RETHINKING TREE GROWTH RESPONSE TO EXTREME DROUGHT ON THE SOUTHEASTERN TIBETAN PLATEAU

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INTRODUCTION

Anthropogenic Influence has been proven to pose destructive impacts on pristine forests. Yet, there is a lack of consensus regarding tree growth response to extreme drought is noticed on the southeastern Tibetan Plateau, specifically on genera of Juniper and Fir.

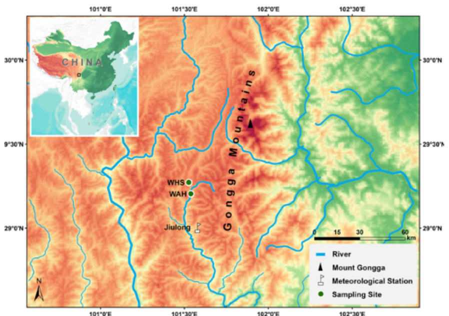

Fig. 1: A map of Gongga Mountain with symbols signifying sampling sites, with the smaller map showing the precise coordinates of meteorological stations in a wider setting of the southeastern TP (Li et al, 2021).

This study aims to indicate the following:

1) How genera of Junipers and Firs in the southeastern TP respond to or tolerate extreme drought?
2) To what extent the micro-climate mitigates the influence of extreme drought event?

in order to project the forest vulnerability of the Tibetan Plateau under anthropogenic influence, we reveal the cross-decade climate responses to drought.

METHODS

Types of Data	Description	Timeframe	Source of Data
Tree-ring Index	37 and 58 increment cores of Abies georgei Orr and Sabina tibetica from the sampling sites WAH and WHS, respectively Standardized in the "signal-free" approach that detrend the statistics with controls from Velmex measuring system and COFECHA programme	1950 - 2014	Li, J., Li, J., Li, T. et al. (2021). Available at doi.org/10.1007/s10584-021-03075-3
The Palmer Drought Severity Index (PDSI)	The nearest grid to the sampling sites (29° 00' N – 29° 5'N, 101°00'E – 101°5'E) was used in this study Definition of drought years and non-drought years: drought (PDSI < 0); non-drought (4 > PDSI ≥ 0) (Liu Y et al.,2015).	1950 - 2014	Data was developed by CRU TS4.05 and be incorporated at a grid resolution of 0.5° from KNMI Climatic Explorer (http://climexp.knmi.nl/).

In order to evaluate responses of tree growth to drought events, methods from Lloret et al., 2011 & Au et al. 2022 in calculating the growth reduction and species resistance, resilience and recovery were used:

$$PGR = \frac{\overline{TRI}_{drought} - \overline{TRI}_{non\text{-}drought}}{\overline{TRI}_{non\text{-}drought}} \times 100$$

$$Resistance = \frac{TRI_{d}}{TRI_{pre1-2}}$$

$$Resilience = \frac{TRI_{post1-5}}{TRI_{pre1-2}}$$

$$Relative\ Resilience = Resilience - Resistance = \frac{TRI_{post1-5} - TRI_{d}}{TRI_{pre1-2}}$$

RESULTS

Part of results from this study is presented below:

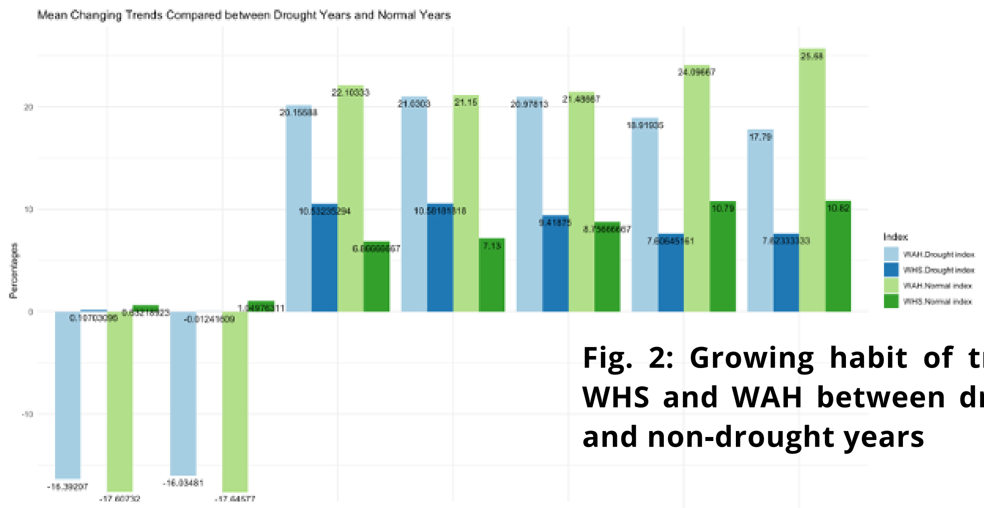

Fig. 2: Growing habit of trees in both WHS and WAH between drought years and non-drought years

