THE TREE RING PROJECT REPORT

Technical school Daruvar
Croatia
(September 2011-September 2013)

Abstract:

The main aim of the Tree Ring Project is to study tree rings and extract information about climate from looking at the light and dark rings of a tree. The general goals of the project were to carry out students’ research projects and work together with the scientists, develop knowledge about each other’s country and school student exchange.

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Research Questions and Hypothesis

What kind of a story can tree rings tell us about the history of an individual tree, of the site and of the climate that influenced its life and growth. Can trees help us understand and reconstruct the climate?

During the research we learned that tree rings form because during each growth season new water and food conducting cells (tracheids) are added around the perimeter of the tree trunk. Cells in the spring growth tend to be larger with thinner walls than the previous set of cells produced at the end of the previous summer. Over the course of the growing season, successive rings of cells become smaller with increasingly thick walls. In winter, growth ceases and no new cells are laid down. Then when the new growing season begins, thin-walled large cells form again producing a clear line between the old wood and the new wood because of the difference in texture. Tree rings provide a record of past climate because their width is determined by tree growth rate, which in turn is determined by environmental conditions. Since one ring is produced every year (usually) the ages of the climatic events can be worked out very precisely by counting back.

Figure 1 – a tree disc of red pine from our school yard used for practice

Data summary:

Our research started with workshops for students at which they were informed about the goals of the Tree Ring Project and they became familiarized with the concepts and principals of dendrochronology and dendroclimatology.

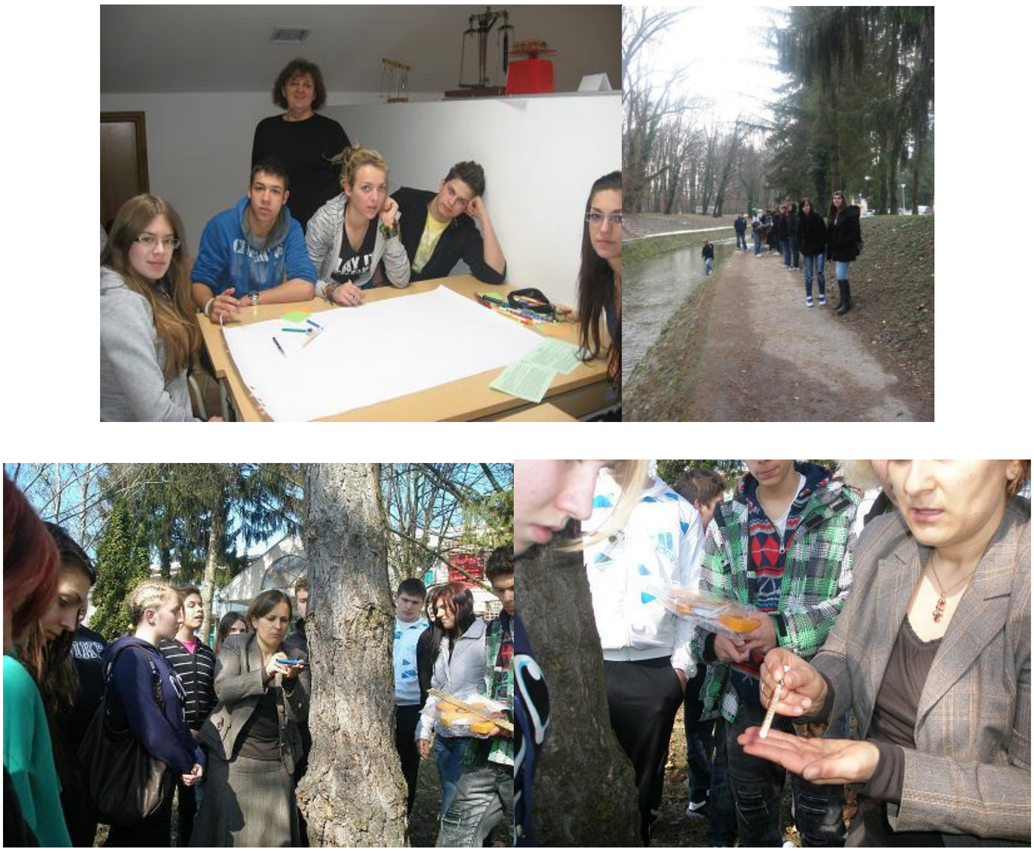


Figure 2 – workshops, coring demonstration, field trips

They practiced coring on different tree species and observed tree rings. Students learned about black pine species which doesn't grow naturally in our environment, Western Slavonia region, and went on field trips in search of pine trees in the surrounding woods. Students inspected tree trunks and attempted to work out the age of the trees by counting the rings. But tree rings tell us much more than the age of individual trees. They provide a year-by-year record of changing climate that can be extended back over centuries, reaching back beyond the beginning of the historical climatic record. This makes them valuable tools for identifying the current trends in climatic change. The trees we used, however, are not very old trees, therefore we could only compare the climatic data of last 50 years.

