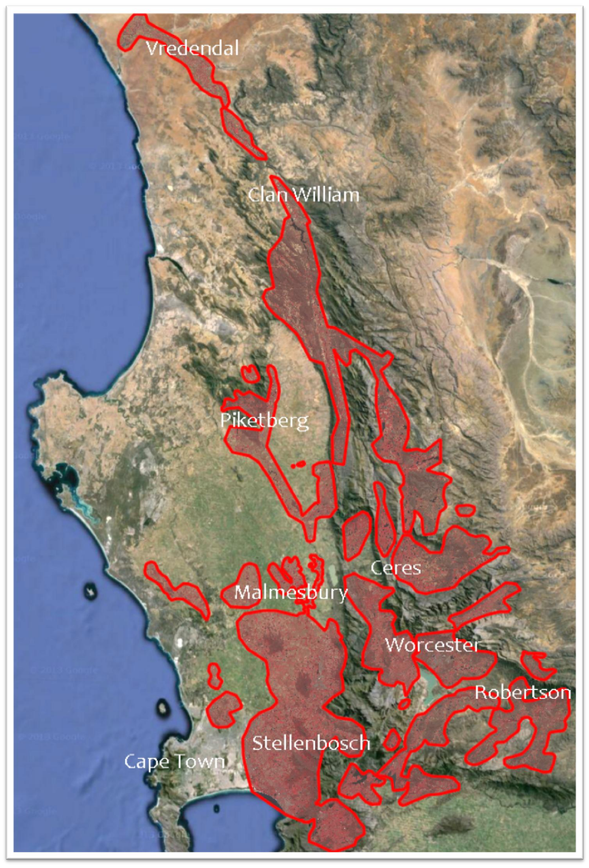
FruitLook

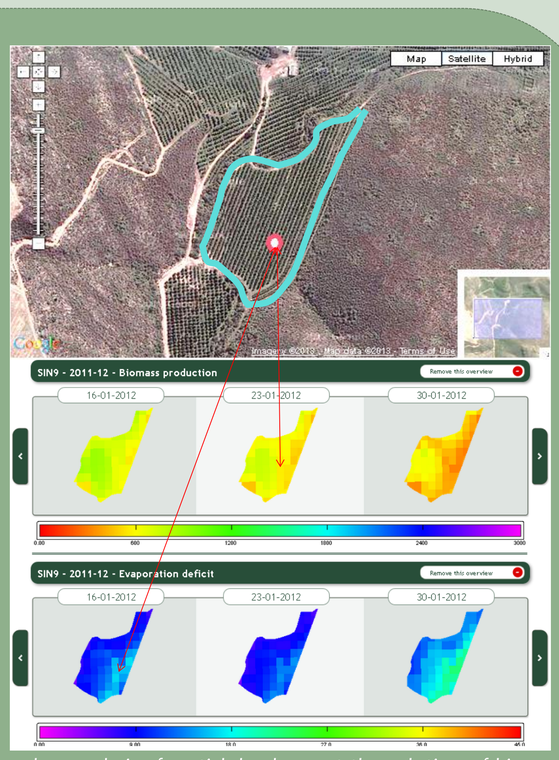
Improving Farming Practices with Satellite Information

FruitLook is a web portal for deciduous fruit and grape growers in the Western Cape Province of South Africa. The FruitLook service is funded by the Western Cape Department of Agriculture to encourage efficient water use in agriculture. FruitLook provides weekly updates of spatial information related to crop water use, growth and leaf nitrogen content in the form of maps ands graphs. Potentially valuable farming advice can be derived from FruitLook data which have been investigated through research and practical application in the field. The FruitLook service covers the vineyards and orchards depicted in the red area on the right. The grape and deciduous fruit season runs from October until April during which weekly updates are provided to the website. The FruitLook database currently spans data for the past four seasons and the developing 2014/15 season. Examples of data use and data accuracy assessment are described below.



Soil Moisture Probe Placement

The FruitLook data can be used innovatively to determine the placement of soil moisture probes in the field. The spatial patterns through time of Evapotranspiration (ET) deficit and Biomass production are evaluated using the "My Field Analysis" page on the FruitLook website. The assumption is that moisture stress within a block always initiates at the same location, i.e. at this specific spot the crop is most vulnerable to water stress (= ET Deficit). The white dot on the upper image below correlates to the place where water stress initiates in this specific block. By the placement of a soil moisture probe at this exact location, the producer is informed on water stress before the rest of his block is affected.

