CHAPTER 5

Tree-Ring/Environment Interactions and Their Assessment

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5.1. Introduction
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It is well known from history and prehistory that there are close relationships between environmental changes and the social, cultural, and economic development within a region. However, environmental impact assessment is a rather new field of research (e.g., Beanlands and Duinker, 1984), partly because of missing knowledge on the frequency and intensity of environmental changes in the past and of their causal mechanisms. Dendrochronology is one of several fields that can contribute to filling this gap.

The information on environmental changes can be recorded in a tree in various ways. Nevertheless, an individual tree represents only a single mosaic stone, whereas the whole picture becomes recognizable only if many trees are interpreted. In the most obvious case an environmental event of the past has injured some trees mechanically, e.g., through fire or rock slides, thus leaving a scar in the wood as a pointer of time. Visible signs can also be set through physiological pathways, e.g., by late frost. Harder to detect are those effects that are recorded but hidden in the width, wood density, and structure of the annual increment of trees. Only in exceptional cases are the deviations of these parameters, from what is assumed to be normal, so obvious that pure visual judgment will lead to a reliable result. In general, statistical procedures have to be applied to differentiate natural from man-made fluctuations. The annual increment of trees can also be analyzed for its chemical content derived from environmental

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sources, particularly heavy metals. Like data on ring width, wood density, and structure, these data are measurable quantities. But rather than relying on statistics, a careful physiological interpretation is needed.

Another category of information in tree rings differs basically from the types mentioned above in the way that it is stored in the trees. For example, a record of the abundance of trees and their felling years from historical, archaeological, or geological material may indicate environmental changes, although the causal links may be difficult to recognize. Also, systematic changes in tree ages over time in a sufficiently large historical or archaeological wood collection, along with systematic changes in the average tree-ring width, may allow some consideration of the changing forest community as well as landscapes in general.

In this chapter various approaches to detect environmental changes of the past are introduced, in which the examples used for illustration are unavoidably subjective.

5.2. Qualitative Assessment of Past Environmental Changes *D. Eckstein*

Man-made impacts on natural environments are as old as the human species itself, but the intensity of these impacts have increased during the past 10,000 years. Some of the early environmental changes can be detected in retrospect.

Becker (1983b) dated hundreds of subfossil oak trunks from Holocene gravel deposits along the Main valley in the Federal Republic of Germany. The dendrochronological dates cluster into groups separated by time gaps without any tree finds. These clusters indicate phases during which oaks from riverine forests were eroded and deposited into the valley fill. According to the dendrochronological dates, periods of increased fluvial activity occurred from 2200 to 1600 B.C. (sub-Boreal times), during the first two centuries A.D. (sub-Atlantic times), and between A.D. 550 to 750 (*Figure 5.1*). It was concluded that the buried trees originated from heavy and repeated floods whereby the river channels migrated laterally.

Sometimes floods reached oak sites far from the earlier flood plains. This is indicated by the fact that the deposition of trunks started with young trees in the second century B.C., includes 300-year-old oaks around the turn from B.C. to A.D., and 400-year-old oaks only 100 years later. The phases of heavy floods are assumed to reflect disturbances caused by forest clearances in the river catchment basin by prehistoric man resulting in accelerated runoff and an increased bed load. The sub-Atlantic deposits coincide with the settling of the Romans and Alemanni in southern Germany. Through this chain of events, the growth conditions in the valley must have improved due to the deposition of alluvial loam and a rise of the groundwater level. This is indicated by wider annual rings and higher autocorrelation in the tree-ring series.

Delorme *et al.* (1983) analyzed subfossil oaks from several bogs in northern Germany deposited between 350 to 150 B.C. They conclude from the clustering of the die-off years that the area became increasingly waterlogged resulting in the