

SP-PAM

User Manual Version 2.0

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Application and Structure

The SP-PAM system is designed for analysis of stress periods in tree growth. It consists of two parts:

1. Desktop Application.

2. Web Application.

Chapter Two describes the functions of the desktop application and Chapter Three of the web application.1.

1. Main Definitions

1.1 Stress periods

Tree rings are a reliable sistem for storing information about the event and the influence of environmental factors on growth.

The samples for the dendrohronological analysis were taken from dominant tree species in forest communities. Sampling is performed with Preslerov drill at 1 - 1,5 m. and the width of each ring is measured. The measurement result is obtained from the ordered sequence (year, latitude) probed for each individual as shown in Figure 1.



Figure 1 Change in the annual tree ring widths

The obtained data is used as an input for the regression analysis. The purpose of the regression analysis is to find a polynomial that approximates the best data from a dendrohronological row. Criterion of proximity of the approximative polynomials to the initial data is given by the determination coefficient h R² ($0 \le R^2 \le 1$). Bigger values of R² mean bigger approximation.

After calculating the approximated values the index values are calculated as a relationship to the approximated value of width for each year. Figure 3 shows a graph of the calculated indices compared to the measured ones shown on Figure 2. When the index value is outside of the acceptable range for normal values say that the year in which it is observed, is a stressful year for the growth. The sequence of one or more adjacent stress years is perceived as stress period. Each stress period is set by a couple years - the initial year (LB) and the end year (RB) sequence. When the stress period consists of one year the right and left border is the same.



Figure 2 Measured and approximated annual tree ring widths



Figure 3 Indexes calculated through regression analysis

1.2 Stress years and Stress periods

Measurement of the stress periods of an individual sample of a species is not sufficient to conclude on the type of stress. Obviously it is necessary to find a common stress periods for a greater number of speciments of the same species.

Let A indicate the stress periods for one dendrohronological row:

(1) $A = \{ SI_i, i = 1n, \},$

where SI_i are the specific stress years. The stress years could be arranges in an increasing order i.e. in the multitude of A there is a specific order. S indicates the multitude of all multitudes of stress years for the sampled tree specimens from the same species:

(2) S = {A_i i \in {1 ... n} }, where A_i are the multitudes of stress years of separate dendrohronological rows;

 \Re represents a multitude of sections of stress years.

(3) $\Re = \{I \mid I = \{SI_{i1}^{j1}, SI_{i2}^{j2}, ..., SI_{ik}^{jk}\}: SI_{i1}^{j1} \cap SI_{i2}^{j2} \cap ... \cap SI_{ik}^{jk} \neq \emptyset \text{ where } SI_{i1}^{j1} \in A_{i1}^{j1}, ..., SI_{ik}^{jk} \in A_{ik}^{jk} \land A_{ik}^{jk} \in S \land \neg \exists SI_{im}^{jm} \in Ai_m \text{ where } i_m \notin \{i_1, ..., i_k\} \text{ such that } SI_{im}^{jm} \cap SI_{i1}^{j1} \cap SI_{i2}^{j2} \cap ... \cap SI_{ik}^{jk} \neq \emptyset \}.$ This means that each element consists of multitudes of separate stress years from dendrohronological rows $A_i \in S$, which contain stress years with total non-empty section. For brevity sections of stress years will be called stress years. Sections that have consecutive years we would call stress periods. Stress periods characterize with the following parameters - cardinality (CARD), left border year (IL), right border year (IR), coverage (CO), confidence interval, standard deviation μ alpha \mathcal{A} . With cardinality we denote the number of the separate stress periods that belong to stress section I $\in \Re$. The coverage (CO, %) is the relation between the cardinality and the number (N) of all dendrohronological rows Ai such as :

 $EY_i \leq IL \leq IR \leq LY_i$, where $EY_i \mu LY_i$ are the earliest and the latest years from A_i.

(3) CO = 100*CARD/N

With (IM) we denote the middle of each stress period.

(4) IM = (LB + RB + 1)/2.

