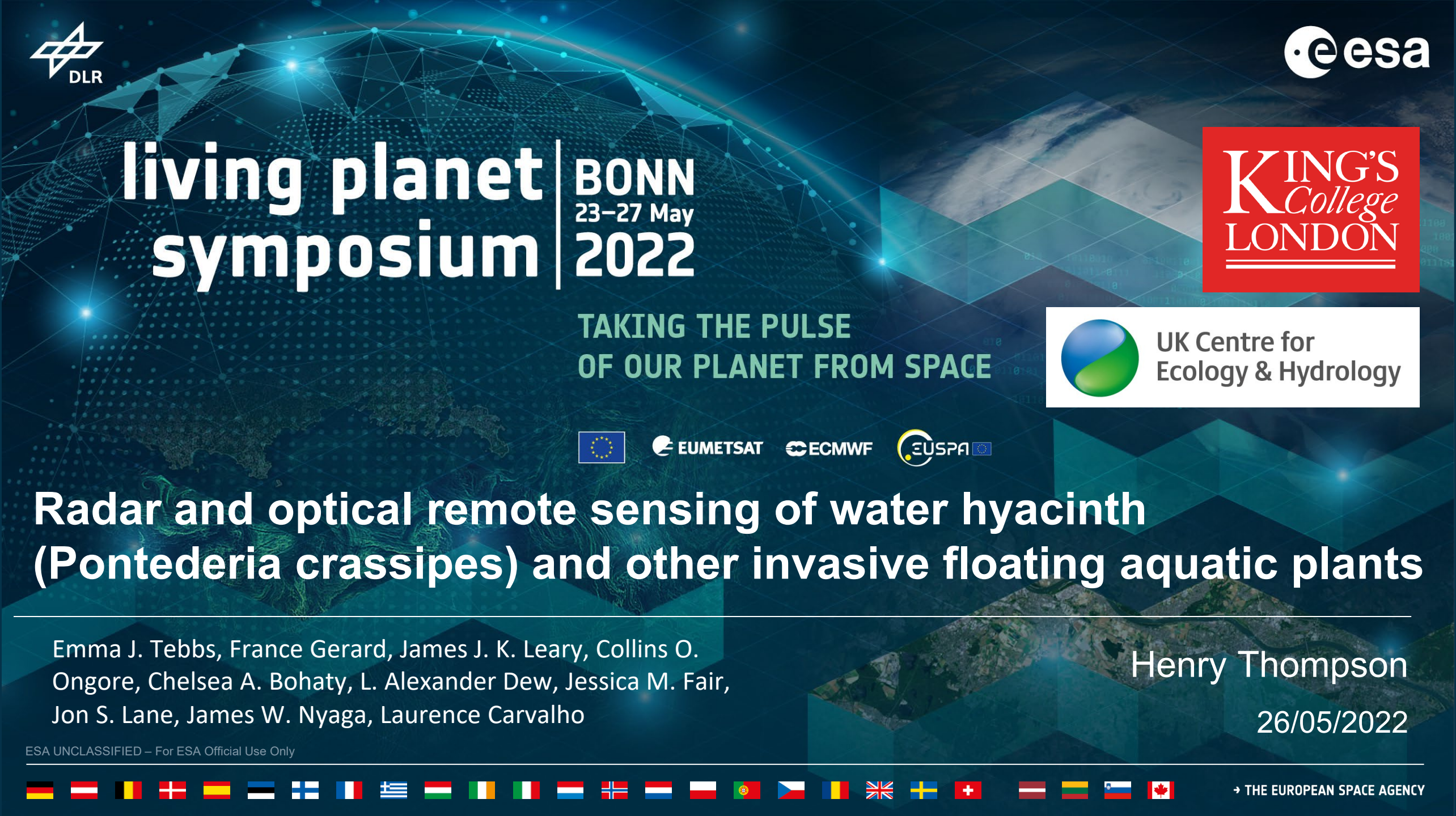


Radar and optical remote sensing of water hyacinth (Pontederia crassipes) and other invasive floating aquatic plants

Emma J. Tebbs, France Gerard, James J. K. Leary, Collins O. Ongore, Chelsea A. Bohaty, L. Alexander Dew, Jessica M. Fair, Jon S. Lane, James W. Nyaga, Laurence Carvalho

Henry Thompson

26/05/2022

Water hyacinth and invasive floating plants

- Originally from S. America, water hyacinth has invaded many tropical aquatic ecosystems globally.
- Rapid growth clogs waterways, lead to deoxygenation and provide habitats for disease vectors (e.g., mosquitos).
- Aquatic invasive alien species have cost the global economy US$ 345 billion, with US$ 21 billion of this due to invasive aquatic plants (Cuthbert et al., 2021).

Cuthbert, R. N. *et al.* (2021) 'Global economic costs of aquatic invasive alien species', *Science of The Total Environment.* doi: 10.1016/j.scitotenv.2021.145238.