Figure 3 – black pine forest Dubrava

The students learned that *Pinus nigra* is a tree of the Mediterranean forests, woodlands, and scrub biome. It is found at elevations ranging from sea level to 2,000 metres (6,600 ft), most commonly from 250–1,600 metres (820–5,200 ft). The elevation of our two represetative sites is 400 -500 meters above sea level. *Pinus nigra* is a large coniferous evergreen tree, growing to 20–55 metres tall at maturity. It is moderately fast growing, at about 30–70 centimetres (12–28 in) per year. The trees we used as samples are relatively young trees, 45-50 years old, 15-25 meters high. Their bark is grey to yellow-brown, and is widely split by flaking fissures into scaly plates, becoming increasingly fissured with age. Its shape is pyramidal and dense when young, with age becoming flat-topped, with spreading branches and umbrella shape. The pollen cones appear from May to June. The mature seed cones are 5–10 cm long, with rounded scales. The seeds are dark grey, 6–8 mm long, with a yellow-buff wing 20–25 mm long; they are wind-dispersed when the cones open from December to April. The tree can be long lived, with some trees over 500 years old. It needs full sun to grow well, is relatively adaptable to most soils and is fairly tolerant of heat, snow, ice damage, pollution and urban conditions.

Materials and Methods:

Indoor material: rulers, markers, pencils, magnifying glass, tape measure, paper, tree core plastic holder, calculator, sandpaper, glue, tree core lath, loupe, PC, rubber, graph paper, microscopes.

Outdoor material: increment corer, compass, height measurer, flags, tape measure, plastic straws.

The students used the Internet and literature to find out more about the species, they used GLOBE and Tree ring protocols for defining the site, measuring height of the trees, canopy density, circumference, soil cover, breast height diameter, degree of damage. We followed the skeleton plotting procedure including coring, sanding and preparation for analysis, numbering tree rings, determining the average value after measuring their width, identifying pointer years, recording all data and looking for cross correlation with other trees.

Analysis and Results:
In cooperation with the employees of the local branch of the Croatian Forest Company we identified two stands of black pine in the wider Daruvar area. We explored both locations and soil type and cored 20 trees at two representative locations called Orašje and Dubrave close to the village of Gornji Borki.
The first location called Orašje is 400m above see level. Black pine is not natural species in the area there, but it was intentionally thickly planted along the mixed stands of European beech with some oak, elm, and other conifers. It was planted 50 years ago in the form of lines along the road on the 3-17% slope. It grows on brown soil on limestone and dolomite, with south-southeast exposure with 298m3 of black pine. But there are also solitary trees inside the section. The ground is covered with bushes and thin beech trees.

Description of location 1

- Section: 16b
- Phytocoenoses: beech and woodruff (asperulo-Fagetum prov. Pelcer)
- Soil type: brown soil on limestone and dolomite
- Exposure: south- southeast (microlocation was east- notheast)Area: 20.76ha
- Slope: 3-17%
- Set: thick
- Age: 50 years
- Elevation: 390-500m (microlocation 480-500m)
- Growing stock:2987 m3 (black pine 298m3)

Figure 4 – Black pine location Orašje

The second representative location is called Dubrave and there are pure stands of black pine. It was planted 45 years ago along the road. Black pine is of uniform shape. Closer to the road there are trees of somewhat reduced growth due to shallow soil. Along the northern edge there are other species of beech, hornbeam, cherry and white pine which grow individually or in groups. At this location black pine grows in thick set on brown soil on dolomite on a 3% slope some 430-450 meters above sea level. It contains 378m3 of black pine.

Description of location 2

- Section: 14e
- Phytocoenoses: allochthonous conifer (Pinus nigra)
- Soil type: brown soil on dolomite
- Exposure: southwest- west
- Area: 1.85ha
- Slope: 1-3%
- Set: thick
- Age: 45 years
- Elevation: 430-450m
- Growing stock: 378 m3 (black pine 345m3)

Figure 5 – Black pine location Dubrava

We cored and took samples of 20 trees, measured their height, width at breast hight, analysed the crown, damage, canopy, exposure and state of the whole tree.

Figure 6 - tree data

Tree no.	DBH	H	crown	Comment	No of rings
01 loc 1	122	24	rare	bent, damaged and missing bark	34
02 loc 1	111	25	asymmetrical	30% dry and damaged branches	39
03 loc 1	98	24,5	rare crest	stump forks into two branches	41
04 loc 1	85,5	25,5	small crest	40% damaged branches	41
05 loc 1	107	25	asymmetrical	15% slope, damaged stem, some broken and dead branches	40
06 loc 1	84	17,5	small	20% slope	41
07 loc 2	108	15	asymmetrical	thicker on the southern side	34
08 loc 2	106,5	17,5	rare crest	forks at 2,5m height	35
09 loc 2	80	20	rare	thick stand	33
10 loc 2	78	13	small, dry	forks at 2,28 m	31
11 loc 2	83	17,5	asymmetrical	Bent	37

