REPORT FROM THE WORKSHOP

Earth Observation for Drought Monitoring and Early Warning in South Africa

Geospatial services for enhanced Decision Making

9TH, 10TH APRIL 2024

Pretoria, South Africa

ANIN South Africa Drought Monitoring

EO AFRICA

National Incubators facilitating adoption of EO with national R&D partners

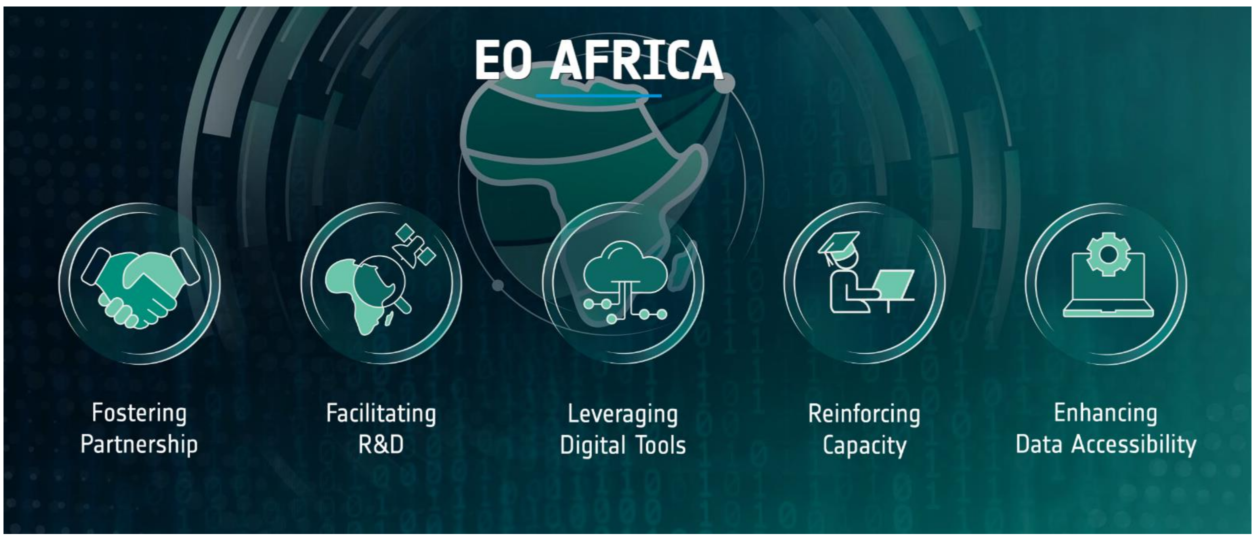
In collaboration with

INTRODUCTION

The event at the Innovation Hub in Pretoria, South Africa, represented a pivotal gathering aimed at bolstering the application and understanding of Earth Observation (EO) data in enhancing drought monitoring and decision-making. This initiative, focused on the development of a comprehensive drought early warning system, involved the collaboration of key stakeholders, including the Department of Water and Sanitation (DWS), the South African Weather Service (SAWS), and participants in the EO Africa programme. Through a series of presentations and discussions, the meeting intended to shed light on the current mandates for drought monitoring, the integration of EO technologies, and the role of Digital Earth South Africa in supporting these endeavors.

BACKGROUND

The objective of the ESA initiative [EO AFRICA (African Framework for Research, Innovation, Communities and Applications)] is to build an African-European R&D partnership to facilitate the sustainable adoption of Earth Observation and related space technology in Africa.

