NORHT-WEST UNIVERSITY

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Feasibility Study

ITRI 614

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# Executive Summary

The product discussed in this feasibility study aims to use satellite data integration, machine learning, and an interactive dashboard. The main focus of this product is to provide farmers with accurate and timely information regarding droughts. The core of this product is the use of AI and sensor-based drought monitoring systems, by collecting, processing, and analysing the data gathered from the sensors on farmers' lands and satellite weather tracking. Currently, there are a few competitors in this market such as African Drought Monitoring and Advisory, African Flood and Drought Monitoring, as well as ICPAC. The target audience for this product is firstly farmers but it is also targeted at policymakers and stakeholders.

The reason for developing this product is to improve and revolutionise drought monitoring and prediction in Africa to help farmers, policymakers, and stakeholders make better and more informed decisions.

# Description of Product

## Key Features

The final product aims to contain these features. **Satellite Data Integration** by leveraging open-source satellite data from agencies like NASA and the European Space Agency, focusing on multispectral and thermal imagery for assessing vegetation health and water availability. We will then use **Machine Learning Models** to develop predictive models that analyse historical and current satellite data to identify patterns indicative of impending drought conditions. Finally, an **Interactive Dashboard** will be built to offer a user-friendly web interface that displays drought monitoring data, historical trends, and predictive analytics in an easily digestible format. This dashboard is intended for use by policymakers, farmers, and researchers to facilitate informed decision-making.

## User Goals

The primary value proposition is to enable farmers to receive timely and accurate forecasts about drought conditions to make informed agricultural decisions. Our secondary objective is to assist policymakers in planning and allocating resources efficiently based on data-driven insights about drought conditions.

## User Stories

1. **As a farmer**, I want to access real-time drought conditions so that I can plan irrigation and cropping patterns effectively.
2. **As a policymaker**, I need to monitor drought trends over time to formulate better agricultural policies.
3. **As a researcher**, I wish to analyse historical drought data to predict future environmental impacts.

## User Experience – Step by Step Flow

1. **Login/Registration:** Users access the system via a secure login or registration module.
2. **Dashboard**: After login, users are presented with a dashboard displaying current drought conditions, forecasts, and personalised alerts.
3. **Data Analysis Tools**: Tools for detailed data analysis are available, such as heat maps, trend lines, and predictive analytics.
4. **Report Generation**: Users can generate custom reports based on selected data points and time frames.
5. **Alerts and Notifications**: Users receive notifications based on specific criteria set for drought conditions.

## Narrative

Imagine a farmer in South Africa, previously reliant on conventional wisdom, now using our AI-driven platform to see real-time data visualisations of impending drought conditions. This enables precise planning of water use, potentially saving crops and livelihoods during critical periods. Policymakers, equipped with predictive insights, can allocate resources more effectively, ensuring food security and economic stability in the region.

# Technical Considerations

The successful delivery of AI and sensor-based drought management systems is critical in terms of addressing climate change specifically droughts and water scarcity in South Africa. This system intends to provide accurate, timely, and actionable drought forecasting and modelling to enhance resource management in South Africa.

## Data Collection and Sources

This system will rely on sensor-based technology and remote sensing data sources to gather important information on drought conditions and other environmental factors that are specific to South Africa in terms of climate

Obtaining data directly from sensors placed in the field is not feasible at this point and is not in the scope of this project. Given this to validate and test the system we will make use of South African drought data (existing datasets) or remote sensing data.

## Data Processing and Analysis

Machine and deep learning models will be used to process and analyse the dataset enabling accurate detection of drought conditions as well as productivity which is affected by drought and water scarcity issues. By making use of these models we can provide precise insights in terms of aiding stakeholders in making informed decisions to optimise productivity. Not only will these models ensure accuracy and reliability but can provide actionable insights for stakeholders.

## Software Development and Delivery

A user-friendly, web-based interface will be developed to provide stakeholders with access to drought forecasts, predictions, and relevant information.

We will make use of Python and MATLAB during the duration of this project. By making use of these technologies we can develop advanced algorithms for the processing and analysing of the dataset to detect drought conditions and develop early warning systems as well predicting land fertility and productivity. Furthermore, these technologies can be used to create a user-friendly web-based interface with the relevant information as required.

The software product will be deployed online via web servers, with mobile-based capabilities to ensure accessibility and usability for users in South Africa.

## Integration with Existing Systems

The AI and sensor-based drought management system will be integrated with an existing dataset.

Standard protocols and technologies will be employed for integration, ensuring compatibility and efficiency in sharing data and insights with relevant stakeholders.

## Infrastructure and Maintenance

Infrastructure, including server hosting, data storage, and network connectivity, will be provisioned to support the operation and maintenance of the drought management system.

Regular maintenance activities, such as software updates will be performed to ensure the reliability and effectiveness of the system.

# Product Marketplace

## Competitors

**African Drought Monitoring and Advisory (ADMA)**

African Drought Monitoring and Advisory (ADMA) is a near-real-time system that uses Earth Observation and Weather information to monitor drought conditions in Africa (African Drought Monitoring and Advisory, 2024).

