



DATA COLLECTION FOR PRECISION FORESTRY: THE ROLE OF AN AUTOMATIC WEATHER STATION PROGRAMME

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Introduction



- **Precision forest management requires:**
 - A base of reliable, relevant information being collected
 - An understanding of how this data impacts tree growth, forest planning, and forest operations

- **Fundamental driver of tree growth and yield:**
 - availability of rain-fed moisture and related temperature regimes
 - Recording of rainfall; submitting this data to SAWS was a daily routine for foresters
 - Major decline in the density and quality of this vital information source
 - Changing role of Foresters
 - Fewer Foresters on plantation
 - Exacerbated by difficulties in obtaining verifiable, comprehensive quality weather data from the South African Weather Service (SAWS)
 - Institute for Commercial Forestry Research (ICFR) has to purchase, at great expense, annual data from SAWS
 - Considerable data gaps need to be patched
 - This takes time and effort - adds to its already high cost

Background



- **2014-2016 Drought:**
- **Highlighted the Forest Industry's exposure to this lack of weather data**
 - Very difficult to:
 - Quantify the growth impact
 - Relate this to reliable weather data to model the impacts
 - In stark contrast, Sugar Industry:
 - Has a dedicated Meteorological team
 - Have a comprehensive weather monitoring programme across their sugar areas
 - Also developed automatic algorithms to validate and fill in missing data (such as where an instrument might malfunction)
 - Researched impact of weather data on the physiology of cane growth
 - Utilise this information to inform strategic decision making (e.g. in the last season did not open a Sugar Mill in one area because predicted insufficient sugarcane available to feed that mill)
 - This information available via a web-service, which provides relevant information to allow farmers to make good management decisions.
<http://portal.sasa.org.za/weatherweb/>

Background cont.



- **2014-2016 Drought:**
- **2015 – Mondi partnered with SASRI to collaborate in the AWS Programme**
 - Deployed 29 automatic weather stations across the Mondi landing holdings
 - SASRI manages the programme on Mondi's behalf
 - Mondi gained access to the full SASRI weather database, expertise and equipment management programme
 - Large geographic overlap between the forest and sugar industries, particularly in KwaZulu-Natal (KZN) - Sugar Industry benefits from additional weather station coverage.

Methodology



○ **Equipment Selection: :**

- Davis® electronic weather stations - fire protection purposes during the fire season (May to October).
- Data does not have a validation/patching system
- Does not provide a robust data source that is required for growth and yield study purposes
- SASRI system required use of same equipment - Campbell Scientific® weather station equipment

○ **Data Collection and Transfer:**

- AWS consists of a data logger connected to sensors on tripod mounting measuring:
 - Temperature; Relative Humidity; Wind Speed/Direction; Rainfall; Solar radiation
- Data is automatically transmitted via a wireless modem connected to the cell phone network (using a standard SIM card on a data package)
- Data is sent to SASRI's centralised web-service, using LoggerNet software package for further validation and processing
- Requires a connection to a power source (Eskom mains) in order to provide power to a battery charger (Solar panels are a security risk)
- Rain gauge mounted on separate pole but connected to logger by cable

Campbell Scientific Automatic Weather Station



vane and anemometer wind sentry



CR800 data logger; Charger Unit; Wireless Modem with SIM



pyranometer



temperature and relative humidity probes



self-emptying tipping bucket rain gauge



Methodology



○ Site Selection:

- Balance between obtaining the maximum coverage but at an affordable cost (equipment cost ~R80 000/site)
- Site criteria:
 - Security; Mains Power Source; Cell Phone Data Coverage
 - Open areas away from buildings; trees to prevent
 - shadows (solar radiation),
 - interference with wind flow (speed and direction)
 - interference with rainfall
 - Grass ground cover to minimise false temperature readings
 - local staff available (usually the local forester) to monitor the equipment
 - power failures/tripping,
 - rain gauge being blocked by leaves, bird droppings etc.
 - other incidental events that might interfere with the continuous operation of the weather station
- Selection done in consultation with SASRI - complement their network
 - Gaps in SASRI coverage – Mondy site selected; vice versa
 - Non-sugar areas: Mondy sites to cover range of weather patterns

Methodology



○ Site Establishment:

- Field visits to confirm the selection criteria were met for each site
- Each site
 - Fenced off
 - Concrete foot pads laid for the weather station tripod mounting
 - Rain gauge mounting pole with conduit for logger cable
 - Power cables and isolator switches installed
 - Done by professional fencing companies
 - properly constructed infrastructure to provide sufficient protection
- Once the sites were erected
 - SASRI Meteorological Staff undertook the actual weather station installation
 - Critical parameters required to ensure accurate data collection

Methodology



○ Data Processing:

- Weather data based predictions, information or decisions significantly influenced by the quality of the input data
- Two complimentary operations to ensure data integrity:
 - On-site sensor maintenance and calibrations by trained SASRI technicians
 - Bi-annual inspections; Ad-hoc for equipment failure
 - Rigorous computer-based automated data quality check and validation system
 - Identify missing, erroneous and suspect data
 - Automatically replaced by data derived from related climatic variables, neighbouring sites or from historical records.
 - Check system occurs daily with each data uploading procedure
 - Two check levels:
 - Acceptable range limits
 - Upper and lower limits are set for all variables based on one criteria or a combination of theory, historical records and specifications of the recording instrument.
 - Limits all values to within an acceptable range
 - e.g. relative humidity has to be within the range of zero to 100 %

Methodology



○ Data Processing cont.:

- Internal and spatial consistency levels
 - consistency at a given site to ensure that there is agreement between related/associated variables
 - e.g. minimum temp. has to be always less than maximum temp.
 - The rate of change of values between successive days is also checked to make sure it's plausible
 - Trends between neighbouring sites are also validated for consistency
 - (may be done for daily, weekly or monthly values depending on the variable in question)

- Application to Growth and Yield Data
 - Once sufficient weather data has been collected - applied to research on impact of weather cycles on tree growth.
 - Link this data to dendrometer trials that are currently being initiated in conjunction with the University of Stellenbosch
 - Modelling approach similar to that proposed by Scolforo *et al* (2016) is planned

Conclusion



○ Conclusion

- Long-term project
- Significant steps have been achieved in a relatively short period of time
 - Extensive infrastructure has been established
 - Linked into a proven data capture/validation/archiving programme in terms of SASRI's weather data collection facility.
- Allow Growth and Yield Researchers to fast-track their investigations into the impacts of weather cycles on forest growth and yield
 - A fundamental input into a Precision Forestry Approach!

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Thank you for attending Questions?

FORWARD - LOOKING STATEMENTS

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