What was the impact of the Western Cape's 2017-18 drought?

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In the Western Cape of South Africa all eyes were focused on the taps during the 2017-18 summer. Dust storms could be seen clouding the sky above bare dams as shown in Figure 1. Three dry winters in a row 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 during the South African summer. As a result, firm measures were implemented to avoid potential disaster by a combination of establishing new water sources, decreasing unproductive water losses (leakages) and firm water restrictions. The impact of the drought on irrigated agriculture during the 2017-18 season has been high. The total economic loss is estimated at ZAR 6 billion with 30 000 jobs lost in the agricultural sector [1,2] .

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.

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 .

In response to the water limitations, in many areas crops were removed and shredded to produce mulch for fields which were kept in production. For orchards and vineyards, this approach will have a long-term impact on productivity as it will take substantial 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.

Satellite-based data

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 .

The results from this analysis display the disastrous impact of a drought, but equally show how varied this impact can be in one single province.

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 the use of FruitLook free of charge for the end user. Via the provision of smart satellite-based data products FruitLook assists in the efficient use of water resources by farmers. Between August 2017 and April 2018 via FruitLook over 750 users monitored more than 50,000 ha of agricultural land.

Satellites can see more than the human eye: for example, near-infrared light, visible to insects but not humans can be captured

FruitLook in numbers in 2017-18	
1	The FruitLook program is unique to the Western Cape in South Africa.
5	The amount of water management areas covered by FruitLook. These 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 provided at Elsenburg and in various regions in the Western Cape during FruitLook 2017-18.
63	Percentage of users who have indicated 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

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 efficiency of water use, probe placement and interpretation and detection of leakages.

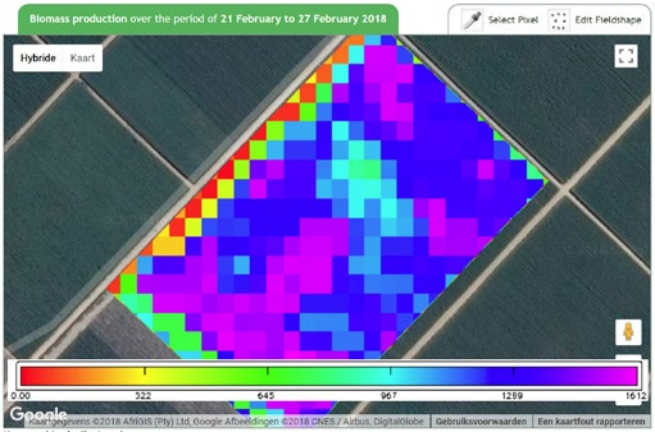

Figure 2 Actual Biomass Production for a table grape field covering the period 21 February to 27 February 2018. The actual biomass production is provided in kg/ha, providing a quantitative indicator of dry matter growth in a field. The biomass production includes roots, shoots, leaves, fruit and all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

Biomass of table grape field

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 of reasons, including differences in soil or disease, fungi or other problems within the crop production process. Figure 2 shows information for only one field; each pixel represents an area of 20mx20m. Analyses exceeding field scale can be done using the dataset as well. The information behind the FruitLook portal is available for all major agricultural areas in the Western Cape as can be seen in Figure 3.

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 during from 25 to 31 October 2017.

Assessing drought impact via FruitLook data

Groenland is located in the south of the Western Cape, near Grabouw. 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 is made on a field-by-field basis for 4 302 fields covering close to 9 000 hectares. This comparison is visualized within the histogram for the Groenland area displayed in Figure 4.

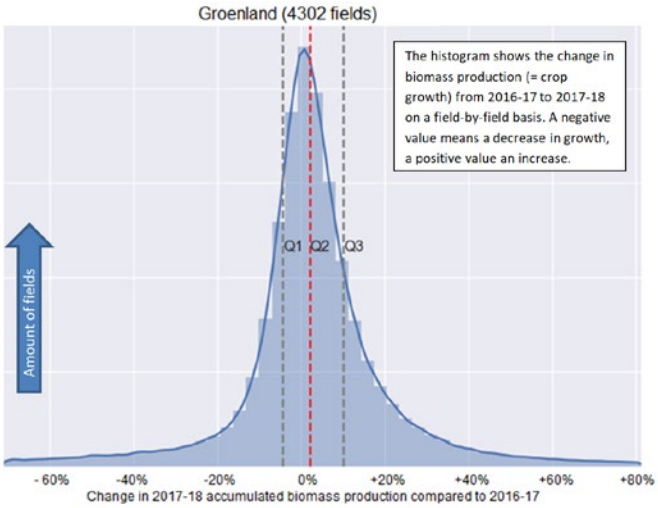

Figure 4 Histogram showing impact on actual biomass production due to the effect of the 2017-18 drought in the Groenland water management area. No particular impact of drought is visible.

Groenland

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 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 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 suggest that this area had adequate water for plant growth and the data reflects the fact that little water conservations measures were needed in this area.

This is confirmed in Figure 5, showing the drought impact in a map, where vegetation growth in 2017-18 is expressed in relationship to 2016-17. Most fields show little drought impact (yellow) meaning 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.