The average values of the midpoints are denoted with M and

$$M = \frac{1}{s} \sum_{i=1}^{s} N_{i}$$

where IM_i are the midpoints of the separate stress periods, constructing the stress section. The standard deviation (STD) is the standard deviation of the midpoints IM_i of the separate stress periods.

(MINT) is the middle of the shared interval..

AMPL is the amplitude (depth) of the stress.

(5) $AMPL = \frac{1}{s} \sum_{i=1}^{s} (1 - IND_i)$ where IND_i are the middle indexes of the stress years of the shared

period and belong to the respective dendrohronological rows.

2. Description of the desktop application

2.1 Application purpose

The main purposes of the application are:

- 1. Locating sections of stress periods for each type of wood, for which data exists, and the characteristics that are described above.
- 2. Providing statistical information for the studied tree species.
- 3. Regression analysis of the calculated indices relative to the climatic data.

2.2 Language for input data description

Application input data.

Each line begins with a description of the keyword. Each keyword is followed by zero or more parameters. The description of the keywords and their importance and the related parameter follow.

SPECIMEN = {name and species} / {ROW| INDX} – specifies the name of the specific instance of which the dendrohronological row is measured / means that an option is set for the data type. ROW is a data option from the type year and tree ring width. INDX denotes indexes, and not tree ring widths. Mandatory keyword.

NROWS = {number of rows} – denote the number of rows that set the measured dendrohronological row.

RAW = {year} {tree ring width} – denotes a paired data sets describing the dendrohronological row. The width of annual rings is a real number.

INDX = {year, index} - denotes a paired data sets describing the indexes of the dendrohronological row.

An Example of input data is shown below:

SPECIMEN = C	SPECIMEN = Chuprene 2 /RAW					
NROW	VS = 34					
RAW = 1968	1,19					
RAW = 1969	0,935					
RAW = 1970	0,73					
RAW = 1971	0,685					
RAW = 1972	0,715					
RAW = 1973	0,57					
RAW = 1974	0,52					
RAW = 1975	0,535					
RAW = 1976	0,505					
RAW = 1977	0,575					
RAW = 1978	0,885					
RAW = 1979	0,88					
RAW = 1980	0,835					
RAW = 1981	0,735					
RAW = 1982	0,865					
RAW = 1983	0,89					

Table 1 Example description of dendrohronological rows of Fagus sylvatica L.

2.3 Results Description.

The processing of input data is performed in two stages. The first one is pre-processing or compilation and the second is finding the stress sections. In both stages the results from the processing of input or intermediate data are displayed.

While compiling the following operations on the input data are performed:

1. Read the data and check for errors. For ease of use of the application and reducing error messages all lines starting with undefined keywords are ignored.

2 . Find the equations of polynomials approximating each dendrochronology . Selection of the polynomial approximating the best data by each of them. Dendrochronology for which R2 is less than 0.45 are rejected as unreliable. Calculating the indices of the dendrohronological rows which are considered as reliable.

3 . Calculating all the best formulas and the corresponding values of R2 by type , area of sampling , individual. Calculating the average of the indices of reliable dendrohronological ranks. Calculating the correlation coefficients between the indices of reliable dendrohronological ranks.

4. Calculating the autocorrelation matrix of the width of annual growth rings for the location.

5. Calculation of the correlation matrix between the indices of the rows of the location.

6 . Analysis of these climate data and calculated indices in the manner in which they are calculated for the width of the annual rings.

7. Determine the type of each climate year.

Table 2 shows an example result of an analysis.