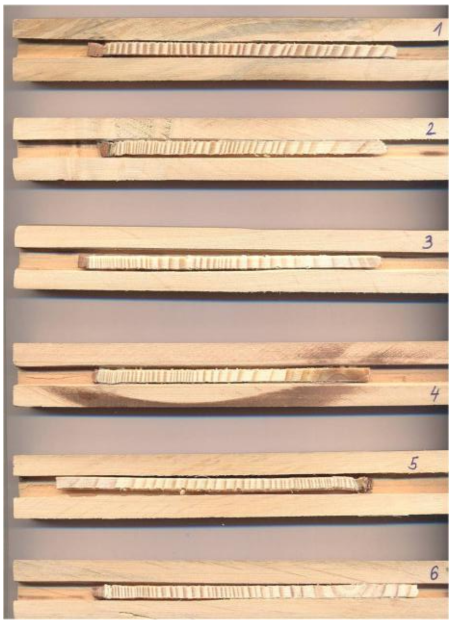
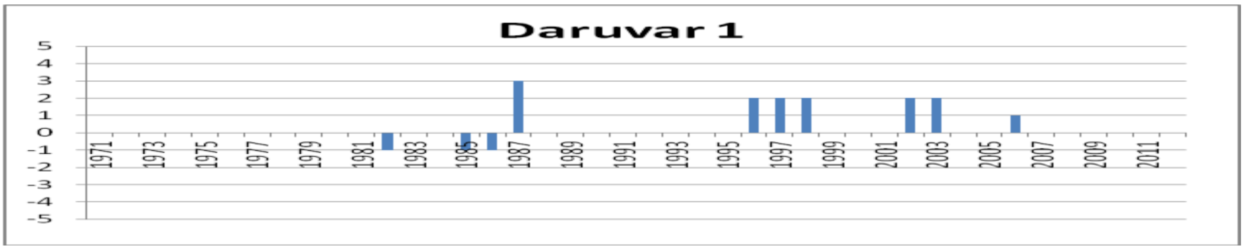
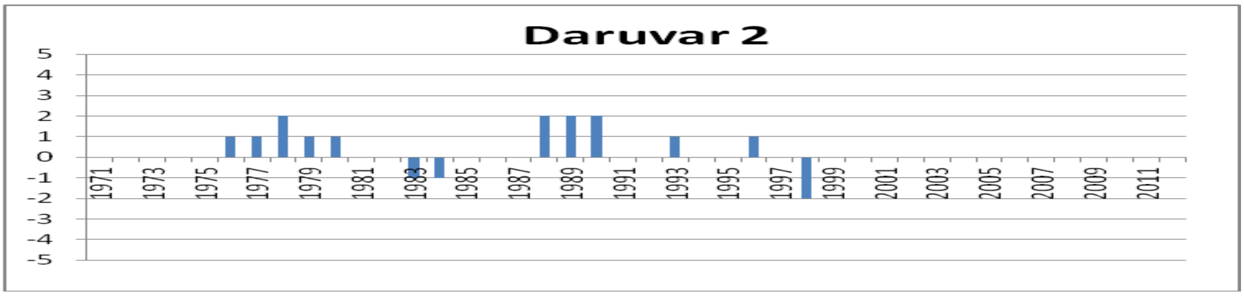


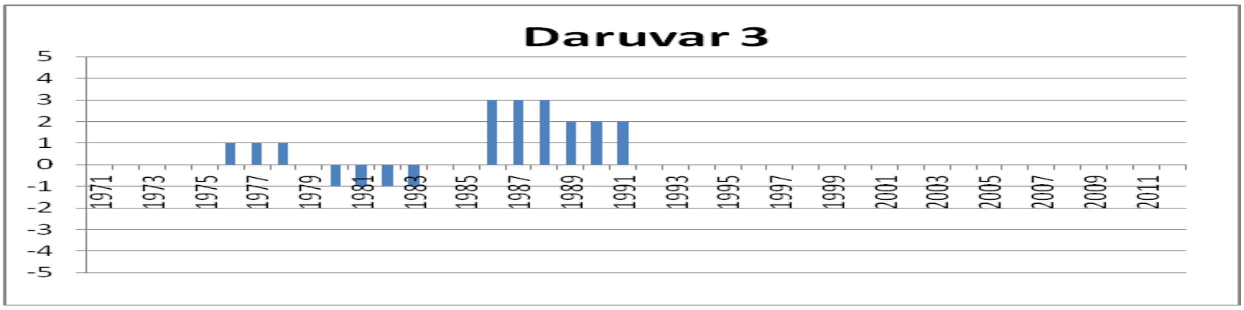
Figure 7 and 8 – samples prepared for skeleton plotting