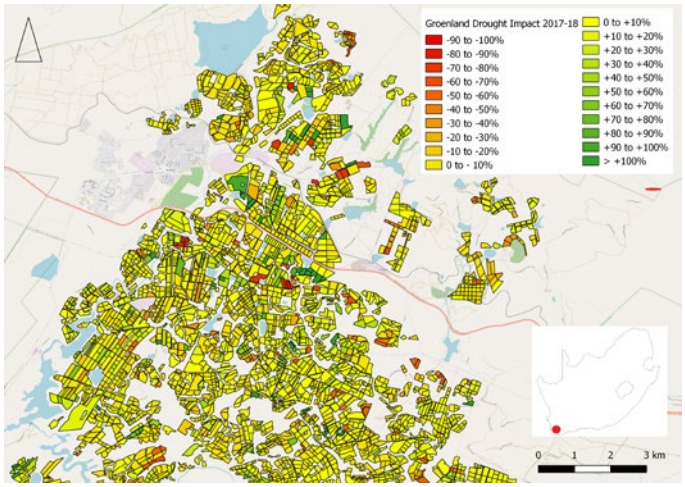

Figure 5 Map showing impact on actual biomass production due to the effect of the 2017-18 drought in the Groenland water management area. No particular impact of drought is visible on the biomass production figures. The dark red fields were likely removed over the past season. Simultaneously, the dark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

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. Especially table grapes are vulnerable for drought conditions.

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

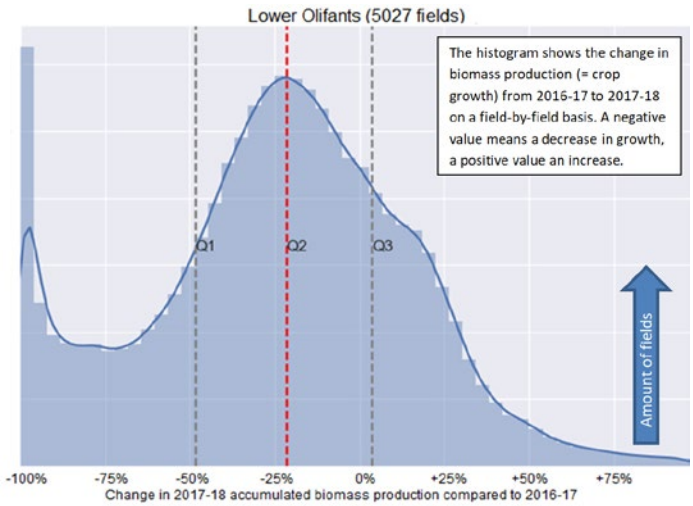

Figure 6 Histogram showing impact on actual biomass production due to the effect of the 2017-18 drought in the Lower Olifants water management area. Strong impact by drought is visible.

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, 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 *www.fruitlook.co.za* for more information.

Consequences seen

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 000ha was analyzed 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 South African Wine Harvest Report 2018 from Vinpro: low water availability from the Clanwilliam dam let to reduced crop vigor, smaller canopies and increased water stress . Worrying is the number of fields which show a (close to) 100% reduction in growth, indicating the removal of vineyards or their complete die-off.

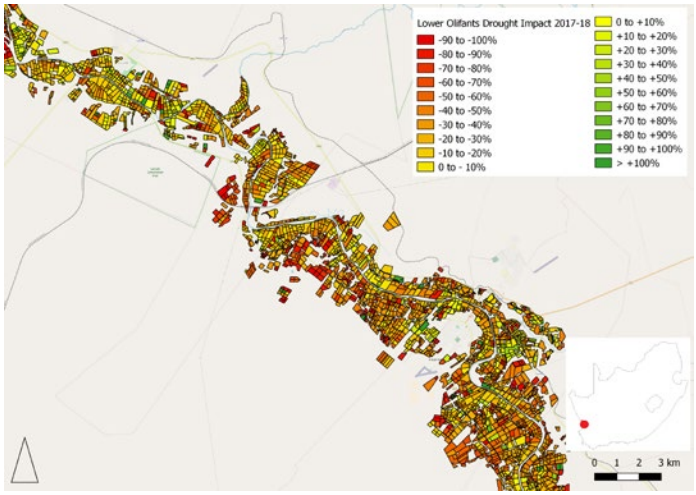

Figure 7 Map showing impact on actual biomass production due to the effect of the 2017-18 drought in the Lower Olifants water management area. A strong reduction in biomass production is visible for almost all production fields. Additionally, many fields show a (close to) 100% decline in growth which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

Figure 7 maps this significant decrease in crop growth (biomass production) resulting from decreased water availability. It shows a section of the canal between Klawer and Vredendal. Almost all fields visible on the map show a drop in production figures. The fields colored 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 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 significant part of the fields show 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 for rainfall which 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 number one resource most essential 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.

Changing of climate

Agriculture, and wine and fruit production in particular, is vulnerable to this changing of the climate and additional stress from droughts 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 live-up to 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. This brings hope and perspective of 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, use it wisely and responsibly!

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