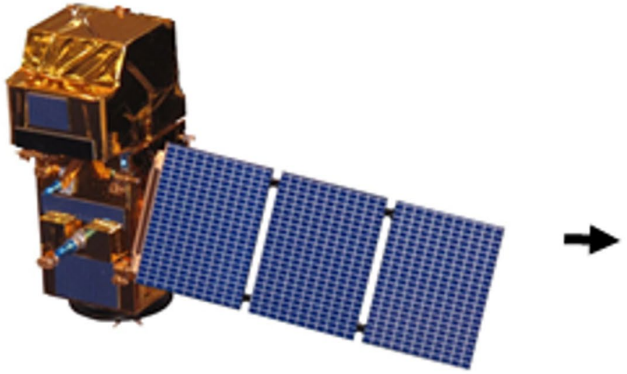
Monitoring and management

- Combination of mechanical, chemical and biological control measures
- Continuous monitoring is vital for tracking floating plants and applying control measures at an early stage to limit invasions.
- Monitoring via boat and aerial surveys are time consuming and expensive

Aims

- A generalised method for floating plant detection (including water hyacinth)
- Using both Sentinel-1 radar and Sentinel-2 optical to provide high frequency maps and complementarity

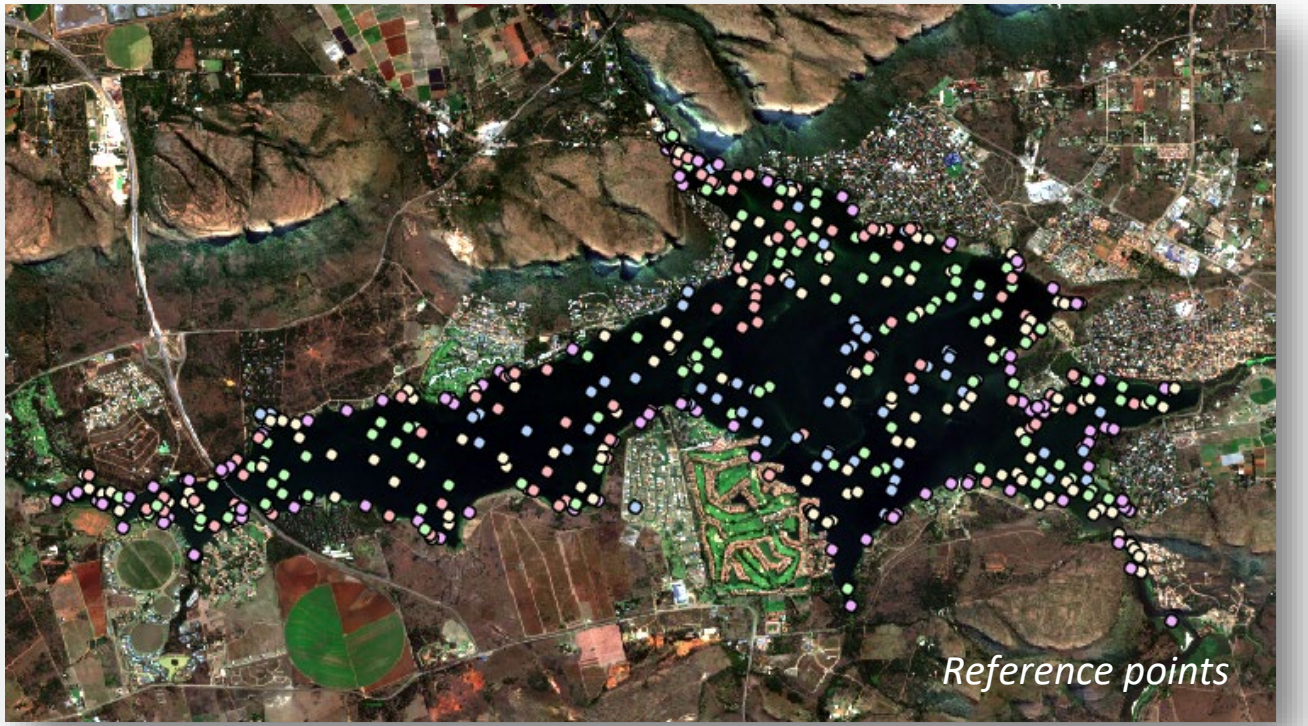
Sentinel- 1 SAR (radar)



Sentinel- 2 MSI (optical)

Study Sites

Eight diverse waterbodies were selected where floating plants are known to be invasive.



