THE IMPACT OF THE 2017-18 DROUGHT:

A case study using FruitLook data

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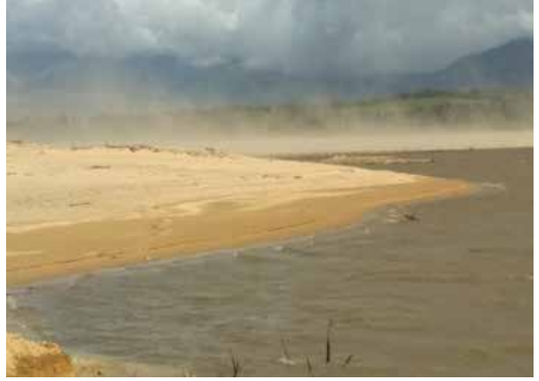
During the 2017-18 summer, dwindling dam levels in the Western Cape became the focus of many conversations. Dust storms could be seen clouding the sky above bare dams, as shown in Figure 1. Three consecutive dry winters caused dam levels to drop to record-low levels. At the end of October 2017 the average dam storage level in the Western Cape was approximately 39% , by far not enough to fulfil all domestic, industrial and agricultural water demands expected during the SA summer. As a result, firm measures were implemented to avoid potential disaster. New water sources had to be found, water losses (leakages) curbed, and firm water restrictions implemented.



PICTURE: CAREN JARMAIN

Figure 1 *Dust-storm in Theewaterskloof Dam. Theewaterskloof Dam is the biggest dam in the Western Cape and responsible for feeding water to Cape Town as well as the local agricultural community.*

The drought had a devastating impact on irrigated agriculture during the 2017-18 season, so much so that an estimated R6 billion in economic losses was incurred, and 30 000 jobs were lost in the agricultural sector [1,2].

During the 2017-18 summer production season water restrictions of 50% were implemented in the Breede Valley, 60% in the Berg River and Riviersonderend region, and various other regions and 85% or more in the Lower Olifants River Valley[3]. In response to the water limitations, crops in many areas were removed and shredded to produce mulch for fields that were to be kept in production. For orchards and vineyards, this approach will have a long-term impact on productivity, as it will take a very long time to replace the trees and vines that were removed. Where such extreme actions were not followed, an insufficient amount of water resulted in a reduction in yield quantity and quality. It is further expected that the absence of post-harvest irrigations will negatively impact production in the 2018-19 season.

For this article the impact of the 2017-18 drought on the Western Cape agricultural sector is assessed using satellite-based data products available via FruitLook (www.fruitlook.co.za). The spatial FruitLook data is used to identify the impact of the drought in two distinct regions: the Groenland Water Management area and the Lower Olifants Water Management Area. The Groenland area is relatively wet and indications are the impact of the drought on production levels was minimal during the 2017-18 season. The Lower Olifants area faced a water deficit of approximately 85% at the start of the season[4]. The results from this analysis displays the disastrous impact of a drought, but equally shows how varied this impact can be in one single province.

FruitLook in numbers in 2017-18

1	The FruitLook program is unique to the Western Cape.
5	The water management areas covered by FruitLook include the Olifants-Doorn region, Berg, Breede, Gouritz and Fish to Tsitsikamma.
9	FruitLook datasets describing crop growth, crop water usage and nitrogen content.
50	Open FruitLook training sessions that were provided at Elsenburg and in various other regions in the Western Cape during FruitLook 2017-18.
63	Percentage of users who have indicated that FruitLook made their water management at least 10% more efficient.
74	Percentage FruitLook users that are farmers. FruitLook is also used by consultants, scientists, students and many others.
218	The amount of raw satellite images processed to create the FruitLook data products for the 2017-18 season
776	Number of users in 2017-18
2011	The year FruitLook became available to farmers in the Western Cape. The data of earlier seasons is still available via the FruitLook website for users.
16 507	Fields ordered during 2017-18
53 049	Hectares ordered during 2017-18
85 000	The approximate amount of fruit fields available for use on FruitLook
200 000	The approximate amount of fruit hectares available on FruitLook

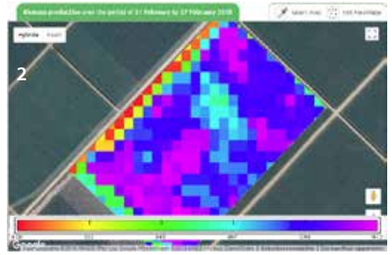


Figure 2 *Actual Biomass Production for a table grape field covering the period 21 February to 27 February 2018. The actual biomass production is provided in kg/ha, providing a quantitative indicator of dry matter growth in a field. The biomass production includes roots, shoots, leaves, fruit and all in-between.*

Figure 3 The data behind FruitLook consists of raster maps describing production in the entire Western Cape on a weekly basis. In this case, a biomass production map shows the vegetation growth from 25 to 31 October 2017.

