processes to create synthetic fuels, construction materials, or even consumer products. Although challenges remain regarding energy consumption and cost, advancements in this field could make DAC a game-changer in the fight against climate change.

Another novel concept is ocean fertilization, an experimental approach that involves stimulating the growth of phytoplankton by adding iron or other nutrients to marine ecosystems. These microscopic organisms absorb significant amounts of carbon dioxide during photosynthesis, helping to reduce atmospheric greenhouse gases. While some early experiments suggest potential benefits, concerns exist about unintended ecological impacts, such as disruptions to marine food chains. Further research is needed to determine the long-term viability of this method, but it remains an intriguing possibility for enhancing the ocean's role as a carbon sink.

At the intersection of technology and agriculture, precision farming is gaining traction as a way to reduce emissions while improving food production. By using artificial intelligence, satellite imagery, and real-time data analytics,

farmers can optimize irrigation, fertilizer use, and pest control, reducing waste and minimizing environmental damage. These techniques not only lower emissions associated with farming but also enhance soil health, which plays a critical role in carbon sequestration. Additionally, regenerative agriculture—focusing on practices like no-till farming, crop rotation, and agroforestry—helps restore degraded lands, capture carbon, and improve biodiversity.

The potential of biochar as a climate solution is also being explored. Created by heating organic material in a low-oxygen environment, biochar is a stable form of carbon that can be added to soil, enhancing its fertility while locking away carbon for centuries. This approach not only aids in carbon capture but also improves water retention and nutrient availability in farmlands. As researchers develop more efficient and scalable ways to produce biochar, it could become a significant tool in climate mitigation, particularly in agriculture-dependent regions.

Another groundbreaking idea involves altering urban environments to combat rising temperatures and extreme weather events. Cities contribute significantly to global emissions and often experience the urban heat island effect, where concrete and asphalt trap heat, raising temperatures. To counter this, architects and urban planners are experimenting with “cool roofs” coated with reflective materials, vertical gardens that absorb carbon, and innovative building designs that promote natural cooling. Moreover, projects to create “sponge cities” are being developed to manage floodwaters through green spaces, permeable pavements, and constructed wetlands, reducing the risk of climate-induced disasters.

Geoengineering, although controversial, is another avenue of research receiving attention. One proposal involves injecting aerosols into the stratosphere to reflect sunlight, mimicking the cooling effect of volcanic eruptions. While this could temporarily lower global temperatures, the long-term impacts remain uncertain, raising ethical and environmental concerns. Another idea under the geoengineering umbrella is marine cloud brightening, which seeks to increase the reflectivity of clouds over oceans by spraying seawater particles into the air. These methods could offer emergency solutions if climate change accelerates beyond current mitigation efforts, but they require careful study and international regulation to avoid unintended consequences.

Shifting economic models also present opportunities for tackling climate change in a more systemic way. The concept of a circular economy—where waste is minimized by designing products for reuse, recycling, and remanufacturing—reduces resource consumption and emissions. Companies are beginning to embrace this model, creating business strategies that prioritize sustainability without sacrificing profitability. Governments, too, are exploring policies such as carbon pricing, which incentivizes industries to cut emissions by making pollution financially burdensome. As these policies gain traction, they encourage businesses and consumers alike to adopt greener practices.

A surprising yet impactful approach involves behavioral science and social interventions. Encouraging people to adopt sustainable habits through psychological nudges—such as labeling products with carbon footprints or implementing gamified reward systems—can drive widespread behavioral change. Studies show that when individuals see peers engaging in eco-friendly actions, they are more likely to follow suit. Leveraging social norms and community-driven initiatives can amplify climate action beyond policy mandates and technological solutions.

Education and awareness are essential for long-term climate resilience. Integrating climate literacy in schools equips future generations to tackle environmental issues. Grassroots movements and citizen science encourage individual participation in conservation. As climate change urgency increases, a multidisciplinary approach—incorporating technology, nature-based solutions, urban innovation, policy changes, and social engagement—is vital for fostering a resilient and sustainable future.

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ASSESSING THE ECOLOGICAL AND CLIMATIC DRIVERS OF TAMIL NADU'S FIRE SEASON

-Ankur Goel
Director, Copper Cross Solutions

Tamil Nadu, a southern state in India, is known for its rich biodiversity, verdant forests, and intricate network of protected areas that support a wide range of flora and fauna. However, this ecological wealth is increasingly under threat due to an intensifying fire season. While traditionally considered less vulnerable to forest fires compared to central and northern Indian states, Tamil Nadu has begun to witness a worrying shift. The fire season in Tamil Nadu typically stretches from late January to the onset of the southwest monsoon in early June. This period is marked by a combination of dry weather, high temperatures, and strong winds, creating ideal conditions for wildfires to ignite and spread.

