Where is the water coming from? At the reservoirs of Vaira and Tonzi Fluxnet core sites (California)

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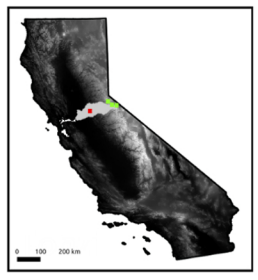
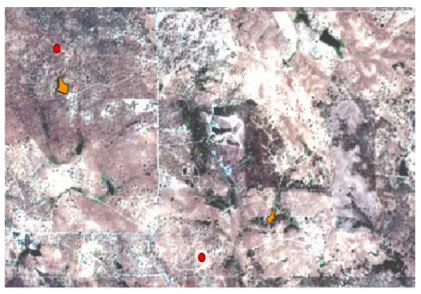
Most of California's water resources come from rain and snow, that fall in the northern and eastern parts of the state. Increases in air temperature and change in precipitation patterns are altering the dynamics of the water cycle components in the Californian watersheds. The snow coverage is reducing its extent, and consequently its capacity to store water; surface and ground water levels, and the snow/precipitation ratio, are also experiencing drastic changes (Indicators of Climate Change in California, 2018). An example is the earlier onset of the snowmelt, with a variation in the seasonal pattern of the reservoirs recharging and draining. All these shifts will have direct effects on the small water reservoirs (>> 10 m2) used as sources on rangeland management.

Are we able to track these effects at the local scale with earth observation? How are these changes affecting daily water management? Tonzi and Vaira long-term Fluxnet sites, located on the lower foothills of the Sierra Nevada Mountains, are exceptional to analyze at short/long term basis how the water cycle variation affects local scales. Both locations, separated 2.3 km from each other, are inside the Upper Cosumnes and Mokelumne watersheds, receiving water through Cosumnes river, from the melt water streams, deep rocky aquifers and precipitation. **The objective of this study (on a preliminary stage) is to track using earth observation the effects of the recent climatic extreme events on the small reservoirs of Tonzi and Vaira (~100 m length), linking (if existing) the shifts in ground/surface water levels with the evolution of the snow in the upstream area of this catchments.**





0 0.5 1 1.5 2 km

Red dot- Tonzi (up) and Vaira (down) ranchs
Orange shape - water reservoirs selected.
Green dots - Snow Stations

METHOD

HIGH RESOLUTION [m] IMAGES MAP SMALL RESERVOIRS NDWI + LOW RESOLUTION [km] IMAGES SNOW COVER EVOLUTION

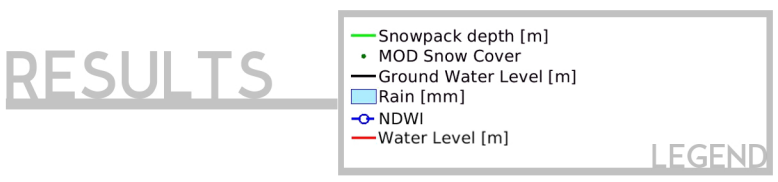
LOCAL MANAGEMENT?

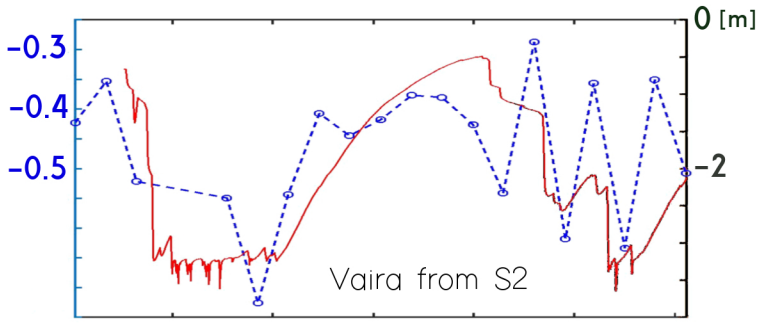
To discriminate water: Normalized Difference Water Index (NDWI - 1996, McFeeters) was used (NIR and GREEN bands, also MIR), derived from Landsat 5TM/8OLI for Tonzi pond (228 images provided by USGS/EROS, from 2009-2018, 30m px) and Sentinel 2 (64 images from 2016-2018, 10m px) for both ponds, atmospherically corrected using sen2cor. Clouds were masked. Extension of the reservoirs was determine with the shapes from the USGS National Hydrography Dataset.

