



2023 ASTRA WHITE PAPER - BANKSIA

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EYES IN SPACE AND ON COUNTRY

Aboriginal and Torres Strait Islander knowledges are integral to shaping the future of Earth Observation and bushfire management.

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Acknowledgement of Country

The Australian Youth Aerospace Association, the Astra Program, and Team Banksia acknowledge the Traditional Custodians of Country throughout Australia. The participants, committee, and supporters of the Astra Program come from a variety of lands across Australia, including the lands of the Meriam-Mir, Wadawurrung, Dharawal, Turrbal, Jagera, Ngunnawal, Mabri, Muwinina, Palawa, Wurundjeri Woi Wurrung, Bunurong Boon, Wurrung, and Gadigal peoples.

We pay our respects to Elders past and present, and extend that respect to all Aboriginal and Torres Strait Islander peoples. We honour Aboriginal and Torres Strait Islander peoples' continued connection to Country, waters, skies and communities. We recognise the First Nations Peoples of Australia as the world's first astronomers, and celebrate their cultures and customs which continue to care for Country and nurture astronomical knowledge.

Introduction

Bushfires are intrinsic to the Australian landscape. Australia's native flora and fauna are reliant on bushfires to maintain a strong level of biodiversity.¹ Aboriginal and Torres Strait Islander peoples have cultivated a relationship with land and bushfires over tens of thousands of years, engaging in cultural burnings with the purpose of caring for Country.² Under the impacts of colonisation, poor land and bushfire management practices and anthropogenic climate change, bushfires pose a significant risk to the environment, society and economy.³

Australia is well positioned to implement and utilise Earth Observation (EO) techniques to support bushfire risk management. However due to the developing state of Australia's space industry, there is currently limited sovereign activity exploring these capabilities, with one of the few current examples being smartsat's Kanyini program.⁴ With such a vast stretch of land to monitor,



it is difficult to effectively manage bushfires without EO, as almost 90 per cent of Australians live within 50 kilometres of the coast.⁵

Upon investigative research and dialogue with industry leaders, this white paper proposes that integrating Aboriginal and Torres Strait Islander knowledge through education programs and policy initiatives and implementation of Earth observation technology, is instrumental in improving bushfire-risk mitigation, preparedness, response, and recovery.⁶

Methodology

Over a period of three months during the Astra Program, Team Banksia have formulated six recommendations intended for Australia's developing space industry, through obtaining and sharing data, education, panel discussions and extensive research. This paper covers a range of areas including engagement, economic growth, and education.

Our team reviewed existing scientific research into EO within Australia and internationally, as well as reports of engagement with Aboriginal and Torres Strait Islander communities in the Australian Space Industry. To assist this process, we adopted personas of critical stakeholders in the Australian space industry. Through independent research in groups from the lens of these stakeholders, we cultivated knowledge that proved later relevant when narrowing our recommendations.

Team Banksia also engaged in discussions with Subject Matter Experts ('SME') to identify common stakeholder interests prior to presenting initial recommendations. These occurred during seminars featuring experts from SmartSat CRC, the National Centre for Cultural Competence, the Australian National University and two First Nations owned and operated businesses: Indigi Lab and Tagai Consulting. The SME's feedback and evaluation of our ideas were then used to finalise the recommendations presented in this white paper.

Limitations and Assumptions

Our team has worked closely with EO issues as they relate to Aboriginal and Torres Strait Islander peoples of Australia, and their scientific knowledge and wisdom which dates back to over 50,000 years from present day.⁷ We recognise that Team Banksia did not have a person of Aboriginal and Torres Strait Islander descent working on the drafting of this white paper. As such, we have been diligent to understand issues of cultural sensitivity, and engage in consultation with Aboriginal and Torres Strait Islander representatives to the greatest degree possible given the limited timeframe.

The 12-week timeline imposed several constraints which limited the time available to conduct a comprehensive analysis of the industry. We had to prioritise research in certain areas which may have resulted in the omission of some details.



Whilst Team Banksia include members from a diverse array of educational backgrounds, our collective experience in the space industry is limited. Team Banksia has made every effort to leverage our skills, knowledge and creativity to produce a meaningful and impactful white paper.

