Using Satelite NDVI Imaging to Identify Mallee Seep Threats: A Guide

Using the Data Farming application for Satellite NDVI imaging to assist in identifying and managing Mallee Seep threats

BACKGROUND

Normalised Difference Vegetation Index (NDVI) has grown in prominence in recent years as a way of monitoring crop and pasture growth in precision agricultural management. NDVI images can be obtained from both drones and satellites, and essentially indicate areas of higher or lower vegetative growth through spatial colour images of targeted paddock areas. A recent SA Murray-Darling Basin NRM project found that strategic use of NDVI imaging can help identify both the formation of mallee seep areas and the potential threat to surrounding areas becoming degraded (McDonough 2018). This is possible because perch water table areas associated with Mallee seeps results in soils remain wetter for longer; resulting in extended periods of plant growth, particularly in annual species. These areas of paddocks having an extended growing season can be identified and analysed to assess the extent to which seep effects occur and impact the landscape. Development of this guide has been made possible through the MSF Mallee Seeps Project.

INTRODUCTION

While there are numerous Satellite NDVI programs and applications available, this guide focuses on the Data Farming website application. This application is freely available and “user friendly”. If users wish to go deeper into the services provided through Data Farming for precision agriculture management, it is possible to subscribe to such applications through the Data Farming website.

The use of this technology primarily focusses on understanding plant growth patterns within paddocks. It is essential that satellite imagery is interpreted in conjunction with on-ground truthing and the local knowledge of the farmer to be able to ascertain a more accurate understanding of paddock situations and potential threats. There are many situations that can result in colour images appearing that may have nothing to do with the development of perched water tables, saturated zones or baring saline scalds. However, when applied correctly, these techniques can provide a highly informative picture and greatly improved understanding of the seep formation dynamics and the most appropriate management strategies for farmers and advisors.
This guide provides the basic steps to utilising a free satellite imaging service that can assist farmers and advisors to access and interpret NDVI technologies in the management of mallee seeps. This guide provides key advice on how to obtain and understand available images, while also outlining key things that can lead to misinterpretation of the data. Analysis of other suitable programs for assessing seep management will be provided in future reports.

**A STEP BY STEP PROCESS TO USING NDVI**

Register and sign up at the Data Farming Website:


Select a site for analysis. Log in and click on ADD FARM, then fill in a suitable Farm name and Enter or click on ADD. This farm name will now appear on the main screen.
Now click on DRAW in the line of the farm name. This will then take you to a map of the world which you can then manipulate with your mouse and zoom in to find the specific area you want to investigate. You will notice a blue dot that appears at your cursor. By clicking your mouse you can outline the perimeter of the area of interest. For seep analysis it is good to focus on a paddock size area of 100-200ha size that includes sandhills, flats and seep concern areas. You can also focus on a much smaller specific seep location if this suits your purpose. Generally, it is best to make a rectangle shape using 4 mouse clicks at each corner, and a 5th click on the original point to complete the enclosed shape.

*Figure 1. Screenshot of using cursor to set site area for NDVI images*

Once you have completed the rectangle (or polygon) the border will turn to orange and you can either confirm this area edit it by moving the corner points with your cursor, or discard the shape altogether.

*Figure 2. Screenshot of area selected for NDVI imaging, ready for confirmation*
Once you are satisfied with your chosen area, press the CONFIRM button. This allows you to then add the paddock or site details. For mallee seep purposes if you select Wheat as the crop type, this allows you to adopt a consistent approach when reviewing paddocks over multiple years. Then press CONFIRM.

**Figure 3. Screenshot of paddock details box to be filled in**

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**Figure 3. Screenshot of paddock details box to be filled in**

The program will then attempt to load links to all the available satellite NDVI images, however from experience this almost always fails in the first attempt. However, if you then click on the orange line area perimeter it will reload successfully. You are then presented with a series of satellite flight dates across the bottom of the screen, along with an indication of the cloud cover percentage for that region at that time. This will allow you to select those images that have minimal to zero cloud interference, thus avoiding possible misinterpretation. (Note: sometimes as little as 3% cloud cover can still interfere with interpretation (particularly if these clouds line up with your particular site). However, occasionally when some critical periods for analysis have all indicated high cloud cover (images as high as 25% cloud cover), but these have still been suitable since the clouds align with areas outside of your specific paddock areas being examined).

**Figure 4. Screenshot of NDVI Satellite images available, showing percentage of cloud cover at that time**
VIEWING AND ANALYSING NDVI MAPS OF TARGETED AREA

Click on the NDVI button for the date you wish to analyse. Blue and green coloured areas represent strong to reasonable vegetative growth, while yellow to brown areas represent areas of little to no active vegetative growth. The most critical times for potential seep area identification is through October and November when the crops or pastures are maturing and drying off, because this will often expose areas that remain greener for longer because they are accessing subsoil moisture for longer due to perched water tables.

