Scan this to
watch our video:

# 1 Details ThirdEye project

## 1.1 Background ThirdEye

Appropriate information at the right location and timing is essential for farmers to take decisions regarding application of their limited resources such as water, seeds, fertilizer and labor. Our innovation is that we provide this essential information: (i) at an ultra-high spatial resolution (NDVI), (ii) at an unprecedentedly flexibility in location and timing, (iii) at a spectrum outside the human eye, and (iv) at an in-country business oriented approach. For this we use low-cost high-resolution flying sensors in a development context to ensure that farmers will get information at their specific level of understanding and simultaneously develop a network of service providers in Mozambique.

ThirdEye is a company initiative by FutureWater and HiView, initially created with the support of USAID in the prestigious Securing Water for Food program. ThirdEye has evolved since 2014 from a start-up to becoming the leading company in Mozambique as to mapping and monitoring services for farmers based on aerial images. Next to the service for smallholder farmers, ThirdEye delivers various services to medium and big sized farmers. To name the most significant:

- Large-scale, detection of crop stress 10 days in advance
- Crop status mapping on tablets for real time usage in the field
- Monitoring of land use
- Identification of areas
- Monitoring of channels and river-beds

ThirdEye's innovation can be considered as a major transformation in farmers' decision making regarding their agronomic practices. Instead of relying on common-sense management, farmers are now able to take decisions based on facts. The flying sensor information helps farmers to see when and where they should apply their limited resources. We are convinced that this innovation is a real game-changing comparable with the introduction of mobile phones that empowered farmers with instantaneous information regarding markets and market prices. With information from flying sensors they can manage also their inputs to maximize yields, and simultaneously reduce unnecessary waste of resources. In summary, the missing information on markets has been solved by the mobile phone introduction, the flying sensors close the missing link to agronomic information on where to do what and when.

## 1.2 Progress (2014 – 2017)

- 14 local flying sensor operators have been trained and obtained their certificate.
- 11 flying sensors are now operational.
- Over 3,500 farmers receive our service, of which 71% is female.
- The number of people benefitting is over 17,000.
- ThirdEye's service area is over 1,600 ha.
- Water productivity is increased by 55%, meaning more crop per drop.

## 1.3 Flying sensors

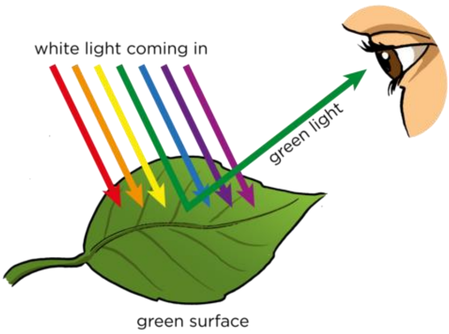
A flying sensor is a combination of a flying platform and camera. Reliable flying sensors are on the market in a wide-range of categories each with its specific characteristics. Based on the consortium's experiences over the last years low-cost flying sensors have been identified that are excellent equipped for our innovation. Typically, a flying sensor flies at a height of 100 meter and overlapping images are taken about every 5 seconds. This results in individual images covering about 50 x 50 meter and an overlap of 5 images for each point on earth. So, to cover 100 ha 500 images are taken during a flight.

The use of flying sensor is unique and no comparative techniques exist that provide farmers with real-time high-resolution information. The use of satellites to provide farmers with spatial information has been promoted but has three main limitations: they have fixed overpass times, the spatial resolution is low, and the presence of clouds halters the information. It is unlikely that, within the coming decades, progress in satellites will be real competitors of flying sensors. Another category of comparable techniques to provide farmers with information is the use of ground sensors. Typical examples of these sensors are soil moisture devices, soil sampling and laboratory analysis, crop sampling and laboratory analysis. However, all those sensor techniques have the common limitation that information is only local point representative, while the main question farmers have is regarding to spatial differences. Moreover, these ground sensors are in all cases too expensive to be used by small-scale farmers.