Recommendation 1: The Australian Space Agency should establish a board that advises on Australian space activities affecting Aboriginal and Torres Strait Islander peoples and lands. Additionally, the Australian Space Agency should support a non-government organisation, established by relevant groups, to advocate for inclusion of traditional knowledge into space education in Australia.

We recommend that the Australian Space Agency (the Agency) establishes an Indigenous Space Advisory Board that would support the Agency in matters that affect Indigenous Australians. This recommendation would aim to ensure the full and effective participation of Indigenous Australians in decision-making processes and to promote respect for and protection of Indigenous cultures, which are both recognised fundamental rights of Indigenous peoples.⁸ The Board would convene on a regular basis and should be modelled on existing advisory frameworks within the Agency, such as the Space Agency Advisory Board⁹ and the Space Industry Leaders Forum.¹⁰ Like these groups, the proposed board would provide input into national civil space strategy and policy while not being a decision making body.

The board would provide advice to the Agency and facilitate direct engagement with Indigenous knowledge brokers on current events in the Australian space industry, such as consideration of Country when managing ground segment development and space debris. Outcomes for the Agency would include more relevant policies and strategies and improved applications of technology by incorporating social and economic advice from Aboriginal and Torres Strait Islander communities, businesses and organisations.

Furthermore, relevant industry, academic and educational stakeholders and community members, in conjunction with Aboriginal and Torres Strait Islander communities, businesses and organisations, should establish a non-government organisation (NGO) that would advocate for the inclusion of traditional knowledges in space education in Australia. The NGO should be supported by the Agency, and should also seek to build alliances with existing independent groups such as Australians for Native Title and Reconciliation, whose mission statement indicates that they work with ‘...other organisations and across sectors in support of common goals.’¹¹

This recommendation would work towards affirming Aboriginal and Torres Strait Islander peoples and culture into Australia’s space industry. Research shows improved educational outcomes when Aboriginal and Torres Strait Islander knowledges co-exist with current science concepts.¹²



This recommendation is driven by case studies that show Aboriginal and Torres Strait Islander students find school science less relevant and more unrelated to their personal lives.¹³ This is reflected in the disparity in engagement and learning outcomes between Aboriginal and Torres Strait Islander students and non-Indigenous students across Australia.¹⁴ As a consequence, Aboriginal and Torres Strait Islander Australians are less likely to find employment in science and technology-related jobs compared to their non-Indigenous peers.¹³

These actions would shape space conversations in Australia, and promote intergenerational learning and collaboration between Aboriginal and Torres Strait Islander knowledges and practices in harmony with current approaches to national space policy and direction.

Recommendation 2: The Australian Space Agency and Australian space companies should implement a policy to ensure that Aboriginal and Torres Strait Islander groups and individuals have sovereignty over collection, analysis, use and re-use of data.

Aboriginal and Torres Strait Islander groups should have the authority to decide how data relating to Aboriginal and Torres Strait Islander land, culture and people, specifically in the context of EO and/or bushfire research, is collected, analysed, used and reused.¹⁵ This is supported by the UN Declaration on the Rights of Indigenous Peoples that notes that Indigenous peoples should have ‘the right to maintain, protect and develop the past, present and future manifestations of their cultures’.⁸ The Maiam nayri Wingara Indigenous Data Sovereignty Collective established a set of principles around Indigenous Australian data sovereignty and governance in 2018.¹⁶ The CARE (Collective Benefit, Authority to Control, Responsibility, and Ethic) Principles for Indigenous Data Governance have been recommended for adoption by organisations conducting environmental research.¹⁷ For example, the use of ‘Biocultural Labels’ to identify and recognise Aboriginal and Torres Strait Islander knowledge in database systems is an application of the ‘Collective Benefit’ and ‘Authority to Control’ principles.¹⁷

We recommend that the Agency and Australian space companies should consider the adoption of those principles or, in consultation with Aboriginal and Torres Strait Islander stakeholders, develop policy for Indigenous Australian data sovereignty within individual organisations. It is important to ensure that data sharing does not occur in the context of an extractive relationship, but a partnership with Aboriginal and Torres Strait Islander peoples.¹⁸



Recommendation 3: The Australian Space Agency, Australian space companies, Universities and other funding bodies, should consider a diversification of funding methods for Earth Observation and bushfire research, to better connect communities, researchers and decision-makers.