The FruitLook Project

Since 2011 farmers in the Western Cape have had access to satellite-based crop monitoring information via FruitLook (www.fruitlook.co.za). Complete funding by the Western Cape Department of Agriculture makes it possible to offer the use of FruitLook free of charge for the end user. FruitLook enables the efficient use of water resources by farmers via the provision of smart satellite-based data products. More than 750 users monitored over 50,000 ha of agricultural land via FruitLook, between August 2017 and April 2018.

Satellites are integral to the success of FruitLook operations. Near-infrared light, visible to insects but not to humans, can be captured via modern sensors mounted on satellites. Via an ingenious combination of satellite data sources, weather information and smart models, data is created each week, describing crop growth, water consumption (= actual evapotranspiration) and plant nitrogen content. Through the FruitLook portal this data has been helping farmers to assess crop development, and to take efficient and timely mitigation measures where needed, leading to an improved crop production process. In the context of water management, farmers can use FruitLook for assessing and comparing field water consumption, assessment of water shortages and crop stress, getting an indication of efficient water use, probe placement and interpretation and detection of leakages.

Figure 2 shows biomass production for a table grape field as visible on the FruitLook web-portal. The image clearly displays in-field variation in growth. Variation in biomass production can be due to a myriad reasons, including differences in soil or disease, fungi or other problems within the crop production process. Figure 2 shows a single field, each pixel represents an area of 20 x 20 m. Analysis exceeding field scale is also feasible via the FruitLook dataset. The information behind the FruitLook portal is available for all major agricultural areas in the Western Cape, as can be seen in Figure 3.

FruitLook data was used to assess the effect of the drought on production levels within the Groenland and Lower Olifants water management areas. The accumulated biomass (= total growth) production during the 2016-17 season is compared to the accumulated biomass production during the 2017-18 season, specifically for the months October to April, thereby covering the main fruit production season. By expressing the accumulated biomass for the 2017-18 season in relative terms to the 2016-17 season, the impact of drought is shown as a percentage reduction of biomass production from 2016-17 to 2017-18.

Assessing drought impact via FruitLook data

Groenland is located in the south of the Western Cape, near Grabouw, and Eikenhof is the main dam in the Groenland water management area. The water in this dam is primarily used for irrigated fruit farming. The Groenland WUA, allowing for a 10% curtailment, could adequately supply water in the demand of their users. The major irrigated crop types in this region are pears and apples, with some wine grapes and stone fruit also present in the area.

When comparing the 2016-17 production season with the 2017-18 production season, accumulated biomass production figures are relatively similar. A comparison was made on a field-by-field basis for 4 302 fields covering close to 9 000 hectares. This comparison is visualised within the histogram for the Groenland area shown in Figure 4.

The histogram shows a normal distribution and the average difference between 2016-17 and 2017-18 is almost 0%. This means, for the two years considered in the Groenland area, the amount of fields

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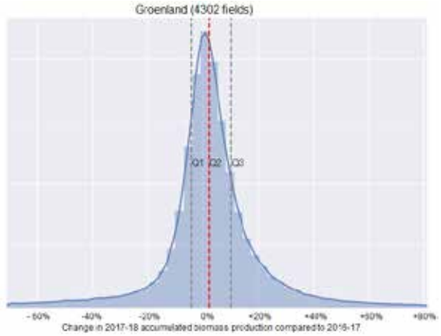

Figure 4 *Histogram showing impact on actual biomass production due to the effect of the 2017-18 drought in the Groenland water management area. No particular impact of drought is visible.*

