



EXPL(	DRING	THE YE	AR RING	GROWTH OF	DOUGLAS
FIR A	ND N	RWAY	SPRUCE 1	IN RESPONSE	TO THE
CHAN	GE IN	WEATH	ER AND	CLIMATE	

Presented By: Md. Rayhanur Rahman Supervised By: Harald Honer Date: 29<sup>th</sup> September, 2020



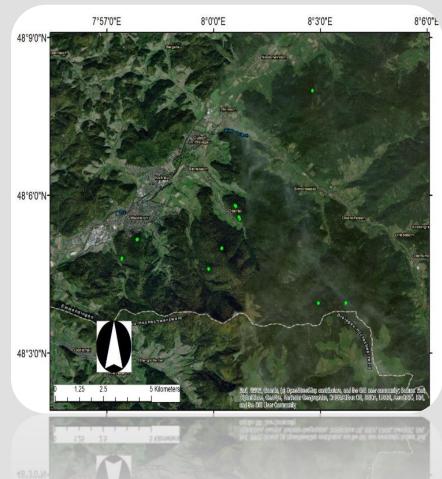
# KONKLIM

- Joint research project between Forest Research Institute Baden-Württemberg (FVA) and the Chair of Forest Growth of Albert-Ludwigs-University Freiburg (ALU).
- Aim: assess the suitability of three most economically important coniferous tree species Norway spruce, Silver fir and Douglas fir regarding their growth increments to predicted climatic changes in the Black Forest.
- Investigating quantitative wood anatomy