Table 2 Analysis result

Species	Fagus sylvatica		
	Type of		
Specimen	Approximation	Formula	R^2
Western Bal	lkan 1		
1	Linear	-0.00090872x+1.9134	0.14923
	Polynomial of		
2	2th degree	-4.9846e-05x^2+0.19299x^1-186.61	0.47914
	Polynomial of		
3	3th degree	-5.959e-07x^3+0.0034272x^2-6.5689x^1+4196.1	0.51253
	Polynomial of		
4	4th degree	+4.6505e-08x^4-0.0003624x^3+1.0589x^2-1374.9x^1+6.6932e+05	0.65468
	Polynomial of	-6.7204e-10x^5+6.5821e-06x^4-0.025784x^3+50.495x^2-	
5	5th degree	49440x^1+1.9361e+07	0.67529
	Polynomial of	+1.0217e-11x^6-1.199e-07x^5+0.0005863x^4-1.529x^3+2242.9x^2-	
6	6th degree	1.7547e+06x^1+5.7195e+08	0.67859
	Polynomial of	+5.8862e-13x^7-8.0038e-09x^6+4.6639e-05x^5-	
7	7th degree	0.15097x^4+293.21x^3-3.4164e+05x^2+2.2113e+08x^1-6.1338e+10	0.68547
	Polynomial of	-4.5315e-15x^8+7.1099e-11x^7-4.8798e-07x^6+0.0019136x^5-	
8	8th degree	4.6893x^4+7353.4x^3-7.206e+06x^2+4.0347e+09x^1-9.8819e+11	0.68572

Year	Measured data	Approximation	Index
1893	0.24	0.23193	1.0348
1894	0.23	0.22205	1.0358
1895	0.2	0.20569	0.97234
1896	0.145	0.19299	0.75132
1897	0.16	0.17737	0.90208
1898	0.155	0.16248	0.95399
1899	0.145	0.15344	0.94498
1900	0.13	0.14282	0.91022
1901	0.13	0.1322	0.98334
1902	0.135	0.12317	1.0961

Table 3 shows the calculated statistics by species, sampling region and individual. The first column is the name of the sampling region. The second – the names of the respective individuals. In the third – the equations of the best approximating polynomials for all dendrohronological rows. The forth column contains R^2 .

	a .		Best approximation		Average	Number of
Location	Specimen	Best approximation polynomial	R^2	Year	index	samples
Western Ba	alkan	4 5215 15 40 5 1000 11 45 4 0500				
	XX	-4.5315e-15x^8+7.1099e-11x^7-4.8798e-				
	Western	07x^6+0.0019136x^5-4.6893x^4+7353.4x^3-	0 (0572)	1002	1 0240	1
	Balkan 1	7.206e+06x^2+4.0347e+09x^1-9.8819e+11	0.68572	1893	1.0348	1
	XX	+1.157e-13x^7-1.5473e-09x^6+8.8628e-06x^5-				
	Western	0.028185x^4+53.744x^3-61444x^2+3.8998e+07x^1-	0 20222	1004	1 0259	1
	Balkan 2	1.06e+10	0.38323	1894	1.0358	1
	Western	+2.8837e-09x^6-3.4209e-05x^5+0.16909x^4- 445.74x^3+6.6095e+05x^2-				
	Balkan 3	5.2269e+08x^1+1.7223e+11	0.63614	1895	0.97234	1
	Daikali 5	+6.3521e-09x^6-7.5331e-05x^5+0.37223x^4-	0.03014	1895	0.97234	1
	Western	980.95x^3+1.4541e+06x^2-				
	Balkan 4	1.1496e+09x^1+3.7869e+11	0.65495	1896	0.75132	1
	Daikaii 4	-6.8493e-12x^7+9.3757e-08x^6-	0.03495	1090	0.75152	1
	Western	$0.00055x^5+1.7924x^4-3504.6x^3+4.1113e+06x^2-$				
	Balkan 5	2.6794e+09x^1+7.4831e+11	0.2675	1897	0.90208	1
	Western	+2.1851e-10x^6-2.5732e-06x^5+0.012625x^4-	0.2075	1077	0.90200	1
	Balkan 6	33.037x^3+48627x^2-3.8172e+07x^1+1.2485e+10	0.53053	1898	0.95399	1
	2 4111411 0	-2.4027e-12x^7+3.2805e-08x^6-	0.000000	1070	0.70077	-
		0.00019194x^5+0.62389x^4-				
	Western	1216.6x^3+1.4234e+06x^2-				
	Balkan 7	9.2515e+08x^1+2.5768e+11	0.50751	1899	0.94498	1
		-3.0122e-13x^7+4.108e-09x^6-2.4008e-				
	Western	05x^5+0.077943x^4-151.81x^3+1.774e+05x^2-				
	Balkan 8	1.1516e+08x^1+3.2035e+10	0.45368	1900	0.84806	3
	Western	-1.251e-12x^7+1.7125e-08x^6-	0.37904	1901	1.0409	4

Table 3 Statistics generated during input data compilation stage.