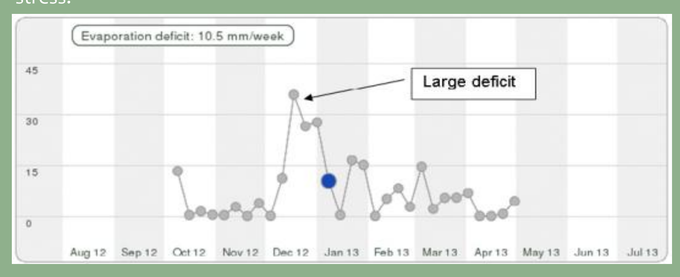


Based on analysis of spatial development through time of biomass production and ET deficit on the "MyFields Analysis" page on FruitLook the soil moisture probe should be placed at the white dot reflected in the upper image.

Evaluating Irrigation Scheduling

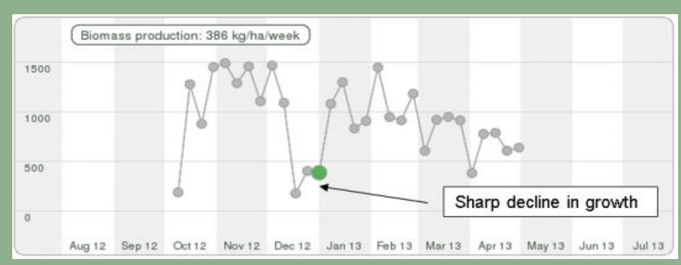
A pear block in Ceres showed how low pear yield corresponded to water availability in the block. The pear block is irrigated through a double dripper line. The actual irrigation scheduling data for the period of 2 November 2012-21 April 2013 were used to determine the amount of water applied during this period. This was compared to the crop requirement during the same period which clearly showed water deficits from November 2012 to January 2013.

FruitLook data was used to verify these theoretical calculations through assessment of evapotranspiration deficit and biomass production between October 1 (2012) and April 30 (2013). From the figure below (evapotranspiration deficit) it becomes clear that a large evapotranspiration deficit occurred around December: the crop hence experienced severe water stress.



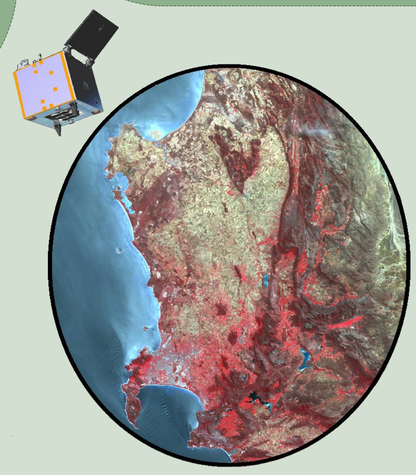
FruitLook evapotranspiration deficit.

The period of water stress reflected in the FruitLook data corresponds to the results from the comparison of crop water requirement calculations to the actual irrigation scheduling. This crop water stress directly affected biomass production, shown in the figure below, which indicates a large decline in the same period.



FruitLook actual biomass production.

Based on both the theoretical calculations and the FruitLook data it can be concluded that the irrigation system was not capable of delivering sufficient water to satisfy the crop requirement, especially in the initial growth stages which are very critical for cell division and fruit formation. The first growth stages of pear development are crucial and lasts from end of September until the end of December. It is critical that the crop does not experience water stress during this period. Because the first two growth stage determine fruit size (ton/ha) through cell division and cell enlargement this water deficit explains the drop in biomass production (shown above) and ultimately the poor performance of this block.