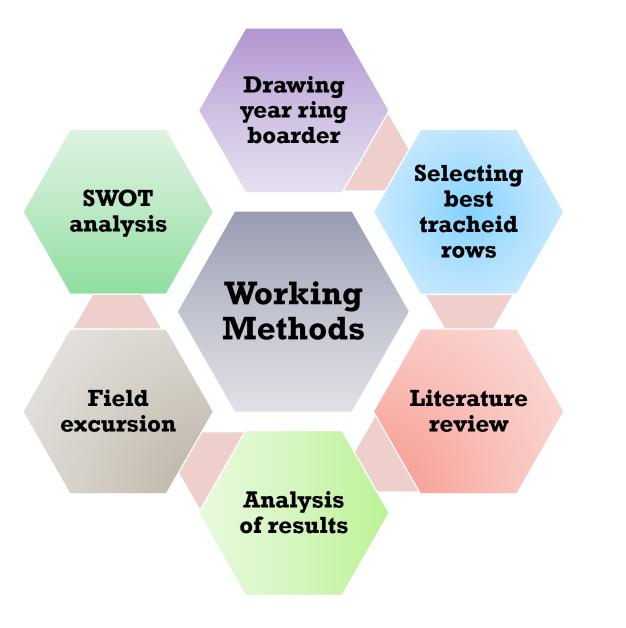
Source: www.Geoportal-BW.de



## SELECTED SAMPLE TREES FROM KANDEL

#### **Kandel Location**

- 20 selected tree individuals
- Data collected from five altitude level



## WORKING METHODS

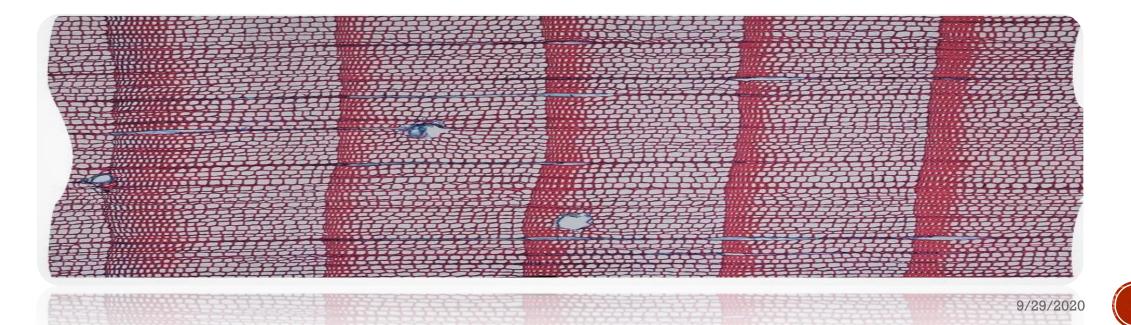


# ROXAS

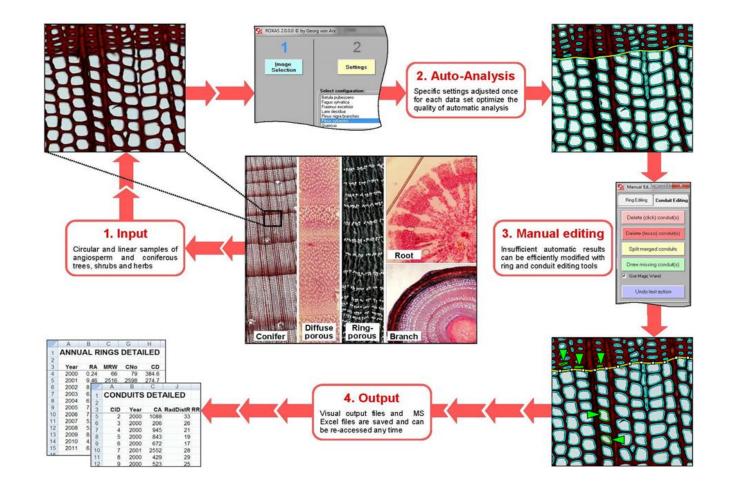
#### **ROXAS 3.0**



ROXAS is a specialized image analysis tool for quantifying xylem anatomy in circular and linear samples of angiosperms and conifers.

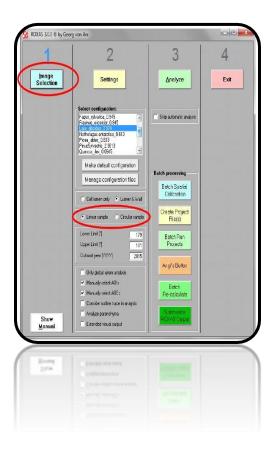


# **ROXAS ANALYSIS CYCLE**





# TASK 1: DRAWING ANNUAL CELL RING BORDERS



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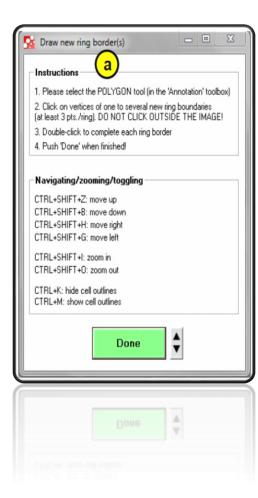