Ba	alkan 9	0.00010046x^5+0.32737x^4-				
		640.06x^3+7.5082e+05x^2-				
		4.8927e+08x^1+1.3664e+11				
		-6.9723e-12x^7+9.5438e-08x^6-				
		0.00055986x^5+1.8245x^4-				
W	estern	3567.3x^3+4.1847e+06x^2-				
Ba	alkan 10	2.7271e+09x^1+7.6164e+11	0.26156	1902	1.0219	4
W	estern	+2.6176e-10x^6-3.1084e-06x^5+0.01538x^4-				
Ba	alkan 11	40.581x^3+60227x^2-4.767e+07x^1+1.572e+10	0.47527	1903	1.0798	4
		-1.215e-11x^7+1.6753e-07x^6-				
		0.00099002x^5+3.2501x^4-				
W	estern	6401.5x^3+7.565e+06x^2-				
Ba	alkan 12	4.9664e+09x^1+1.3973e+12	0.31843	1904	1.0259	4

Table 4 shows the matrix of correlation coefficients between the indexes of the reliable dendrohronological rows.

Table 4 Correlation coefficients of dendrohronological rows indexes.

			Correlation coefficients	
	Wester	Western Balkan 3	Western Balkan 4	Western Balkan 6
Western Balkan 1		0.52	0.26	0.04
Western Balkan 3			0.15	0.11
Western Balkan 4				0.16

For each sampling region (location) additional average characteristics are shown:

- Location name.
- Sampled species names.
- Equation of the best approximating polynomial for each individual.
- Relative value of R².
- Average indexes, resulting from the reliable dendrohronological rows, specified for the species year, average index, row number, for which the average index is calculated.

Table 5 shows a sample location characteristic.

Locatio n Petroha n	Specimen	Best approximation polynomial	Best approximatio n R^2	Yea r	Averag e index	Numbe r of sample s
11	Petrohan_ 1	+8.9744e-05x^5-0.86219x^4+3313.3x^3- 6.3663e+06x^2+6.1163e+09x^1-2.3504e+12 -5.0641e-05x^5+0.48668x^4-	0.19298	191 7	0.9932 8	2
	Petrohan_	-5.0041e-05x^5+0.48008x^4- 1870.9x^3+3.5959e+06x^2-		191	0.9528	
	2	3.4558e+09x^1+1.3285e+12 -0.00078462x^5+7.539x^4-	0.80171	8	6	2
	Perohan_	28975x^3+5.5681e+07x^2-		191	0.9530	
	3	5.3501e+10x^1+2.0563e+13	0.82908	9 192	6	2
				0 192	1.0897 0.7350	2
				1 1 192	7	2
				192 2 192	1.0833	2
				192 3 192	1.1631	2
				192 4 192	0.8454	2
				192 5 192	1.0482 0.8945	2
				192 6	0.8945	2

Also the following characteristics are displayed:

- The equations of approximative polynomials in temperature and precipitation.
- Suitable values of R2.
- For each year for which data are available for widths of annual rings, temperature and precipitation, the following information appears - year average index of the width of annual rings dendrohronologichnite forefront of location, temperature index, rainfall and type of the year. Type of year for short is specified as - the first letter may be N - normal year, W - warm year or C - cold year and the second N - normal year, W - wet year or D - dry year. These labels depend on the value of the corresponding index.