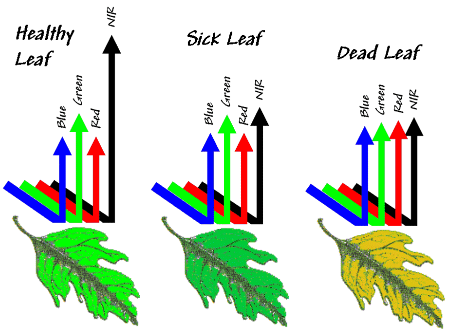
We trained several flying sensor operators, who are going to the fields on a daily basis to gather information with their flying sensors and advice farmers on potential interventions they could take. These operators are able to support over 400 small-scale farmers, by collecting information and sharing it with farmers on weekly basis. Based on the information, farmers take decisions on where to do what in terms of irrigation, fertilizer application and pesticides.

## 1.4 NDVI technology

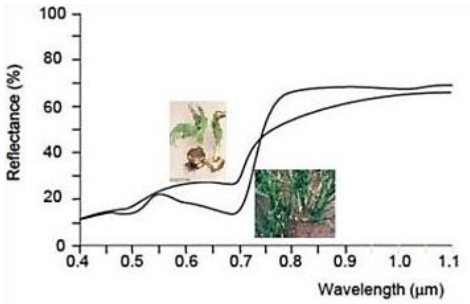
When light falls on a leaf, reflection occurs. The amount of reflection of green light (0.54 µm) is very high, making plants green to the human eye. Healthy vegetation does not reflect much red light (0.7 µm), since it is absorbed by chlorophyll abundant in leafs. In the near-infrared spectrum (0,8 µm) the amount of reflection increases rapidly to 80% of the incoming light. This increase is caused by the transition of air between cell kernels. This is characteristic for healthy vegetation.




Damaged plant material does not show this increase in reflected near-infrared light. Moreover, the reflection of red light is much higher than in healthy plant material. By measuring the reflection in these spectra, damaged plant material can be distinguished from healthy plant material (Schans et al., 2011).




Our flying sensors have cameras which can measure the reflection of near-infrared light, as well as visible blue light. These two parameters are combined with a formula, giving the Normalized Difference Vegetation Index (NDVI). This information is delivered at a resolution of 2x2 cm in the infra-red spectrum. Infra-red is not visible to the human eye, but provides information on the status of the crop about two weeks earlier than what can be seen by the red-green-blue spectrum that is visible to the human eye.




NDVI is the most important ratio vegetation index and says something about the photosynthesis activity of the vegetation. Moreover, NDVI is an indicator for the amount of leaf mass, and therefore, ultimately biomass. In general, open fields have a NDVI value of around 0.2 and healthy vegetation of around 0.8. NDVI values give an indication of crop stress. This can be caused by a lack of water, lack of fertilizer, pests or abundancy of weeds.

# 2 Our Team


- **Nadja den Besten, MSc.**
  Field Manager/Hydrologist - FutureWater
  Estrada Kwame Nkrumah 1293, Maputo, Mozambique
  Email: n.denbesten@futurewater.nl
  Mobile: +258 84 438 7747

- **Bacelar Muneme BSc.**
  Sales Representative - FutureWater
  Mozambique
  Email: bacelar@thirdeyewater.com
  Mobile: +258 82 781 2703

- **Martijn de Klerk, MSc.**
  Project Manager - FutureWater
  Costerweg 1V, 6702 AA Wageningen, Netherlands
  Email: m.deklerk@futurewater.nl
  Telephone: +31 317 460 050

- **Jan van Til, MA.**
  Project Manager - HiView
  Costerweg 1V, 6702AA Wageningen, Netherlands
  Email: j.vantil@hiview.nl
  Mobile NL: +31 6 181 417 72
  Mobile MZ: +258 849 006 966

- **Dr. Peter Droogers**
  Hydrologist/Project Leader - FutureWater/HiView
  Costerweg 1V, 6702AA Wageningen, Netherlands
  Email: p.droogers@futurewater.nl
  Telephone: +31 317 460050
  Mobile: +31 6 4879 4729


# 3 Corporate Information

## 3.1 FutureWater

FutureWater is a research and consulting organization that works throughout the world to combine scientific research with practical solutions for water management. FutureWater works at both global, national and local levels with partners on projects addressing water for food, irrigation, water excess, water shortage, climate change, and river basin management.