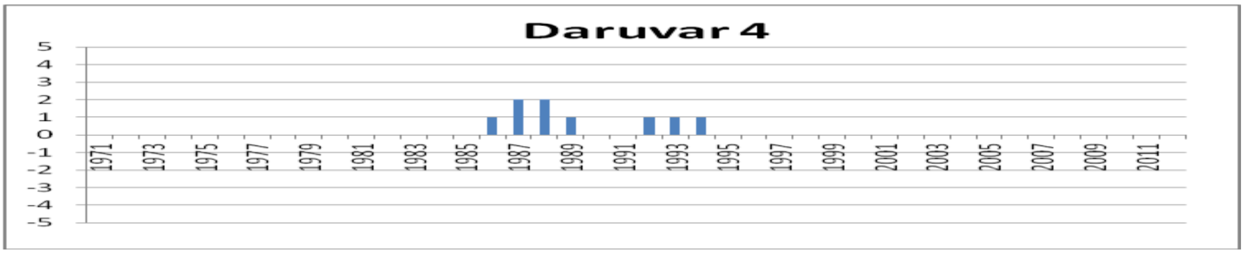
Then we started processing the samples. We sanded them, pasted them onto wooden laths, prepared them for further analysis. We did skeleton plotting: numbered tree rings from pith to bark, whenever possible, and determined the chronology of the tree, measured tree ring width, determined the average value after measuring the width, identified any particularities in the tree rings such as extreme rings, abrupt changes, pointer years, and recorded all data in protocol sheets.

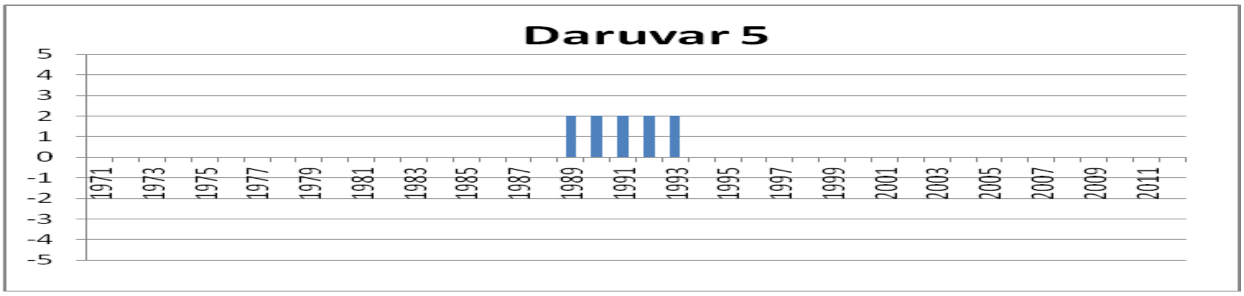
Figure 9 - skeleton plots of 10 samples:

