

Remote sensing estimation of the resistance and resilience of a Japanese cedar plantation versus native broadleaf trees in the Shuang-lian-pi Forest following the 2015 typhoons.

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1. Introduction



Fig. 1 a. Shuang-lian-pi forest is located in the North-East of Taiwan, around a lake in a relatively steep area at an elevation of 500 meters. b. Study area (excluding lake, crops, rivers, roads and buildings). c. Japanese cedar d. Broadleaf trees.

~ 1.85 typhoon per year impacted Taiwan, from 1981 to 2020, (Truong-Vinh L. et al., 2024).

In August 2015, Shuang-lian-pi forest, located in northeastern Taiwan, has been struck by typhoon Soudelor, followed by typhoon Dujuan, in September.

Climate is subtropical and trees studied are evergreen.

Leaf Index Area at Fushan forest (10 km to Shuang-lian-pi)	Jan 2023	Mar 2023	Jun 2023	Oct 2023
	3.24	2.79	3.96	3.35

Objectives :

- Quantify the impact of the 2015 typhoons on the broadleaf trees (mostly *Machilus* and *Castanopsis*) and on a 100 years old Japanese cedar plantation.
- Determine how long it took for photosynthetic activity to return to pre-2015 typhoons levels?
- Compare the resistance and resilience of Japanese cedars (*Cryptomeria japonica*) vs. broadleaf trees.

2. Reading vegetation, with light

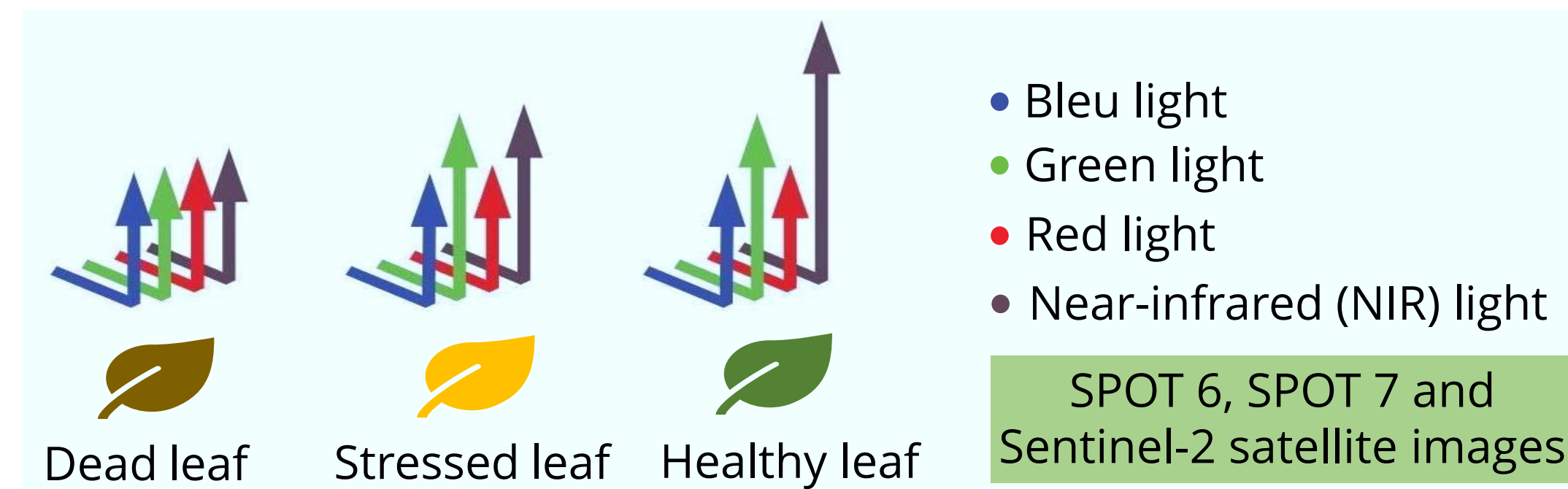


Fig. 2. The reflected light indicates the health of the vegetation. (Adapted from Ren et al., 2020)

$$\text{Normalized Difference Vegetation Index (NDVI)} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$$