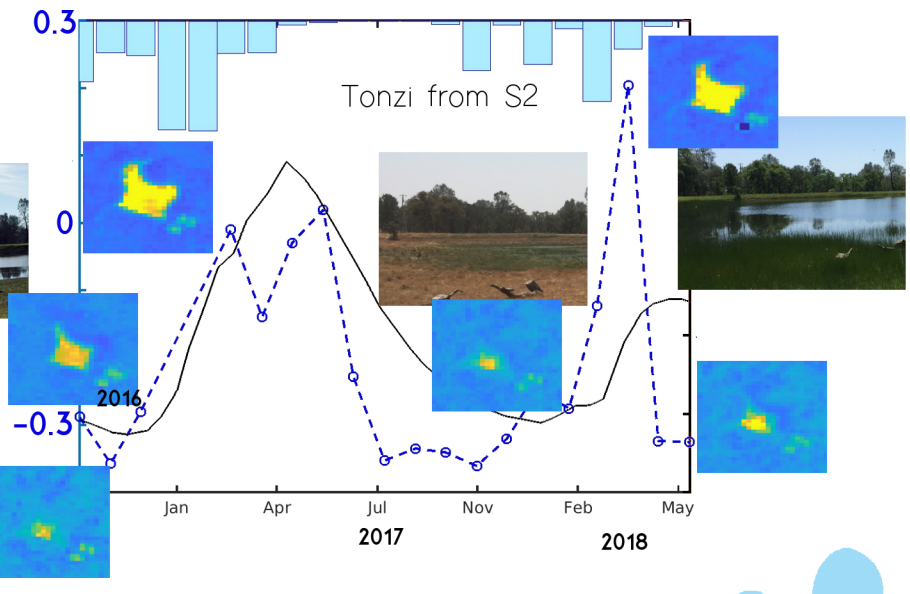
For the snow coverage: MOD10A2 product (composites 8 days snow/no-snow) was used (436 images from 2009-2018), and masked using the river basins extension.

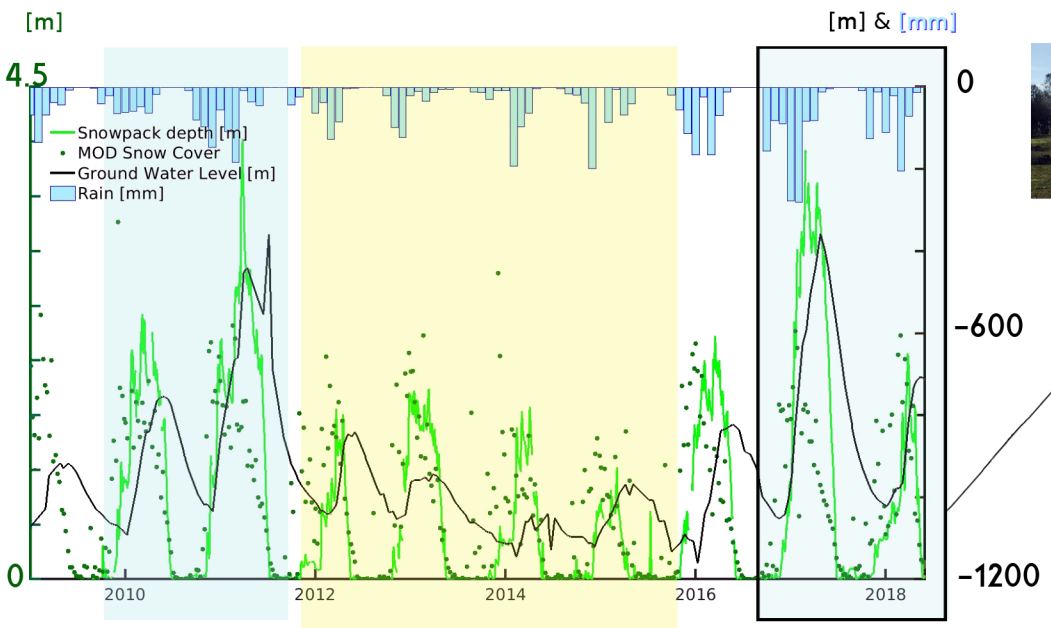
Meteorological/ground data: was obtained from Tonzi/Vaira ameriflux/fluxnet towers (red dot on the study area map), and the snowpack depth from 3 stations (green points on the map of the study area) from the Californian Department of Water Resources.