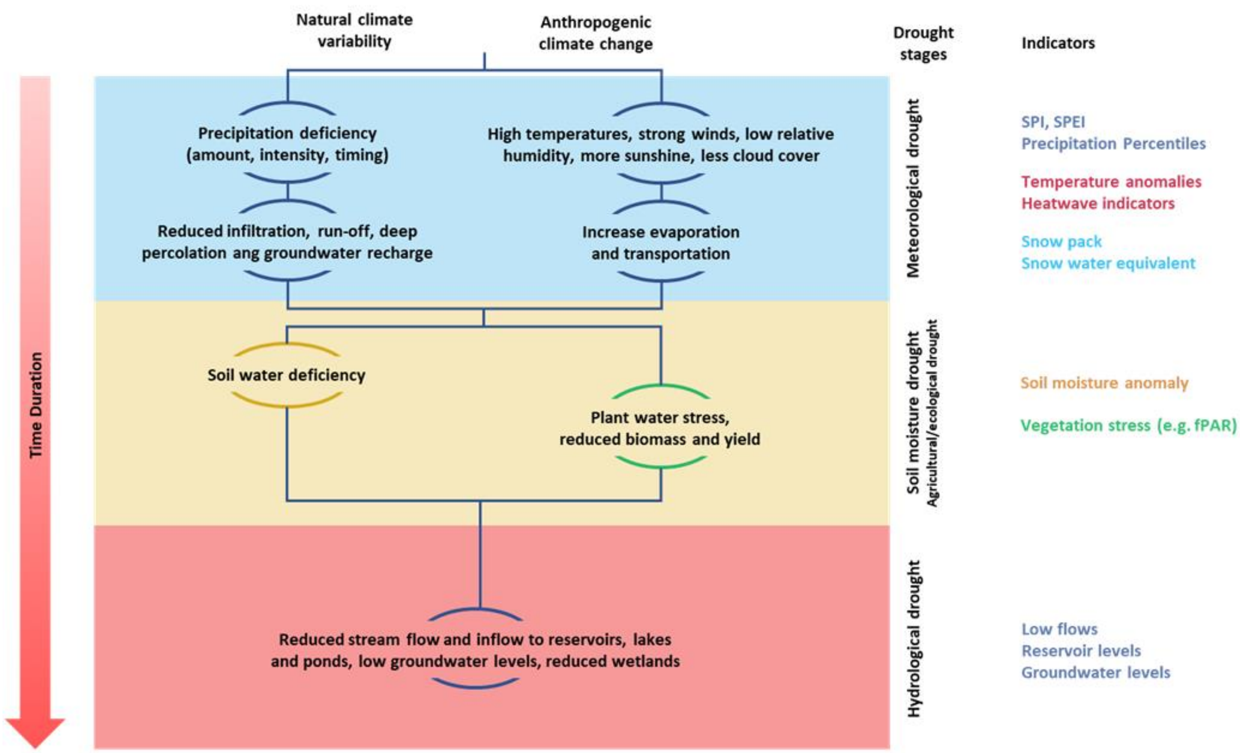


EO AFRICA follows a long-term vision (>10 years) for the emergent digital era in Africa. Starting from September 2022, 10 new projects are being kicked off, involving African developers, research groups and early adopters. This project is one of the four EO AFRICA 'National Incubators' projects that investigate how sustainable agriculture and/or drought monitoring at a national scale can be achieved in the African continent, by co-developing innovative EO-based solutions with African experts.

The ANIN South Africa Drought Monitoring Project aims to increase the awareness of EO data potential to support the operation of added-value services in the field of drought monitoring decision making. The project aims to build a drought early warning system that is based on the continuous calculation of a set of satellite-based indices and indicators.

EARTH OBSERVATION FOR DROUGHT MONITORING

Drought is a recurrent feature of all climates that results from a shortfall in precipitation over an extended period, its inadequate timing compared to the needs of the vegetation cover, or a negative water balance due to an increased potential evapotranspiration caused by high temperatures. These conditions may be exacerbated by strong winds, atmospheric blocking patterns and antecedent conditions in soil moisture, reservoirs, and aquifers among others. If this situation leads to an unusual and temporary deficit in water availability, it is termed a drought.



The European Space Agency (ESA)-funded ANIN project kicked-off on 13th of September 2022. The project aims to provide a Drought Early Warning system by calculating meteorological, agricultural, and hydrological indices based on satellite data.

WORKSHOP OUTCOMES

The workshop held at the Innovation Hub in Pretoria, South Africa, was designed with the primary goal of enhancing the operational use and understanding of Earth Observation (EO) data in drought monitoring and decision-making processes.

Main outcomes are:

1. **Increase Awareness:** Elevate stakeholder knowledge of the value EO data can provide in augmenting services related to drought monitoring and decision-making.
2. **Promote Collaboration:** Facilitate engagement and cooperation among key stakeholders, including government entities such as the Department of Water and Sanitation (DWS) and the South African Weather Service (SAWS), alongside participants from the EO Africa program and other pertinent organizations.
3. **Enhance Capacity:** Address and identify deficiencies and need in accessing and utilizing EO data for drought monitoring, with the goal of improving technical and operational capabilities.
4. **Develop Innovative Solutions:** Investigate and create new approaches for incorporating EO technologies into current and prospective drought monitoring and early warning systems.
5. **Ensure Sustainability:** Formulate strategies that maintain and enhance the effectiveness and adoption of EO services for drought monitoring after the conclusion of initial funding, to guarantee continued relevance and success.