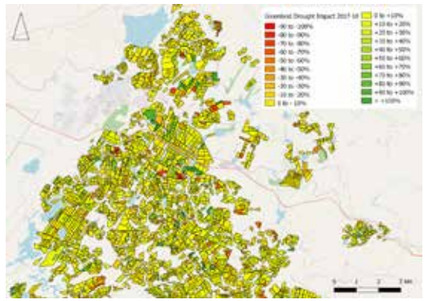

Figure 5 *Map showing impact on actual biomass production due to the effect of the 2017-18 drought in the Groenland water management area. No particular impact of drought is visible on the biomass production figures. The dark red fields were likely removed over the past season. Simultaneously, the dark green fields are likely new in production.*

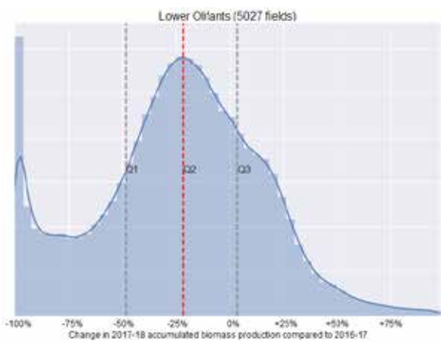

Figure 6 *Histogram showing impact on actual biomass production due to the effect of the 2017-18 drought in the Lower Olifants water management area. Strong impact by drought is visible.*

which showed an increase in growth (biomass production) is similar to the amount of fields showing a decrease in growth. For more than 2/3 of all fields in the region, the difference in accumulated biomass production between the 2017-18 and the 2016-17 production season was less than 10%. It also indicates the that the amount of fields in production is relatively stable: almost as many fields show a sharp decrease in production as there are fields showing a sharp increase. According to the histogram this water management area displays little to no detrimental effects of drought. This suggests that this area had adequate water for plant growth and that the data reflects the fact that minimal water conservation measures were needed in this area.

This is confirmed in Figure 5, showing the drought impact on a map, where vegetation growth in 2017-18 is expressed in relation to 2016-17. Most fields show little drought impact (yellow), meaning that production during 2017-18 is similar to 2016-17. The data suggests that some orchards were taken out (in red), but also that new fields were planted or came into production (dark green). Although the data considered in this assessment shows vegetation growth (total biomass production) and not crop yield, it would indicate a close to average production season, compared to the year before.

A similar assessment for the Lower Olifants water management area (LORWUA) tells a completely different story. The LORWUA region is highly dependent on the Clanwilliam dam, which feeds water through a system of canals to the water users downstream. In this area 90% of all irrigated fields are under wine and table grape cultivation. Table grapes are particularly vulnerable in drought conditions.

At the start of the 2017-18 season, the Clanwilliam Dam was filled to only 40% of its capacity, prompting the introduction of major water restrictions for irrigated crop production. Under 20% of the normal water quota was made available to producers.

The data clearly shows the dramatic consequences of a season experiencing a severe drought. The histogram (Figure 6) displays the effect of the 2017-18 drought by comparing the biomass production figures to that from 2016-17. Close to 15 000 ha was analysed covering 5 027 fields. On average, nearly 25% less biomass was produced over the entire Lower Olifants water management area. This perceived drop in production is confirmed by the SA Wine Harvest Report 2018 from Vinpro: low water availability from the Clanwilliam dam led to reduced crop vigour, smaller canopies and increased water stress[5]. The number of fields that show a (close to) 100% reduction in growth is concerning, because it indicates the removal of vineyards or their complete die-off.

Figure 7 maps this significant decrease in crop growth (biomass production) resulting from decreased water availability. Almost all fields visible on the map show a drop in production figures. The fields coloured in deep-red are likely cleared.

Assuming a drop larger than 90% indicates permanent removal of the crop, based on the FruitLook data it is estimated that close to 200 fields were cleared over the course of the 2017-18 season. This accounts for close to 5% of all vineyards and orchards in the region. At the same time almost no darker green fields are visible, meaning there were nearly no new plantings during the 2017-18 season. The histogram displayed in Figure 6 highlights this too: a large part of the fields shows a -90% drop (or more) in biomass production, while almost no fields show a sharp growth increase between the two years.

Adding to the difficulties stated above, there was no water available to producers for post-harvest irrigation. The impact of this still remains to be seen during the 2018-19 season. The combined effect of decrease in productive area and the absence of post-harvest irrigation means the 2017-18 drought will be felt for years to come in this region.