Figure 5 shows the NDVI image from October 2017, which although it was a below average rainfall year, did follow the very wet spring of 2016 which was still greatly impacting seep prone areas at this site. Having some prior knowledge of the landscape and paddock activities is of considerable advantage in assessing the image. In this example there are areas of deep sands, stony and loamy flats as well as remnant vegetation.

*Figure 5. NDVI image from Oct 29, 2017, indicating seep scald areas and area under threat.*

Looking at one image will only give a snapshot in time which may be of limited value. It is recommended to take “screen grabs” of multiple images of the same site and paste them into PowerPoint or Word, along with their image dates. That way it is possible to easily flick between pages and see the dynamics of the site through critical times. For example, the Oct 29 image (Figure 5) image shows numerous large areas of blue and green which are not as a direct result of a potentially forming Mallee seeps. However, when viewing subsequent images of Nov 13 (Figure 6) the dark blue areas of concern become more defined (with plants still growing strongly). Note that the native vegetation also remains dark blue.
The importance of local knowledge is vital in the 3rd image on Nov 28 (Figure 7). Potential seep area 1 is currently not presenting with any surface scalds but is clearly retaining moisture and should be tested for saturated layers and management action taken before degradation occurs. Area 2 is above an existing scald and shows where it is most likely expanding to. Area 3 has a seep scald in the top end which ponds after rain and overflows in a southeast direction. The green area now has elevated yields but will become scalded if no remedial action is taken. Area 4 reveals 2 developing saturated and scalded areas at the base of deep sands. However, summer weed control after harvest removed growth (no longer blue) from this area before summer a crop was sown there. It also reveals the regeneration of the lucerne patch directly above the main seep area.

Figure 7. NDVI image, Nov 28, showing growing crop or weed areas after main crop senescence
INTERPRETING AND ANALYSING IMAGES

Identifying seep threatened areas before they become degraded salt scalds

A key advantage of using NDVI maps late in the growing season (or after senescence of the main crop area) is that it can provide a strong indication of the potential areas of land under threat. This allows farmers to take action while it is just a water logging issue long before it becomes a salt scald. It can also show how far a scalded area is likely to spread if no action is taken.

Figure 8 represents an image taken in mid-October 2017, which had very poor spring rainfall and an early season finish. The brown/orange areas indicate plants that have mostly dried off, particularly across the sandhills (brown strips) due to the lack of plant available water. The yellow/green areas show plants that are senescing more slowly due to slightly longer moisture available from the loamy soils. The deep blue strips along the base of the sandhills in all the paddocks cropped that year are indicative of areas where there is a perched water table supplying crop roots with a sustained amount of available water to keep them alive and flourishing. There are only a few scalded areas indicated within these green zones where to soil salinity has become too high to support crop growth. These “seep threatened blue areas” are far greater than the farmer expected and provide a much clearer incentive for action to be taken immediately to achieve higher water utilisation on the sandhills and soil cover over summer through saturated areas to prevent the further development of land degradation and production loss.

*Figure 8. NDVI map 16th Oct 2017 showing areas under threat from seep degradation (blue)*

Identifying likely recharge areas to target management.

Figure 9 reveals a seep scald with areas immediately to the south and west (blue) under threat of degradation. While there was a large sandhill to the north that was thought to have contributed water to the seep, closer inspection of the site showed that it grew excellent crop, with no obvious soil compaction issues, and was not likely to be causing recharge. However, when walking back down toward the seep there appeared to be a specific strip of non-wetting sand in the mid-slope. This was confirmed through the NDVI image showing a lack of crop growth for the whole growing season, and thus being a likely site for contributing recharge, along with a similar mid-slope zone south of the seep. This became the target for some strategic clay spreading to rehabilitate the non-wetting sand and improve the water use and production off of these recharge areas.
**The importance of ground truthing**

Use of satellite NDVI technology is one tool that can assist our understanding of a potential seep threat and strategic management options, rather than something that provides complete answers. When first assessing site images over time, it is very easy to misinterpret features or changes over time, but these can be critically re-evaluated after visiting the site and discussing with the owner.

Digging holes to about 1m using an auger or soil probe at strategic locations can provide important insights into the landscape dynamics. This includes searching for saturated soil layers often sitting above impervious clays. The location of non-wetting or less productive deep sandy rises, often associated with compacted layers preventing the deep penetration of crop roots and poor water use, can provide good indications of significant recharge areas, along with other landscape features.