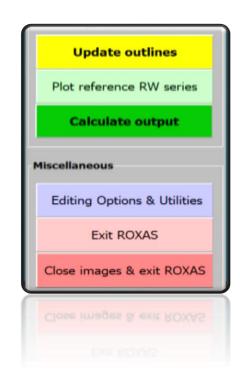


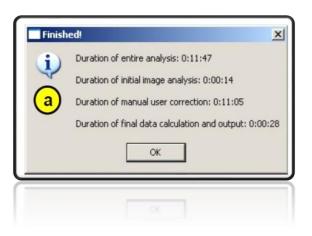
Von Arx, 2016



# TASK 1: DRAWING ANNUAL CELL RING BORDERS





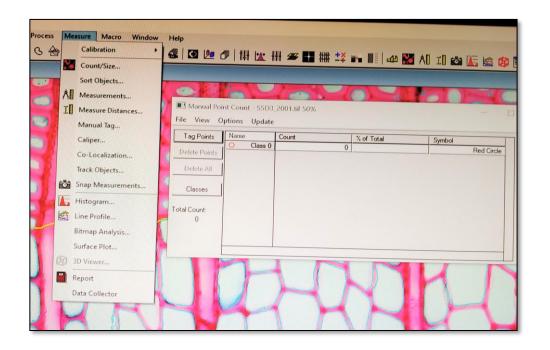


Von Arx, 2016



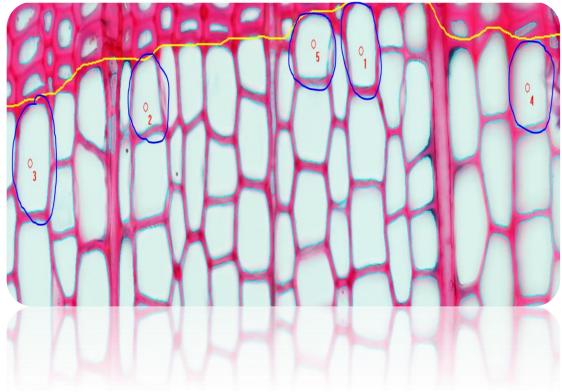
# TASK 2: SELECTION OF BEST FIVE TRACHEID ROWS

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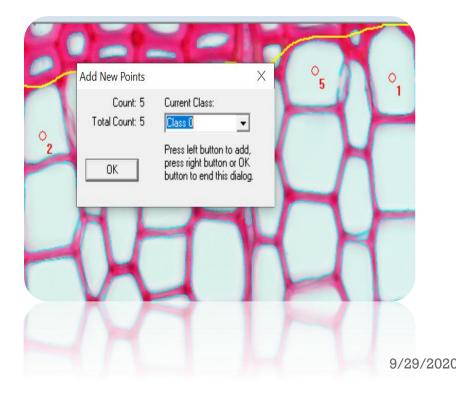




## TASK 2: SELECTION OF BEST FIVE TRACHEID ROWS



Selected best tracheid rows





# TASK 2: SELECTION OF BEST FIVE TRACHEID ROWS

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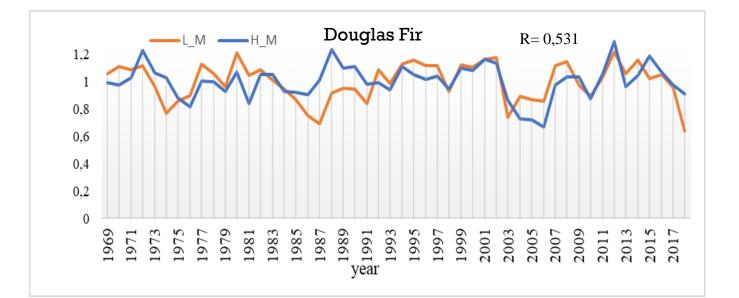
Saving tag files

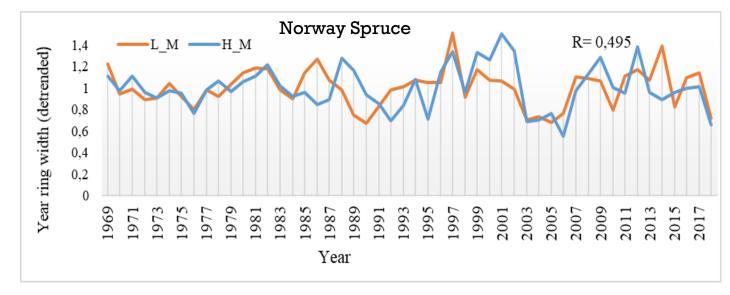
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Saving cnt files





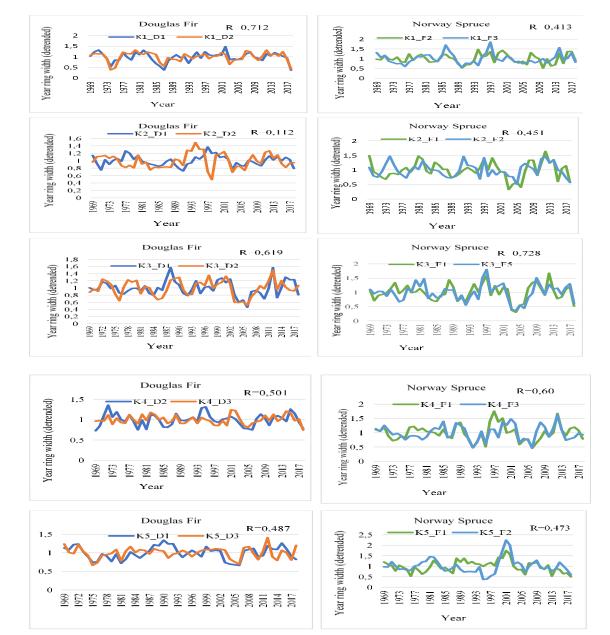




Here, L\_M= Lower altitudinal range (350 -650m) and H\_M=Higher altitudinal range (650-1100m) of Kandle