Rousse et al., 1974

$$\text{NDVI Ratio} = \frac{\text{NDVI}_{\text{after typhoon}} - \text{NDVI}_{\text{before typhoon}}}{\text{NDVI}_{\text{before typhoon}}} * 100$$

Kang R-L et al., 2005

3. Distinguishing Japanese cedars

With false colors on Sentinel-2 and field validation:

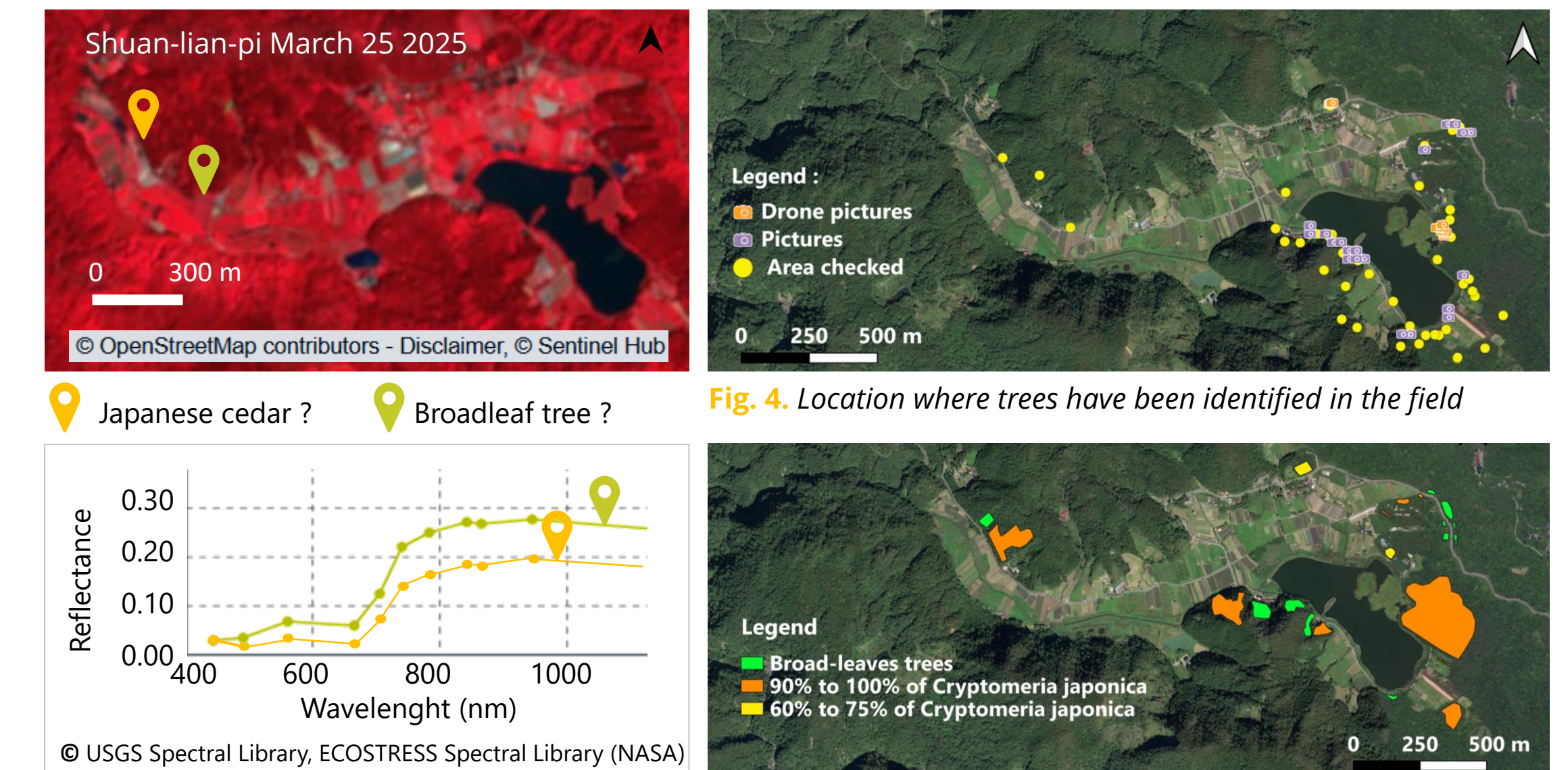
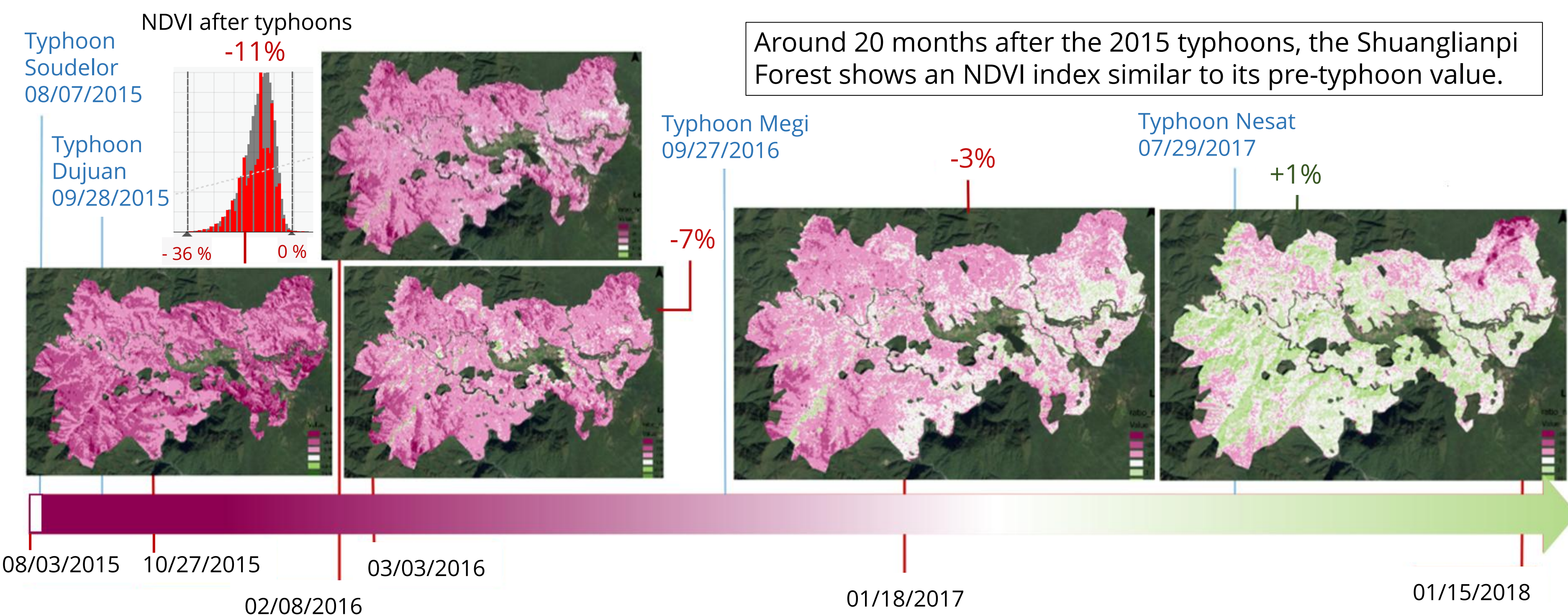


Fig. 3. Does this difference in reflectance indicate where the needles are and where the leaves are?