Climate	Width	Temperature -3.4253e-11x^7+4.703e-07x^6-	Precipitation +2.9087e-10x^7-3.9574e-06x^6+	Type of year
		0.0027673x^5+9.0459x^4- 17741x^3+2.0876e+07x^2-	0.023072x^5-74.722x^4+1.4518e+ 05x^3-1.6924e+08x^2+1.0958e+	
Polynomi	al	1.3646e+10x^1+3.8228e+12	11x^1-3.0408e+13	

R^2		0.054965		0.15249	
	Width				
Year	index	Temperature index	Precipitation index		
1917	0.99328	1.0159		0.92622	NN
1918	0.95286	0.97602		1.0731	NN
1919	0.95306	1.011		1.2981	NW
1920	1.0897	0.9785		0.66689	ND
1921	0.73507	0.97166		1.053	NN
1922	1.0833	0.99343		0.86377	NN
1923	1.1631	1.0499		1.2729	NW
1924	0.8454	0.97775		0.99302	NN
1925	1.0482	1.0152		0.90687	NN
1926	0.89455	1.0443		0.84161	NN

After approximation and filtering of the input data the second stage of processing begins. During this stage the following operations on the intermediate reliable dendrohronological data are performed:

1. Locating the stress section and calculation of the statistical characteristics.

2. Calculating the statistical characteristics of dendrohronological rows separately by area of sampling and the species as a whole.

Stress sections and statistical data

Table 7 a and b shows a sample excerpt of a part of a description of a stress section. Columns (a) show the species name, number, name of the dendrohronological rows, first and last years of the dendrohronological rows, the stress period which is part of the section, amplitude of the shared stress period, cardinality, coverage, middle of the total period, standard deviation, confidence interval, α , intersection and union of the stress periods.

			Earlie	st					
Pinus nigra	No	Specimen	Year	La	test Year Inter	rval	А	mplitude Ca	ardinality
		1Vitosha 1		1901	2000	1968	1972	0.204798	22
		Vitosha 2		1906	2000	1968	1974	0.181296	
		Vitosha 4		1903	2000	1968	1973	0.104699	
		Vitosha 6		1895	2000	1968	1969	0.277354	
		Vitosha 7		1909	2000	1968	1970	0.021656	
		Vitosha 8		1914	2000	1966	1976	0.1808	
		Vitosha 10		1912	2000	1966	1970	0.280289	
		Vitosha 11		1949	2000	1965	1969	0.066499	

Table 7 a Stress sections and statistical data.

Table 7 b Stress sections and statistical data (continued)

Cove	erage		Standard						
%		Mean	deviation	Confidence	Alpha	Intersection	τ	Jnion	
	81.48	1968	1.708	16	0.25	1968	1968	1962	1978

The statistics related to the stress periods of the dendrohronological sequences are shown in Tables 8a and b. These include the period of each dendrohronological row, the number of stress periods, frequency of stress periods, calculated for 100 years, the average amplitude, the largest amplitude, the average length of the stress period, the longest stress period - initial and final year. The same data - aggregated and averaged are calculated and for the specific species sampling location.

Fagus sylvatica					
			Number of stress		
	Period		periods		Frequency
Petrohan					
Petrohan_2	1900	1909		5	50
Perohan_3	1900	1909		3	30
Average per Location	1900	1909		4	40
Boishte					
Boishte_1	1913	1922		3	30
Average per Location	1913	1922		3	30
Gabra					
Gabra_1	1900	1909		5	50
Gabra_2	1900	1909		3	30
Average per Location	1900	1909		4	40
Average per Species	1900	1922		3.667	36.67

Table 8 a Statistics connected to the stress periods of dendrohronological rows.

Table 8 b Statistics connected to the stress periods of dendrohronological row (continued).

Average amplidude	Highest amplitude	;	Average period	Longest str period	ess	Longest stress period length	
0.1094	1907	0.1904	1.2	1906	1907		2
0.2245	1907	0.4585	2.667	1900	1902		3
0.1669	1907	0.4585	1.933	1900	1902		3
0.05989 0.05989	1915 1915	0.103 0.103	2 2	1918 1918	1920 1920		3 3
0.1094	1907	0.1904	1.2	1906	1907		2
0.2245	1907	0.4585	2.667	1900	1902		3
0.1669	1907	0.4585	1.933	1900	1902		3
0.1313	1907	0.4585	1.956	1900	1902		3

2.4 Desktop application functions description

Figure 4 shows a general view of the application. The desktop application is a table containing the results from the processing of the input data.