SPECIFIC OUTCOMES:

Day 1:

- **Delivered a Comprehensive Overview**: Provided participants with a detailed understanding of the EO Africa programme, emphasizing its importance and application in drought monitoring.
- **Examined Current Efforts and Integration Opportunities**: Engaged in thorough discussions about the existing responsibilities and initiatives of the Department of Water and Sanitation (DWS) and the South African Weather Service (SAWS) regarding drought monitoring, along with exploring possibilities for integrating EO technologies.
- **Enhanced Collaboration and Impact through Group Work**: Conducted focused group activities aimed at identifying the primary users of EO-derived drought data, understanding their specific requirements, and planning collaborative efforts to maximize impact through the ANIN project.

Day 2:

- **Delved into the Technical Specifics**: Explored the technical details of data processing algorithms and visualization techniques essential for effective drought monitoring.
- **Demonstrated the Application and Impact of EO Data**: Showcased the use and significance of EO data through practical examples and use cases, with a particular focus on the Berg Oliphants region.
- **Engaged Participants in Technical Discussions**: Involved participants in detailed technical discussions aimed at refining the next steps and strategies for implementing the insights and solutions identified during the workshop.

GROUP SESSION OUTCOMES

Earth Observation Data Use in Participant Organizations

During the group session focused on the utilization of Earth Observation (EO) data within various organizations, participants provided insightful responses that highlighted the diversity and breadth of EO data applications. The discussion revealed several key areas where EO data is being actively used, reflecting its critical role in environmental monitoring and decision-making processes.

- **Monitoring and Compliance**: Many organizations use EO data for drought monitoring, water volume tracking, and irrigation compliance. This application is crucial for managing water resources efficiently and ensuring adherence to regulatory standards.
- **Data Processing and Analysis**: A significant portion of the discussion centred around the technical aspects of EO data use. Participants detailed their processes involving data acquisition, processing, analysis, and the derivation of products. This includes the generation of 'analysis-ready data' for dissemination and decision-making, which supports a range of strategic activities from policy formulation to operational adjustments.
- **Policy and Research Applications**: EO data serves as a foundational element in the development of policies related to climate change and its impact on agriculture. Organizations employ this data to conduct comprehensive climate analyses, which inform policy frameworks and help in crafting measures to mitigate adverse effects on agriculture and other sectors.
- **Geographical Information Systems (GIS) and Safety Applications**: Several participants noted the integration of EO data with GIS for enhanced mapping and spatial analysis, which is pivotal in areas like information services, safety monitoring, and water quality assessments.
- **Disaster Management and Research**: EO data is extensively used in disaster management, helping organizations monitor and respond to natural disasters such as floods and droughts. Furthermore, it supports a wide range of research initiatives, particularly in universities where students and faculty leverage EO data for academic studies and innovation in environmental monitoring.
- **Educational and Practical Applications**: The session also highlighted the role of universities and educational institutions in capturing and utilizing EO data, not only for teaching and research but also for practical applications related to monitoring environmental phenomena like water bodies and land use changes.

These diverse applications underscore the value of Earth Observation data across multiple sectors, aiding in both strategic decision-making and operational functions. The group session outcomes demonstrate a strong consensus on the critical role of EO data in enhancing organizational capabilities to address environmental and societal challenges.

Potential of Earth Observation to Improve Drought Monitoring

The group session extensively discussed the potential of Earth Observation (EO) data to enhance drought monitoring capabilities across various sectors. Participants provided a range of insights, affirming the significant role of EO in understanding and managing drought conditions. The key points raised during the discussion are summarized below:

