Consolidation of datasets of Essential Climate Variables: case of the Lake Water Extent exploiting HR imagery and Altimetry times series within the ESA CCI Lakes Framework

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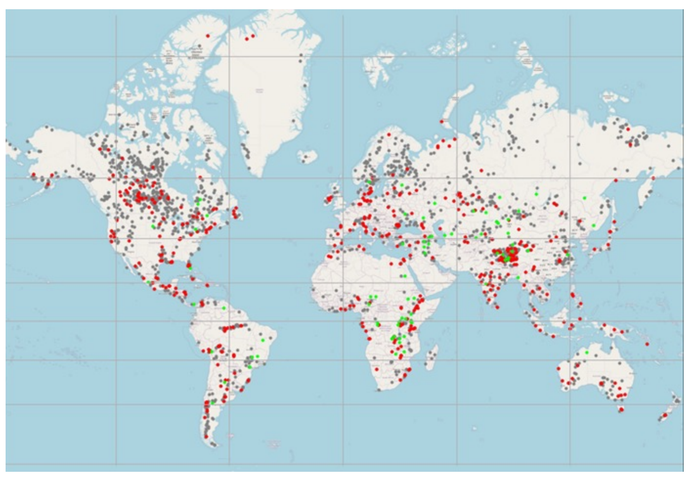
Context: Water bodies- Climate Sentinels

- Essential climate variables (ECVs), lake surface temperature (LSWT), water level and extent (LWL & LWE), ice cover and thickness (LIC and LIT), and lake water leaving reflectance (color)(LWLR) for a better understand the lake physical response to climate change
- LWE definition: outline of a water body or as the total areal extent of a waterbody
- Very challenging to process the HR satellite imagery required to generate maps of water presence for hundreds of lakes at the accuracy (5%) and temporal frequency (1-10 days)



LWE in CCI DB: : 84 lakes
No altimetric data: 447
Further analysis : 1493

Fig.1: Actual status of LWE within the Lake products, Version 2.0.2

Method: Twofold strategy

- Collect a set of satellite imagery spread out over a long period
- Selection of the images based on altimetry water level time series at low, medium and high levels (Fig.2).
- Combinate LWL and LWE by least square adjustment, LWE=f(LWL) to relate LWL from altimetry to LWE using the hypsometry process (Fig.5).
- Then a high temporal resolution based only on altimetric mission without overwhelming image processing requirements.

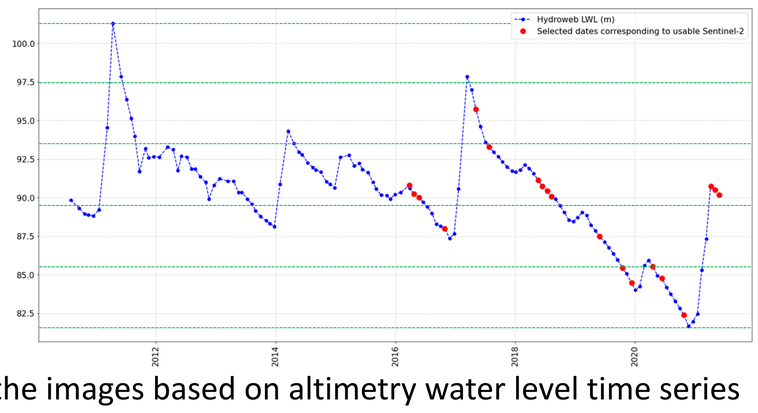


Fig.2. Selection of the images based on altimetry water level time series

LWE generation

- Based on HR optical imagery: Sentinel2 for the recent years, Landsat collection for the older ones.
- Water surfaces and cloudd detection using a multilayer perceptron algorithm and integrating the GSW database for sampling within ExtracEO in house tool box (Fig. 3-4)
- Outliers' detection, and reprocessing of identified problematic dates with automatically readjusted thresholds
- Validation done exploiting exiting high resolution database with the known limitations of their representativity, as well based on VHR optical imagery (Fig.6)