The landscape of Tamil Nadu is diverse, ranging from the dry deciduous forests of the Eastern Ghats to the moist evergreen forests of the Western Ghats and the scrublands interspersed across the plains. These varying ecosystems respond differently to climatic shifts, but they all share an increased vulnerability during the dry months. During the fire season, the absence of moisture in the soil, fallen dry leaves, and the accumulation of biomass on the forest floor form a combustible mixture. Even a small spark—whether from a lightning strike, human activity, or deliberate fire-setting—can quickly escalate into a destructive blaze.

Forest fires in Tamil Nadu are not a recent phenomenon, but their frequency, intensity, and geographical spread have grown in recent years. Satellite data and on-ground reports show an increasing number of fire alerts during the peak fire months. One of the major concerns is the impact of climate change, which is altering traditional rainfall patterns and intensifying dry spells. Rising temperatures, particularly during March and April, are drying out forest fuel loads faster and for longer durations, effectively lengthening the fire season.

Increased anthropogenic pressure is another critical factor. Encroachment into forest areas for agriculture, tourism-related activities, and illegal logging disrupt natural forest ecosystems and fragment habitats, making them more fire-prone. Cattle grazing and collection of non-timber forest products, which involve the burning of forest patches to promote new growth,

sometimes lead to uncontrolled fires. The growth of monoculture plantations like eucalyptus, which are highly flammable, further escalates fire risks. Such practices, when left unregulated, turn the fire season into an annual environmental hazard.

Tamil Nadu's hill regions, particularly the Nilgiris, Sathyamangalam, and parts of the Western Ghats, are among the most affected by seasonal wildfires. These areas house several endemic and endangered species, whose survival becomes more precarious with each passing fire season. Repeated fires disrupt breeding cycles, reduce food availability, and damage natural habitats, putting immense pressure on wildlife. Elephants, leopards, gaurs, and several bird species are frequently displaced, forced to venture closer to human settlements in search of shelter and sustenance, thereby increasing the risk of human-wildlife conflict.

Besides the impact on wildlife and biodiversity, forest fires in Tamil Nadu have serious implications for the environment and local communities. Fires release significant amounts of carbon dioxide and other greenhouse gases into the atmosphere, contributing to global warming. They degrade soil quality, reduce groundwater recharge, and affect the overall health of forest ecosystems. In rural areas, many communities depend on forests for their livelihoods and daily sustenance. When fires destroy forest resources, these communities face economic losses and resource scarcity, exacerbating existing socio-economic challenges.

Government efforts to address this growing threat have been multifaceted, involving fire line maintenance, early warning systems, and awareness campaigns. Fire watchers are deployed during peak months, and forest departments use satellite-based monitoring tools to detect fire outbreaks in real time. Yet, challenges persist. Limited manpower, funding constraints, and rugged terrain make fire control and containment a difficult task. In many cases, by the time officials reach a reported fire site, significant damage has already been done.

Prevention and community participation remain the cornerstone of effective fire management. Forest fire prevention committees, involving local residents in monitoring and reporting, have shown promise in a few districts. Traditional knowledge systems, when integrated with modern fire science, can also aid in designing sustainable fire management strategies. For instance, scheduled, controlled burns under supervision can help reduce excess fuel load without endangering ecosystems. However, these measures require long-term commitment, capacity building, and greater coordination between various stakeholders.

Education and outreach are equally vital. Engaging school children, village elders, and youth groups in understanding the ecological importance of forests and the risks of fire can help cultivate a culture of conservation. Reimagining forest stewardship as a shared responsibility rather than the sole burden of forest departments could transform fire management from a reactive process into a proactive movement. Collaborative efforts can lead to innovative solutions, where community-driven initiatives and traditional knowledge play a central role in forest preservation.

As Tamil Nadu faces a changing climate and increasing human encroachment, the fire season has evolved from a seasonal occurrence to a pressing environmental concern. It is no longer just about dousing flames—it is about safeguarding biodiversity, protecting rural livelihoods, and preserving ecological balance. Addressing this growing threat requires not only technical solutions but also a deeper respect for nature, inclusive governance, and a long-term vision for sustainable coexistence with our forests. By fostering partnerships between government bodies, NGOs, and local communities, we can develop strategies that are both effective and culturally relevant. This united approach can ensure that future generations inherit a world where forests thrive, serving as a testament to our collective commitment to environmental stewardship.

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PIONEERS OF THE INDIAN SPACE PROGRAM: BUILDING A LEGACY AMONG THE STARS

India's journey into space is a story of vision, determination, and scientific excellence. From modest beginnings to becoming a global leader in space technology, this remarkable trajectory has been shaped by visionary pioneers whose contributions laid the foundation for what is today the Indian Space Research Organisation (ISRO). Here's a look at the legendary figures who steered India into the space age.