Reassessing NDVI maps after visiting the site, and possibly downloading more images from other critical times, can be very enlightening once one has a clear understanding of the landscape, previous weather events and paddock activities. The NDVI images may also then be used to help monitor the effectiveness to management strategies in achieving higher water use and soil cover to assist in ameliorating soils and reversing the soil degradation caused by the Mallee seeps.
Key factors that could lead to misinterpretation

Cloud cover

While the DATA FARMING program presents an estimate of cloud cover across your site region for each image, and it is recommended to use images showing 0% cloud cover, there are times when the period you need to analyse has cloud cover on every satellite pass. Sometimes you can gain cloud free images from times when there is 20-30% cloud cover shown on the tab, as these clouds may not fall on your particular site. There are some rare occasions when a 0% cloud cover tab may still show a cloud in your image, so keep this in mind if something appears out of place. As seen in Figure 10, clouds can present as areas lacking growth, such as a very sandy or bare area. Cloud shadows can also distort NDVI image colours. Cloud distortions are recognised by:

• comparing these images with other site dates, comparing the presence of specific features;

• ground truthing, or just knowing the site you are dealing with; and

• becoming familiar with the distinct clouds image shapes after gaining program experience.

Figure 10. NDVI image of same location by with (left) and without (right) cloud cover

Trees or other perennial vegetation

Perennial vegetation can easily be mistaken for seep affected areas, particularly when they appear in close proximity to sandy rises, as shown in Figure 11. Again, a knowledge of the site, or ground truthing will quickly overcome any confusion. While the first image (left) shows seep affected areas appearing similar to the treed areas in October, the second image (right) is in late November after harvest and a summer weed spray. The plant growth associated with the seep areas has essentially been removed while the treed areas remain blue.

Figure 11. NDVI image of same location showing how trees can imitate seep affected areas
Summer crops / summer weeds

In targeting areas of persistent plant growth through summer to help ascertain any presence of perched water tables in the landscape, one must be mindful of other factors causing paddock growth. Summer rainfall resulting in unsprayed summer weeds could appear as a potential seep threatened area. This may well be an indicator of areas of higher water availability, but may also be unrelated to deeper soil moisture. Similarly, Figure 12 shows a contrast of times and reasons for the blue high growth areas due to summer crops. Seeking farmer knowledge is vital in these cases.

Figure 12. NDVI image from Nov 5th showing frost effects on NDVI imaging.

Frost Events

October and November are key times to assess potential seep affects due to crops maturing later in wet areas. However, sometimes frost events can cause a similar affect in areas where they have reshot and remain green for an extended period. Farmer knowledge of the areas affected by frost may prove critical in gaining an accurate interpretation of spring NDVI images and assessing potential seep risks and management strategies, as evident in Figure 13. In a season that cut off early with a dry spring, many of the swale areas between sandy rises were frosted and stayed green. However, there were also specific zones of seep affected areas that were clearly identifiable through the following spring’s NDVI imaging as well as ground truthing.

Figure 13. Same NDVI Site. Nov 4 (left) - threatening seeps, Jan 18 (right) - summer cropping
Other NDVI Programs
Four other NDVI Satellite imaging websites were briefly assessed as to their potential to be used in a similar way. The GEOGLAM https://map.geo-rapp.org/#australia is not useful for this purpose, having a spatial resolution of 500m. VegMachine© https://vegmachine.net/ and FarmMap4D Spatial Hub https://farmmap4d.com.au provide a smaller 30m pixel size but only provide 3 monthly seasonal compilations of ground cover to end users, so will not provide the clarity or the timely flexibility of data required for this type of seep analysis.

However, the Decipher website https://www.decipher.com.au/ is fairly similar to the DATAFARMING program, in that it uses a 10m pixel size, has data from satellite flights every few days, indicates cloud cover levels for images and is freely available. Initial assessments show this website appears to have more features and is more flexible in applying these features to the seep sites under analysis. This website will be reviewed and reported on in more detail in the coming year.

Conclusions
Satellite NDVI technology has an extremely useful and relevant application in the identification, prediction of potential threat and the strategic management of Mallee Seeps. The DATA FARMING website provides an excellent tool for this purpose and is readily available for researchers, consultants and farmers to use. Using NDVI images to identify variations in plant growth across landscapes at critical times greatly assists the user to ascertain where recharge is most likely to be contributing water into the system, as well as the extent of the potential land under threat of degradation if no action is taken. This can be vital in motivating farmers into action, as well as inform farmers and advisers as to the most appropriate management strategies available to address the problems, avoid further degradation and bring land back into production.

This report provides a simple guide as to its application of DATA FARMING, along with key information as to how best interpret the image data for Mallee Seep management. However, it must always be used in conjunction with ground truthing and local knowledge to ensure that the most appropriate analysis is determined, and best management strategies pursued. Further analysis as to the application of other suitable NDVI website application tools will continue to be reviewed with updates provided through the Mallee Seeps Project on a regular basis.

References