Tree growth dynamics of two natural secondary gallery forest stands in West Yen Tu Reserve, Northeast Vietnam

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1. Introduction

Gallery forests in Northeast Vietnam have an important function as buffer zones in controlling water supply and erosion. Despite the important ecological role in water protection as shelter for associated fauna, in biodiversity conservation, in the contention of erosive processes for the region, they are continuously degraded by anthropogenic activities. Thus, promoting the in-situ bio diversity conservation needs to be intensified and associated with multi-disciplinary knowledge. Whereby, not only vegetation composition, structure and dynamics of the gallery forests, but also their reaction towards the site conditions were elaborated. Tree ring analysis serves as a tool for describing and interpreting the stand and tree dynamics and development. The major objectives of this research are to i) investigate the relation between precipitation and growth dynamics; ii) investigate diameter growth and growth trend of dominant tree species.

2. Site descriptions

The study sites belong to West Yentu Reserve - Northeast Vietnam, located in Sondong district, Bacgiang province ($20^0 17^{'} - 21^0 21^{'}$ N, $106^0 02^{'} - 107^0 23^{'}$ E) (Fig. 1). Climate data were obtained from the Sondong station with the time series from 1961 to 2002. Mean annual precipitation is 1663 mm with seasonal distribution. The dry season with precipitation less than 60 mm per month lasts from November to February. The annual mean temperature is 22.7^0C (Fig. 2).

The so called Tuandao stand lies on Tuandao branch river in the buffer zone of the Reserve. The forests here are continuously affected by human activities in exploiting timber woods, bamboos and other non-timber forest products. In contrast to that the so called Khero forest

belong to the strictly protected watershed area of the Reserve; since 1991 every forest intervention has been forbidden strictly. These forest stands can be classified as secondary riverine ever-green forest containing many valuable tree species for timber, oil-resin bearing and medicinal. Many tree species in these areas are listed in the red book of endangered species in Vietnam, such as: *Erythrophloeum fordii* Oliver (Ironwood), *Aquilaria crassna* Pierre, *Madhuca pasquieri* H.Lec., *Vatica odorata* Sym..