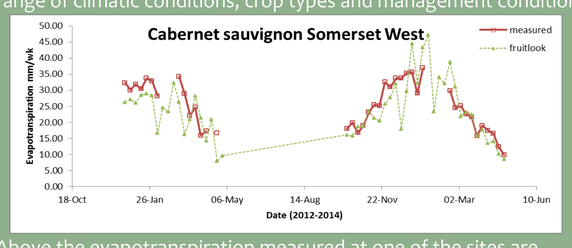
Disease Detection

Regular monitoring of biomass production can be used to timely identify areas of lagging production which could indicate pests, diseases or other potential threats to yield. Disease affected fields have a lower biomass production in comparison with "healthy" fields. Timely detection supports timely action to mitigate crop damage. Additionally, money can be saved due to a more localized application of pesticides. The farmer can use FruitLook to delineate the infected areas. As a result pesticides can be applied more effectively, saving resources and the environment.

Nematode infection in an orchard is reflected in the biomass production and delineated in yellow.

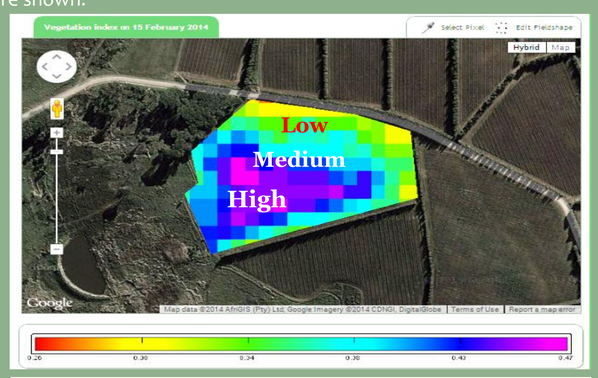
Data Accuracy Assessment

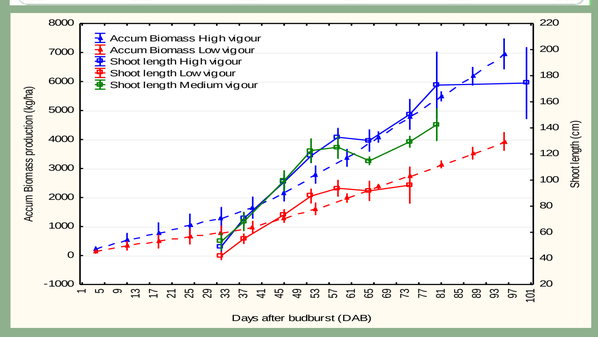
The accuracy of the data provided through FruitLook is an important aspect and hence the University of KwaZulu-Natal and Stellenbosch University have been assisting in evaluating various data sets qualitatively (trends analysis of the spatial data) and quantitatively (actual values comparison). The accuracy assessments thus far have focused on growth and crop water use. Evaluation sites represent a range of climatic conditions, crop types and management conditions.



Above the evapotranspiration measured at one of the sites are compared to that extracted from FruitLook. Typically the FruitLook Evapotranspiration was slightly lower than that measured, except for periods in mid-summer.

The Normalised difference vegetation index (NDVI) from FruitLook is shown for one of the vineyards studied in the image below. FruitLook NDVI agreed well with multispectral aerial photography estimates. Below differences between low, medium and high growth vigour areas are shown.





Above the shoot growth measured in the field at areas with different growth vigour similarly compared very well to the biomass production extracted from FruitLook for the corresponding areas.

Evaluation of Hexriver Valley Table Grape Cultivation

The cultivation of table grapes requires a hot, dry climate with water supplied through irrigation. At the same time, water shortages can lead to direct reductions in table grape yield. Sufficient irrigation is hence critical for the commercial cultivation of table grapes and as a consequence the table grape industry is a large consumer of fresh water.

Seasonal actual evapotranspiration and seasonal biomass water use efficiency (WUE) of the table grape fields in Hexriver Valley was calculated and extracted from the FruitLook dataset for the 2011/12 and 2012/13 seasons. The pixel based data was simplified to zones for this analysis. These zones are determined by "natural" boundaries, like road and rivers.

Spatial Distribution of Seasonal Evapotranspiration

In the Western part of the valley seasonal actual evapotranspiration is generally higher than in the Eastern part (left figure below). This can be related to the convergence of the Hexriver and Amandelriver in the Western part. Furthermore, in the fields closer to Hexriver the actual evapotranspiration from the table grapes is mostly higher in comparison with fields more uphill.