FutureWater's key expertise is in the field of quantitative methods, based on simulation models, geographic information systems and satellite observations. Important clients and collaborators are: World Bank, Asian Development Bank, National and Local Governments, River Basin Organizations, Science Foundations, Universities, and Research Organizations.

In addition to carrying out research and providing advice on request to clients FutureWater frequently initiates state-of-the-art scientific and applied research projects. FutureWater has a pro-active approach to research where we use models to investigate a variety of problems and challenges in water management and emphasize possibilities for the future.

FutureWater has offices in Wageningen (Netherlands) and in Cartagena (Spain). Details can be found at: http://www.futurewater.eu.

## 3.2 HiView

HiView supports professionals by providing data, information and services based on ultra-high resolution imageries obtained by flying sensors. HiView deploys a range of platforms on which various sensors (both in the visible and non-visible parts of the spectrum) can be mounted. Raw data is converted to information using various state-of-the-art software packages. Information is transferred to knowledge by our highly qualified scientific staff.

HiView has a broad range of projects in various countries. Typical examples include:

- Moorland restoration monitoring (UK)
- Glacial movement detection in Himalayas (Nepal)
- Vegetation classification in nature reserves (Netherlands)
- Small-holder farmers support in water-agro decisions (Mozambique)
- Large-scale farmer support in farm management (Netherlands)
- Drought detection in nature reserves (Netherlands)

HiView is based in Wageningen (Netherlands) and is accredited by the Civil Aviation Authority of the Netherlands and fully certified by EuroUSC. Details can be found at: http://www.hiview.nl.

# 4 Examples of flying sensor Products

## 4.1 Orthomosaic

An orthomosaic is a geo-rectified stitch of a series of aerial images.


*Figure 1. Orthomosaic of sugar cane field. Orthomosaic was made from the images of 1 flight with our flying sensor Sensy_gps+*

## 4.2 Details sugar cane field

Our orthomosaics contain ultra-high detail. The flying sensors have a resolution of up to 2 cm/pixel.