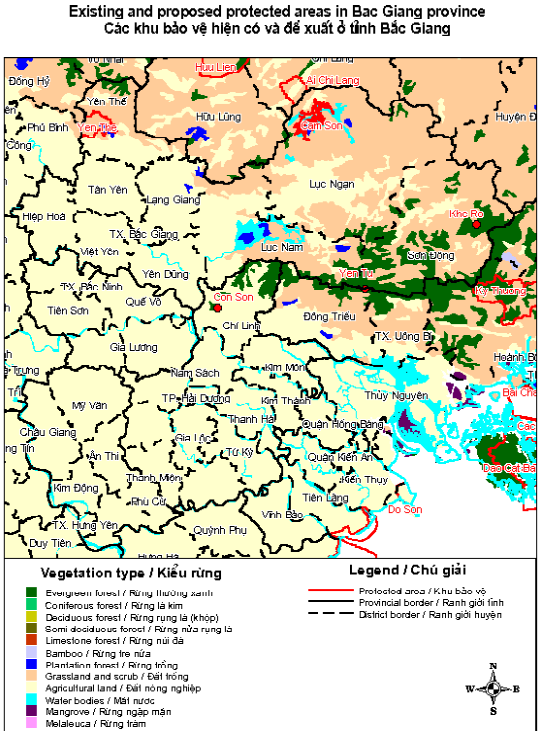

Fig. 1. Protected areas in Bacgiang Province and study areas

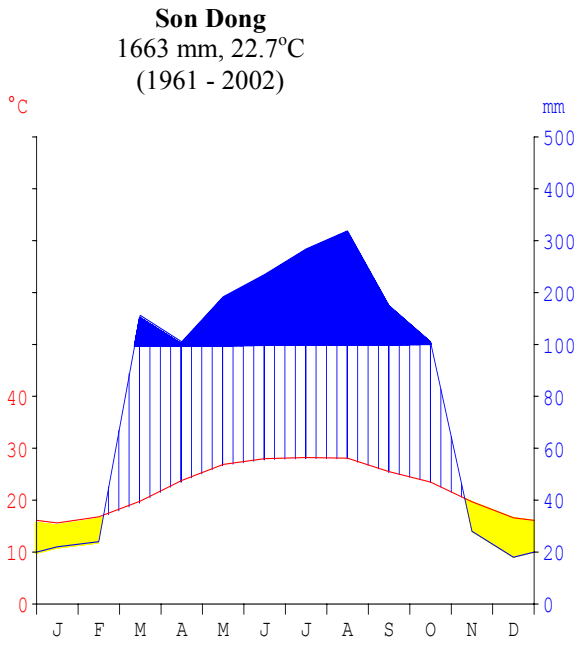

Fig. 2. Climate diagram of the study areas (according to WALTHER and LIETH 1967)

3. Materials and methods

The investigation was carried out in two natural secondary gallery forest stands in North-eastern Vietnam. The inventory was conducted on 40 transects (10 x 50 m) along two rivers, which are located in the watershed area of Luc Nam river in the West Yen Tu Reserve. Based on the topographic map on scale 1:10,000 a systematic transect design was applied. The distance between transects is 150 m depending on size and form of the forest area and the desired sampling rate. The transects were located in such a form that their direction were

perpendicular to the direction of the gallery forest. Within the transects all the trees with diameter at the breast height (DBH) over 5 cm are included (SCHEUBER, MORAIS and KLEINN, 1996, IMANA, 2002).

For tree ring analysis five dominant tree species, which show distinct annual rings, within the two study sites were selected. 70 suitable sample trees were cored at the height of 1.3 m with increment borers and analysed using standard dendrochronology methods in Göttingen. The cores samples were dried and glued on the wooden support. In order to increase the visibility of the growth zones the cores were polished with fine sand paper of grit size from 80 to 600. The ring widths were measured to the nearest 0.01 mm using a tree ring measurement device introduced by RINN and TSAP program (RINN, 1996). The measured ring-width series of every tree species were cross-dated in order to match variations in the ring width or find out the possible false or absent rings (FRITTS, 1976). Then the cross-dated ring width curves were summarized a mean curves for every tree species for further analysis.

In order to analyse the climatic influence on the tree growth three different time series of precipitation, recorded at the Son Dong station from 1961 to July 2002 (fig. 2), were calculated:

- *Annual precipitation* "Annualprec.".
- *Precipitation in the rainy season (March to October)* "Rainyprec.".
- *Precipitation in the dry season (November to February)* "Dryprec.".

4. Results and discussions

4.1 Tree growth - precipitation relationship

The annual tree growth is generally affected by many site condition factors, such as: Annual temperature, precipitation, flooding... The existence of a dry season with a length from 2 to 3 months and a monthly precipitation less than 50 mm per month is one factor that may induce annual tree rings in the tropics due to seasonal alternating favourable and unfavourable growth conditions (FRITTS, 1976; WORBES, 2001). Within the tropics several studies already showed significant correlations between tree ring widths chronologies with

precipitation in different time periods (WORBES, 1999; PUMIJUNGNONG, 1999; NYI NYI KYAW, 2003).

In the present study, the precipitation of different time series were correlated with standardized tree ring mean curves which were summarized for every species after cross-dating. The results show that in both study areas the annual ring indices of all tree species showed a significant positive correlation with the total amount of precipitation in the year as well as with the total precipitation in the rainy season (March to October). The parallel variation value (Glk.-value), as a measure for the similarity of two tree ring series, are in all cases comparably high, over 60%. However the correlation between tree-ring width series and total precipitation in the dry season was not significant (Table 1, 2).

Table 1: Correlation between tree-ring width indices and precipitation in Tuandao forest.

