NEW

# Two Impact Factors Analysis versus NDVI Assessment

In detecting the internal health of an individual tree, "two impact factors analysis" refers to evaluation of NIR and RED **separately**, instead of merging them **together** in one formula as in NDVI assessment. We use high resolution WorldView-2/-3 satellite data for our study.

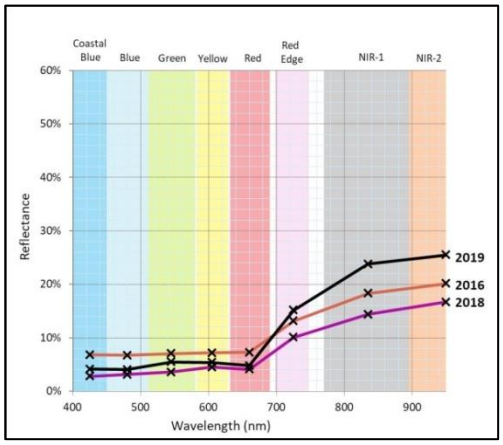
From our global case studies of stressed trees, we have found the following results:

(1) NDVI works when the spectral reflectance in both NIR and RED bands deteriorate **together/concurrently**.

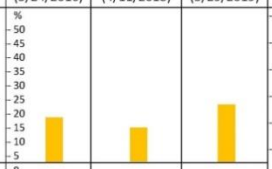
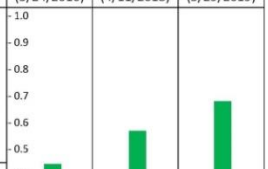
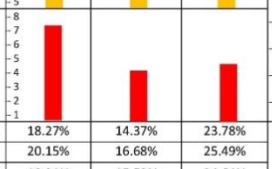
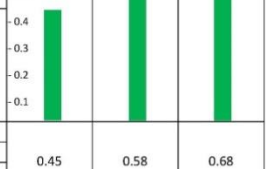
(2) NDVI does not work when the spectral reflectance in NIR and RED bands **vary**. This will happen, as shown by our case studies of Tree 1 and Tree 2 of the removed stressed trees, and Tree 4 and Tree 5 of the collapsed stressed trees.

## (a) Removed Stressed Trees

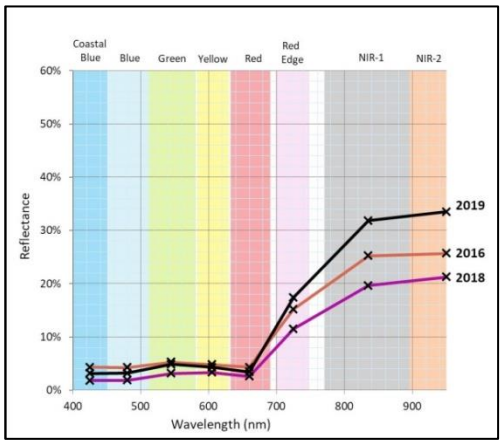
**Tree 1** Wrong NDVI Result



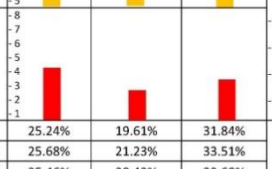

Removed tree No.6 in Paramount Blvd. (Date of removal: June 2019)

| Comparison | | Leaf cellular structure and Chlorophyll content | | | $NDVI = \frac{NIR - RED}{NIR + RED}$ | | |
|---|---|---|---|---|---|---|---|
| Year | | 2016 (5/24/2016) | 2018 (4/11/2018) | 2019 (5/29/2019) | 2016 (5/24/2016) | 2018 (4/11/2018) | 2019 (5/29/2019) |
| Leaf cellular structure (Average NIR) | |  | | |  | | |
| Chlorophyll content (Red) | |  | | |  | | |
| Band | NIR1 | 18.27% | 14.37% | 23.78% | | | |
| | NIR2 | 20.15% | 16.68% | 25.49% | | | |
| | Average NIR | 19.21% | 15.53% | 24.64% | 0.45 | 0.58 | 0.68 |
| | Red | 7.28% | 4.09% | 4.77% | | | |
| Remarks | | Fluctuating in both NIR and Red, indicating internal abnormality/ **unhealthy** condition | | | NDVI value rising continually, indicating **healthy** condition | | |