A: Winam Gulf, *Lake Victoria, Kenya*

B: Vembanad Lake*, India*

C: Hartbeespoort Dam, *South Africa*

D: Rodman Reservoir, *USA*

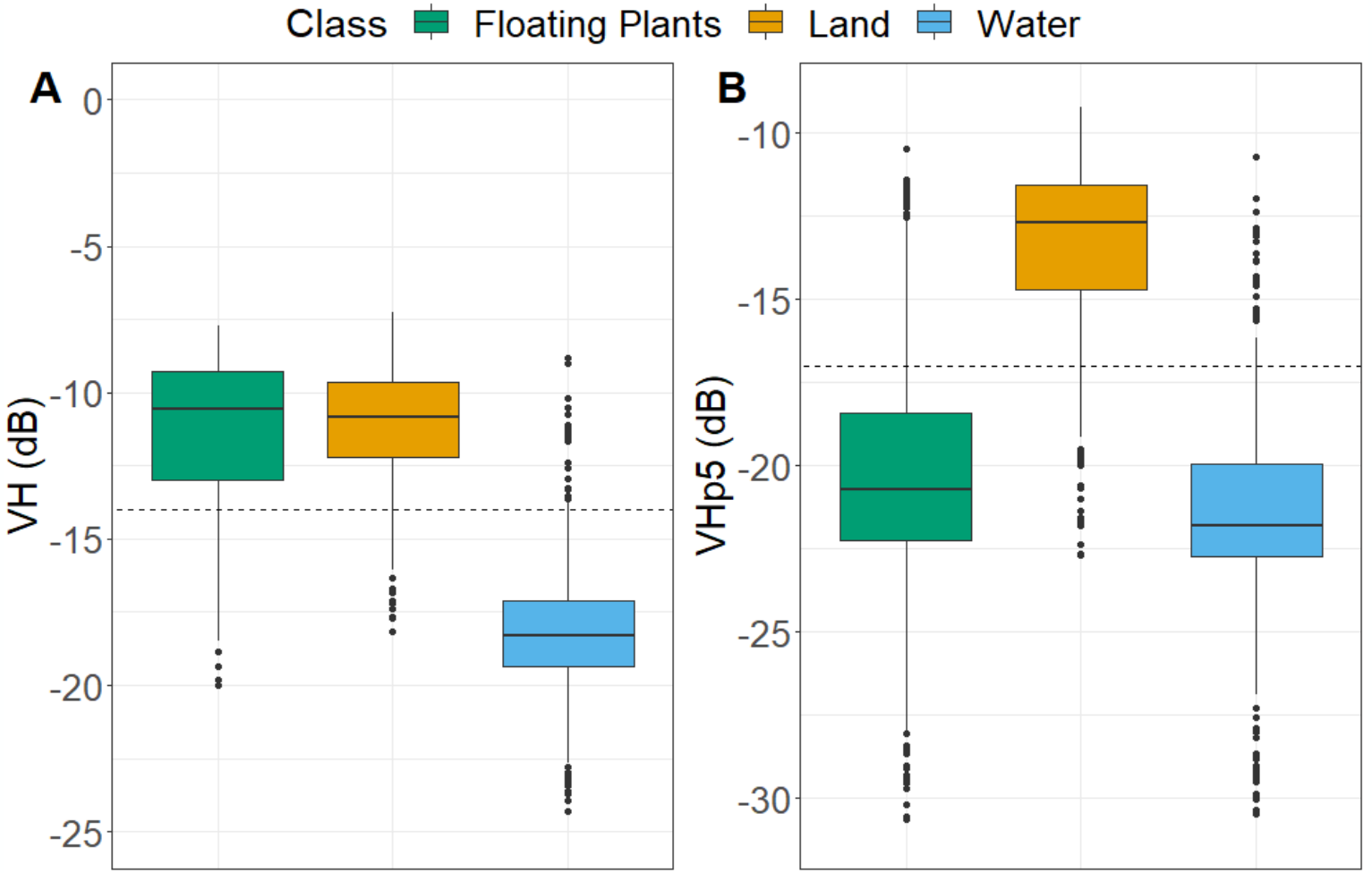
E: Lake Rawapening, *Indonesia*

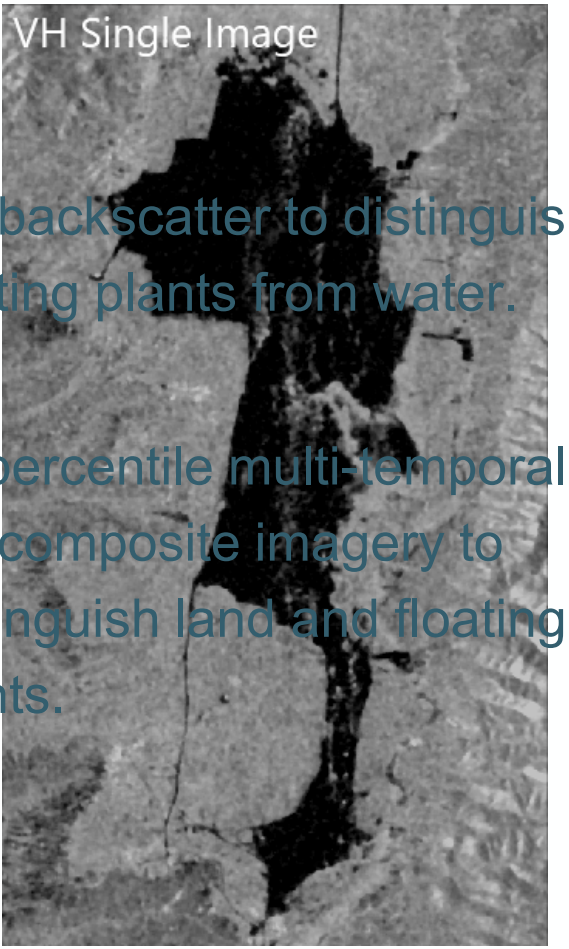
F: Inle Lake, *Myanmar (Burma)*

G: Mula River, *India*

H: Valsequillo *Reservoir, Mexico.*

Sentinel- 1 (SAR)