	Lithocarpus		*Erythrophloeum*		*Pygeum*		*Mischocarpus*	
Precipitation periods	Glk.(%)	R	Glk.(%)	R	Glk.(%)	R	Glk.(%)	R
Annual precipitation	66.2	0.37 *	62.9	0.34*	70.0	0.51 *	70.0	0.43 *
Rainy precipitation	61.2	0.39 *	62.9	0.36 *	60.0	0.37 *	67.5	0.35*
Dry precipitation	55.0	0.02	44.3	0.23	51.2	0.17	56.2	0.21

Table 2: Correlation between tree-ring width indices and precipitation in Khero forest.

	Catanopsis		*Erythrophloeum*		*Pygeum*	
Precipitation periods	Glk.(%)	R	Glk.(%)	R	Glk.(%)	R
Annual precipitation	67.5	0.38 *	70.0	0.44*	65.7	0.32 *
Rainy precipitation	65.0	0.32 *	70.0	0.37 *	68.6	0.19
Dry precipitation	43.8	0.11	51.2	0.16	55.7	0.03

The mean curves of *Erythrophloeum fordii* Olive in Khero and *Mischocarpus oppositifolius* (lour) Merr.) in Tuandao correlated highest with the annual precipitation by 0.44 and 0.43, the Glk.-value in these cases are 70 % (fig. 3, 4).

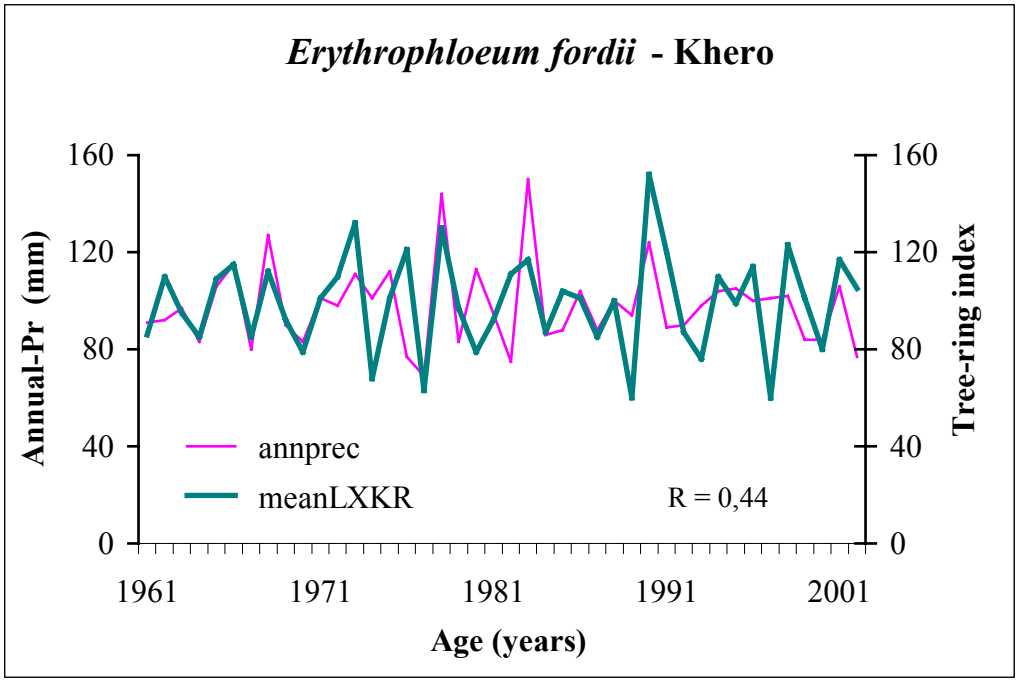

Fig. 3. Mean ring-width indices of *Erythrophloeum fordii* Olive (meanLXKR) and annual precipitation (annprec) in Khero