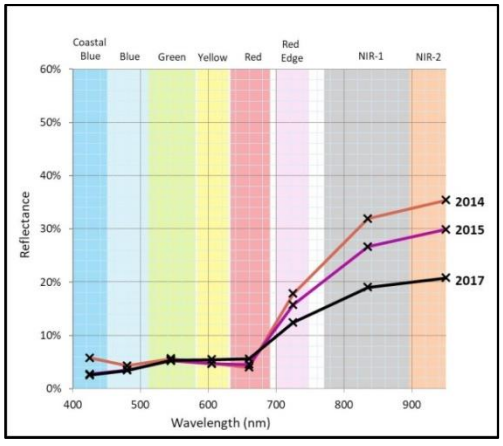
**Tree 2** Wrong NDVI Result



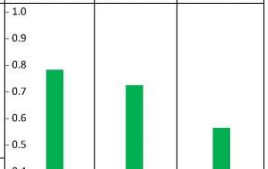
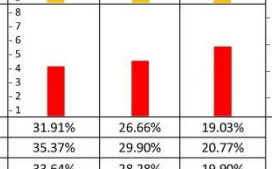

Removed tree No.25 in Paramount Blvd. (Date of removal: June 2019)

| Comparison | | Leaf cellular structure and Chlorophyll content | | | $NDVI = \frac{NIR - RED}{NIR + RED}$ | | |
|---|---|---|---|---|---|---|---|
| Year | | 2016 (5/24/2016) | 2018 (4/11/2018) | 2019 (5/29/2019) | 2016 (5/24/2016) | 2018 (4/11/2018) | 2019 (5/29/2019) |
| Leaf cellular structure (Average NIR) | |  | | |  | | |
| Chlorophyll content (Red) | |  | | |  | | |
| Band | NIR1 | 25.24% | 19.61% | 31.84% | | | |
| | NIR2 | 25.68% | 21.23% | 33.51% | | | |
| | Average NIR | 25.46% | 20.42% | 32.68% | 0.72 | 0.78 | 0.80 |
| | Red | 4.29% | 2.58% | 3.43% | | | |
| Remarks | | Fluctuating in both NIR and Red, indicating internal abnormality/ **unhealthy** condition | | | NDVI value rising continually, indicating **healthy** condition | | |

**Tree 3** Correct NDVI Result

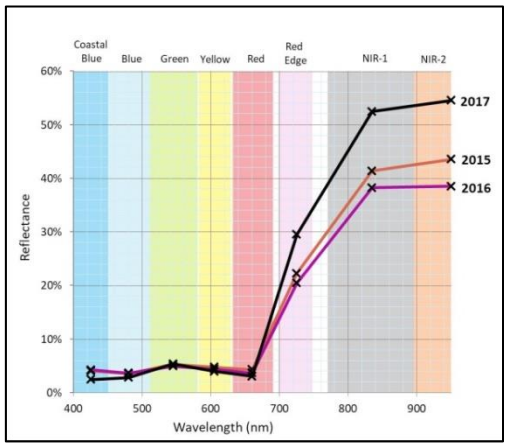



Removed tree in Lei Yue Mun Park, Hong Kong (Date of removal: February 17, 2017)

