

## **Tree rings reveal prolonged stress prior to drought-induced tree death**

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In summer 2003, a severe drought occurred throughout Europe. Several trees died in many forest stands. We studied pine (*Pinus sylvestris* L.) mortality in South Tyrol (North Eastern Alps, Italy). We observed that, at the same site, some trees died whereas some others survived. Trees in deeper soils seem to have suffered more than trees growing on rocks and in very shallow soils. In particular, we analysed trees which died after summer 2003 ("dead trees"), and trees which survived the summer drought ("survivors"), at three different sites. We found that "dead trees" had faster growth rates than "survivors", until a first major drought in 1976. After 1976, "dead trees" were already weakened and had very slow growth rates, in comparison with those of the "survivors". At the beginnings of the 90s, the "dead trees" had a further abrupt growth reduction in comparison with the "survivors". Tree-ring carbon stable isotopes show clearly that "dead trees" had a significantly reduced stomatal activity during the past ten years prior to their death, which occurred in 2003, in comparison with the "survivors". Thus, the drought in 2003 can be considered as a lethal factor that finally lead to death trees which were already suffering for a long time span. Tree-ring stable carbon isotopes may therefore enable us to identify trees which will not survive future major drought events.