Sap flow TDP sensor: a practical application

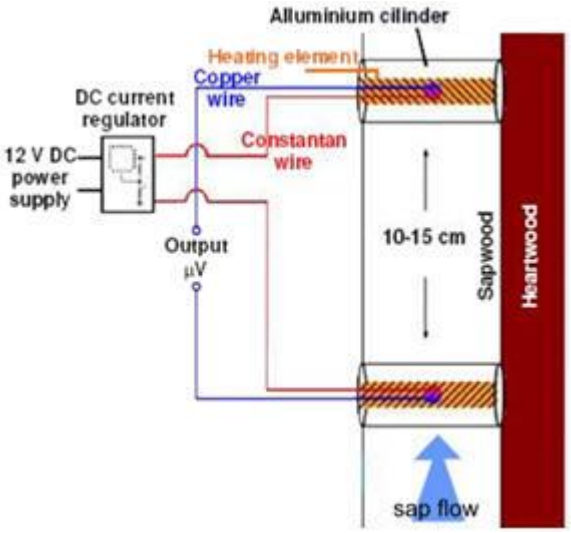
We use one point thermal dissipation method (TDP) mainly to study trees water relations regard the variation of environmental factors. For instance, the evaluation of water stress periods due to drought conditions or the stomata closure response with water pressure deficit. Moreover, especially for Larch, it's possible assessing, quite easily, the beginning and the end (hence the length), of vegetation season. Sap flow measurements could be useful also to quantify the whole plant/forest water use, but the radial variability in sap flow density, the need of sapwood area determination and also the proved underestimation of sap flow density (probably due the empiric calibration), makes the application of TDP method difficult for this purpose.

How sap flow is measured

The thermal dissipation method is based on the Granier's procedure (1985) that consists of two probes (needles) both incorporating a fine wire T-type thermocouple. The upper probe is heated and the sap flow is related to the temperature difference (ΔT) between the thermocouples, that decreases when the water uptake progressively rises. This relation was used to perform an empiric calibration of probes, deducing an esteeming sap flow density ($dm^3dm^{-2}h^{-1}$) equation:

$$Fd = 4.284\left(\frac{\Delta Tmax}{\Delta T} - 1\right)^{1.231}$$

Despite algebraically the sap flow dimension could be reduced to dmh^{-1}, that is a velocity (or to be more precise, a speed, because it is a scalar rather than a vectorial quantity, this simplification is inappropriate. In fact, the sapwood area doesn't represent the real hydraulic surface, which is given by the total lumen area. Hence, the sap flow density can be considered as the contribution of a unit of sapwood area to the sap flow.



How to get the sensors

Granier's TDP system is sold by several distributors, but is also possible to construct it. We provide, in fact, to make the measuring system (probes and electronic circuit of current regulator) in our laboratory), preparing and assembling every single component (needles, thermocouples, heating wires).

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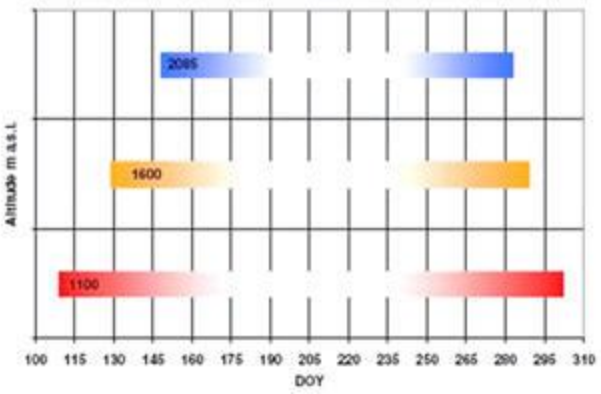
When sap flow occur

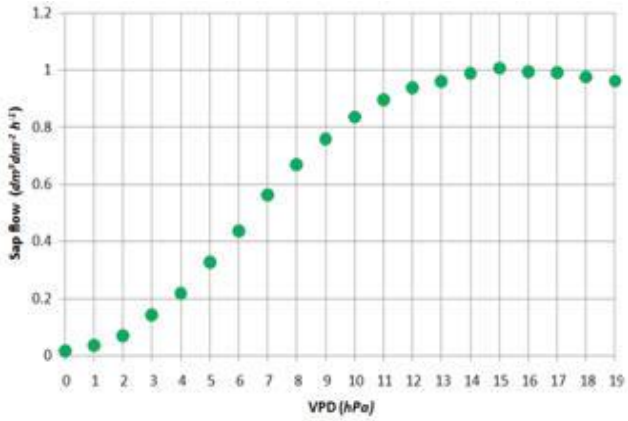
Water uptake depends on stem temperature (water availability) and/or phonological phases. Larch sap flow starts immediately after leaves formation, instead, for spruce, or other evergreen species, it is measurable when mean stem temperature exceeds 0 °C. For the same reason, the time when sap flow occurs, varies with the altitude.



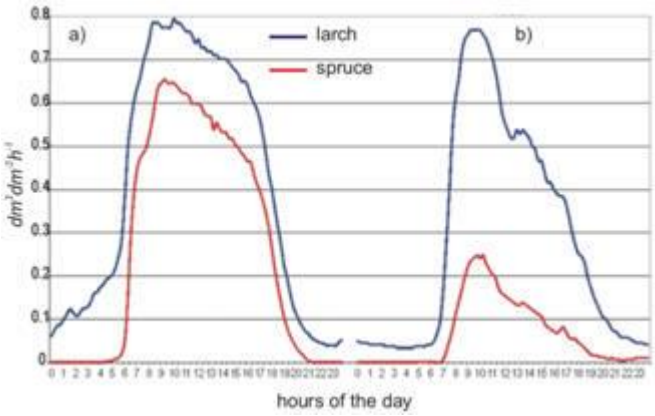
Larch sap flow occurrence at several altitudes in the Dolomites

The main factors influencing sap flow

Sap flow rate is strongly coupled with atmospheric vapor pressure deficit (VPD), until the threshold where stomata control takes place. Moreover, since stomata conductance is also influenced by soil water content, for similar atmospheric conditions, during a dry period sap flow can undergo a considerable reduction (depending on the specie).



Variation of mean sap flow density of spruce at 1100 m a.s.l. with VPD



Larch and spruce sap flow a wet (a) and dry (b) season day