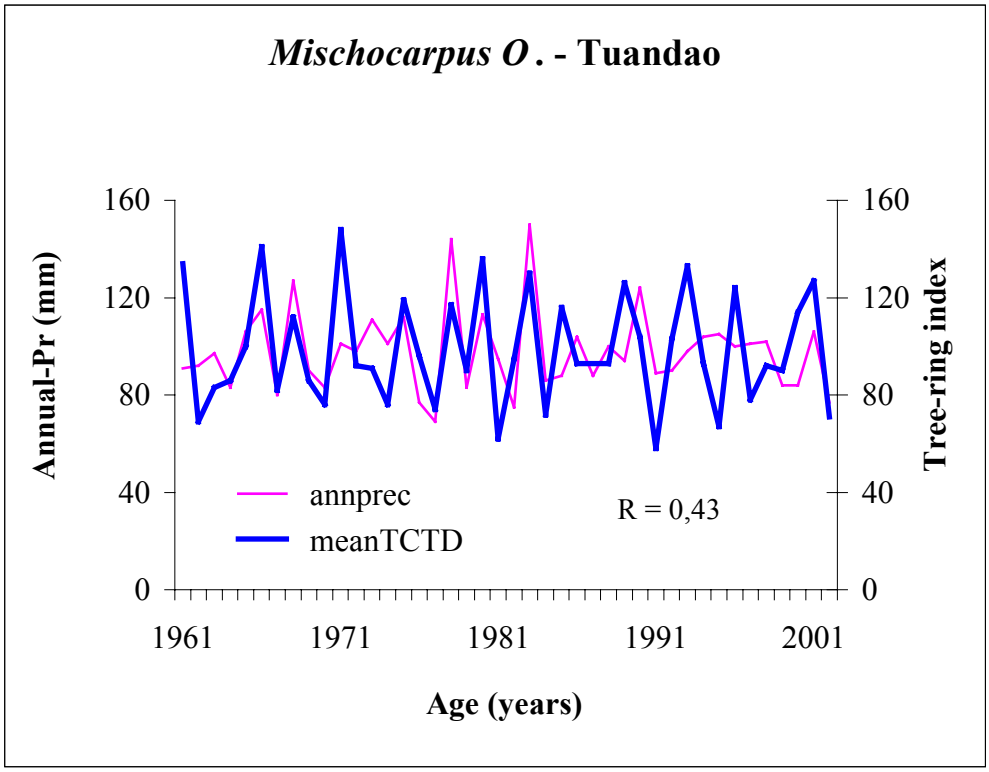

Fig. 4. Mean Ring-width indices of *Mischocarpus oppositifolius* (lour) Merr.) (meanTCTD) and annual precipitation (annprec) in Tuandao .

4.2 Tree diameter growth and growth trends

The diameter growth data are important criteria for evaluating of site quality, growth performance of the tree species and developing silvicultural systems. In order to present the tree long-term growth data for each study site the cumulative annual diameter growth curves of all measured individuals were calculated for every species separately (fig. 5, 6).