Fig. 5. Definition of plots of *Cryptomeria japonica* and plots of broadleaf trees

4. NDVI \ 11% on average, after the 2015 typhoons



NDVI values compared to those recorded before the 2015 typhoons:

- 20% or worse
- 10% to -20%
- 2% to -10%
- +2% to -2%
- +2% to +10%
- +10% to +20%
- +20% or better

Fig. 6. Changes in the NDVI ratio over time.

5. Resistance of Japanese cedars vs. broadleaf trees

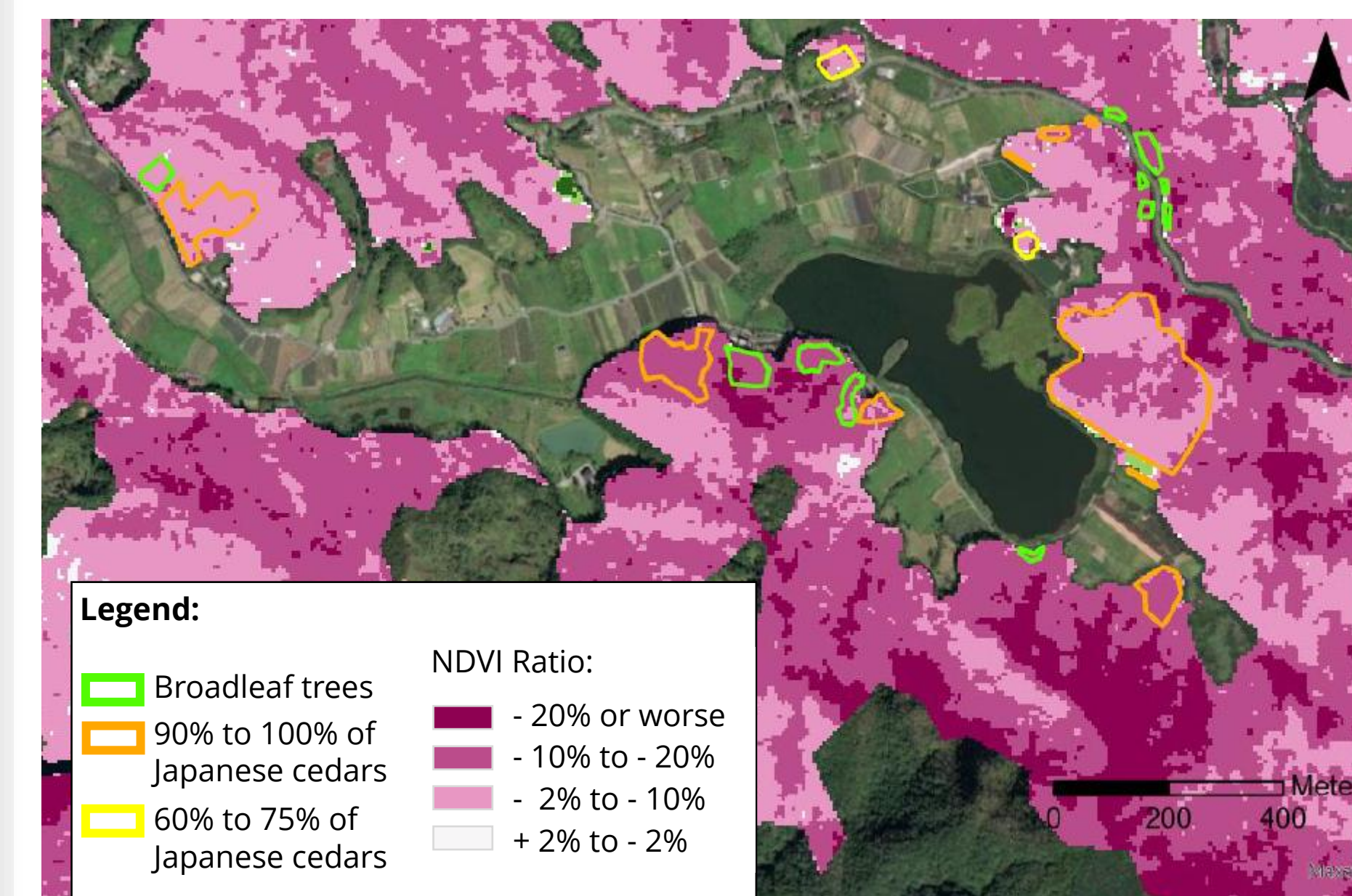


Fig. 7. A comparison of NDVI values on October 27, 2015, with those of August 3, 2015.