LWE generation: Case of Argyle Lake, Australia

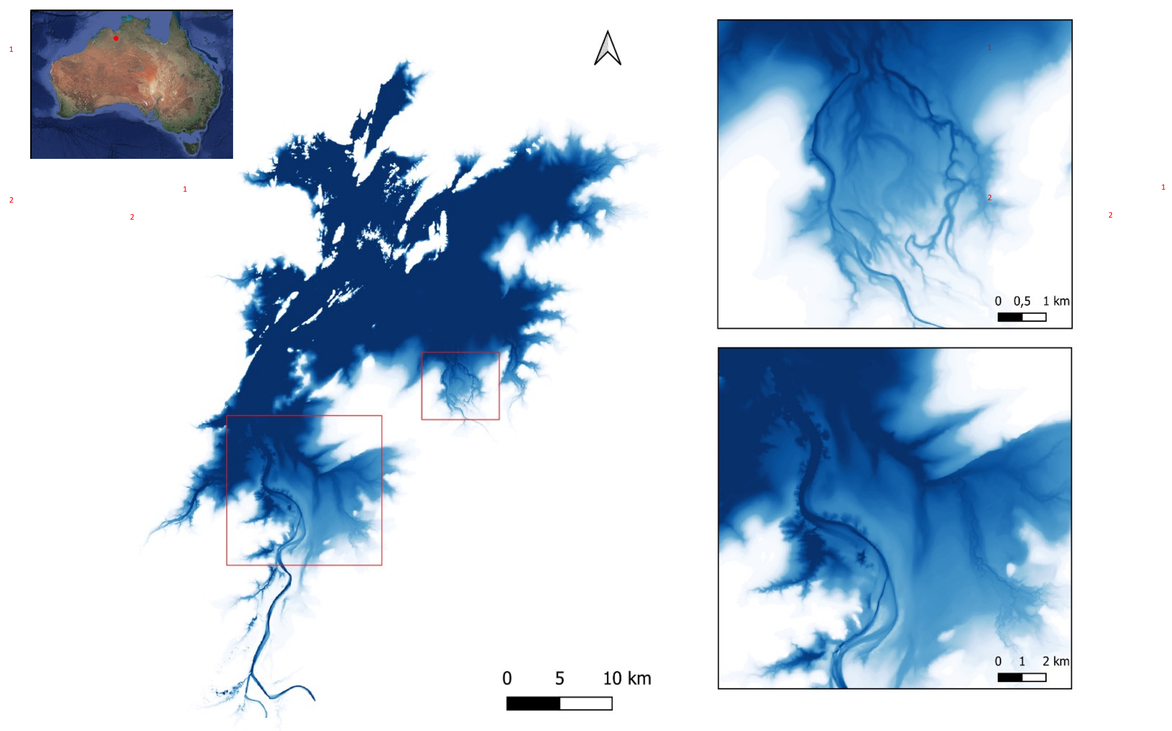


Fig. 3. Water occurrence derived from LWE 229 LWE computed from S2 data with less than 5 % of cloud over the lake (over an amount of 390 processed images acquired from October 2015 to August 2022)

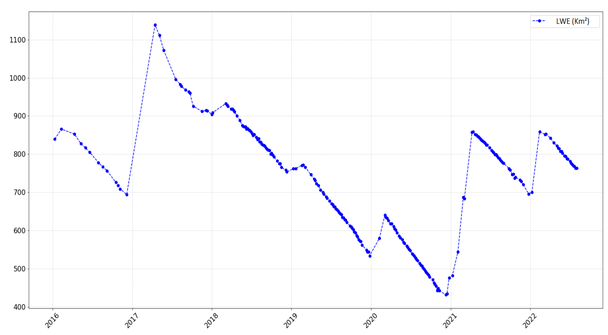


Fig.4. LWE temporal behaviors derived from 229 S2 L2A data ExtractEO structure based on multilayers perceptron algo with selection of training samples based on GSW

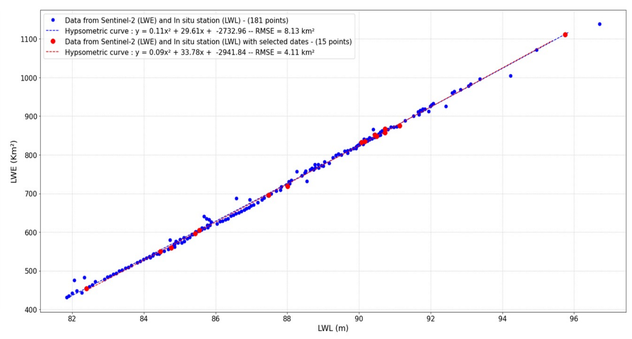


Fig. 5. Hypsometric curves based on 181 pair S2 LWE and altimetric LWL (all Hydroweb measuremetns), and from a selected set of 15 dates

LWE validation: Case of Fitri Lake (Chad)

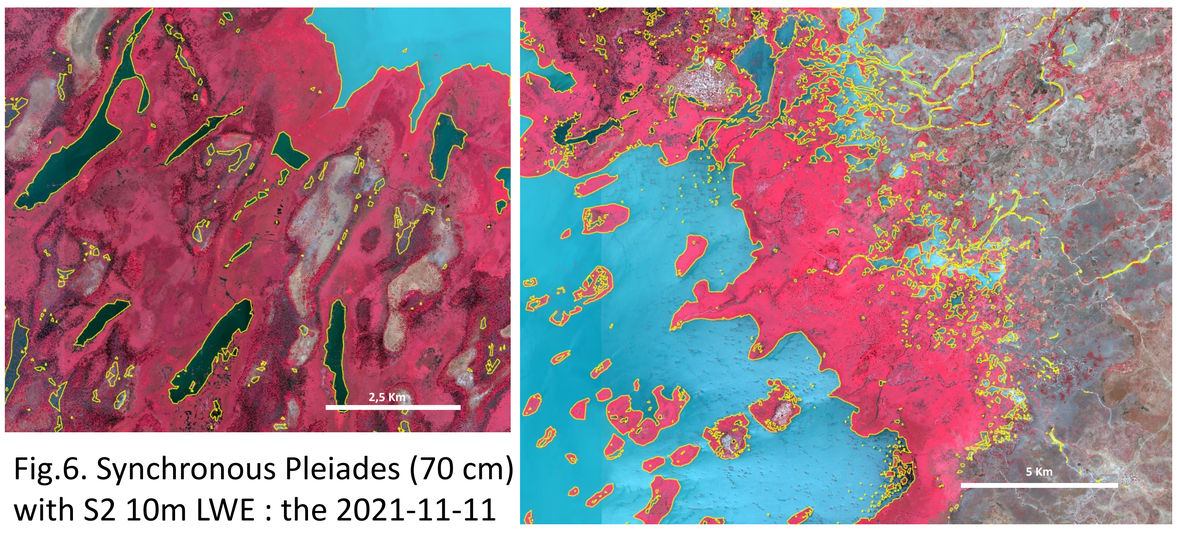


Fig.6. Synchronous Pleiades (70 cm) with S2 10m LWE : the 2021-11-11

Conclusion-perspectives

- Operational and accurate tools:
  - ExtractEO, for LWE extraction and monitoring both for large water bodies and small ones
  - A tool for selecting dates in order to reduce the amount of processed images without degradation of results' accuracy's
  - Next steps:
  - Approach's validation on a set of selected lakes in various environment (North America; South America & Africa)
  - Launch the production tile by tile

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