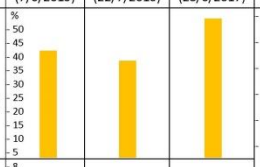
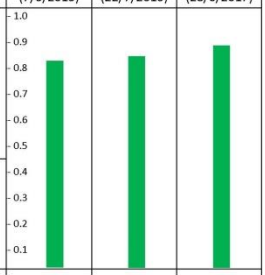
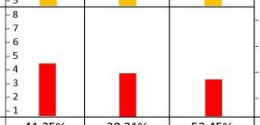
| Comparison | | Leaf cellular structure and Chlorophyll content | | | $NDVI = \frac{NIR - RED}{NIR + RED}$ | | |
|---|---|---|---|---|---|---|---|
| Year | | 2014 (19/11/2014) | 2015 (9/1/2015) | 2017 (21/1/2017) | 2014 (19/11/2014) | 2015 (9/1/2015) | 2017 (21/1/2017) |
| Leaf cellular structure (Average NIR) | |  | | |  | | |
| Chlorophyll content (Red) | |  | | |  | | |
| Band | NIR1 | 31.91% | 26.66% | 19.03% | | | |
| | NIR2 | 35.37% | 29.90% | 20.77% | | | |
| | Average NIR | 33.64% | 28.28% | 19.90% | 0.79 | 0.72 | 0.56 |
| | Red | 3.99% | 4.51% | 5.59% | | | |
| Remarks | | Declining in NIR and decreasing absorption in Red, indicating internal abnormality/ **unhealthy** condition | | | NDVI value dropping continually, indicating **unhealthy** condition | | |

## (b) Collapsed Stressed Trees

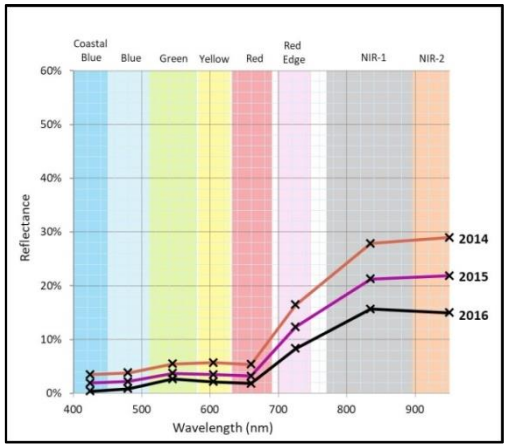
**Tree 4**
Wrong NDVI Result



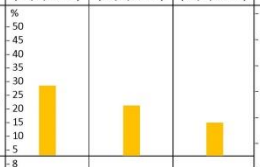
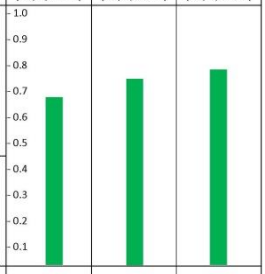
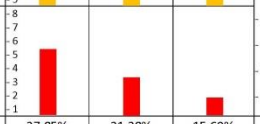

Collapsed tree in Central Park, New York (Date of collapse: August 15, 2017)

| Comparison | Leaf cellular structure and Chlorophyll content | | | $NDVI = \frac{NIR - RED}{NIR + RED}$ | | |
|---|---|---|---|---|---|---|
| Year | 2015 (7/6/2015) | 2016 (22/7/2016) | 2017 (28/6/2017) | 2015 (7/6/2015) | 2016 (22/7/2016) | 2017 (28/6/2017) |
| Leaf cellular structure (Average NIR) |  | | |  | | |
| Chlorophyll content (Red) |  | | | | | |
| Band NIR1 | 41.35% | 38.21% | 52.45% | | | |
| Band NIR2 | 43.54% | 38.49% | 54.50% | | | |
| Band Average NIR | 42.45% | 38.35% | 53.48% | 0.82 | 0.83 | 0.89 |
| Band Red | 4.27% | 3.62% | 3.04% | | | |
| Remarks | Fluctuating in NIR and increasing absorption in Red, indicating internal abnormality/ **unhealthy** condition | | | NDVI value rising continually, indicating **healthy** condition | | |