Dr. Vikram Sarabhai – The Father of the Indian Space Program

Dr. Vikram Sarabhai is universally hailed as the architect of India's space program. With a vision rooted in self-reliance and societal development, he believed that science and technology should address India's developmental needs.

Key Contributions:

Established the Indian National Committee for Space Research (INCOSPAR) in 1962, which later evolved into ISRO.

Initiated India's first space project and collaborated with NASA to launch India's first sounding rocket from Thumba in 1963.

Laid the groundwork for the Aryabhata satellite and the development of Indian launch vehicles.

His famous quote captures the essence of his vision:

"We do not have the fantasy of competing with the economically advanced nations in the exploration of the Moon or the planets or manned spaceflight. But we are convinced that if we are to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society."

Dr. Homi Jehangir Bhabha

Dr. Homi Jehangir Bhabha, best known as the father of India's nuclear program, also played a crucial role in shaping India's space science initiatives. A close associate of Dr. Vikram Sarabhai, he provided institutional support and actively promoted scientific innovation in space research. He strongly believed in building indigenous capabilities in advanced technology and emphasized self-reliance in scientific endeavors.

Key Contributions:

Founded the Tata Institute of Fundamental Research (TIFR), where India's earliest space science work was initiated.

Played a crucial role in convincing the Indian government about the importance of space research and securing funding for early projects.

Advocated for interdisciplinary collaboration, bringing together experts from physics, engineering, and mathematics to strengthen India's scientific foundation.

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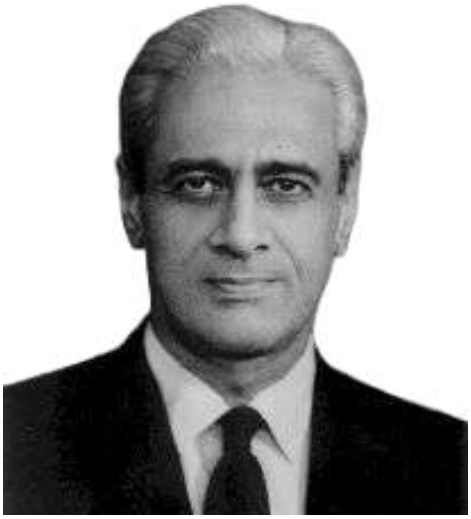
Supported the establishment of India's first Rocket Launching Facility at Thumba (TERLS), which later became a key center for ISRO's research.
Instrumental in creating a strong base of scientific manpower and infrastructure, enabling India to develop indigenous space technology.
His leadership ensured that India laid the foundation for space exploration while also focusing on its peaceful applications for societal development.
Bhabha's visionary approach not only propelled India's nuclear advancements but also created a strong scientific ecosystem that greatly benefited the country's space program.

Prof. Satish Dhawan – The Institution Builder



Taking over ISRO after Sarabhai's untimely death, Prof. Satish Dhawan brought a new era of organization, structure, and technical advancement.

Key Contributions:

Oversaw the successful SLV-3 (Satellite Launch Vehicle) mission in 1980, which placed Rohini Satellite RS-1 into orbit — making India one of the few countries with satellite launch capabilities.
Known for his ethical leadership, he delayed announcing the SLV-3 success until every scientist involved had verified the mission.
Strengthened ISRO's organizational culture, focusing on self-reliance, cost-efficiency, and innovation.

Dr. A.P.J. Abdul Kalam – The Missile Man and Space Scientist

Dr. Kalam was a key figure in India's space and defense programs. He played a pivotal role in the development of SLV-3, and later, in India's missile and nuclear weapons programs.

Key Contributions:

Project Director for SLV-3, which successfully deployed the Rohini satellite.
A passionate advocate for indigenous technology and youth empowerment.
As President of India, he inspired generations to dream big and believe in the power of science and technology.

The Indian space program is not just about rockets and satellites—it is about vision, innovation, and national pride. These pioneers transformed India's space dream into reality with limited resources but limitless ambition. Today, as ISRO eyes missions to the Moon, Mars, and beyond, it does so standing on the shoulders of these giants.
Their legacy continues to inspire new generations of scientists, engineers, and dreamers — proving that with the right vision and determination, the sky is not the limit; it's just the beginning.