🔲 Un	titled - SP - PAM							- 🗆 ×
<u>Fi</u> le <u>E</u> o	lit <u>S</u> tatistics <u>R</u> egre							
	Ø 🛃 🖬 🛛	🗇 🖻 📐	. >					
	1	2	3	4	5	6	7	<u> </u>
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								-
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11								

Figure 4 Overall application view.

With marking the cells or part or them the marked area could be copied Ctrl C on the clipboard and subsequently transferred into Excel, Open Office Calc or another application.

2.4.1 File manipulation functions

The file functions menu is shown in Figure 5. New input description opens with the sequence: File -> New description - a file choice dialog appears, as shown on Figure 6.

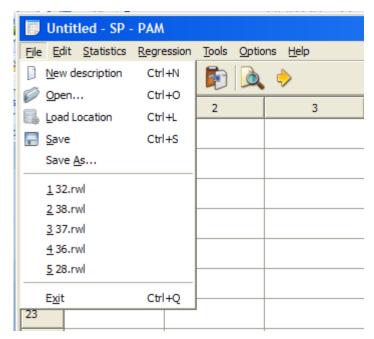


Figure 5 File manipulation menu.

If the function New Description is selected a dialog for file choice appears, containing a description of rows of tree ring widths from a location, as shown on Figure 6.

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<u>Fi</u> le <u>E</u> di	t <u>S</u> tatistics <u>R</u> egression <u>T</u> ools <u>O</u> ptions <u>H</u> elp			
	1 2 3 4 5	6	7	
1	Open new desctription ? ×			
2	Look in: 🔁 SPPAM 🔽 🛍 🖝 🖽 🗸			
3	SampleData1 Ø 8.rwl Ø 16.rwl Ø 24.rwl □ 1.txt Ø 9.rwl Ø 17.rwl Ø 25.rwl			
4	🗒 2.txt 🕑 10.rwl 🕑 18.rwl 🕑 26.rwl			
5	Ø 3.rwl Ø 11.rwl Ø 19.rwl Ø 27.rwl Ø 4.rwl Ø 12.rwl Ø 20.rwl Ø 28.rwl			
6	Ø 5.rwl Ø 13.rwl Ø 21.rwl Ø 29.rwl Ø 6.rwl Ø 14.rwl Ø 22.rwl Ø 30.rwl			
7	Ø 7.rwl Ø 15.rwl Ø 23.rwl Ø 31.rwl			
8				
9	File name:			
10	Files of type: Description files (*.txt *.rwl)			
11				
12				
13				_
		1	<u> </u>	
11		-		_//_

Figure 6 File choice with input description dialog.

Users can choose two types of input description formats – description, which is standa5rd for the application(.txt extention) and a description which is specific to some dendrohronological databases (.rwl extention). Table 9 shows an example of an .rwl description of the tree rings. The .rwl format is the de facto standard for the description of the measurements of widths of annual rings.

626	1 Blumon	ng M	alga Mi	ק חיים.	INC PC	AR -						
626	2 Italy		rway sp)25 184	10 1980) <u> </u>			
626	3 FRITZ		EINGRUE		1000	1000 10	20 10	10 1900	5			
626031	1851	262	241	176	188	300	295	230	262	290		
626031	1860	251	321	263	350	305	404	369	379	340	265	
626031	1870	53	47	97	132	132	118	151	118	138	145	
626031	1880	143	116	113	104	98	137	138	124	155	130	
626031	1890	120	117	137	177	175	189	177	167	159	168	
626031	1900	152	194	213	208	307	242	215	185	187	166	
626031	1910	112	184	205	158	103	150	181	225	206	165	
626031	1920	217	185	157	129	175	159	158	184	184	218	
626031	1930	198	166	135	123	154	138	114	133	106	133	
626031	1940	133	132	253	211	238	300	263	313	273	313	
626031	1950	252	179	273	309	246	275	262	253	190	262	
626031	1960	278	243	210	223	323	292	258	273	288	293	
626031	1970	260	283	239	250	233	229	218	198	208	241	
626031	1980	187	999									

Table 9 Example data format from .rwl file.