#### ANALYSIS OF YEAR RING INCREMENT IN DIFFERENT ALTITUDINAL LEVEL OF KANDLE

- 20 tree individuals of Norway Spruce and Douglas Fir
- The interseries correlation for both species showed significant differences (p<0.05) from each other</li>
- Used dplR package (Bunn 2008)



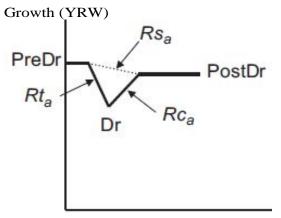
Here, D1= Douglas Fir first, D2= Douglas Fir second, D3= Douglas Fir third tree individual, F1= Norway Spruce first, F2= Norway Spruce second, F3= Norway spruce third, F5= Norway spruce fifth tree individual; K1= 350-500m, K2= 500-650m, K3= 650-800m, K4= 800-950m, and K5= 950- 1100m range of altitude

CORELATIONS BETWEEN THE TWO INDIVIDUALS IN FIVE ELEVATION LEVEL

- good corelation is observed in almost every case

## TREES RESPONSE TO DROUGHT EVENT AND THE EFFECT OF **GROWING ELEVATION**

**Resistance (Rt)** = 
$$\frac{Dr}{PreDr}$$
 **Recovery (Rc)** =  $\frac{PostDr}{Dr}$  **Resilience (Rs)** =  $\frac{PostDr}{PreDr}$ 



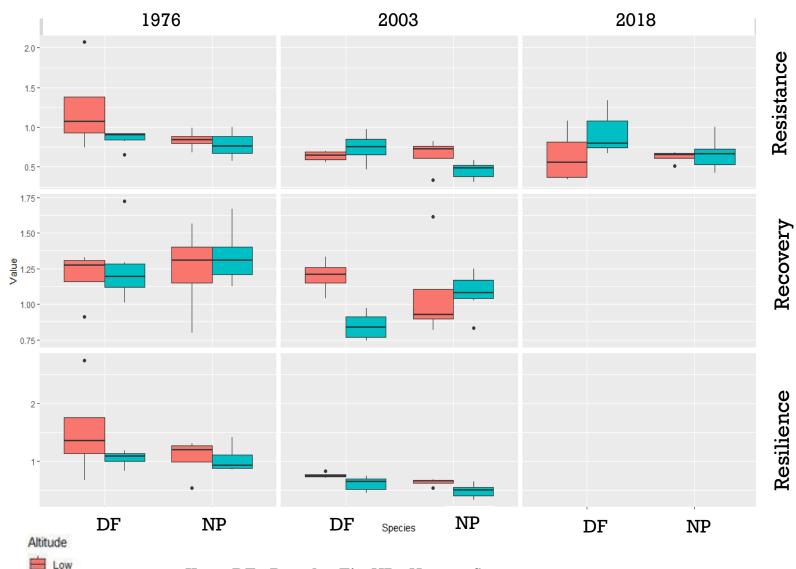
Time

Dr= width of tree year ring in a drought year PreDr= mean tree ring width 2 years before the disturbance PostDr= mean tree ring width 2 years after the disturbance

Growth indices in hypothetical case

Lloret et al. 2011; Vitali 2017





Here, DF= Douglas Fir, NP= Norway Spruce

High

THE EFFECT OF GROWING ALTITUDE AND SPECIES RESPONSES TO DROUGHT EVENTS

- Better resistance found for Norway spruce in higher altitude level
- Resilience recorded better for both species in lower altitudinal level