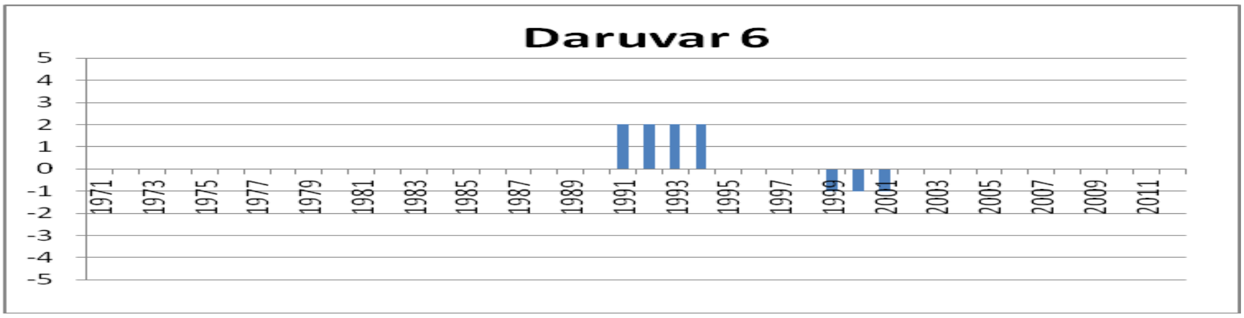








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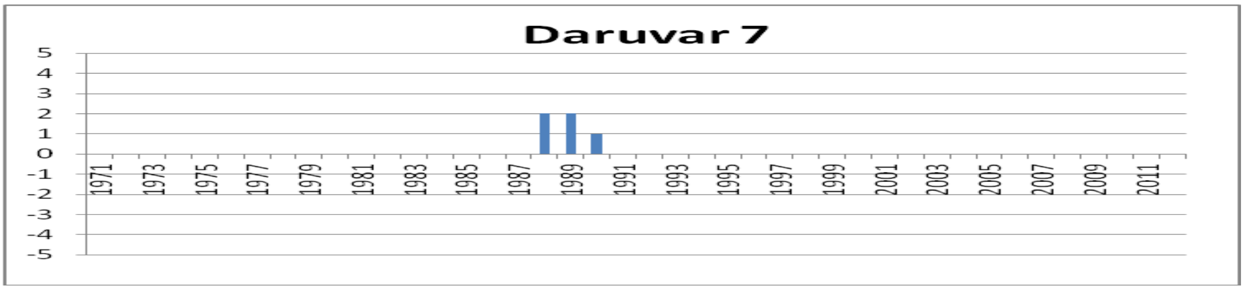
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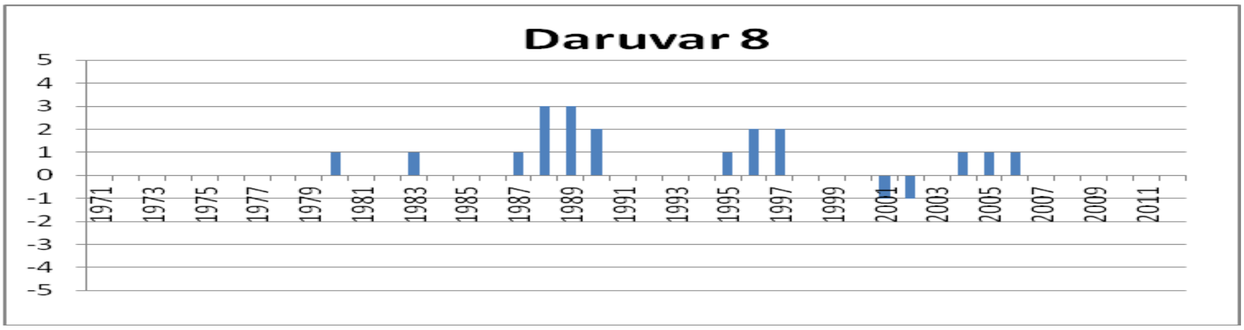
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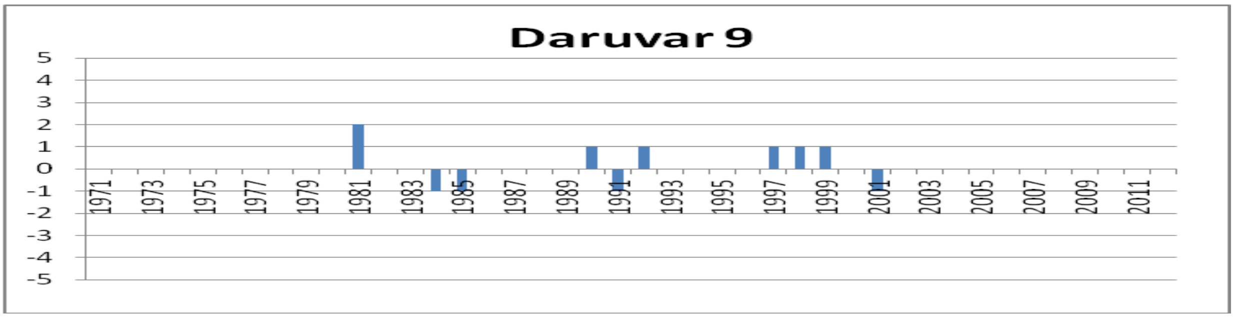
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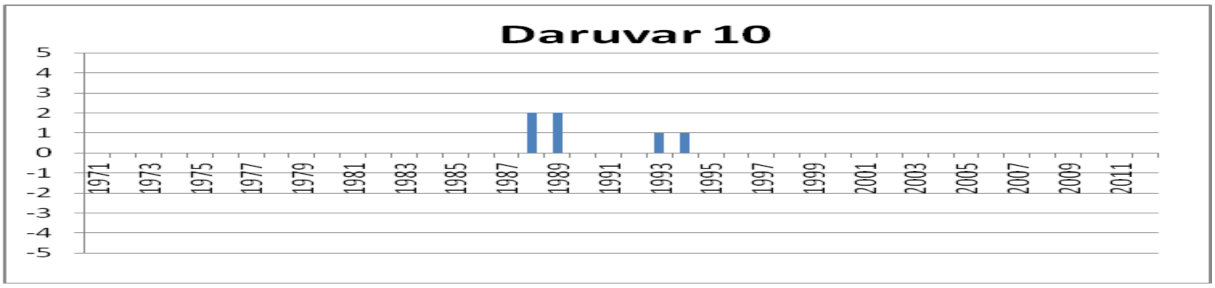
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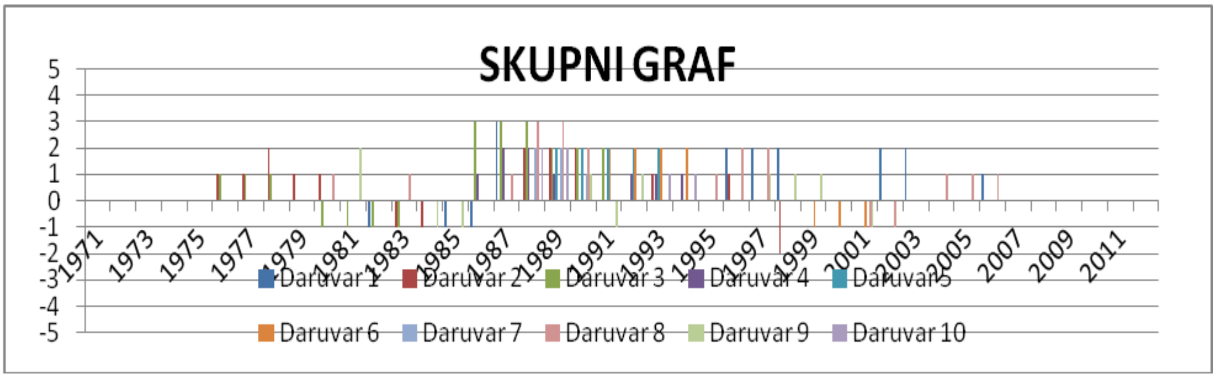
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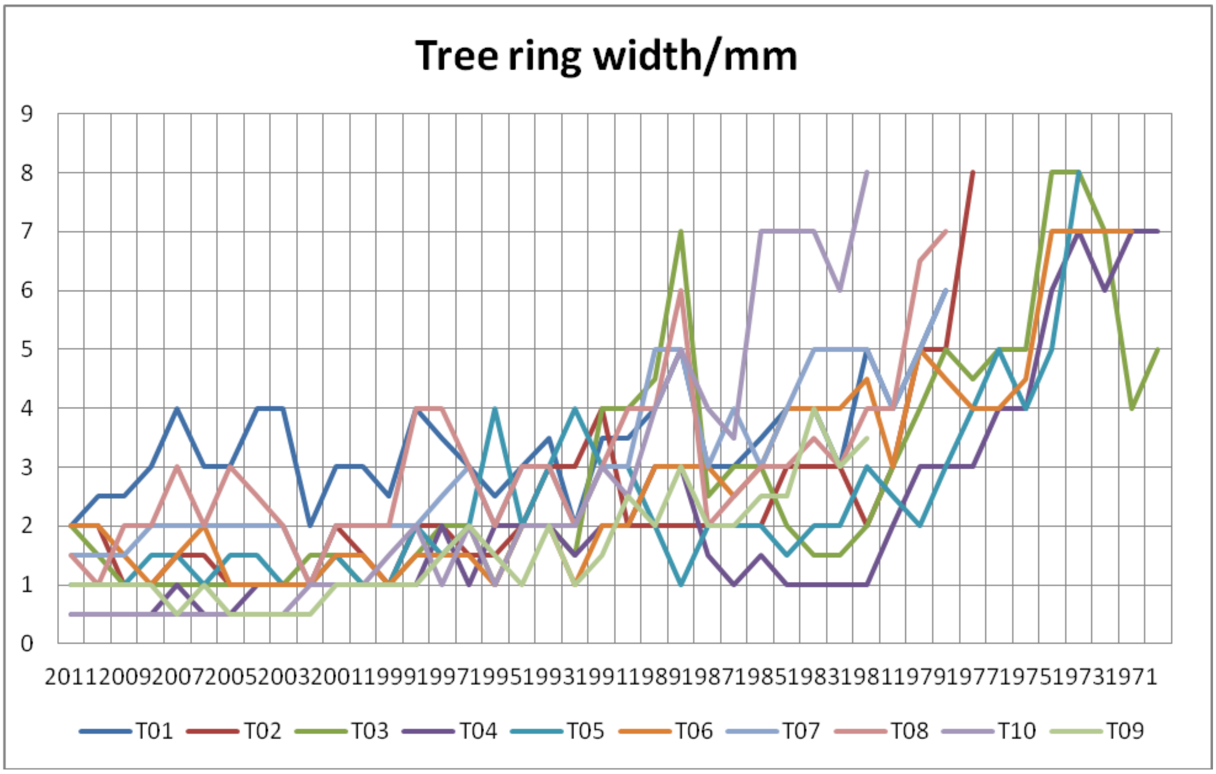
Students measured the width of each tree ring and recorded them in table.