After selecting the file with a description of the widths of the annual rings, the user must enter the place of sampling:,

1. From the list of countries a country is chosen.

2. In the Location name a name of the location must be entered.

3. In the fields Location latitude, Location longitude and Location altitude appropriately are fed geographical width geographical longitude and altitude of the location. The data is an integer format as in the standard .rwl files. The system converts them to decimal numbers. The last two digits are converted into tenths and hundredths of a geographical degree.

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08011 1750 187 1 08011 1760 198 1 Location name 78 170 183 62 112 145	
08011 1760 198 1 08011 1770 153 1 Zagradeniye Forest 62 112 145 33 184 176	
08011 1780 184 1 Location latitude 73 158 152 08011 1790 152 1 74 136 160	
08011 1790 132 1 2463 2463 49 111 120	
08011 1810 141 1 Location longtitude 24 206 246 08011 1820 263 2: 1420 07 192 137	
08011 1820 283 2 4140 08011 1830 155 1: 4140 78 72 81	
08011 1830 195 1. 08011 1840 106 Location altitude 77 90 70	
08011 1850 97 1710 80 98 84 08011 1860 113 1 1710 84 75 104	
08011 1870 117 1: OK Cancel 55 100 112	_1
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For Help, press F1	

Figure 7Sample location data choice.

After selecting the OK button a dialog for selecting the sampled tree species is shown, as shown in Figure 8.

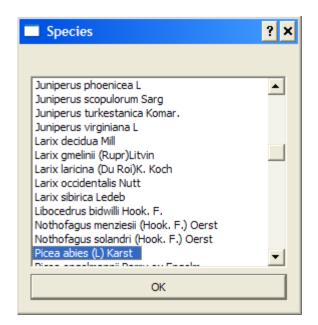


Figure 8 Tree species choice dialog.

The functions Open, Save and Save as in the current version work with files containing comma separated fields(csv). The buttons for the functions New description, Open and Save from the File menu are shown on Figure 9.



Figure 9 New description, Open and Save functions buttons.

2.4.2 Cell editing functions

The functions for cell redactions are located in the Edit menu. Figure 10 shows all cell redaction functions.

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Figure 10 Cell editing functions.

2.4.3 Tools

When choosing Tools-> Settings the dialog shown on Figure 11 appears. Here it can be choosen which of the following data to appear when showing the data for stress sections.



Figure 11 Tools

The options that can be set in the window shown below are:

- Minimal coverage the minimum amount of coverage rates over which stress sections are considered reliable.
- Variation interval The value of the percentage for which it is assumed that the indexes are not stressful. If this value is not set the confidence interval of the sequence of indices is chosen.

The following options determine whether to display certain characteristics of stress sections of all intervals or only those for which climate information is available.

The last group of options specifies which of the calculated data are to be virtualized.

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Figure 12 Stress sections characteristics condition choice.

2.4.5 Functions for displaying statistical information

Statistical information related to the results of data processing of the measured widths of annual rings and stored air information can be obtained by selecting the menu item - Statistics-> By Geolocation as shown in Figure 13. Then a wood species is selected, as shown in Figure 8. After the selection of tree species a parameters of statistics are introduced:

- 1. Geographic coordinates longitude, latitude and altitude.
- 2. Select information output on screen or csv file.
- 3. Choice of statistics data.

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Figure 13 Geographic coordinates statistics function choice.

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Figure 14 Geographic coordinates statistics parameters choice.

2.4.5 Functions for regression analysis

The application supports functions for regression analysis. Regression analysis includes functions for multidimensional linear analysis and one-dimensional nonlinear analysis. In both cases, the dependent variable is a variable of the values of the average index of the annual rings from a selected location.

The choice of one of two types of regression analysis is done by selecting the menu function Regression. Multivariate linear regression analysis is selected by

Regression-> Linear Regression, and non-linear regression analysis using

Regression-Nonlinear Regression as shown in Figure 15

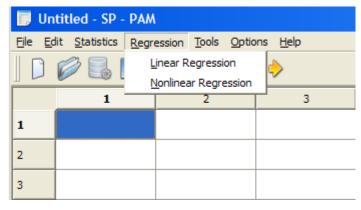


Figure 15Regression analysis type choice.

After selecting the type of the regression analysis is tree species is selected (Fig. 8).