In October, following the passage of Typhoons Soudelor on August 7, 2015, and Dujuan on September 27, 2015, broadleaf trees and Japanese cedars showed a decline in NDVI.

% decrease in NDVI on 10/27/2015 compared to its pre-typhoon value	Japanese cedars	Broadleaf trees
-2% to -10%	1/6 of the plots	1/8 of the plots
-2% to -20%	1/2 of the plots	1/8 of the plots
-10% to -20%	1/3 of the plots	1/2 of the plots
-10% to -30%		1/4 of the plots

Of the 8 hardwood plots, 4 show an NDVI that has decreased by 10% to 20% compared to pre-typhoon levels. 2 of the 6 Japanese cedars plots where the index is visible, show an NDVI that has dropped by 10% to 20% compared to pre-typhoon levels. Overall, the NDVI of the hardwood plots is lower than the NDVI of the Japanese cedars plots.

6. Resilience of Japanese cedars vs. broadleaf trees

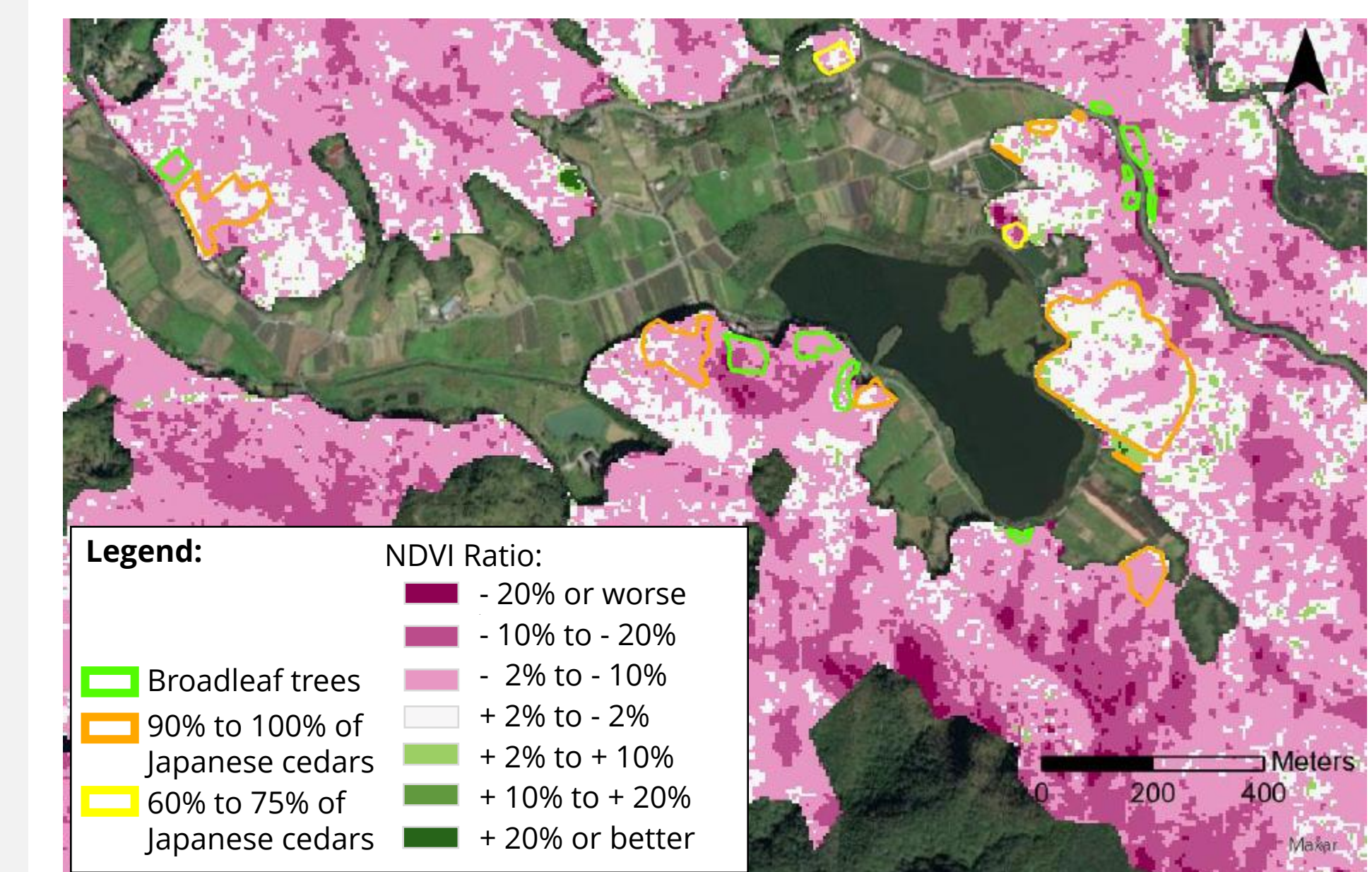


Fig. 8. A comparison of NDVI values on February 8, 2016, with those of August 3, 2015.

In February 2016, more than 4 months after the passage of Typhoons Soudelor and Dujuan, Japanese cedars plots show a higher NDVI than broadleaf trees plots.

% decrease in NDVI on 02/08/2016 compared to its pre-typhoon value	Japanese cedars	Broadleaf trees
+2% to -10%	5/6 of the plots	1/8 of the plots
-2% to -10%		1/2 of the plots
-2% to -20%		3/8 of the plots
+10% to -20%	1/6 of the plots	

% decrease in NDVI on 01/18/2017 compared to its pre-typhoon value	Japanese cedars	Broadleaf trees
+2% to -10%	1/6 of the plots	5/8 of the plots
-2% to +10%	1/3 of the plots	3/8 of the plots