Figure 10– Annual tree ring width /mm

Year	**Tree ring width /mm**									
2012	**T01**	**T02**	**T03**	**T04**	**T05**	**T06**	**T07**	**T08**	**T09**	**T10**
2011	2	2	2	0,5	1	2	1,5	1,5	1	0,5
2010	2,5	2	1,5	0,5	1	2	1,5	1	1	0,5
2009	2,5	1	1	0,5	1	1,5	1,5	2	1	0,5
2008	3	1	1	0,5	1,5	1	2	2	1	0,5
2007	4	1,5	1	1	1,5	1,5	2	3	0,5	0,5
2006	3	1,5	1	0,5	1	2	2	2	1	0,5
2005	3	1	1	0,5	1,5	1	2	3	0,5	0,5
2004	4	1	1	1	1,5	1	2	2,5	0,5	0,5
2003	4	1	1	1	1	1	2	2	0,5	0,5
2002	2	1	1,5	1	1	1	1	1	0,5	1
2001	3	2	1,5	1	1,5	1,5	2	2	1	1
2000	3	1,5	1	1	1	1,5	2	2	1	1
1999	2,5	1	1	1	1	1	2	2	1	1,5
1998	4	2	1,5	1	2	1,5	2	4	1	2
1997	3,5	2	2	2	1,5	1,5	2,5	4	1,5	1
1996	3	1,5	2	1	2	1,5	3	3	2	2
1995	2,5	1,5	1	2	4	1	2	2	1,5	1
1994	3	2	2	2	2	2	3	3	1	2
1993	3,5	3	2	2	3	2	3	3	2	2
1992	2	3	1,5	1,5	4	1	2	2	1	2
1991	3,5	4	4	2	3	2	3	3	1,5	3
1990	3,5	2	4	2	3	2	3	4	2,5	2,5
1989	4	2	4,5	3	2	3	5	4	2	4
1988	5	2	7	3	1	3	5	6	3	5
1987	3	2	2,5	1,5	2	3	3	2	2	4
1986	3	2	3	1	2	2,5	4	2,5	2	3,5
1985	3,5	2	3	1,5	2	3	3	3	2,5	7
1984	4	3	2	1	1,5	4	4	3	2,5	7
1983	4	3	1,5	1	2	4	5	3,5	4	7
1982	3	3	1,5	1	2	4	5	3	3	6
1981	5	2	2	1	3	4,5	5	4	3,5	8
1980	4	3	3	2	2,5	3	4	4		
1979	5	5	4	3	2	5	5	6,5		
1978	6	5	5	3	3	4,5	6	7		
1977		8	4,5	3	4	4				
1976			5	4	5	4				
1975			5	4	4	4,5				
1974			8	6	5	7				
1973			8	7	8	7				
1972			7	6		7				
1971			4	7		7				
1970			5	7						