Scientific research is typically funded using project, block and/or competitive funding methods.¹⁹ Whilst these are valid funding options, STEM research is complex and diverse especially when research is of direct importance to the public, and therefore could benefit from different funding approaches.²⁰ Project-focussed funding requires specific outcomes to be achieved in a short or restrictive time frame and whilst it can encourage novel research, funding allocation for such research has been noted to favour researchers with higher status or privilege.¹⁹

Other funding models that are not as prevalent in STEM research are place-based or a combination of funding models (e.g. competitive place-based funding). Place-based funding can include funding projects that are restricted by a specific spatial or geographic location, identifying, researching and resolving an issue experienced in that location or building a holistic approach to a research problem using local knowledge and resources.²¹ Place-based funding has the potential to achieve long-term change in one geographical location and allows for the integration of local knowledge and collaboration into the project (such as local Aboriginal and Torres Strait Islander knowledge or knowledge from local Rural Fire Service (RFS) groups).²² It also provides flexibility for the research goals to pivot throughout time and allows for the time and space for learning and reflection to ensure consistent, positive outcomes.²¹

This recommendation encourages organisations and funding bodies such as SmartSat CRC to consider a diversification of the funding options available in order to effectively achieve research outcomes and connect communities, researchers and decision-makers. Whilst limited literature exists on place-based funding, with most examples of its implementation existing in the arts sector,²³ it could provide positive outcomes for EO and bushfire research. Place-based funding could encourage collaboration and knowledge sharing between researchers and groups who live in and carry knowledge about the place being researched.

Recommendation 4: Australian Rural Fire Services should increase connections with Aboriginal and Torres Strait Islander knowledge brokers.

Traditional fire management techniques are far different to those currently used within Australia's bushfire management system.²⁴ State and territory rural fire authorities have differing levels of engagement with Indigenous Australian communities and knowledge holders.²⁵ The removal of Indigenous Australian peoples and cultural fire knowledge from their traditional lands has been attributed to the increase of uncontrolled and destructive fires.²⁴ Notably, the 2019/20 Black Summer bushfires resulted in 5.5 million hectares of land being burnt and 26 lives lost.²⁶ Research



into the disaster has resulted in Royal Commission recommendations for improved disaster prevention. Included in these recommendations is specific mention of the need for increased employment of Indigenous Australian land management techniques.²⁷

An example of existing engagement between the RFS and Indigenous Australian cultural knowledge brokers can be found in the all-Indigenous Australian Firefighting crews in Bourke and Brewarrina in NSW.²⁸ Other States and Territories have also employed Indigenous Australian crews, such as the firefighting team of Gunaikurnai women in Victoria's Gippsland region.²⁹ NSW RFS state Aboriginal program coordinators have noted that the community connections possessed by Indigenous Australian crews have allowed access to previously isolated areas.²⁵ These crews, selected by community Elders, are employed to reduce fire hazards within the community with the use of traditional techniques, ranging from cultural burnings to tree trimmings.²⁹

We recommend that there be an expansion of all-Indigenous crews to other regions and that the RFS pursue further involvement with organisations promoting cultural burnings, such as the Firestick Alliance.³⁰ This will enable the RFS to support the elevation of cultural fire knowledge to a primary means of fire reduction. Furthermore, the promotion of Indigenous Australian knowledge brokers to leadership positions within the RFS could allow for cultural fire knowledge to become utilised on a more regular basis.

Although we cannot ascertain a majority opinion, many Indigenous Australian knowledge brokers have asserted their belief that cultural fire management is crucial to the maintenance of Australia's bushland.³¹ Bundjalung man and Founder of the Firesticks Alliance, Oliver Costello, says 'We've got a vision to see cultural fire management as the premier fire management practice [in Australia] and really bringing back the traditional knowledge.'³² This goal, which includes the further implementation of all-Indigenous crews and increased communication, should be pursued by the RFS on a larger scale.

Recommendation 5: The Australian Space Agency should coordinate stakeholder engagement to utilise ground stations of partnering nations in support of a publicly funded Earth Observation satellite, with delivery to be led by SmartSat CRC, to provide the sensor capabilities required to better enable preventative bushfire management practices.

The Agency should coordinate stakeholder engagement between partner nations to commence design and manufacture of a publicly funded EO satellite. This project requires a strategic Whole-of-Government approach which the Agency can provide to reduce costs domestically, and share an otherwise under-utilised asset globally. Investing in this will contribute to the



Agency's Earth-based Observation from Space Road Map 2021-2030³³, but will require interagency coordination to ensure the best outcomes for any public funding in the development.