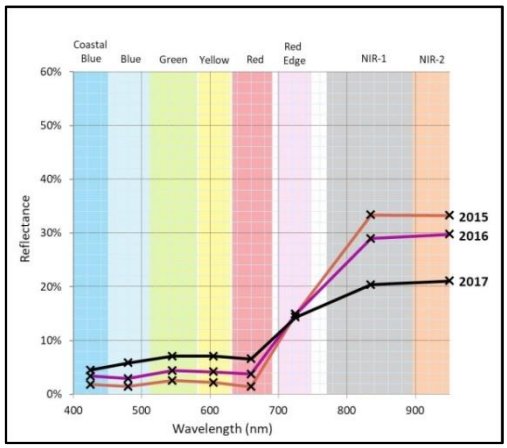
**Tree 5**
Wrong NDVI Result



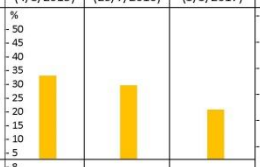
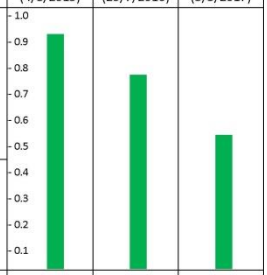
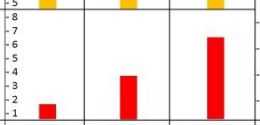

Collapsed tree in Düsseldorf, Germany (Date of collapse: October 20, 2016)

| Comparison | Leaf cellular structure and Chlorophyll content | | | $NDVI = \frac{NIR - RED}{NIR + RED}$ | | |
|---|---|---|---|---|---|---|
| Year | 2014 (18/7/2014) | 2015 (30/6/2015) | 2016 (19/7/2016) | 2014 (18/7/2014) | 2015 (30/6/2015) | 2016 (19/7/2016) |
| Leaf cellular structure (Average NIR) |  | | |  | | |
| Chlorophyll content (Red) |  | | | | | |
| Band NIR1 | 27.85% | 21.28% | 15.69% | | | |
| Band NIR2 | 28.98% | 21.84% | 14.97% | | | |
| Band Average NIR | 28.42% | 21.56% | 15.33% | 0.68 | 0.74 | 0.79 |
| Band Red | 5.39% | 3.18% | 1.82% | | | |
| Remarks | Declining in NIR and increasing absorption in Red, indicating internal abnormality/ **unhealthy** condition | | | NDVI value rising continually, indicating **healthy** condition | | |

**Tree 6**
Correct NDVI Result




Collapsed tree in Fanling, Hong Kong (Date of collapse: July 24, 2017)

| Comparison | Leaf cellular structure and Chlorophyll content | | | $NDVI = \frac{NIR - RED}{NIR + RED}$ | | |
|---|---|---|---|---|---|---|
| Year | 2015 (4/8/2015) | 2016 (29/7/2016) | 2017 (3/3/2017) | 2015 (4/8/2015) | 2016 (29/7/2016) | 2017 (3/3/2017) |
| Leaf cellular structure (Average NIR) |  | | |  | | |
| Chlorophyll content (Red) |  | | | | | |
| Band NIR1 | 33.37% | 28.95% | 20.37% | | | |
| Band NIR2 | 33.27% | 29.74% | 21.06% | | | |
| Band Average NIR | 33.32% | 29.35% | 20.72% | 0.92 | 0.77 | 0.52 |
| Band Red | 1.39% | 3.74% | 6.56% | | | |
| Remarks | Declining in NIR and decreasing absorption in Red, indicating internal abnormality/ **unhealthy** condition | | | NDVI value dropping continually, indicating **unhealthy** condition | | |

In NIR reflectance, **rise** implies **improvement** and **fall** indicates **deterioration**. But if it **surges** and **declines** drastically, it implies internal **abnormality/instability**. If it rises and falls or falls and rises, it means fluctuation.

In the Red band, **higher reflectance** implies **less** chlorophyll content to absorb Red light and **lower reflectance** implies **more** chlorophyll content to absorb Red light.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