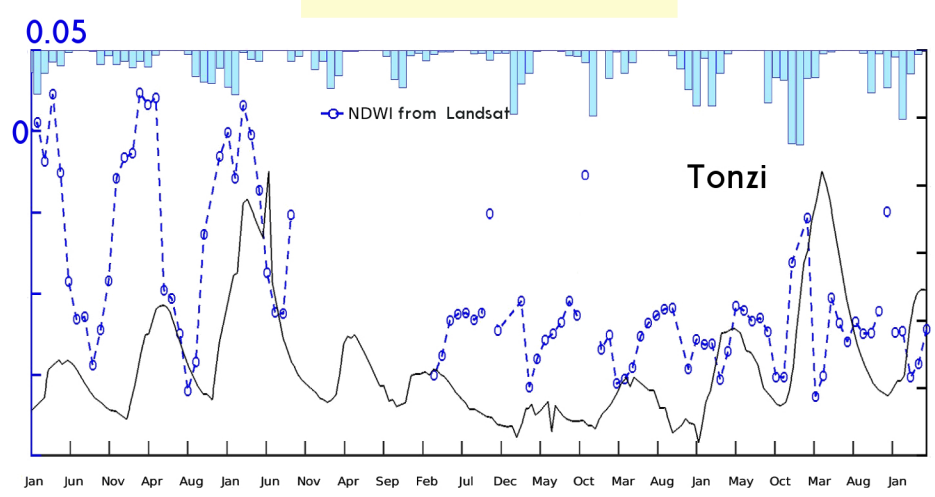
RESULTS











DISCUSSION & NEXT

1. Ground water level follow the snowpack depth ground data, with a delayed phase due to the melting process - figure based on Ma et al., (2016).
2. Snow cover index derived from MODIS product follows the snowpack depth trend. -- The relation between them (or other ground snow parameter) needs to be study deeply.
3. Masked/lost data at this local scale highly affect the final index. 32/64 S2 images and 92/228 Landsat images were finally used due to non-quality data. This encourages the use of other type of radiometric information. -- e.g. Sentinel 1 ?
4. NDWI threshold value was set to -0.29 for all images. -- NDWI derived from MIR should be analyzed.
   With S2 it is possible to study the evolution of the local ponds (seasonal).Vaira reservoir is disconnected from the ground water, and it behavior differs from Tonzi. Tonzi NDWI follows the underground water level, while Vaira NDWI seems to follow the water level field data. Tonzi pond is better represented, the signal being clearer and with less noise (NDWI values higher). With the NDWI derived from Landsat we are able to track the dry/humid periods over Tonzi pond. NDWI seems to follow the ground water level, although with a (different) phase regarding the Landsat sensor (5TM or 8OLI) -- Radiometric information of the ground (soil, water, humid soil) was collected to better classify. -- Volumn of Tonzi pond will be estimated with LIDAR data (non published from Beland et al., 2011).

Ma S., Baldocchi D., and Wolf S. (2016) doi: https://doi.org/10.1016/j.agrformet.2016.07.016
Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (2018) Indicators of Climate Change in California. https://oehha.ca.gov/climate-change/report/2018-report-indicators-climate-change-california#download
McFeeters S.K. 1996. doi: https://doi.org/10.1080/01431169608948714
Béland M., Baldocchi D., Widlowski J-L., Fournier R.A., and Verstraete M.M. (2014) https://doi.org/10.1016/j.agrformet.2013.09.005

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