The students plotted the ring-width data (on the y-axis) against time (on the x-axis).
Figure 11 - Graph of tree ring width against year



The width of a tree ring shows the amount of growth that has taken place during one year and thus indicates the growing conditions for that year. When the conditions are good the tree grows faster and so lays down more tissue in the year, resulting in a wider growth ring. Poor conditions mean slower growth, less tissue laid down and consequently a narrower ring.
By comparing pointer years we tried to cross-date samples and confirm the stories of individual trees growing in the same climate conditions.

During the reasearch students learned that tree growth can be affected by climatic cycles and seasonal cycles. Once the skeleton plotting of samples was finished, we tried to find correlations between enhanced or reduced growth and available climate records. We also used data that has been collected and recorded by Technical school Daruvar that is closest to both representative locations. Here is an example of average monthly temperatures for year 2001.

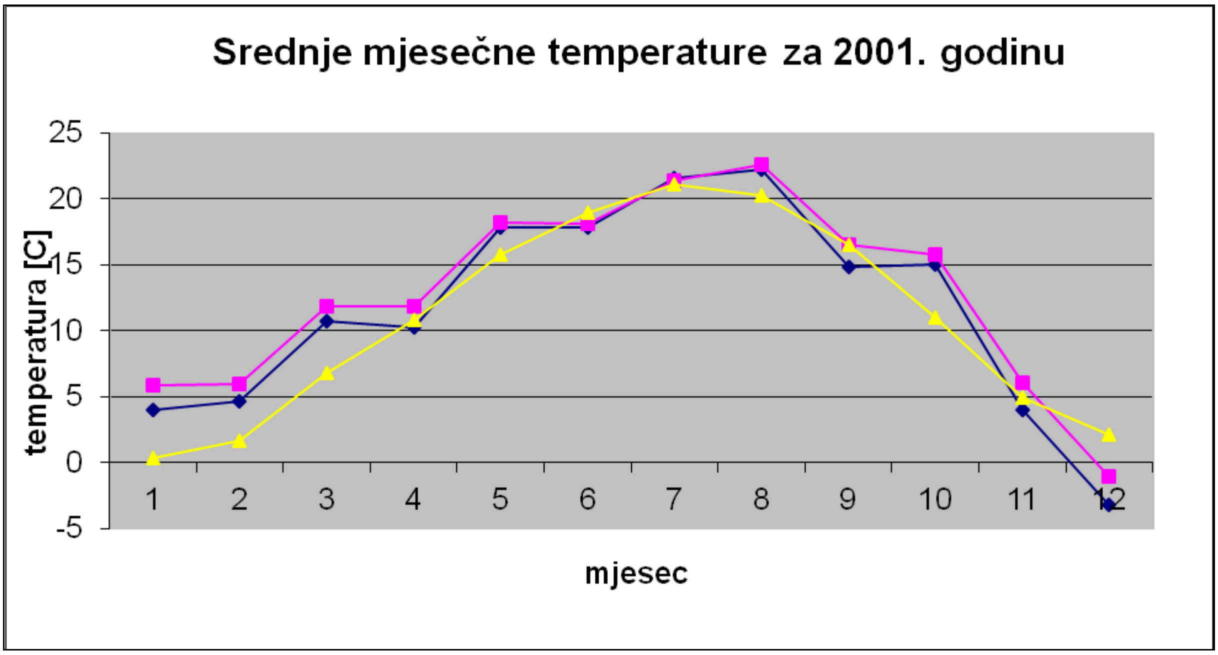


Figure 12 – average monthly temperature in 2001

As another example, here are the data for August 2001, the hottest month of the year.