This proposal suggests that partnering nations contribute ground segment sites to downlink the EO data. The international agreement would require a reciprocal contribution of data handling and processing, with resources committed to analysing the information to increase EO payload effectiveness. This recommendation strategically suggests brokering agreements with nations in the Americas due to shared concerns around fire management and their suitable location for downlinking of EO data.

The satellite design and manufacture should be led by organisations with experience and links to local industry, such as SmartSat CRC, as they have existing heritage in leading similar projects. The satellite payload sensors should be capable of detecting dry vegetation and fuel quantities to allow Australia to utilise the data to proactively address bushfire concerns. Microwave sensors could provide this invaluable tool to complement other imaging payloads.³⁴ Another sensor which could be employed is short-wave infrared, as there is less absorption of this type of radiation in dry vegetation due to the lower levels of water it contains.³⁵

Sharing this satellite during the varied orbital coverage periods will generate diplomatic goodwill and would be mutually beneficial in addressing bushfire/wildfire concerns with sensors allowing for application of pre-emptive measures. This recommendation aligns with the efforts by OzFuel, and the findings from this may also assist in informing the sensor selection for the proposed satellite to enable improved implementation of EO for bushfire management practices.³⁶

A key outcome from this recommendation is to mitigate the extensive damage that is caused by fires when proactive measures are not implemented or are ineffective. This satellite would assist in improved bushfire management when coupled with traditional burning conducted by Indigenous Australian response teams positioned regionally, travelling to treat areas which are most at risk. This enables the most effective use of limited resources.

Potential Partner - USA

The US is prone to extensive fires raging across regions of the west coast during the summer. We propose that, in agreement with the US, an Alaska-based Earth Station will be utilised in close proximity to the Arctic Circle. A LEO satellite would have 8-14 passes over the state per day (depending on orbital height and earth station location) presenting an increased opportunity for data downlink.³⁷ This will greatly improve the connectivity with the satellite, and data would then be shared via terrestrial means.



Potential Partner – Brazil

Brazil has suffered highly destructive wildfires and would benefit from preparing to mitigate future costly natural disasters through EO data.³⁸ Brazil has a growing space industry which could provide support to this project with a ground station and an additional source of data sharing to assist in optimising the EO capability.³⁹ The usage of the proposed satellite over Brazil will not be of impost to anticipated employment within the typically vulnerable regions of the US, due to Brazil's position on the east coast of the Americas.

Benefits to Australia

Improved Education Opportunities	This would provide additional opportunities for Australian universities to thrive and build their educational relationships internationally, and exchange research on the satellite subsystems.
Growing Australia's Space Industry	The satellite design and development would assist in building the Australian Space Industry capabilities, another key outcome for the Agency targets for 2030. ⁴⁰ This stimulus to the Australian space sector will also be beneficial in upskilling the workforce in other high-tech industries.
Increased avenues for fire management research	Liaison should be conducted with CSIRO counterpart organisations internationally to assist in facilitating the design, sensor selection and data analysis. Opportunities for mutually supportive research will be accessed by combining efforts with the National Space Mission for Earth Observation from CSIRO: a \$1.2Bil program which includes the 10% ownership of NovaSAR. ⁴¹
Opportunities for employment for First Nations people and business growth	Synchronised with Indigenous Business Australia, this capability could create more financial sustainability for Indigenous Australian members – an expenditure of public money which addresses government objectives in other departments.
Responsible expenditure of budget	Partnering with other nations will reduce cost to the Australian Government. It would ensure a more efficient expenditure of taxpayer resources while minimising idle time of the satellite.



Recommendation 6: The Australian Government (Department of Industry), in conjunction with SmartSat CRC, should fund university-based research into the processing of satellite image data and development of Artificial Intelligence datasets for fire monitoring.

Satellites present an exclusive viewpoint with unobstructed visual access, which can yield valuable information about weather patterns, vegetation changes, and fire activity. However, manually analysing large volumes of captured data is impractical, particularly when the majority of images are obscured by clouds. Typically, data collected by radiometric or spectral sensors undergoes processing using classical machine learning and specialised algorithms at ground stations.⁴² Artificial Intelligence (AI) has demonstrated its ability to solve intricate problems by relying solely on the inherent information embedded within the data, resulting in a reduction in the preprocessing and postprocessing required by conventional methods.⁴³

Funding for PhD student research in AI and space technology and the development of AI datasets for fire monitoring are recommended to advance the Australian space industry and profit from the benefits of on-board processing.