TP1020 machine

Histocore Arcadia H machine



## LABORATORY DEMONSTRATION

- TP1020- Paraffin (Wax) to stabilize sample
- Histocore Arcadia H prevent the sample to become solid
- Rotary Microtomeaccurate slides of sample
- Cresyl Violet Acelate differentiate the state
   of cells





#### Schauinsland study area



**Microcores collection** 

### FIELD EXCURSION IN SCHAUINSLAND

- Microcores collection
- 45 sample trees
- Instruments used -Trephor
- Eppendorf tube filled with 50% Ethanol





- Has stabilized voltage and induction sensors
- Radial growth and shrinkage of the tree

- Saved data on flash memory card
- Data can be downloaded via cell phone modem



FIELD EXCURSION IN SFB RESEARCH AREA

•

Point dendrometer and data logger observation





• Measure radial growth and water stress condition

- USB/IrDA cable used
- Mini32 software required

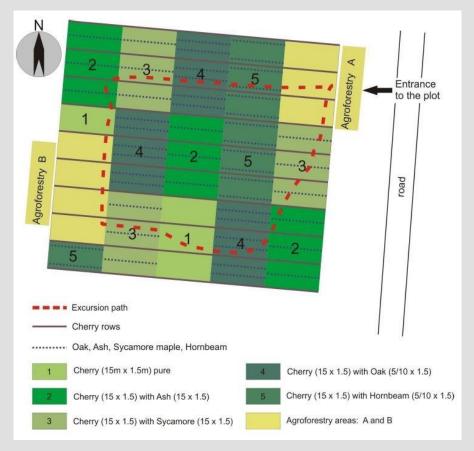


## FIELD EXCURSION TO BLAUEN MOUNTAIN

- Band Dendrometer measurements
- Microcores
   Collection
- DBH measurements
- Exposition measurement



Study area demonstration



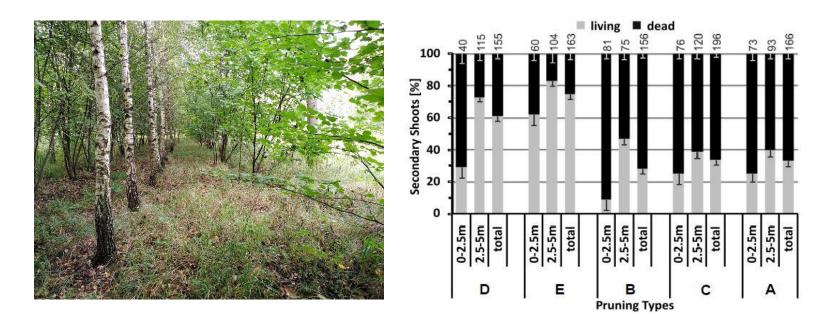
#### Plot orientation of valuable broadleaved trees

### FIELD EXCURSION IN BREISACH

### Established: 1997

- Area: 2.5 ha
- -15 plots (RBD used)
- Objectives: Growing valuable timber with broadleaved trees

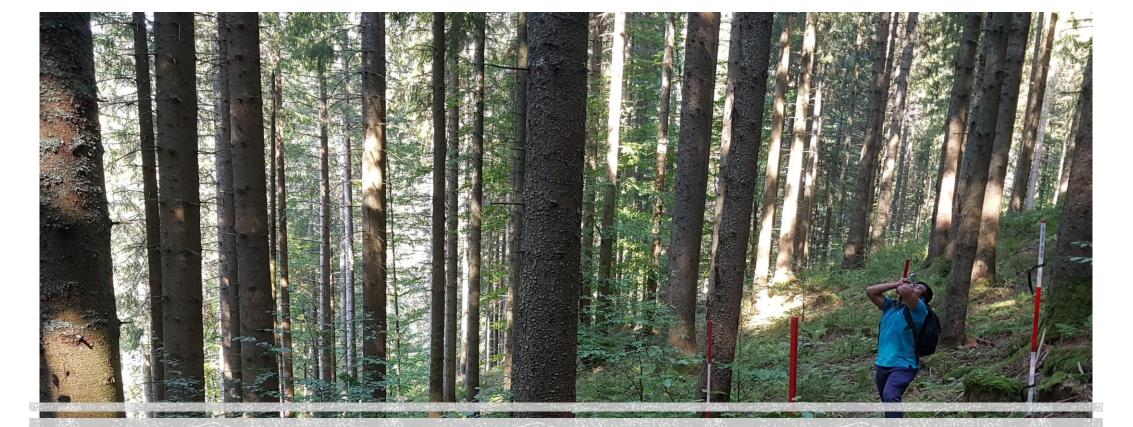
- The number of dead shoots increases by application of pruning type B and C (Anticipatory pruning approach)
- Sixty Cherry trees has been sun burned
- Dying back of Ash tree