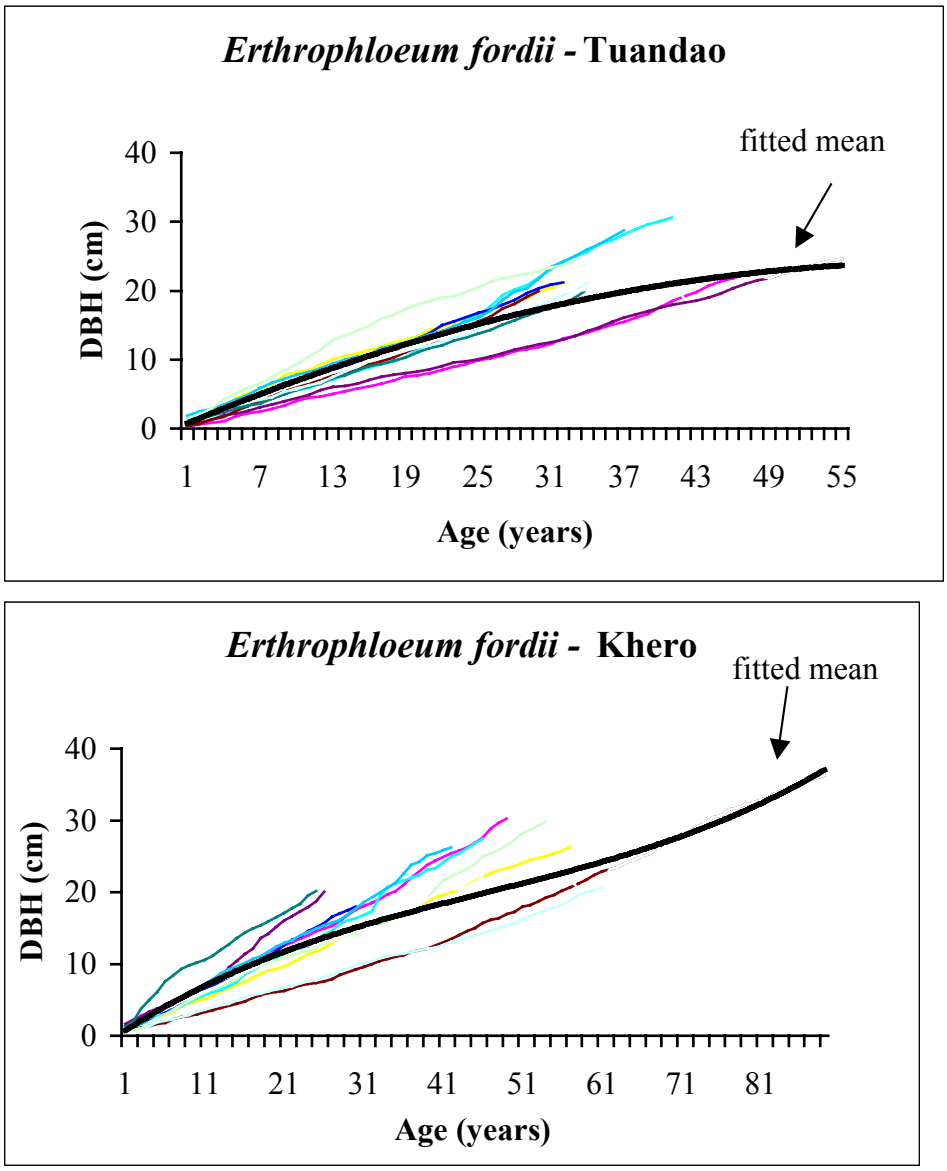

Fig. 5, 6. Individual and mean cumulative diameter increment of *Erythrophloeum fordii* Olive from Tuandao and Khero

To gain the overview of diameter growth of two sites the mean curves in three species in Khero and four species in Tuandao were fitted by polynomial function as shown in figure 7 and 8.

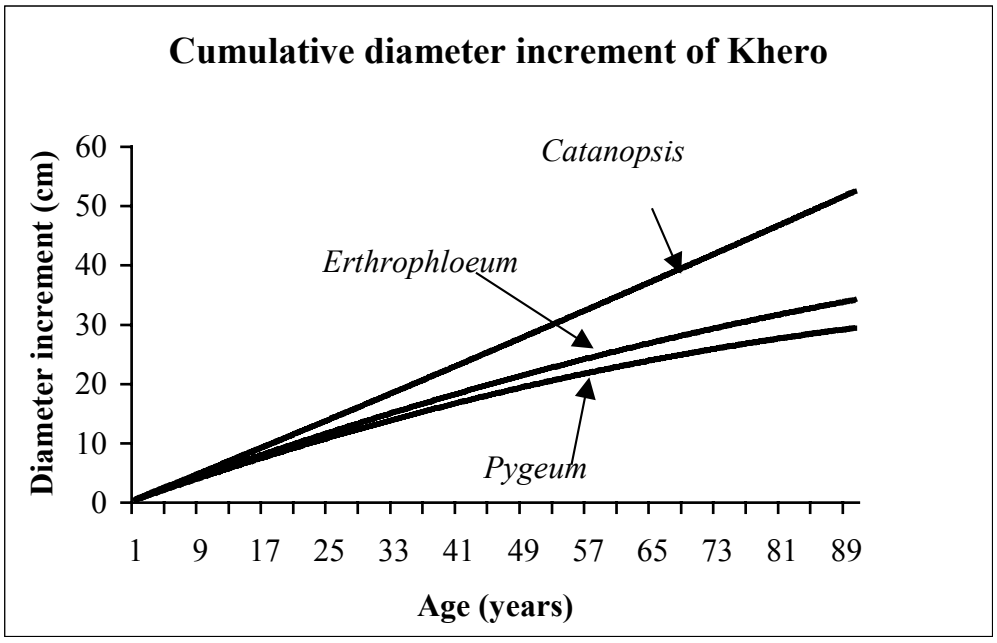

Fig. 7. Fitted diameter curves of 3 investigated species in Khero.