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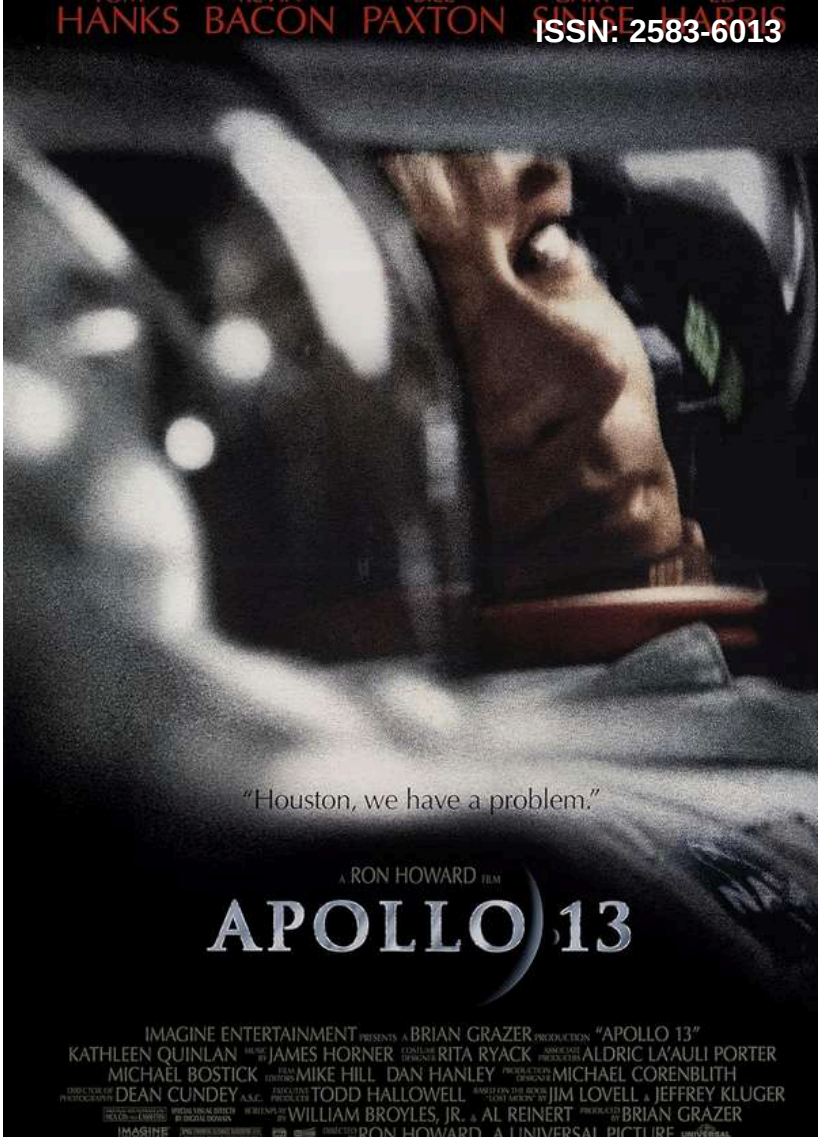
MOVIE
RECOMMENDATION

APOLLO 13

Apollo 13 (1995) is a gripping space drama directed by Ron Howard, based on the true story of NASA's ill-fated 1970 lunar mission. Starring Tom Hanks, Kevin Bacon, and Bill Paxton as the astronauts Jim Lovell, Jack Swigert, and Fred Haise, the film chronicles their harrowing struggle for survival after an oxygen tank explodes mid-mission. With the famous line, "Houston, we have a problem," the movie showcases the teamwork, ingenuity, and resilience of both the astronauts and NASA's ground control as they race against time to bring the crew safely back to Earth.



PLOT SYNOPSIS

Apollo 13 (1995) is a gripping true story of NASA's ill-fated 1970 lunar mission, transformed from a groundbreaking spaceflight into a desperate fight for survival. Veteran astronaut Jim Lovell (Tom Hanks) leads the Apollo 13 crew, alongside Command Module Pilot Jack Swigert (Kevin Bacon) and Lunar Module Pilot Fred Haise (Bill Paxton), as they embark on what is meant to be the third manned mission to the Moon. Excitement and optimism surround their departure, but just days into the mission, an oxygen tank explodes, crippling the spacecraft and throwing the crew into a life-or-death struggle.

With the command module losing power and oxygen, the astronauts are forced to move into the lunar module, using it as a lifeboat despite it not being designed to support all three men for an extended period. As temperatures drop and carbon dioxide levels rise, they must work quickly, improvising with whatever materials they have to survive. Meanwhile, back on Earth, NASA's Mission Control, led by Flight Director Gene Kranz (Ed Harris), races against time to develop solutions, testing procedures on simulators and guiding the crew through a series of near-impossible maneuvers to ensure their safe return.

Facing exhaustion, dwindling resources, and extreme uncertainty, the astronauts rely on each other and the unwavering support of their ground team. As they make their final approach to Earth, tensions rise over whether their damaged capsule will withstand re-entry. After a nerve-wracking radio blackout, the world watches in relief as the Apollo 13 crew safely splashes down in the Pacific Ocean. Their survival stands as a testament to ingenuity, teamwork, and the unyielding human spirit, forever marking Apollo 13 as "NASA's successful failure."

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