- **Comprehensive and Timely Data**: Participants highlighted that EO data offers timely and comprehensive coverage essential for monitoring drought dynamics. This allows for the early prediction of drought onset and the assessment of drought severity, which are critical for developing effective mitigation strategies.
- **Drought Characterization**: EO data is instrumental in characterizing different types of droughts, including agricultural, hydrological, and meteorological droughts. Tools such as the Normalized Difference Vegetation Index (NDVI) and the Vegetation Health Index (VHI) are used to measure and monitor vegetation health and stress, thereby providing valuable data for agricultural management during drought conditions.
- **Improvement of Models and Systems**: The use of EO data significantly contributes to the improvement of models that predict drought patterns and impacts. This includes the implementation of near real-time systems that offer updated insights into drought conditions, enhancing the responsiveness of mitigation efforts.
- **Risk Quantification and Management**: EO data plays a crucial role in quantifying post-drought risks, such as the potential for veld fires, which is vital for planning recovery and response strategies. The ability to track changes in land surface temperatures also aids in monitoring ongoing drought conditions and their progression.
- **Data Validation and Research**: The validation of satellite data, particularly precipitation measurements, using ground-based observations ensures the accuracy and reliability of drought assessments. Furthermore, EO facilitates extensive research into mitigation strategies for related phenomena, such as heatwaves, thereby broadening the scope of drought management strategies.
- **Challenges and Limitations**: While the potential for EO to enhance drought monitoring is high, participants also noted several challenges, including the resolution of data and the need for high-resolution Digital Elevation Models (DEMs) to improve the precision of assessments. Despite these challenges, the consensus was that EO data's extensive coverage and near real-time availability hold substantial promise for advancing drought monitoring techniques.
- **Automated Updates and Data Utilization**: The automation of updates for newly available data on derived products was also noted as a significant advancement. This ensures that stakeholders have access to the latest information, facilitating more informed decision-making processes.

Overall, the group session outcomes reflect a strong belief in the high potential of Earth Observation data to revolutionize drought monitoring, making it more precise, timely, and effective. These advancements are expected to significantly aid in the proactive management and mitigation of drought impacts across various sectors.

Limitations of Earth Observation Usage (Capacity, Infrastructure, Financial)

During the group session, participants discussed various challenges and limitations that hinder the optimal utilization of Earth Observation (EO) data in their organizations. The discussion broadly categorized these challenges into three primary areas: capacity, infrastructure, and financial constraints. The key limitations identified in each category are as follows:

Capacity Limitations

- **Lack of Training and Personnel**: There is a significant gap in training and availability of personnel skilled in EO data usage and analysis. This shortage hampers the ability of organizations to effectively implement and leverage EO technologies.
- **Need for Skilled Workforce**: Participants expressed a need for more skilled individuals ("warm bodies") who can handle the complexities of EO data. The lack of such expertise is a critical barrier to effectively deploying EO-based solutions.
- **Skills Transfer Issues**: There is a notable lack of effective skills transfer from industry experts to personnel in governmental institutions, which further exacerbates the capacity issues.

Infrastructure Limitations

- **Inadequate Storage and Computing Resources**: Many organizations face challenges with inadequate storage capabilities and lack of high-performance computing resources necessary for processing large volumes of EO data.
- **Limitations for Advanced Applications**: Specifically, the infrastructure is often not robust enough to support advanced applications such as deep learning and artificial intelligence, which are crucial for maximizing the utility of EO data.
- **Scaling Challenges**: There is a consistent issue with the limited resources available for scaling up infrastructure to meet the increasing demands of EO data applications.

Financial Constraints

- **Cost of High-Resolution Data**: The high cost associated with acquiring high-resolution EO data is a significant financial barrier for many organizations, limiting their ability to obtain the most detailed and useful data.
- **Budget Limitations**: Financial restrictions, especially in terms of fiscal budgets within organizations, severely limit the ability to invest in necessary EO data, infrastructure, and training.
- **Funding for Data Acquisition and Infrastructure**: There is a clear need for more substantial financial investment in both data acquisition and the development of infrastructure to support the effective use of EO data.

Participants also highlighted a general **lack of awareness** about the benefits and applications of EO data, which indirectly influences financial commitment and infrastructure development. Addressing these limitations requires a concerted effort to enhance capacity through training and education, improve infrastructure with targeted investments, and increase financial support to make EO data more accessible and usable for a wider range of applications. These challenges underscore the need for a strategic approach to overcome barriers and fully harness the potential of EO data in various sectors.

Strategies to Create Impact through Collaboration on ANIN/DESA Drought Services

The group session provided a rich discussion on developing impactful strategies through collaboration around the ANIN project and Digital Earth South Africa (DESA) drought services. Participants proposed a variety of approaches to enhance the accessibility and effectiveness of these services. Here are the key strategies discussed:

Centralized Data Repository

Establishing a centralized EO data repository, such as cloud-based storage or interactive dashboards, was highlighted as a pivotal strategy. This would facilitate easier access to data and support the integration of various data sources, making it more streamlined for users to retrieve and utilize information.