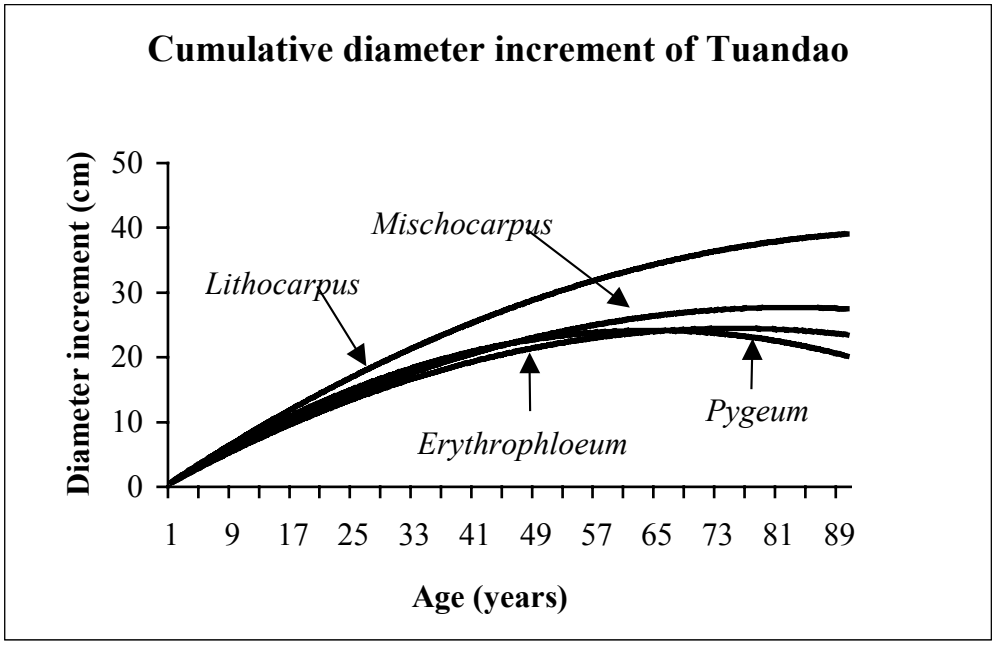

Fig. 7, 8. Fitted diameter curves of 4 investigated species Tuandao

As can be seen from figures 7 and 8, the mean annual growth rates differ from species to species and in both sites. In Khero the mean ring-widths vary between 4.8 mm per year in *Pygeum arboreum* and 5.4 mm per year in *Catanopsis indica*. Tree species of Tuandao show higher annual increment with 5.2 mm per year in *Pygeum arboreum* and 6.7 mm per year in *Lithocarpus ducampii.*. Although trees in Tuandao show higher mean annual growth rates than those in Khero at early stage, later they tend to level off distinctly. This may be the result of prevailing light and soil condition. The Khero forests have higher stand densities that may be a disadvantage for the initial growth of trees, while the Tuandao stand has more openings from previous bamboo and timber exploiting. The later is expected to improve the growth condition of the remaining trees.

5. Conclusions

All the researched species of both study sites showed a positive relation with the annual rainfall and total precipitation in the rainy period. Tree species of Tuandao showed the higher mean annual diameter increment than those from Khero. Future research should extend the investigation to additional tree species and varying site conditions on further gallery forests to achieve information on growth behaviour of these endangered and important ecosystems on sustainable management and future silviculture approaches. This could be one basis to develop sustainable management operations in order to reserve these endangered ecosystems.

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