Website link: <https://ada.acmad.org/>

The advantages of ADMA are:

* Near-real-time Monitoring
* Integration of multiple data sources
* Visualization Tools
* Easy access using a Web-based Interface.
* Covers 54 countries.
* Easy to use interface.

Disadvantages of ADMA are:

* Experimental AI Incorporation.
* No Visualization for AI

**African Flood and Drought Monitoring**

The African Flood and Drought Monitor (AFDM) is a sophisticated system developed by the Princeton Climate Institute (PCI) in collaboration with the University of Southampton and Princeton University. It aims to provide early warning for flood and drought conditions across Africa. The system utilises a combination of ground observations, satellite data, and modelled datasets to generate real-time hydrological assessments and forecasts (African Flood and Drought Monitor, 2024). PCI also offers other drought monitoring services covering other areas of Africa, such as the South Africa Flood and Drought Monitor (SAFDM).

Website link: <https://hydrology.soton.ac.uk/apps/afdm/>

The Advantages of AFDM:

Early Warning

* Comprehensive Data Integration: combining ground observations, satellite data, and modelled datasets.
* Real-Time Updates: The system is operational and updated daily, albeit slightly behind real-time, ensuring timely information for decision-making.
* High Resolution: The use of a 5km resolution hydrological model allows for detailed assessments of streamflow and hydrological conditions.
* Seasonal Forecasting.
* Bias Correction: Bias correction techniques are applied to remove any biases from the climate forecast model, improving the accuracy of forecasts.
* Probability Estimates.

The Disadvantages of AFDM:

* Operational Lag: The system operates with a slight delay of 1-2 days behind real-time, which may impact the timeliness of response for urgent situations.
* Limited user configuration.
* No AI

**ICPAC**

ICPAC is a service that provides climate services to Eastern Africa (ICPAC, 2024).

Website link: <https://eahazardswatch.icpac.net/map/ea/?mainMap=eyJzaG93QW5hbHlzaXMiOnRydWV9&map=&mapMenu=eyJtZW51U2VjdGlvbiI6ImRhdGFzZXRzIiwiZGF0YXNldENhdGVnb3J5IjoiQWdyaWN1bHR1cmUifQ%3D%3D>

The Advantages of ICPAC:

* Weekly Forecasting
* Monthly Forecasting
* Seasonal Forecasting
* Climate monitoring
* Food Security Statements
* Visualization analysis
* User Friendly Interface
* User configurability

Disadvantages:

* Beta version.

## Target Market

The product we are offering is a web-based drought monitoring system tailored for farmers, policymakers, and other stakeholders to track drought conditions. It is distinguished by using AI algorithms to process and analyse gathered data and employing AI machine learning models to interpret both sensor-based and remote sensing data. This enables the system to monitor and forecast agricultural land fertility and productivity effectively.

Our product is mainly targeting farmers, policymakers, and other stakeholders. However, it would be beneficial to understand our competitors' target audience to gain insight. Figure 1 shows the target audience of each of the competitors. ADMA partners are ACMAD, European Commission, Norwegian Capacity, and IGAD (African Drought Monitoring and Advisory, 2024). ICPAC partners were the European Commission, the African Development Bank Group, the Norwegian Refugee Council, the Met Office, and NASA Harvest (ICPAC, 2024). African Flood and Drought Monitor has the following funding support from the UNESCO International Hydrology Programme (IHP) and the International Centre for Integrated Water Resources Management (ICIWaRM) (United Nations, 2024). Relevant partners discovered during the market analysis were between competitors the EU, and the Norwegian Refugee Council. The partners of each competitor can be grouped in the following areas: farmers, research and institutions, policymakers, governments, banks, and world health unions.

Figure 1: Competitors Partners

A screenshot of a computer screen

Description automatically generated

### Condition

The market condition has proven fruitful since each competitor has more than one partner/sponsor. Some sponsors are members of the government, banks, or even high-market-value organisations such as NASA. The reason why members of high power are aiding in these systems is that drought has an impact on the condition of the food supply, which is a necessity for human well-being.

### Demand

The demand for drought monitoring services also proves to be fruitful:

* The competitors are funded, an example would be African Drought Monitoring which is funded by the UNESCO International Hydrology Programme (IHP) and the International Centre for Integrated Water Resources Management (ICIWaRM) (United Nations, 2024).
* Users of the systems require it to be effective in their career, the users of ICPAC said this:
  + “We appreciate ICPAC's timely forecasts. The monthly and seasonal forecasts are especially relevant to us to advise farmers” (ICPAC, 2024).
  + Another user in BBC Media Action stated this: “ICPAC has been very instrumental in breaking down weather information for our media partners using simplified visuals like maps and icons. This has in turn helped our media partners to better understand how to communicate and package weather and climate content to the end users. (ICPAC, 2024)”
* The government relies on these types of systems to predict drought, to effectively recover and prepare for these natural occurrences, for example, African Drought Monitoring which is funded by UNESCO (which is an intergovernmental Hydrological Program) (United Nations, 2024).