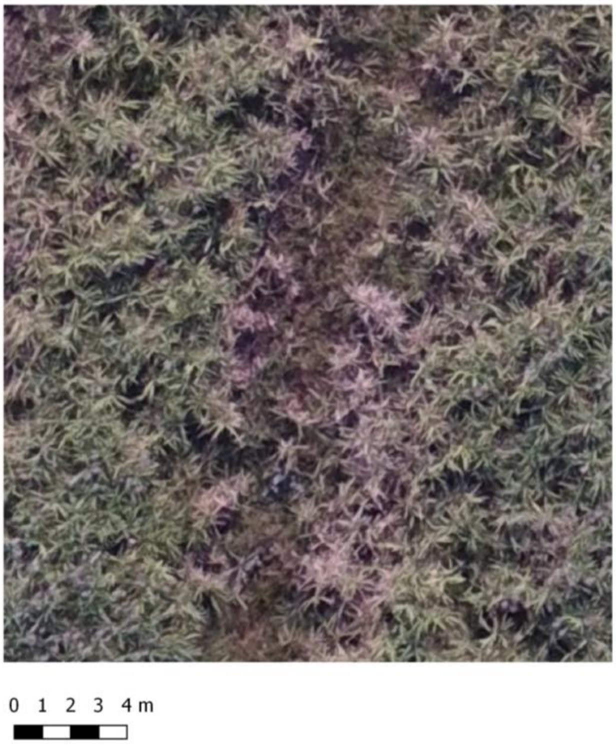



*Figure 2. Detail sugar cane field 20 x 20m*

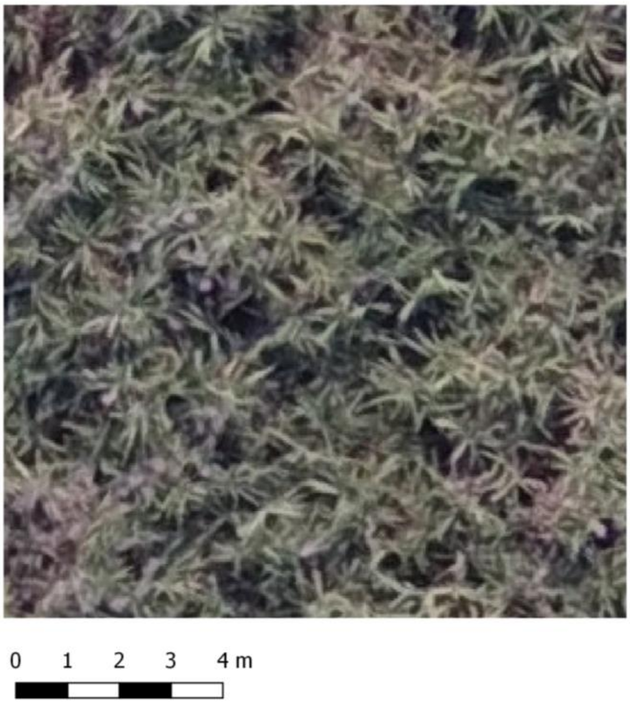



*Figure 3. Detail sugar cane field 12 x 12m*

## 4.3 DEM

A DEM (digital elevation model) can show the elevation of the terrain and the height of the crops. Depending on ground measuring of control points DEMs with an accuracy of up to 5-10 cm can be generated.