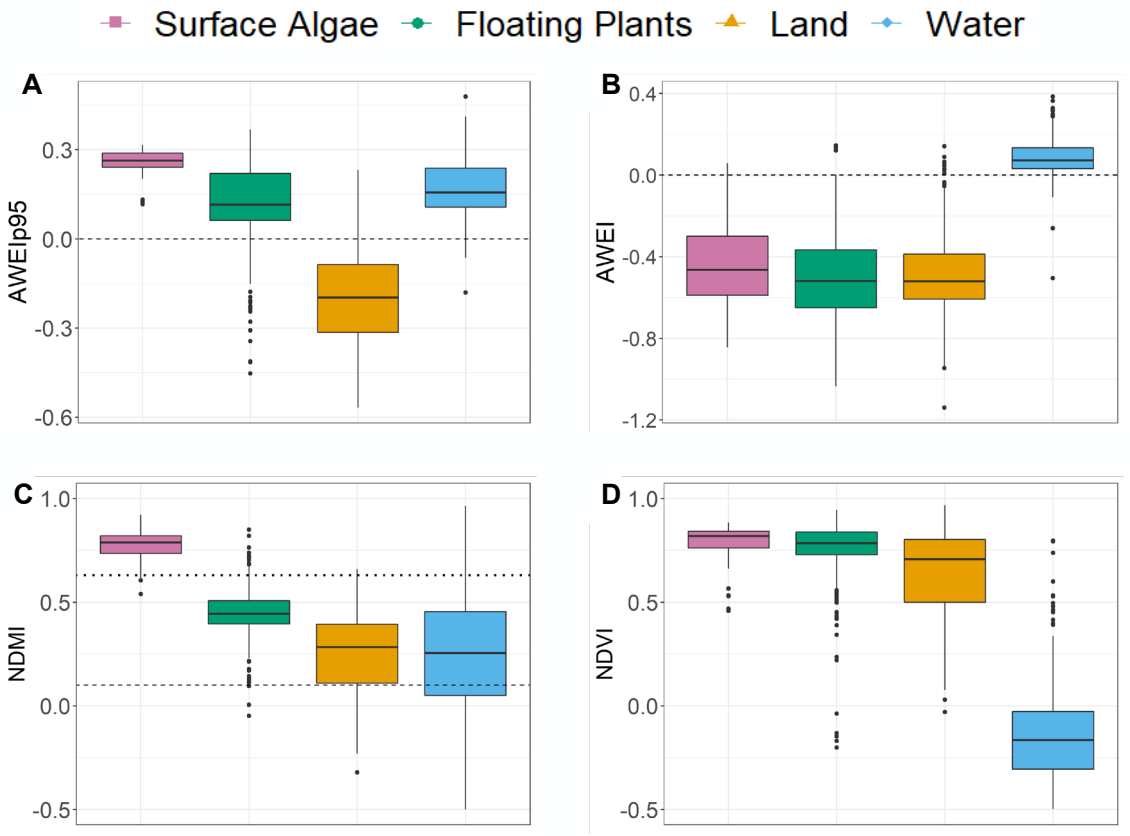




- VH backscatter to distinguish floating plants from water.
- 5th percentile multi-temporal VH composite imagery to distinguish land and floating plants.

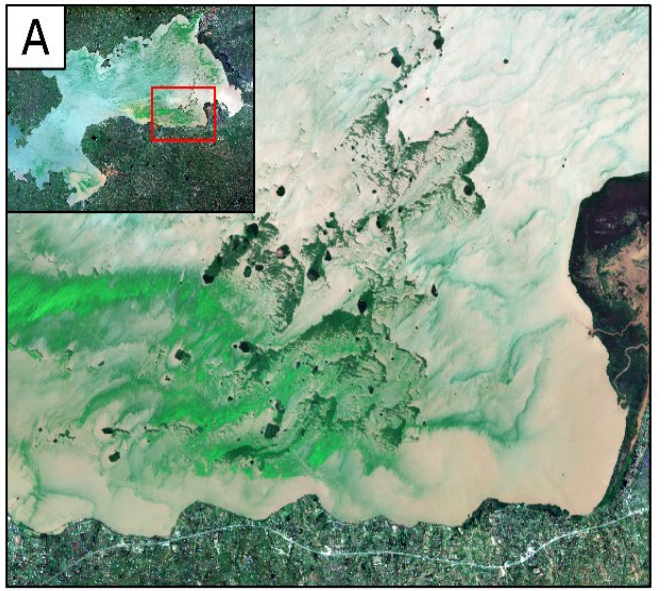
Inle Lake, Myanmar

Sentinel- 2 (MSI)

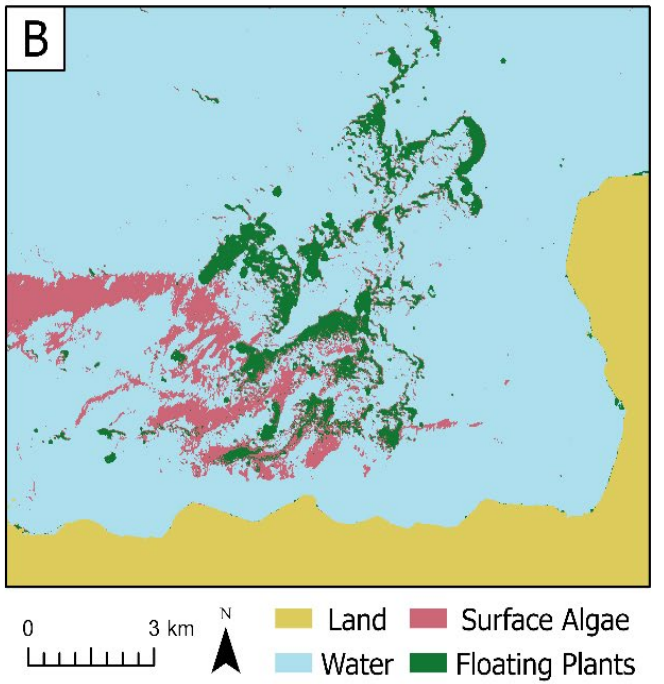


Oyama, Y., Matsushita, B. and Fukushima, T. (2015) 'Remote Sensing of Environment Distinguishing surface cyanobacterial blooms and aquatic macrophytes using Landsat / TM and ETM + shortwave infrared bands', Special Issue: Remote Sensing of Inland Waters. Elsevier Inc., 157, pp. 35–47. doi: 10.1016/j.rse.2014.04.031.

