

Introduction

Dendrochronology, tree-ring analysis, has been widely applied in many fields of studies [1]. Though, dendrochronology was mainly used in the temperate forests, some studies have been also carried out in the tropics. Various automated and manual methods have been developed for dendrochronological studies, which are usually unaffordable to many developing countries. In this study, we examined the applicability of Geographic Information System (GIS) as an affordable tool to undertake dendrochronological studies. We used disks from *Junipers procera* (Cupressaceae), which is a suitable species for dendrochronological studies in Ethiopia[3].

Objective

The aim of this work was to examine the applicability of GIS in dendrochronology.

Methods

Sample disks were collected from northern Ethiopia located at 13°55'3"N, 39°48'46"E, at an altitude of 2700 m a.s.l. (Fig 1). The basic steps used in this study are indicated in Fig. 2.

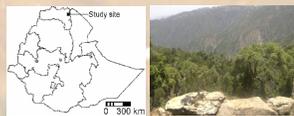


Fig.1 The study site on the map of Ethiopia (left) and a photo from the study site (right).

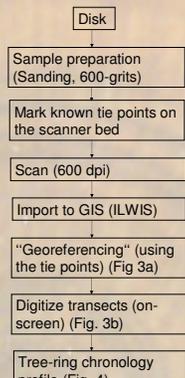


Fig. 2 Steps used in the study

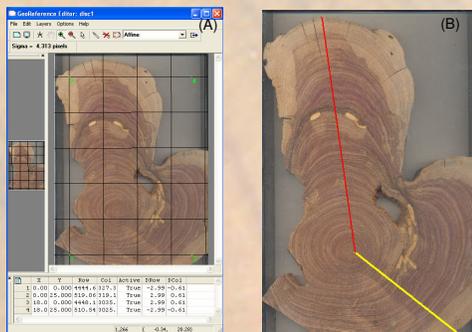


Fig. 3 "Georeferencing" the disk (A) and creating transects across the disk (B) in a GIS environment.

In our approach, the disk is considered as a map with a pseudo-georeference that enables us to manage it in a GIS environment. In this study, we used the Integrated Land and Water Information System (ILWIS) remote sensing and GIS software, which is freely available [3].

Good sample preparation and higher scanner resolution give more visible tree-rings (Fig. 4).



Fig. 4 Scanned *J. procera* disk sanded with 600-grit sandpaper and scanned with 600 dpi scanner.

Results

The theoretical assumption about the applicability of GIS in dendrochronology is acceptable, and we found GIS as a useful tool in tree ring studies. The applicability of the GIS technique is influenced by the visibility of tree-rings, which depends on data preparation, acquisitions and the type of species. Although it depends on the purpose of tree ring study, the GIS method may be less precise than other microscope based methods. But, compared to other manual methods, this method gives many GIS facilities like, better visualization, data archiving, user comfort, and working out side dendrochronology laboratories is possible.

The accuracy of the GIS based method can be improved using:

- well prepared samples
- high scanner resolution
- previously developed masterchronologies to correct and validate results
- microscope to treat less visible (narrow) rings, adding missing rings and removing false rings can be easily managed in GIS

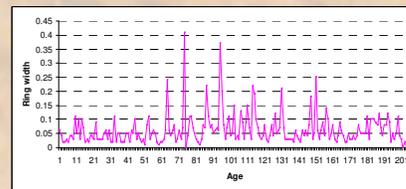


Fig. 5 Tree ring chronology developed for a transect using GIS

The annual tree-ring width can be analysed in GIS and it is also possible to export the attribute data from GIS to other spread sheet programs like Excel for further analysis.

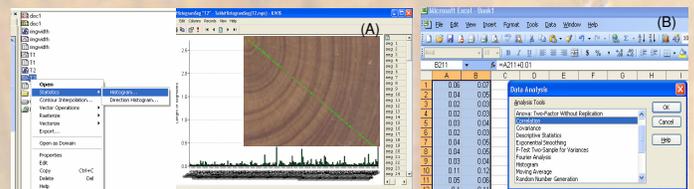


Fig. 6 Data analysis in the GIS (A) and in Excel (B)

Conclusions

Although the GIS based tree ring analysis might have some limitations and require more visible tree rings, it can be used in tree ring analysis with acceptable accuracy in circumstances where dendrochronological laboratory facilities are not available. To improve the accuracies of this method, further studies on sample preparation, increasing scanner resolution, using microscopes to treat difficult rings (missing/false), GIS applications (e.g. image enhancement), etc., are recommended.

Acknowledgements

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References

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