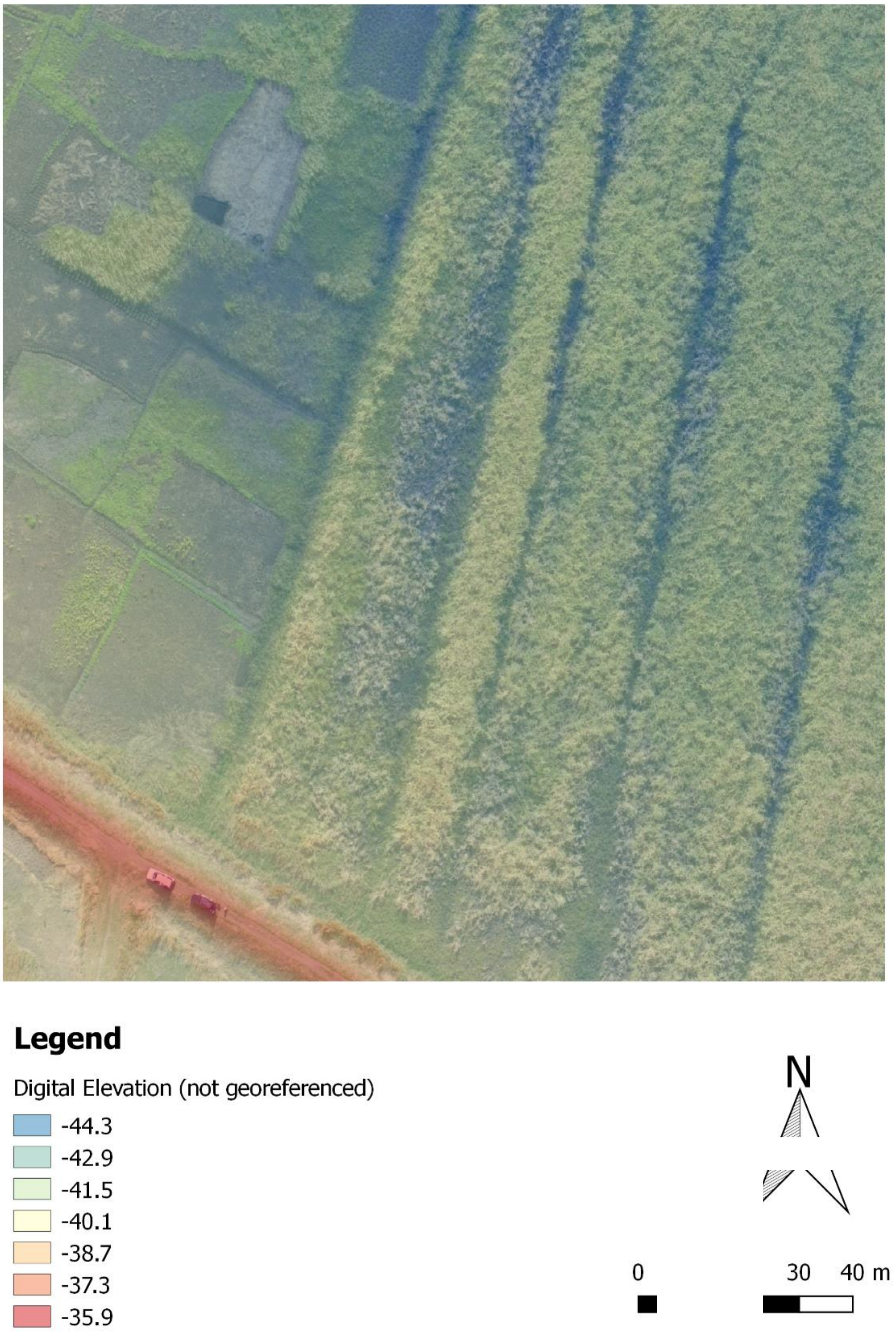



*Figure 4. DEM of sugar cane field showing the height of sugar cane*

## 4.4 KMZ/KML

A KMZ (a zipped KML) helps to find the location on Google Earth in a twinkle. A KMZ loads itself automatically into a satellite viewer like Google Earth.


*Figure 5. Insert in Google Earth of orthomosaic of sugar cane field*

## 4.5 Analysing crops with NDVI & Anomaly

NDVI (normalized difference vegetation index) and Anomaly (further processed NDVI) show the condition of the crops. NDVI maps can be produced with a resolution of up to 2 cm/px. The NDVI is derived from the NIR (near infrared) image source.