Sequential combination of the Automated Water Extraction Index (AWEI) and Normalised Difference Moisture Index (NDMI) (Oyama et al., 2015).

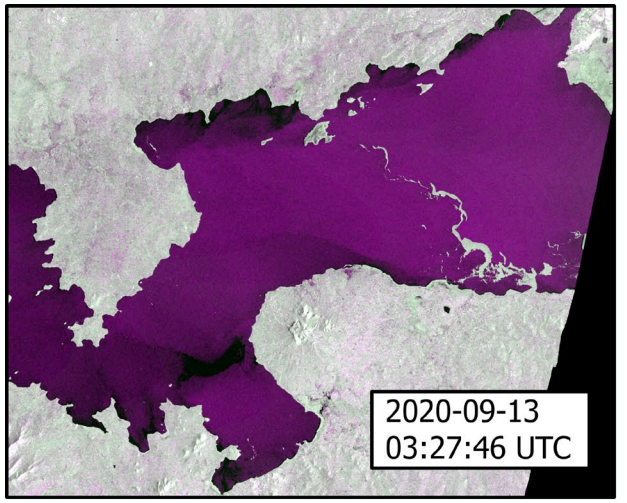


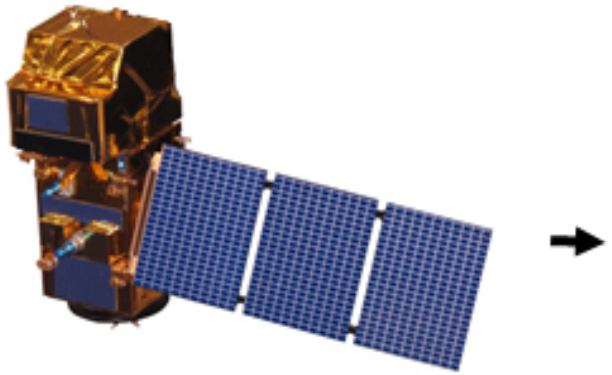
Winam Gulf, Lake Victoria



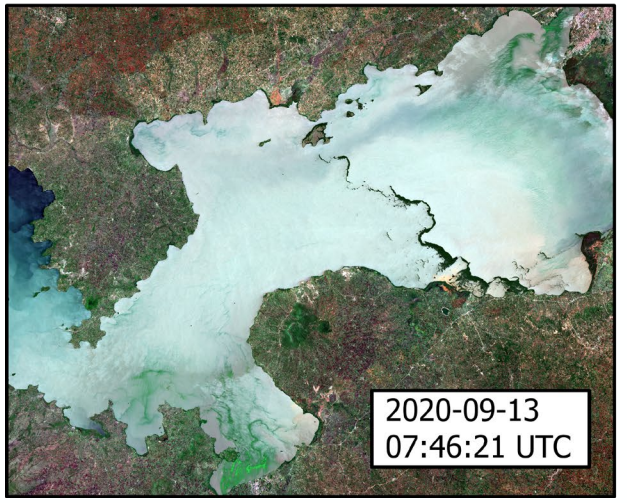
Comparison

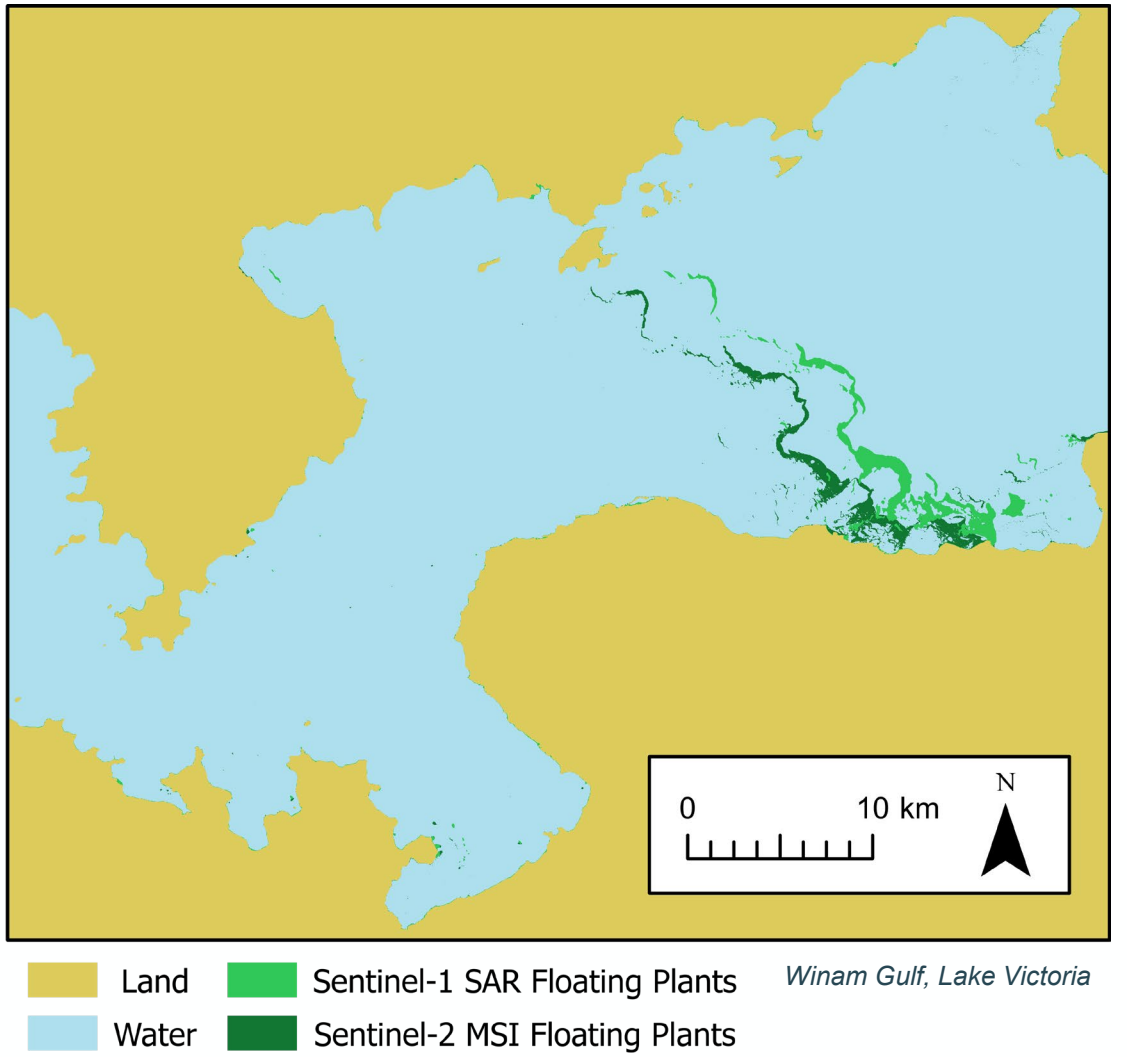
Sentinel- 1 SAR (radar)





Sentinel- 2 MSI (optical)

