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Paleo-event data standards for dendrochronology

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Extreme environmental events, such as storm winds, landslides, insect infestations, and wildfire, cause loss of life, resources, and human infrastructure. Disaster risk-reduction analysis can be improved with information about past frequency, intensity, and spatial patterns of extreme events. Tree-ring analyses can provide such information: tree rings reflect events as anatomical anomalies or changed growth patterns at an annual- or even sub-annual resolution (Fig. 1). These centuries-long times series of paleo-events are far longer than historical records.

Dendrochronologists embraced information technology in the 1970s and, over time, developed specialized software using data in formatted, plain-text files. Analytical approaches developed in the 80s and 90s for fire-history analysis (Grissino-Mayer 2001) continue to be used and provide a context to analyze other paleo-events; for example, insect infestations (Speer et al. 2010). The early data structures developed for use in these specialty tools became entrenched and continue to be used today, with some awkwardness and significant limitations. They are inadequate to manage event-related tree-ring data that integrate the disciplines of paleoclimatology, ecology, hydrology, and geomorphology.

With PAGES' support, 15 dendrochronologists[1] from five nations attended a workshop addressing PAGES' Data Stewardship Integrative Activity[2]. The goal was to highlight the commonalities and differences among event indicators and to develop a general data model for dendrochronological-event data. After discussing the commonalities and differences among indicators, we agreed to utilize and expand the Tree Ring Data Standard, TRiDaS (Jansma et al. 2010) as a data and metadata structure to promote best practices of data stewardship. We concurred that a common data management framework would facilitate analysis without dictating software usage.

We summarized event indicators observable in wood anatomy, chemistry, and size variation, and the metadata necessary to describe them. We developed a preliminary list of event types, indicators, and new metadata for TRiDaS, agreeing to adopt existing, vetted metadata definitions (in particular the Forest Inventory and Analysis - FIA[3]) rather than developing new ones. We acknowledged that interoperability with NOAA Paleo, the LiPD format, and LinkedEarth data model (McKay and Emile-Geay 2016) is essential. We agreed to contribute to and to expand the LinkedEarth ontology through the "Trees Working Group" and the NOAA WDS-Paleo ontology, to describe paleo-events, provide a catalogue of current practices, and a list of needed analytical and graphical capabilities. Following these agreements we were easily able to develop a list of products, activities, and outreach efforts that can promote the adoption of these data standards.

In closing, participants agreed that there is sufficient need to merit further development of these concepts with a larger and broader international group. We will seek funding to engage the community in collective crowdsourcing and for the scientific effort needed to create the data framework. In adopting common data standards, this effort can serve the needs of land management and disaster risk-reduction analysis to great societal benefit.

LINKS

[1]http://fhaes.org
[2]pastglobalchanges.org/ini/int-act/data-stewardship
[3]www.fia.fs.fed.us

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Figure 1: A *Larix occidentalis* tree, from western Montana, USA, injured by a 2003 wildfire. Indicators of injury include killed cambium, presence of traumatic resin ducts, resin flooding around the injury, and woundwood rib and scar formation (Smith et al. 2016). Photo courtesy of K.T. Smith; sample prepared and photo taken by K.R. Dudzik, both of USDA Forest Service Northern Research Station, Durham, USA.