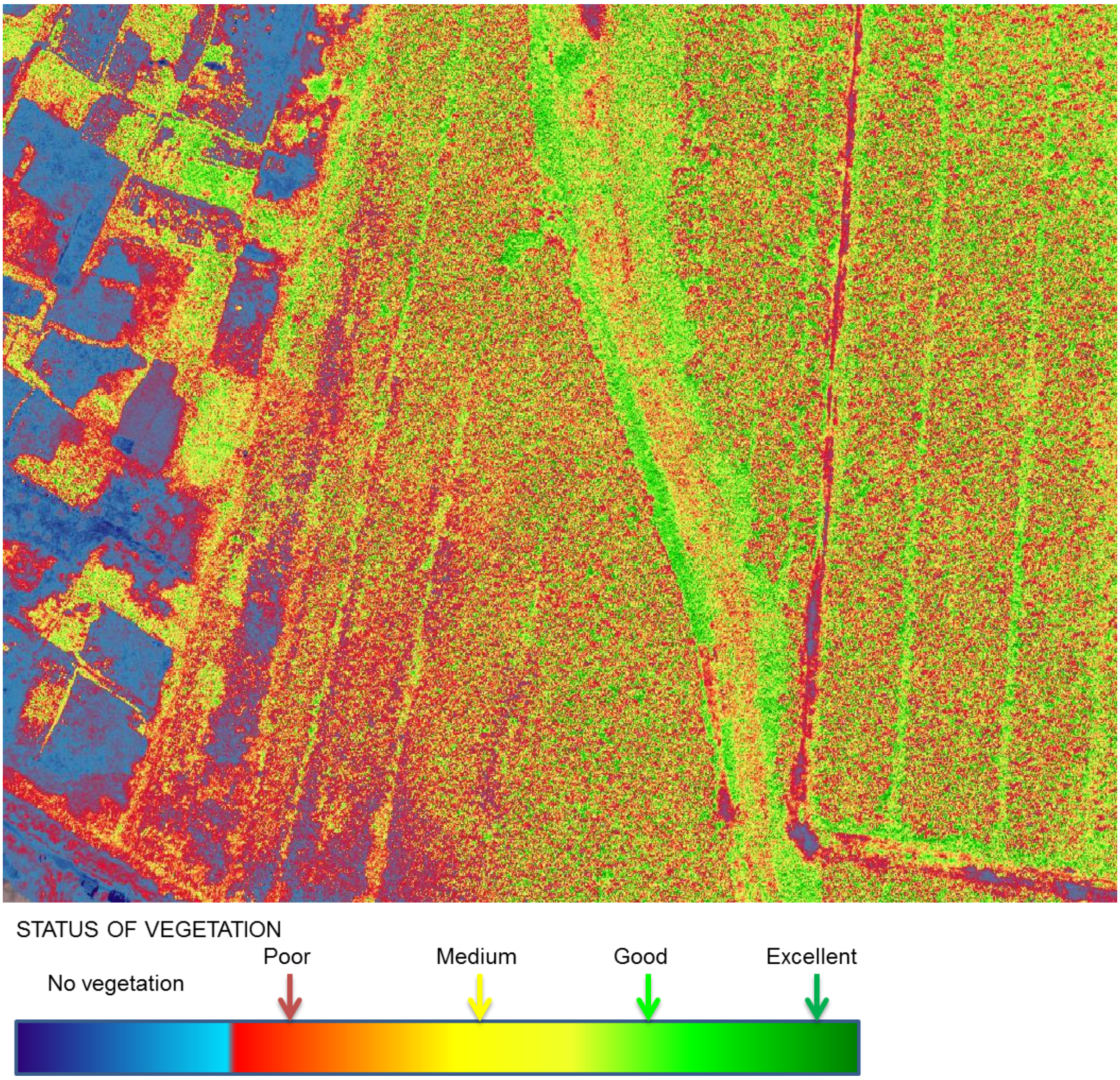



*Figure 6. NDVI of small farmer crop fields in the regadio of Chokwe*

## 4.6 Details of NIR and NDVI

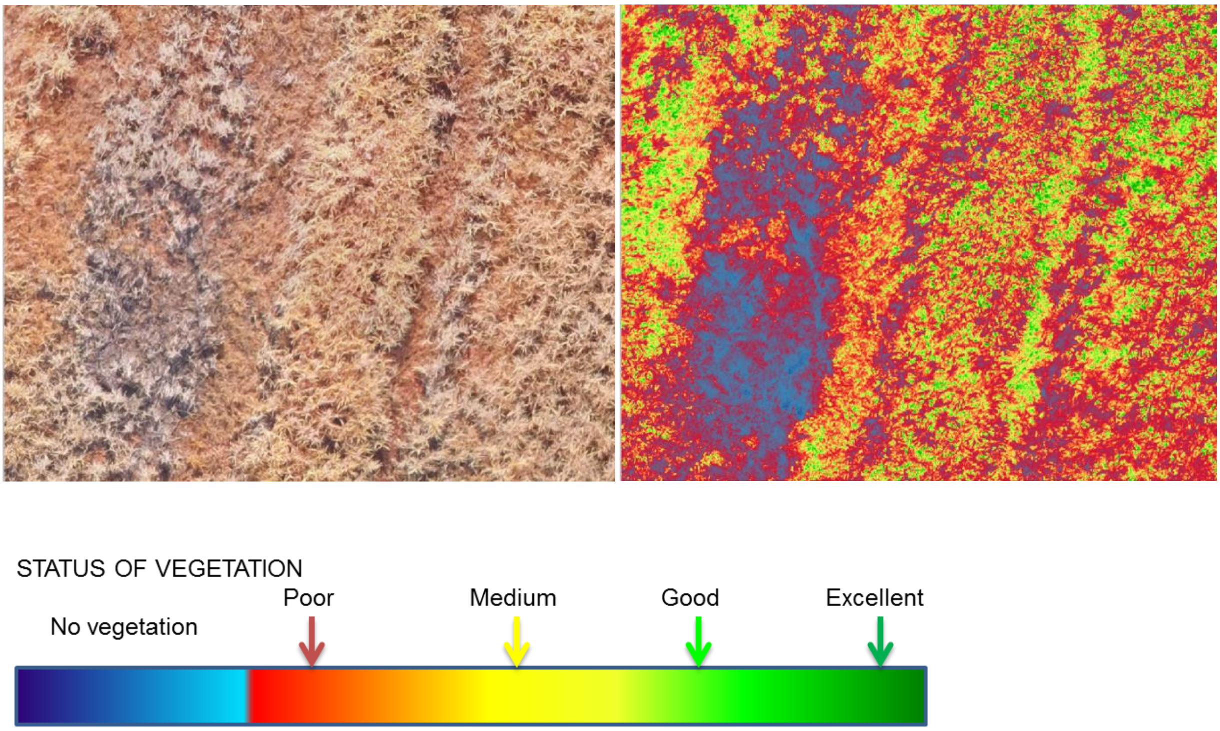



*Figure 7. Details of NIR image source (left) and the processed NDVI (right).*

## 4.7 Tablet mapping

Tablet mapping is a very handy tool making it possible for flying sensor operators to localize special attention areas, add location specific information (categories per colour/ text/ coordinates) and store as customized maps.