Integration and Coordination

Enhancing the integration of ANIN, DESA, and the National Integrated Water Information System (NIWIS) to create a unified platform that ensures continuity and coherence in data presentation and accessibility.

Training and Awareness Programs

Conducting training sessions, workshops, and symposiums to raise awareness and increase the capacity of users to fully utilize the system. Partnering with academic institutions for these training programs can help bridge the skills gap and promote advanced research and application of EO data.

Policy and Accessibility Enhancements

Advocating for policy adjustments that allow broader data sharing within the industry and between different sectors. This includes making data for research purposes free and creating frameworks that facilitate collaboration between industries and governments.

User Engagement and Interface Improvement

Focusing on user engagement through workshops to create awareness and foster collaboration. Improving the user interfaces of digital platforms to make them more user-friendly was also seen as crucial. This would help in accommodating users with varying levels of technical skills and enhance their interaction with the system.

Expansion of Data Services

Exploring additional data options to include in the DESA platform, such as more diverse data sets that cater to varying needs of the drought monitoring community. Considering expansions in data storage capabilities to handle the increasing volume and complexity of data.

Shared Resources and Processing Chains

Establishing shared processing chains that can be utilized by various stakeholders to reduce redundancy and increase efficiency in data processing and analysis.

These strategies collectively aim to enhance the impact of the ANIN and DESA initiatives by improving data accessibility, enhancing user capacity, and fostering a collaborative environment. Implementing these strategies requires concerted efforts from all stakeholders, including government bodies, research institutions, and the private sector, to ensure the sustainable and effective use of EO data in drought monitoring and management.

Capacity Gaps for Effective Use of the ANIN System and Its Services

The group session dedicated to identifying capacity gaps in the effective use of the ANIN system revealed several challenges that hinder its optimal deployment and utilization. Participants from various backgrounds shared their experiences and perceptions, pinpointing key areas where improvements are necessary. The following capacity gaps were highlighted:

Technical Skill Gaps

- **Programming Skills**: A major gap identified is the prerequisite of programming knowledge to effectively use the ANIN system. Participants noted that the system is challenging to navigate for those without a programming background, limiting its accessibility to a broader user base.

- **Extraction of Satellite Data**: The technical skills required to efficiently extract and process satellite data were noted as lacking, which impedes the ability to fully leverage the system's capabilities.

Financial Capacity

The financial constraints of organizations, especially in light of budget cuts, affect their ability to invest in the necessary infrastructure and training to support the use of the ANIN system. This financial incapacity restricts the adoption and effective utilization of the system.

Infrastructure Sustainability

There is a concern about the sustainability of infrastructure to support the continuous and efficient use of the ANIN system. This includes both the physical infrastructure for data handling and storage and the technological infrastructure for system maintenance and updates.

Understanding the System and Its Integration

A significant gap exists in the understanding of how the ANIN system operates, its data sources, and how it integrates with other data systems and tools. There is a need for clearer explanations and training materials that delineate the system's functionality and its linkage to broader environmental data ecosystems.

Building Trust

Building trust in the ANIN system's reliability and applicability within the South African context is essential. Scepticism about its effectiveness and relevance to local conditions can hinder its adoption and use. Addressing this gap requires proven case studies and demonstrations of successful implementations in similar contexts.

Addressing these capacity gaps involves a multi-faceted approach, including enhancing technical training, improving financial investment in EO technologies, expanding infrastructure development, simplifying the system's interface, and conducting outreach to build trust and understanding among potential users. Filling these gaps will not only improve the usability of the ANIN system but also ensure its effective application in critical areas like drought monitoring and environmental management.

Next Steps for the Sustainability of ANIN Beyond ESA's Financial Support

The discussion regarding the sustainability of the ANIN system beyond the financial support of the European Space Agency (ESA) was comprehensive and forward-thinking. Participants recognized the necessity of developing a robust framework to ensure the continued effectiveness and relevance of the ANIN system. Several key strategies were proposed to maintain and enhance the system's sustainability:

Continuous Awareness and Training

Emphasizing the need for ongoing awareness campaigns and training programs to keep users informed about the ANIN system and its capabilities. Continuous education will help in expanding the user base and ensuring that the system's potential is fully realized.

Research and Development

Further research into the use of satellite data for monitoring environmental phenomena like drought was highlighted as crucial. This would not only improve the system's functionalities but also its accuracy and reliability in various applications.

