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Tree rings and groundwater levels: filling the gaps

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In the beginning of the 20th Century a USGS hydrogeologist, Oscar E. Meinze, observed that the apparent location of the water table in reference to land surface had a direct effect on plant occurrence and distribution. Meinzer (1927) examined plants as indicators of the presence of groundwater, and concluded that some plants habitually use groundwater as water supply, where others can utilize it under certain circumstances. He designated these plants as phreatophytes, word derived from the Greek, meaning "well plant", and defined as "a plant that is literally as a natural well with pumping equipment, lifting water from the zone of saturation". After this early work, T. W. Robinson (1958) defined phreatophytes as "plants that depend for their water supply upon ground water that lies within reach of their roots". Robinson (1958) considered that the phreatophytes could represent a tremendous waste since they use large amounts of groundwater. Nowadays, nature's fundamental role is recognized as it contributes to a sustainable human well-being with provisioning, cultural, regulating and maintenance services. The European Union Water Framework Directive states that the quantitative and qualitative status of groundwater may affect the ecological quality of surface waters and terrestrial ecosystems associated. Considering the future uncertainty under global changes, the assessment of the trend and current patterns of groundwater level fluctuations is necessary over a range of timescales. For instance, long term groundwater level data are necessary to disentangle the effects of climate factors from other changes.

Currently, groundwater management requires the maintenance of groundwater quantity and quality that sustain groundwater dependent terrestrial ecosystems (GWDTs). However, monitoring biological response functions for the entire ecosystem is difficult and, instead, key species are used as indicator biotic responses to groundwater draw-down. Some trees rely on their deep root system to reach groundwater, decoupling their growth from seasonal fluctuations of precipitation, namely in Semi-Arid and Mediterranean climates. Several studies have showed that tree ring chronologies can be related to trees roots access to groundwater in alluvial aquifers. Hence, Dendrochronology (Douglass, 1909) can have an important contribution providing proxy records of hydrological and climatological variables, especially when the time series are short or with gaps.

In what concerns groundwater and particularly GWDTs issues, tree-ring research can be used in a wide range of applications, such as: to assess the impact of human activities in groundwater resources, to evaluate the degree of dependency of trees on groundwater and their resilience to drought periods, and to assess global warming mitigation measures, e.g., afforestation and reforestation. Furthermore, even the bark (cork) rings of the cork tree (Quercus Suber) can record the annual groundwater level changes during the tree growth period.