From the maps below, it is clear that the distribution of biomass WUE in Hexriver Valley (middle figure below) does not necessarily correspond to the distribution of actual evapotranspiration. I.e. high crop water use (evapotranspiration) does not necessarily correspond to a low WUE and vice versa. It does show there is a large variation within biomass WUE present within one crop type (e.g. table grapes) under similar climatic conditions . This could be indicative of over and under irrigation occurring within an area. For example, a low biomass WUE in combination with high seasonal actual evapotranspiration is a strong indication for over irrigation. By combining crop evapotranspiration and biomass WUE a first evaluation can be made of efficient water use, per field or per zone, within the Valley.

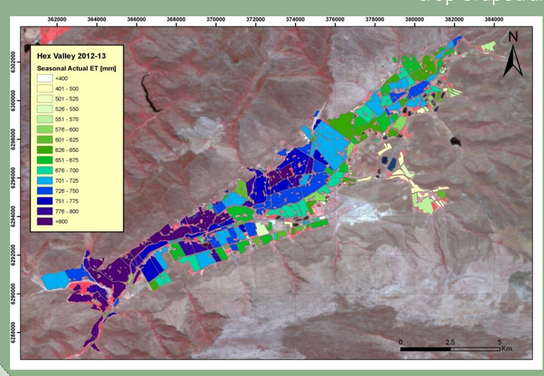
Cultivar Biomass Water Use Efficiency Evaluation

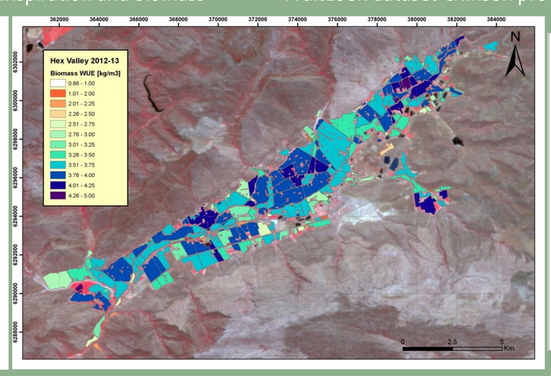
In the graph below the average seasonal biomass WUE [kg/m³] for various table grape cultivars in Hexriver Valley is shown. Only cultivars which are grown on more than 50 fields in Hexriver Valley were taken into account. This graph shows that Crimson is the most biomass water efficient table grape according to the FruitLook data in both 2011/12 and 2012/13. Thompson is the most water efficient white table grape cultivar. It is acknowledged that WUE is not the only factor important in grape production and that harvest time, the utilization of the labor force and the income generated per cultivar play important roles, often more than the pure WUE of the cultivar.

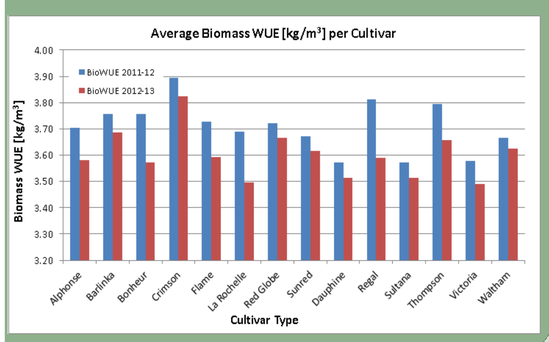
In literature Crimson is renowned for its growth vigor . Also according to the FruitLook dataset Crimson produces most biomass per unit of water used. It must be noted that biomass does not equal yield. Biomass production includes dry matter production of roots, shoots, fruits and cover crop if present. Thus, while Crimson may be the most efficient producer of biomass it does not necessarily mean it produces the highest grape yield with the least amount of water. Only access to actual grape yield data will allow the estimation of the water productivity.

Conclusive Remarks

In this analysis the Hexriver Valley table grape cultivation has been generally evaluated for the 2011/12 amd 2012/13 season. It gives an indication on the versatility and applicability of the FruitLook data in providing information on water use for larger areas. Of course many other statistical methods and ways of visualization can be adopted to gain information from the FruitLook dataset, like linking crop grow/water use to soil type, slope, aspect and weather conditions.







Hexriver Valley seasonal actual ET [mm] and biomass WUE [kg/ha biomass per m³ water] per zone in the 2012/13 table grape season. The table on the right shows the average biomass WUE [kg/m³] per cultivar type in Hexriver Valley.

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