Conclusion

Satellite-based data is extremely useful to assess the impact of droughts. The effectiveness of doing so is shown within this article: although the causes, effects and predictions on the 2017-18 drought made headlines throughout the Western Cape, satellite imagery shows the agricultural impact of the drought varied strongly between regions. In Groenland, sufficient water was available, enabling the farming community to run a relatively normal season. In stark contrast, farmers in the Lower Olifants region were watching the sky expectantly for rainfall that never came. As the FruitLook data analysis shows, the farms in the Lower Olifants region were severely impacted during the 2017-18 production season.

It underlines the vital importance of available water as the resource most critical to agricultural production. Climate models predict a gradual to rapid change in climatic conditions and an increased likelihood of extreme weather conditions like hail, flooding and prolonged droughts in the Western Cape. Agriculture, and wine and fruit production in particular, are vulnerable to this changing of the climate and additional stress from drought on the already limited water supplies. In combination with significant non-climatic pressures, like increasing competition for water from the urban and industrial sector, climate change forms a potent threat to agricultural sustainability.

To effectively mitigate the challenges of the future, the agricultural sector needs to find ways to access more water and at the same time, irrigate more efficiently and with a higher precision. More water might be accessed via expensive measures, like the introduction of new dams, increasing the storage of existing ones, and increasing groundwater abstraction reducing vulnerability to drought. Simultaneously, fresh water is ultimately a limited resource and the efficient use of water in irrigation is essential for a sustainable (agricultural) future. This is where tools like FruitLook can help - now, and in the future.

Fortunately, the Clanwilliam Dam was completely refilled during the winter of 2018, making the future of agriculture in the Lower Olifants region a lot brighter than it seemed a few months ago. This is also true for most regions in the province where the water situation at the start of the 2018-19 production season was less dire than the previous year. It brings hope and perspective – there are better times to come. At the same time areas like the Little Karoo and Central Karoo continue to face drought challenges. As such the lessons learned from last year(s) remain vital: water is life, let's use it wisely and responsibly.

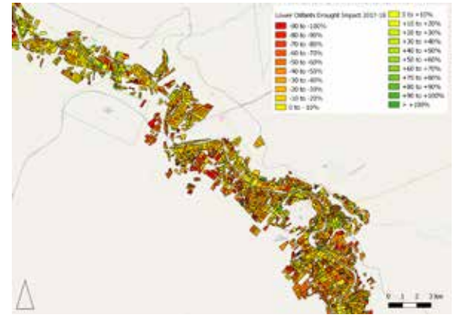

Figure 7 *Map showing impact on actual biomass production due to the effect of the 2017-18 drought in the Lower Olifants water management area. A strong reduction in biomass production is visible for almost all production fields. Additionally, many fields show a (close to) 100% decline in growth, which means these fields are likely cleared.*

FruitLook 2018-19 provides data from 1 August 2018 to 31 July 2019 and can be used for planning, monitoring and evaluating farming activities:

PLANNING: FruitLook data can be used to draw up water budgets and prioritise water allocations in terms of field water use efficiency.

MONITOR: FruitLook data can assist with water management (how much water should be applied where and when), probe placement, selective sampling prior to and during harvesting and general problem detection through deviations in the spatial pictures and data trends, and in subscribing to FruitSupport.

EVALUATE: FruitLook allows users to do a post-seasonal analysis, relating crop yield to the FruitLook data, and to analyse changes implemented.

Interested to learn more? *Hands-on training on FruitLook is offered for optimal use of this program. Training sessions are presented at Elsenburg free of charge, visit the FruitLook website for more information.*

[1]Informing the Western Cape agricultural sector on the 2015-2017 drought, A Drought Fact Sheet. Western Cape Department of Agriculture, November 2017.

[2]https://www.dailymaverick.co.za/article/2018-04-23-western-cape-drought-impact-hard-long-term-and-requiring-tough-intervention/

[3]http://www.wwf.org.za/water/?25441/Agricultural-water-file-Farming-for-a-drier-future

[4]http://www.fruitnet.com/eurofruit/article/175645/olifants-river-asks-water-questions

[5]South African Wine Harvest Report 2018 – Big challenges in the vineyards, big surprises in the cellar. VINPRO, in collaboration with SAWIS, May 2018.