The system we are proposing will be similar in functionality to the competitors mentioned with one critical distinction, the implementation of AI. The use of AI algorithms to process and analyse gathered data and employing AI machine learning models to interpret both sensor-based and remote sensing data could prove to be an advantage because of more effective and fast analysis and use of the data.

# Marketing Strategy

## Overview

We are dedicated to revolutionising the way drought conditions are monitored and managed. With a passion for sustainability and innovation, we leverage cutting-edge satellite technology to provide real-time insights into drought conditions, empowering our users to make informed decisions and mitigate risks effectively.

## Product/System Description

Our product is a state-of-the-art drought monitoring system that utilizes satellite imagery and advanced analytics to deliver accurate and timely information about drought conditions in Africa. By combining remote sensing data with powerful algorithms, our system offers unparalleled precision and reliability, enabling users to monitor drought severity, assess water availability, and optimize resource allocation with confidence.

## Unique Selling Proposition

What distinguishes us is our dedication to providing actionable intelligence that produces tangible results. Our system offers:

* High-resolution satellite imaging that allows for more detailed monitoring.
* Real-time data updates which enable fast decision-making.
* For convenience, the interface is user-friendly, and alarms can be customized.
* Advanced algorithms for detailed drought analysis and forecasts.

## Target Market

Our target market includes:

* Businesses within the agricultural sector as well as farmers who seek to improve water usage and crop yields.
* Departments that manage water resources.
* Environmental protection authorities who monitor drought conditions and implement mitigation strategies.
* Drought monitoring research institutions.

## Value Proposition

Our drought monitoring and prediction system enables users to:

* Detect drought conditions early and take proactive measures to reduce risks.
* Optimize water usage and resource allocation to achieve maximum efficiency and sustainability.
* Improve crop yield in response to shifting climate patterns.
* Improve environmental management by encouraging data-driven decision-making and conservation initiatives.

## Technology and Data Sources

We make use of satellite imagery from renowned providers, as well as proprietary algorithms and data processing approaches or techniques, to provide precise and reliable drought monitoring. Our system integrates existing infrastructure and data platforms, ensuring compatibility for our consumers.

## Business Model

We offer flexible pricing plans tailored to the needs of our customers, with options for individual users, enterprises, and institutional users. Our transparent pricing model includes tiered packages with scalable features and support options, ensuring affordability and value for all users.

## Future Plans

Our roadmap for continued innovation and evolution includes:

* Enhancement to our system's capabilities, such as increased geographic coverage and higher data resolution.
* Integrating complementary technologies, such as IoT sensors with weather forecasting models, can improve predictive capabilities.
* Collaboration with industry partners and stakeholders to solve new problems and opportunities for drought monitoring and management.

# Organisation

# Schedule

Figure 2: Gantt Chart

A screenshot of a computer

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# Financial Projections

To successfully deliver this project/product a lot of factors must be taken into consideration, given the fact that this is not just a normal project with tangible expenses and fixed costs but one where costs fluctuate due to maintenance fees, boosted security, future developments and on-going developments.

A financial projection focuses on giving a comprehensive analysis of the financial aspect of developing and launching a project and ensuring that an informed decision is made.

## Cost Estimation

An estimation will be made with hypothetical values to give an understanding of what needs to be done and how much it will cost.

Figure 3: Cost Estimation

A screenshot of a spreadsheet

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As seen in (Figure 3), we are focusing on estimating costs per deliverable rather than hours which are subject to changed depending on what is discovered in the ideas. The following costs were not included due to needing to plan on what needs to be used, Licensing Fees for Third Party Services, Salaries Maintenance Developers and ongoing development for adding new features and improvements.

Upon finishing a feasibility study, a more comprehensive financial projection will be created, factoring in Revenue as well as Return on Investment.

# Findings and Recommendations

The biggest hurdle for this product is the data that needs to be collected for processing, however in this case the use of open-source data from NASA and the European Space Agency makes that hurdle easy to cross. The use of Machine Learning will eventually help improve overall efficiency and accuracy, however, the training of the model will require intensive support and monitoring to ensure its accuracy. The physical implementation will probably go through many iterations to ensure user-friendliness, if there is good communication between user and developer this should not be a problem. There is mention of sensors in the fields of the farmers, this could be an interesting avenue to explore further down the line as more funds becomes available. The users will access the system online which will allow for accurate and timely data. There are competitors in this field already, but the use of AI could be promising, as long as the customers are also on board with using AI, as some could be very tentative, since it is a relatively new field being implemented into the industry, thus this could be a key selling point.

The schedule looks a bit tight, and does not allow all that much room for tasks exceeding due dates, this could be something that needs to be looked at. The cost estimation is also something that could be quite challenging as funds would need to be procured from external investors, this could be something that could stop the project from even starting.

# References

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