### FIELD EXCURSION IN BREISACH

# Observations from experiment area

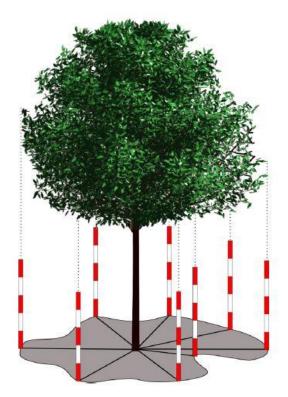
(Springmann et al. 2011)

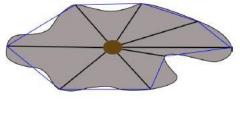


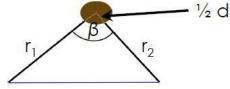
# FIELD EXCURSION IN MENZENSCHWAND

Responsibilities
 Diameter at breast height,
 Crown projection area measurement,
 Competitor trees

# **CROWN PROJECTION AREA MEASUREMENT**







Area<sub> $\Delta$ </sub> = a x b x sin $\beta$  x  $\frac{1}{2}$ 

Area  $_{\Delta 1} = (r_1 + \frac{1}{2} d) \times (r_2 + \frac{1}{2} d) \times \sin\beta \times \frac{1}{2}$ 

Crown projection area =  $\Sigma$  Area  $\Delta$ 

Spiecker, 1991





- Collaborative process
- Strong background, skills of researchers
- Well equipped lab
- ROXAS analytical tool



#### **OPPORTUNITIES**

- Comprehensive research
- Noble research; create a good portfolio for the selected conifers
- Funding for new research
- Enhanced forest management strategy with changing climate





- Planned very ambitiously
- Limited meetings to share the current activities
- Financial limitations
- Limited cooperation among all the working packages



#### THREATS

- Current COVID-19 situation
- Uncertainties due to climate change
- Delays will increase ultimate cost of projects
- To get continuous collaboration of future projects

# TAKE AWAY MESSAGES

ROXAS- quantitative analysis of year rings
 Ideas about dendrochronological research
 From field excursion
 Microcores collection
 Data saving from band dendrometer

Crown projection area measurement

>Professionalism, official rules and norms





## REFERENCES

Von Arx G. 2016. ROXAS 3.0 Reference Manual. Swiss Federal institute for forest, snow, and landscape research. Pp 115.

Springmann S, Rogers B, Spiecker H, 2011. Impact of artificial pruning on growth and secondary shoot development of wild cherry (Prunus avium L.). Forest Ecology and Management 261: 764-769.

Spiecker H. 1991. Zur Steuerung des Dickenwachstums und der Astreinigung von Trauben- und Stieleichen (Quercus petraea (Matt.) Leibl. Und Quercus robbur L.). In: Schriftenreihe der Landesforstverwaltung Baden-Wurttemberg. Band 72. Ministeriumn fur landlichen Raum, Ernahrung, landwirtschaft und Forsten.

Bunn A. 2008. A dendrochronology program library in R (dplR). Dendrochronologia 26: 115–124.

Vitali V. 2017. Silver fir and Douglas fir are more tolerant to extreme droughts than Norway spruce in south-western Germany. (January). Doi: 10.1111/gcb.13774.

Lloret F, Keeling EG, Sala A. 2011. Components of tree resilience: effects of successive low-growth episodes in old ponderosa pine forests. Oikos, 120: 1909–1920. doi: 10.1111/j.1600-0706.2011.19372.x



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