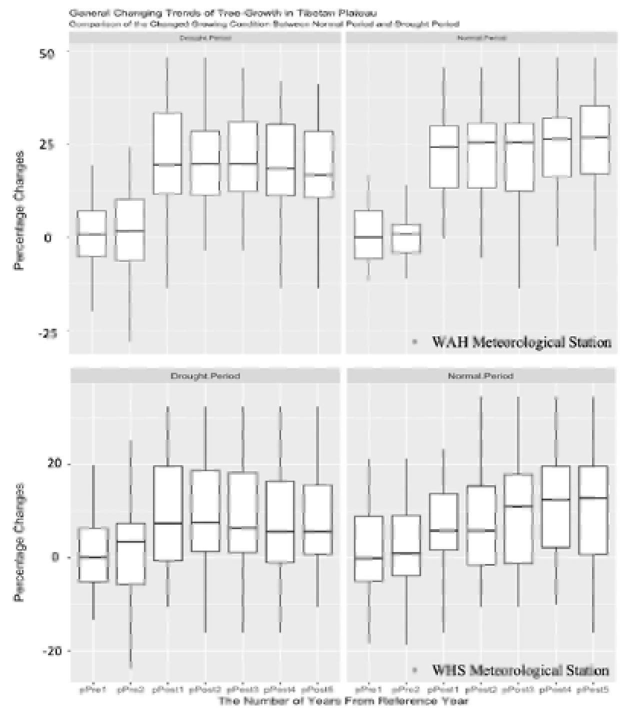

Fig. 3: Trend of percentage changes in Tree-ring index between drought years and non-drought year

Drought events are found interrupting a usual cumulative growth in tree species in southeastern Tibetan Plateau. Yet, the influence over Sabina tibetica in WHS was statistically indicated stronger, by 2.91% drop in mean; but by merely 2.37% on average in WAH instead.

Despite the drought influence, growing habit of trees in both WHS and WAH tend to have little change prior to the third year and forth year respectively

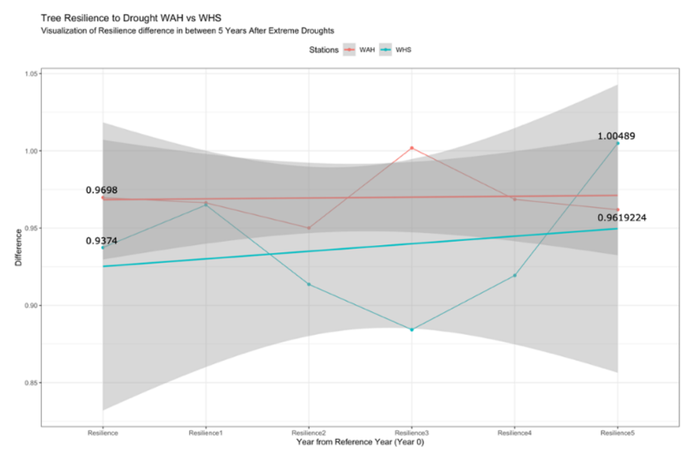

Fig. 4: Variations of average drought resilience of trees in WAH and WHS respectively.

The resilience and resistance rates of Abies georgei Orr in WAH was found to be generally higher than that of Sabina tibetica in WHS

In spite of the pseudo-growth in the third year, trees in WAH showed a generally steady decline in resilience rate, suggesting that the legacy of drought stress still be destructive even in the fifth year.

DISCUSSION

Microclimate acts as an important factor in maintaining consistent growth rates in Abies georgei Orr than Sabina Tibetica in the southeastern Tibetan Plateau.

Statistics demonstrated a lack of responses from tree-rings to the climatic parameter implies trees' adaptation in WAH and WHS against drought events. Yet, their generally different rates of resistance and resilience further proved the elevation-specific influence of temperature on the two species.
Despite the anisohydric nature causing a slower onset of xylogenesis, elevation of over 3900m a.s.l creates a humid microclimate that outweighed junipers' anisohydric physiology, so that species can remain growth in a minimum rate.

Adaptive Mechanisms of the two species create a paradoxical protective shield for Abies georgei Orr in WAH

Abies georgei Orr is a type of firs which is considered isohydric plant that strategically close its stomatal conductance during extreme droughts. It can reduce the reliance on intrinsic physiology but consumes carbohydrate reserves to protect itself from sudden deficiency of water.
However, such biological strategy could instead lead to a prolonged recovery time after drought event (Bréda et al., 2006) or even an irreversible breakdown of cohesion and massive vessel embolisms, ultimately resulting in tree mortality.

REFERENCE

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