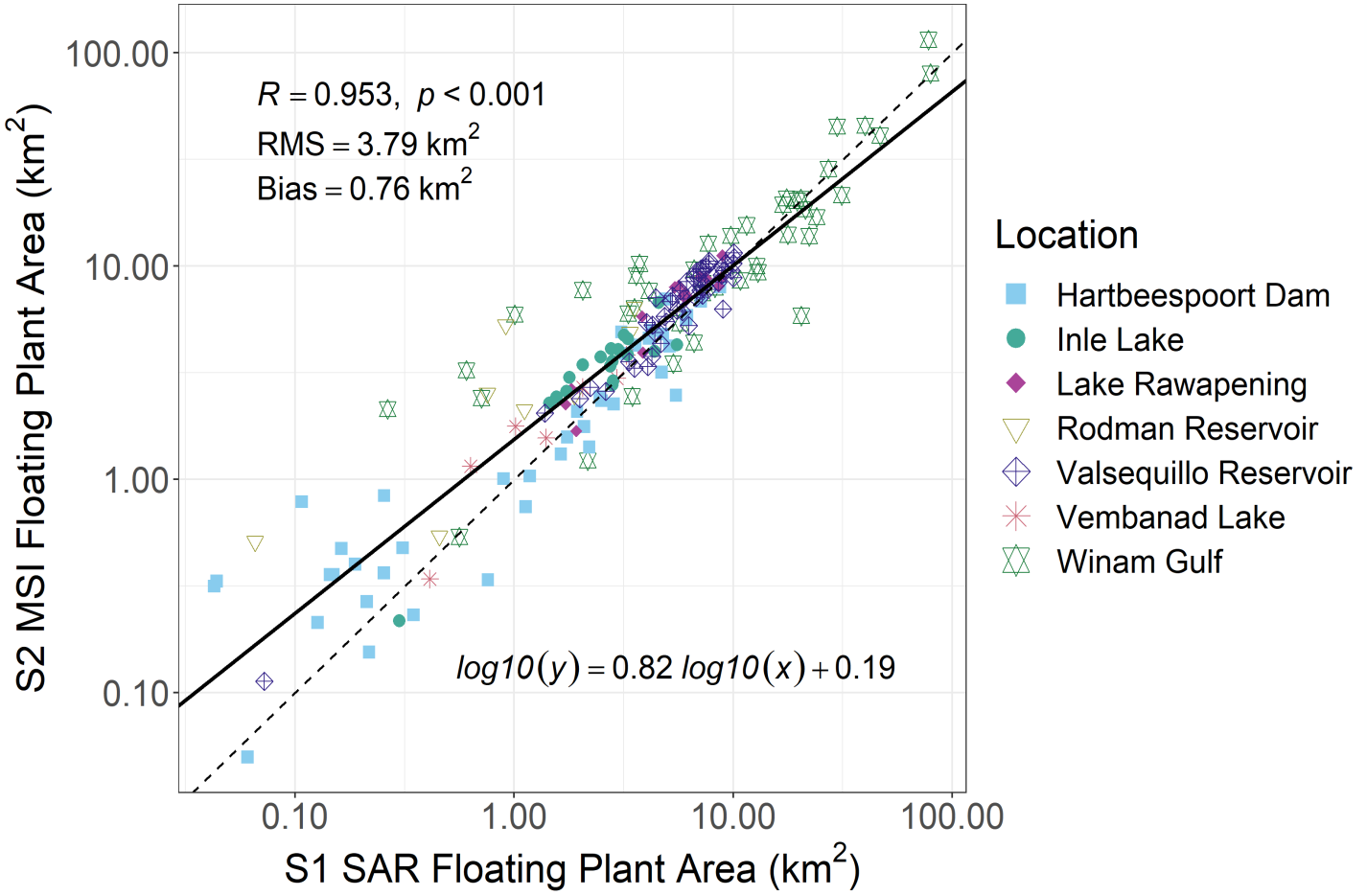




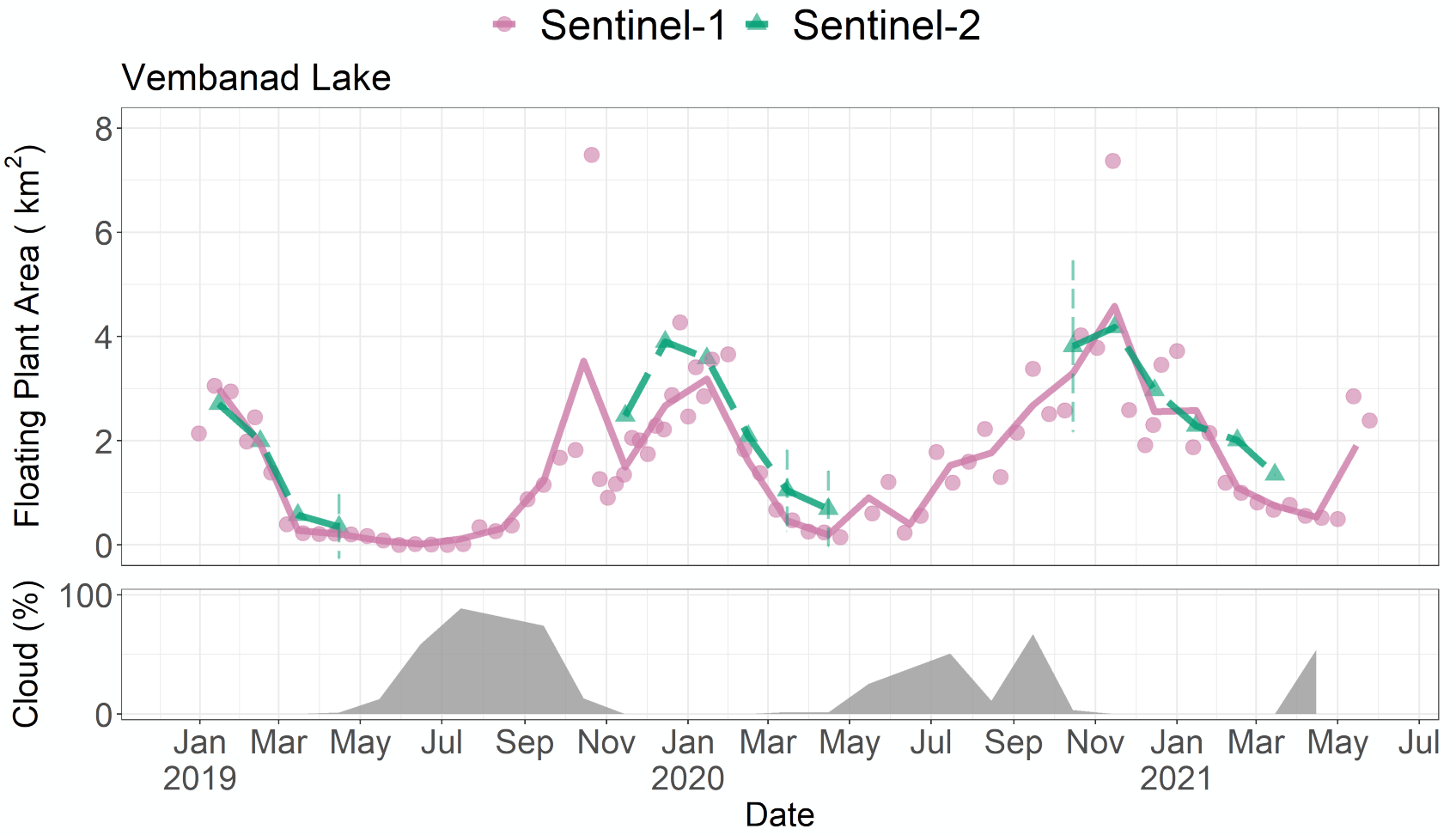
Winam Gulf, Lake Victoria

Accuracy

- Overall accuracies of radar and optical based methods were 94.7% and 92.4% respectively.
- Radar was unaffected by cloud but with lower revisit frequency
- Combining radar and optical imagery provides complementarity.