Processing Data

Research into processing AI data is crucial for the advancement of the Australian space industry. We recommend a collaboration between the Australian Government and SmartSat CRC to fund PhD student research in AI and space technology, specifically in the following areas:

- The potential for AI deep convolutional neural networks in an EO data application.
- On board data processing capabilities for AI algorithms for smart processing directly on orbit.
- Innovation in radiation hardening for electronic chips in a space application.

The Australian space industry stands to gain significantly from research centred on on-board processing. These networks can effectively reduce bandwidth requirements by filtering out non useful data. This capability proves to be especially significant as limited budgets drive the adoption of cubesats, which feature highly restricted downlink data rates.⁴⁴

Development of AI datasets for fire monitoring

To capitalise on the benefits of on-board processing, we recommend that funding is also provided for PhD students to conduct research in development of AI datasets for fire monitoring.

The complexity of fire behaviour, which involves various physical and chemical factors, makes it difficult to map accurately. Recent research suggests that machine learning algorithms can be



employed to create a satellite-like image in real-time using data collected from Internet of Things (IoT) sensors.⁴⁵ In this process, the target variables are determined by an ensemble of regression models. However, training these types of AI algorithms necessitates a large volume of data, and remote sensing data gathered via EO processes typically has low to medium spatial and temporal resolution⁴⁶, which can complicate the training process. To address this challenge it is recommended that additional data sources be combined with remote sensing data to enhance its interpretation.

To achieve these goals, we recommend research to be conducted in these areas:

- Development of an AI dataset combining data from remote sensing, meteorological and environmental sources.
- The creation of bushfire simulation tools that integrate algorithms and theoretical models of bushfire propagation which could be used to model a nationwide fire extent and severity map.

Collaborating with Smartsat CRC and PhD students could drive significant economic growth in Australia by creating new commercial outputs and spin-in and spin-off technologies, and developing new capabilities that can be applied in a range of settings. This has potential to generate new businesses, encourage innovation, and build research capacity. Exploration of these fields can produce cutting edge research, improve and expand the national science research sphere, and can attract more foreign investment in Australia's space industry and related fields.



Recommendations

Recommendation 1: The Australian Space Agency should establish a board that advises on Australian space activities affecting Aboriginal and Torres Strait Islander peoples and lands. Additionally, the Australian Space Agency should support a non-government organisation, established by relevant groups, to advocate for inclusion of traditional knowledge into space education in Australia. This recommendation is directed primarily towards the Agency though would require input from relevant action groups.

Recommendation 2: The Australian Space Agency and Australian space companies should implement a policy to ensure that Aboriginal and Torres Strait Islander groups and individuals have sovereignty over collection, analysis, use and re-use of data. This recommendation is targeted primarily towards the Agency but should be strongly considered by space industry companies and university research groups.

Recommendation 3: The Australian Space Agency, Australian space companies, Universities and other funding bodies, should consider a diversification of funding methods for Earth Observation and bushfire research, to better connect communities, researchers and decision-makers. This recommendation is directed towards the Agency, the Australian Government Department of Industry, Science and Resources (e.g. the Australian Research Council), SmartSat CRC and Australian universities.

Recommendation 4: Australian Rural Fire Services should increase connections with Aboriginal and Torres Strait Islander knowledge brokers. This recommendation is directed to Rural Fire Services of each state and territory within Australia.

Recommendation 5: The Australian Space Agency should coordinate stakeholder engagement to utilise ground stations of partnering nations in support of a publicly funded Earth Observation satellite, with delivery to be led by SmartSat CRC, to provide the sensor capabilities required to better enable preventative bushfire management practices. This recommendation is directed to SmartSat and the Agency.

Recommendation 6: The Australian Government (Department of Industry), in conjunction with SmartSat CRC, should fund university-based research into the processing of satellite image data and development of Artificial Intelligence datasets for fire monitoring. This recommendation is directed towards SmartSat, the Australian Government Department of Industry, the Agency, CSIRO and Geoscience Australia.



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