-10% to +10%	1/2 of the plots	

Conclusion

Preliminary results show that :

- NDVI index value \ 11% after Typhoons Soudelor (August 7, 2015) and Dujuan (September 28, 2015).
- Photosynthetic activity returned similar to pre-2015 typhoons level after approximately 20 months.
- Japanese cedar plantation is more resistant and more resilient than the native broadleaf trees on the plots analyzed around the Shuang-Lian-Pi Lake.

References

- Bailo D., Paciello R., Michalek J., et al. 2023. The EPOS multi-disciplinary Data Portal for integrated access to solid Earth science datasets. *Sci Data* 10, 784.
- Kang R-L, Lin T-C, Jan J-F, Hwang J-L, 2005. Changes in the Normalized Difference Vegetation Index (NDVI) at the Fushan Experimental Forest in Relation to Typhoon Bilis of 2000, *Taiwan Journal of Forest Science* - March 2005, 73-87.
- Lee M.-F., Lin T.-C., et al. 2008. Remote sensing assessment of forest damage in relation to the 1996 strong typhoon Herb at Lienhuachi Experimental Forest, Taiwan, *Forest Ecology and Management*, 255, 3297-3306.
- Ren Q., Zhang R., Cai W., Sun X., Cao L. 2020. IOP Conf. Ser.: Earth Environ. Sci. 440, 052041
- Rouse, J.W., Haas, R.H., Schell, J.A. et Deering, D.W., 1974. Monitoring Vegetation Systems in the Great Plains with ERTS, Third ERTS Symposium, NASA SP-351, 309-317.
- Truong-Vinh L. et al. 2024. Revealing the intricate relationship: Droughts and typhoons in Taiwan using the Standardized Precipitation Index (SPI), *Journal of Hydrology: Regional Studies*, 55, 101917.