Figure 13 –August 2001 data

DATE	LAT	LON	ELEV	SCHOOL	SITE	TCUR	TMAX	TMIN	
20010801	455.975	172.214	170	3c1RvNI	ATM-01	28	33	16	24,5
20010802	455.975	172.214	170	3c1RvNI	ATM-01	27	32	16	24
20010803	455.975	172.214	170	3c1RvNI	ATM-01	29	34	18	26
20010804	455.975	172.214	170	3c1RvNI	ATM-01	32	37	19	28
20010805	455.975	172.214	170	3c1RvNI	ATM-01	25	29	20	24,5
20010806	455.975	172.214	170	3c1RvNI	ATM-01	22	26	18	22
20010807	455.975	172.214	170	3c1RvNI	ATM-01	26	30	15	22,5
20010808	455.975	172.214	170	3c1RvNI	ATM-01	27	32	15	23,5
20010809	455.975	172.214	170	3c1RvNI	ATM-01	26	34	16	25
20010810	455.975	172.214	170	3c1RvNI	ATM-01	32	37	18	27,5
20010811	455.975	172.214	170	3c1RvNI	ATM-01	15	18	14	16
20010812	455.975	172.214	170	3c1RvNI	ATM-01	19	23	9	16
20010813	455.975	172.214	170	3c1RvNI	ATM-01	21	26	8	17
20010814	455.975	172.214	170	3c1RvNI	ATM-01	23	29	11	20
20010815	455.975	172.214	170	3c1RvNI	ATM-01	26	31	14	22,5
20010816	455.975	172.214	170	3c1RvNI	ATM-01	26	31	15	23
20010817	455.975	172.214	170	3c1RvNI	ATM-01	26	31	15	23
20010818	455.975	172.214	170	3c1RvNI	ATM-01	26	32	16	24
20010819	455.975	172.214	170	3c1RvNI	ATM-01	27	33	15	24
20010820	455.975	172.214	170	3c1RvNI	ATM-01	27	33	17	25
20010821	455.975	172.214	170	3c1RvNI	ATM-01	23	29	19	24
20010822	455.975	172.214	170	3c1RvNI	ATM-01	21	27	17	22
20010823	455.975	172.214	170	3c1RvNI	ATM-01	23	28	17	22,5
20010824	455.975	172.214	170	3c1RvNI	ATM-01	23	25	16	20,5
20010825	455.975	172.214	170	3c1RvNI	ATM-01	24	30	15	22,5
20010826	455.975	172.214	170	3c1RvNI	ATM-01	27	31	16	23,5
20010827	455.975	172.214	170	3c1RvNI	ATM-01	26	31	16	23,5
20010828	455.975	172.214	170	3c1RvNI	ATM-01	19	22	17	19,5
20010829	455.975	172.214	170	3c1RvNI	ATM-01	21	27	14	20,5
20010830	455.975	172.214	170	3c1RvNI	ATM-01	21	25	8	16,5
20010831	455.975	172.214	170	3c1RvNI	ATM-01	16	19	12	15,5

Conclusions:

Geographically, Western Slavonia region of Croatia is a mixture of continental climate, mountain climate and Mediterranean influence from the Adriatic sea. Pinus nigra can grow on extreme sights and has good response to climate and reaches ages up to 500years. It tolerates summer droughts and high temperatures but doesn't tolerate drought during early spring well. Summer sunshine is tightly connected with moisture stress in trees, so the width of annual tree rings is under the influence of the direct and interactive effects of sunshine duration (temperature, precipitation, cloud cover and evapotranspiration).

Black pine generally reacts positivelly to January –April temperatures. There is significant negative correlation with mean June-August sunshine hours from Osijek meteorological station. The June-July period is the most important part of the growing season for the tree ring formation beacuse of the moisture stress. To conclude, black pine experieces good growth after a warm but also moist spring, especially when followed by a cool and moist summer. If the summer is hot and dry, pine trees react negativelly because of drought conditions and stops growing.

However, there are other factors that may have influenced growth of certain trees such as fires, pollution, erosion, landslides. Certain factors influencing tree growth may be very local in effect. A landslide or erosion for example might only affect one tree in a woodland, so it might give a narrow ring for a year when other trees just a little bit further away have a wide ring.

Since the trees are of the same species and all grew under similar conditions the tree-rings are expected to be the same distance apart in the same year. Skeleton plot of analysed samples proved certain growth patterns in representative trees. All trees show fast growth of young trees that lasts for some 13-14 years. Then the distance between annual tree rings decreases and becomes more dense. Most trees indicate positive event years and enhanced growth of the late 1980s (1987 – 1990), as well as late 1990s (1996-1998). Negative event years cannot be qualified as a pattern but some trees reponded negativelly to early 1980s period and show reduced growth. Other negative events are mostly sporadic and probably related to individual tree stess such as heavy snow causing damage to branches and crown or certain desease or blight. During our field visits to both locations we spotted many forked and damaged trees which are direct results of mechanical damage caused by severe winter weather conditions. Generally, most samples taken from two representative locations of Orašje and Dubrava are relativelly complacent and show low degree of annual variation.The rings are roughly the same for many years consecutivelly and limiting growth factor is not variable from year to year.

References:

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Long-term summer sunshine/moisture stress reconstruction from tree-ring widths from Bosnia and Herzegovina – S.Poljanšek, A. Ceglar, and T. Levanič, Slovenian Forestry Institute, Clim. Past, 9, 27-40, 2013.