Strategic Collaborations

Establishing partnerships with space agencies and other relevant organizations to ensure a continuous flow of knowledge, technology, and possibly funding. These collaborations can provide technical support and innovation, essential for the system's longevity.

System Maintenance and Hosting

Determining the main host organization responsible for maintaining the ANIN system is critical. This includes defining roles for system upkeep, technical support, and updates. Ensuring that the host organization has the capacity and resources to manage these responsibilities is vital.

Integration with Existing Systems

Participants suggested integrating the ANIN system with other currently used systems to enhance its utility and reduce redundancy. This integration helps in streamlining data processes and improving user accessibility.

Open Sourcing of Data

Advocating for the open sourcing of data to increase transparency and encourage wider use across various sectors. Open access to data can foster innovation and broader application of the system's outputs.

Infrastructure Centralization

The idea of having a centralized infrastructure, potentially through organizations like the South African National Space Agency (SANSA) or DESA, was discussed as a means to consolidate resources and expertise.

Capacity Building

Continuation of capacity-building initiatives to equip local stakeholders with the necessary skills to effectively use and manage the ANIN system. This includes regular updates and training sessions tailored to the evolving needs of the users.

Commitment to System Maintenance

Securing a commitment from various organizations to contribute to the maintenance of the system. This collective responsibility ensures that the system remains operational and effective, regardless of the financial status of any single supporting entity.

The consensus was that a multi-pronged approach involving continuous education, strategic collaborations, and robust infrastructure would be essential to sustain the ANIN system in the long term. These strategies will help in maintaining the relevance and operational capability of the system, thus ensuring that it continues to serve its purpose effectively beyond the initial phase of external financial support.

PARTICIPATNS

The target audience for this workshop was strategically divided to cater to both decision-makers and technical professionals, ensuring a comprehensive approach to enhancing drought monitoring and management capabilities. The first quarter of the first day was specifically tailored for decision-makers, aiming to provide them with an overview of Earth Observation (EO) data's potential and its application in drought monitoring decision-making processes.

SUMMARY OF DAY 1

The event at the Innovation Hub in Pretoria, South Africa, represents a pivotal gathering aimed at bolstering the application and understanding of Earth Observation (EO) data in enhancing drought monitoring and decision-making. This initiative, focused on the development of a comprehensive drought early warning system, involves the collaboration of key stakeholders, including the Department of Water and Sanitation (DWS), the South African Weather Service (SAWS), and participants in the EO Africa programme. Through a series of presentations and discussions, the meeting intends to shed light on the current mandates for drought monitoring, the integration of EO technologies, and the role of Digital Earth South Africa in supporting these endeavors.

The day's agenda is structured to facilitate a deep dive into the potential of EO data, with sessions dedicated to understanding the practical use of drought indicators, identifying the main users of EO-derived data, and addressing the capacity gaps in accessing and utilizing this information. Group work sessions aim to foster collaboration and strategize on creating impactful solutions through the ANIN project. By focusing on practical steps for collaboration, strategies for impact creation, and sustainability of services, the meeting seeks to lay the groundwork for a robust response mechanism to drought conditions, ultimately contributing to more effective environmental management and disaster mitigation efforts in South Africa.

SUMMARY OF DAY 2

The second day of the event at the Innovation Hub in Pretoria, South Africa, continues to advance the dialogue and development efforts around leveraging Earth Observation (EO) data for drought monitoring and decision-making. With a focus on the technical aspects of data processing and visualization, the day is poised to build upon the foundational discussions and outcomes of the previous sessions. Starting with a recap of Day-1, the agenda quickly shifts towards an in-depth examination of algorithms essential for processing EO data, setting a technical tone for the day. This emphasis on the technical intricacies underscores the event's commitment to enhancing the analytical capabilities essential for interpreting complex environmental data.

Following a morning dedicated to data processing techniques, the afternoon sessions delve into the practical applications and visualization of EO data, highlighting the importance of making this information accessible and interpretable for decision-makers. The presentation on Digital Earth South Africa's web platform and a specific use case involving the Berg Oliphants region illustrate the tangible benefits and potential impacts of these technologies on local and regional drought monitoring efforts. The day concludes with a technical discussion aimed at synthesizing the insights gained and outlining the next steps, ensuring that the momentum generated by the meeting translates into actionable strategies for improving drought resilience and response through the innovative use of EO data.

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