Dendrochronology and Climate Change

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INTRODUCTION

Importance of Global Warming and its' effects on natural resources, plants, animal and in general on human life are among subjects that received attention of scientists and politicians in recent years. To both understand the present climate and to predict future climate change, it is necessary to have both theory and empirical observation. Any study of climate change involves the construction (or reconstruction) of time series of climate data. How these climate data vary across time provides a measure (either quantitative or qualitative) of climate change. Types of climate data include temperature, precipitation (rainfall), wind, humidity, evapotranspiration, pressure and solar irradiance (aric, 2008). Climate change assessments and evaluation should be done by using recorded observation data as well as prepared and provided proxy data (Jafari, 2010). Plant ecophysiological study has very important role to recognize climate changes (Jafari, 2007). Trees and also woods can be used as archive of past events. Water, environment humidity and temperature are main factors of plant growth. Majority of plant and forest ecosystems on the earth are formed under these two main factors. Whatever amount of humidity and required water are available and also favorable temperature for plant growth cause plant community reach higher plants and trees and forest ecosystems would develop. In fact plants are important climate indicators. Trees are not an exception. Investigation of quantity and quality of these growths could help to consider past climatic conditions. Tree ring widths can be measure and record to produce time series (Figure 1).

Trees growing in temperate climatic region are under seasonal changes. In spring and summer time plants grow better than unpleasant seasons like fall and winter. The outermost layer of a tree is composed of bark. Bark itself is composed of two tissues: an innermost layer of live phloem, and an outer layer of periderm (the bark 'proper'), which has an outermost layer of waterproofing cork (phellum) which protects the wood to some degree from insects, etc (Figure 2). The cork has its own cambium (phellogen) between the phloem and cork layer. Only the outermost layer of a tree is alive (essentially only the phellogen, phloem, cambium, and maturing xylem of the current year's

Figure 1. Tree ring densities (TGTC, 2008)

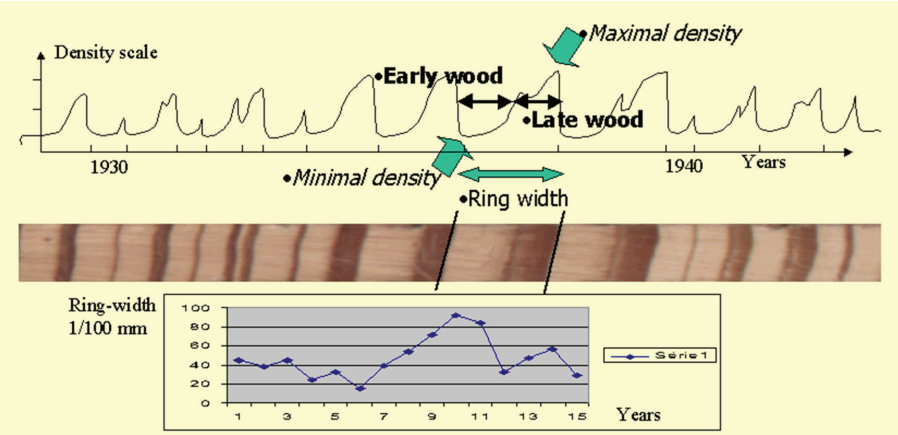

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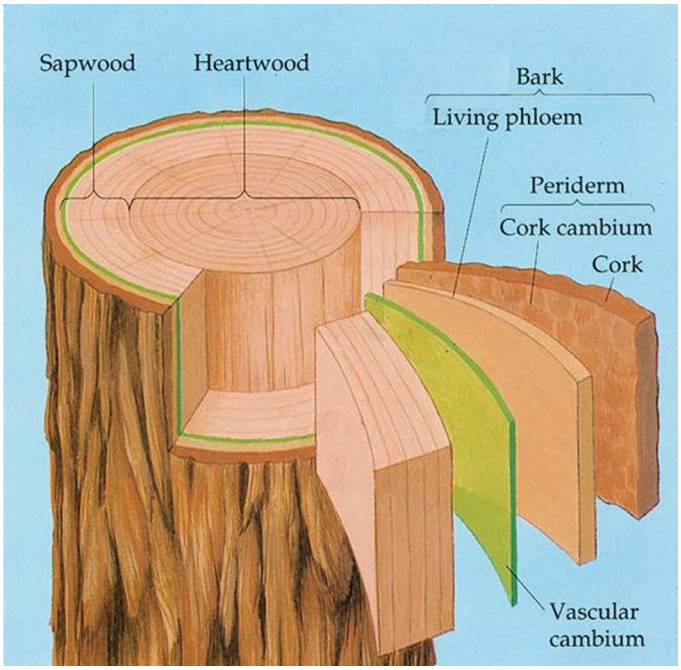
Figure 2. Wood anatomy (Anonymous, 2008a)



growth). Consequently, the majority of the trunk does not require gaseous exchange. The bark is punctuated by lenticels, a sort of giant stoma, which allows the thin outermost living layers of the trunk to 'breathe' (Anonymous, 2008a),

Wood is secondary xylem produced by growth of the vascular cambium tissue. Sapwood is xylem that conveys water and dissolved minerals from the roots to the rest of the tree. The darker heartwood is older xylem that has been infiltrated by gums and resins and has lost its ability to conduct water. Each growth layer is distinguished by early wood (springwood), composed of large thin-walled cells produced during the spring when water is usually abundant, and the denser latewood (summerwood), and composed of small cells with thick walls. Growth rings vary in width as a result of differing climatic conditions; in temperate climates, a ring is equivalent to one year's growth. Certain conducting cells form rays that carry water and dissolved substances radially across the xylem. Bark comprises the tissues outside the vascular cambium, including secondary phloem (which transports food made in the leaves to the rest of the tree), cork-producing cells (cork cambium), and cork cells. The outer bark, composed of dead tissue, protects the inner region from injury, disease, and desiccation (Encyclopedia Britannica, 2006). A big trunk of a harvested tree can be use as an archive of data and may provide its life long time series (Figure 3)(Jafari, 2010).

Common objectives of dendrochronology are: a) Put the present in perspective of the past, b) Better understand current environmental processes and conditions, and c) Improve understanding of possible environmental issues of the future. To meet these objectives, the exact year of formation of each growth ring must be known: a) Merely counting rings doesn't ensure accurate dating, and b) Crossdating, also known as pattern matching, ensures accurate dating (Sheppard, 2013).

BACKGROUND

In temperate zone trees the cambium becomes dormant in the fall and activates each spring. This leads to annual rings and the vessels produced in the spring are often larger than in the fall; the large vessels allow for rapid sap movement in the spring, whereas the narrow vessels minimize the risk of cavitations under dry conditions