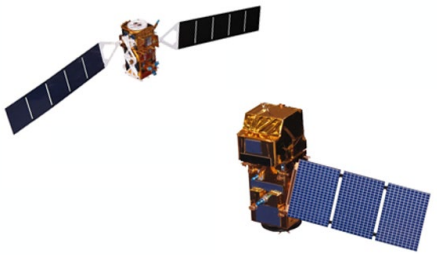
Timeseries



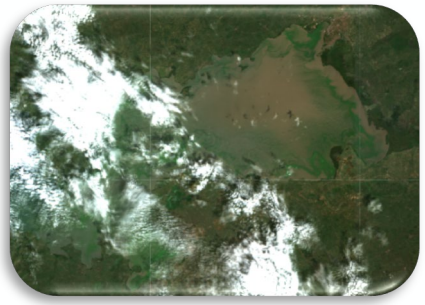
Sentinel-1 SAR (radar)

Sentinel-2 MSI (optical)

Advantages and Limitations



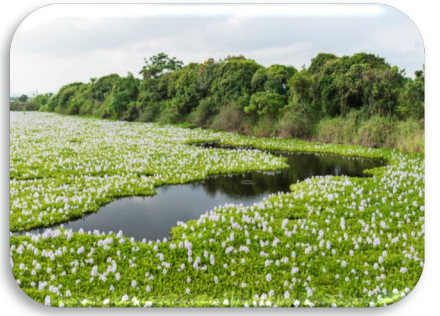
Independently derived outputs



Compensation for weather factors (i.e., wind, cloud, algal blooms)

Increased temporal frequency (3.6 days or better across all sites)

Challenges close to the shoreline. Stationary or intermixed with emergent vegetation



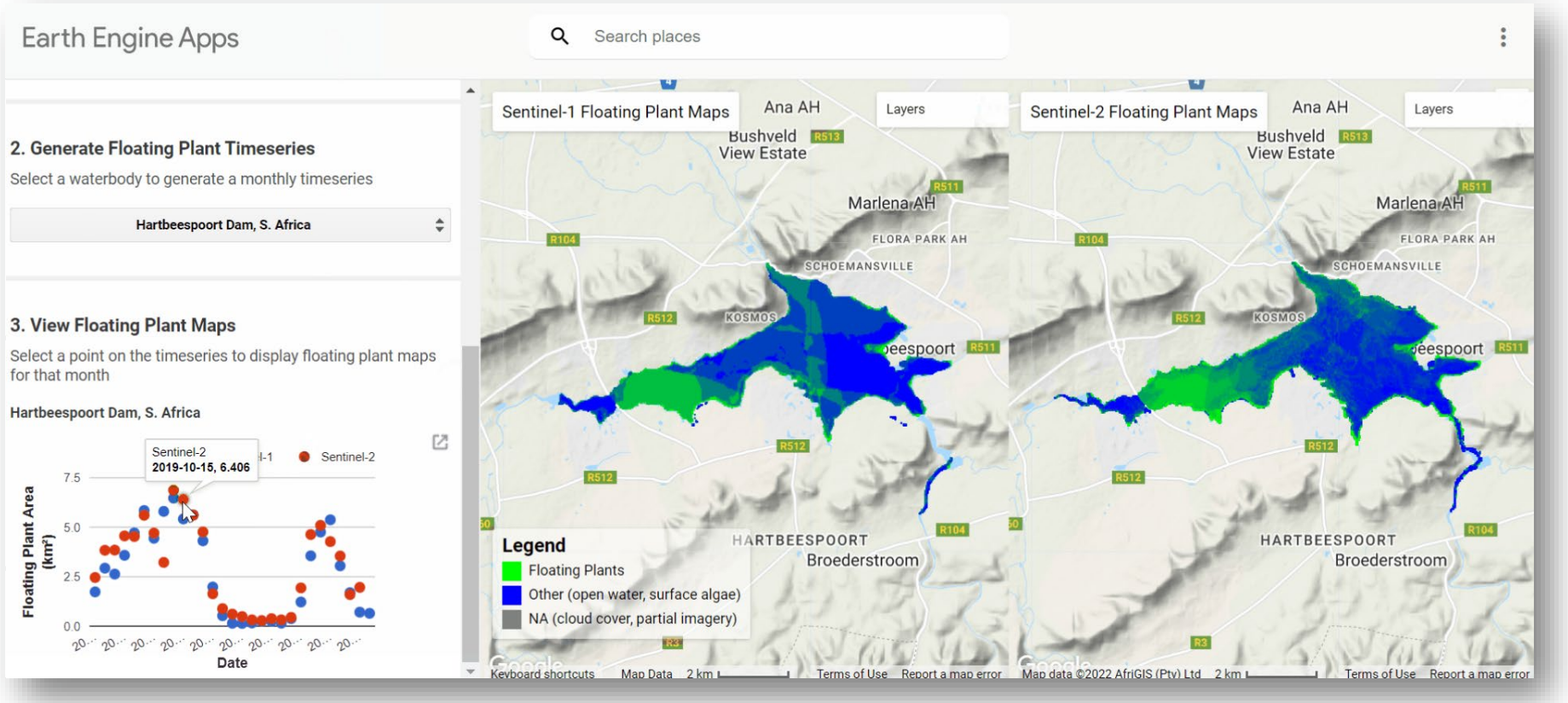
Spatial resolution limiting for narrow channels (< 20m)

Mula River, India

No information on plant species or phenology

Publications

Tebbs et al. (in review) “Complementary Radar- and Optical-based Remote Sensing Increases Temporal Resolution of Highly Dynamic Floating Aquatic Plant Invasions“, Remote Sensing of Environment



https://henrythompson.users.earthengine.app/view/floating-plant-detection

Thank you for listening

Tebbs et al. (in review) “Complementary Radar- and Optical-based Remote Sensing Increases Temporal Resolution of Highly Dynamic Floating Aquatic Plant Invasions“, Remote Sensing of Environment

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