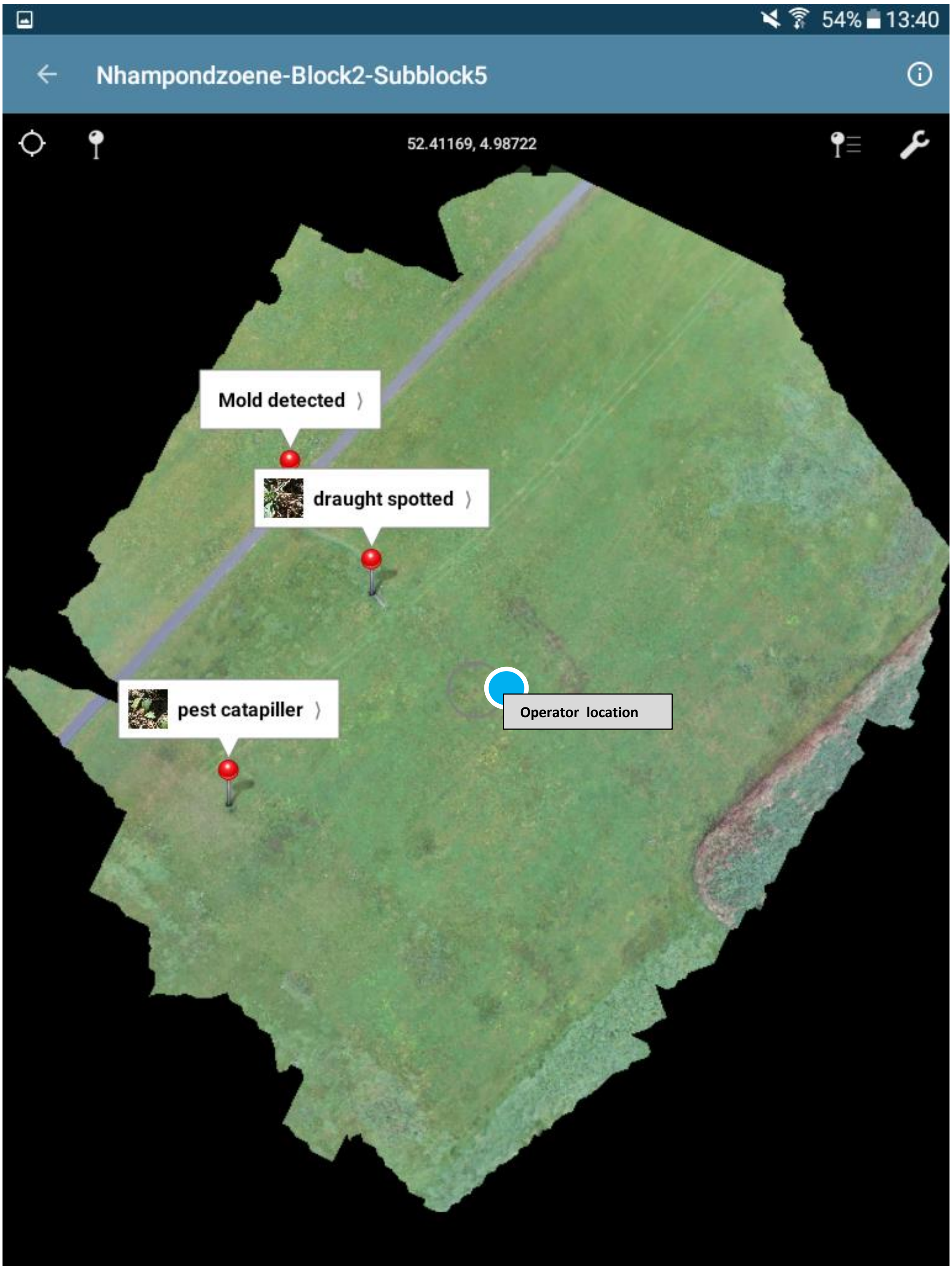



*Figure 8. Example of tablet mapping (RGB, visual light image).*


*Figure 9. Example of tablet mapping (NDVI image).*