Figure. 16 shows a window for selecting the location and the independent variables. The independent variables can be one or more of the following - the temperature for the years for which there is a calculated index difference of the mean temperatures , precipitation and a differential of average precipitations .

Figure 17 shows the window for selecting the location, type of nonlinear regression and independent variables. The independent variables can be one or more of the following - the temperature for years for which there is a calculated index, difference of the mean temperatures, and precipitation and a differential of average precipitations. In case more than one independent variable is selected a regression analysis for each of them is carried out.

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6	Spain Guadarrma?rascafria (1) Spain Guadarrma?rascafria (2)					
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Figure 16 Dialog for choosing locations and independent variables for linear multidimensional regression analysis.

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4	Finland Sompio (2) Finland Suojanpera (2) Norway Hurdal (2)					
5	Norway Jondalen (2)	•				
7	Select one or more independant variables					
8	Delta Temperature Precipirtation					
9	☐ Delta Precipirtation ☐ Nonlinear regression type					
11	Parabolic Regression					
12	C Exponential Regression C Logarithmic Regression					
13	OK Cance					
11						

Figure 17 Dialog for choosing locations, independent variables and type for one dimensional regression analysis.

3. Web Application Description

The web application is designed for public access to information related to the processing of the widths of the annual rings of all locations processed and stored in the database.

3.1 Results

Entering the link - <u>http://sppam.e-ecology.org/results</u> to the results page as shown on Figure 18.

About Results How it works Login Regist	SPPAM WebAp	p	
Species Ables alba Mill Ables alba Mill Ables balsamea (L)Mill Ables borisii-regis Mattf Ables cephalonica Loud Ables concolor (Gord & Glend)Lindl	Home About Results How it works	Login	Regist
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Ables cephalonica Loud Ables concolor (Gord & Glend)Lindl	Abies balsamea (L)Mill		
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Abies concolor (Gord & Glend)Lindl	Abies cephalonica Loud		
	Abies concolor (Gord & Glend)Lindl		

Figure 18 Results page of the wen application

3.1 Registration and Login

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The system supports user registration, as logging-in is done by entering user name and a password as shown on Figure 19 and Figure 20.

Username		
username		
Password		
password		
Submit		
Submit		

Figure 19 Web application login

ne About Results How it works		Login	Registe
Registration			
First Name	Last Name		
Email			
Password	Confirm Password		
Password must be between 6 to 20 characters with letters, n symbols \?,_	imbers or		
off Recieve information news, updates () respected).	rivacy	Submit	

Figure 20 Web application registration.

3.2 Initial processing results display

Access to the data from the initial processing is open to any visitor to the site. It operates through a consistent choice of tree species (Fig. 21), country and location (Fig. 22). After selecting a location a list of all rows of the location having R2> 0.45 is displayed. For each row the best approximation polygon and R2 are shown.

When selecting the id of a location two graphics are visualized :

- 1. The measured and approximated values of annual ring widths of the selected row.
- 2. The calculated index as the ratio between the measured and calculated values for each year.

Home About Results How it works Login Regi pinus	SPPAM WebAp	р		
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Pinus regida Mill Pinus strobus L Pinus sylvestris L	pinus			
Pinus regida Mill Pinus strobus L Pinus sylvestris L				
Pinus sylvestris L	Pinus regida Mill			

Figure 21 Tree species choice.

ome About	Results	How it works				Login	Register	r
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species				Countries		Locations		
rinus resinosa Ait			*	Spain	A E	Hurdal (2)		Ĭł
Pinus regida Mill				Norway		Jondalen (2)		
Pinus strobus L				Norway		Karasjok 2001 (2)		ŀ
Pinus sylvestris L				Sweden		Veolia,Dombas 30km (2)		
Pinus taeda L			-	Spain	-	Rorstaddalen (2)		
Sequences Polino	mial					P	square	
9875		+5.3678e-12x^8-	8.167	5e-08x^7+0.00054361x^6-2.0671x^5+4912x^4-7.4689e+06x/	^3+7		0.617	
9876	-8.7211e-13x^8+1.3204e-08x^7-8.7447e-05x^6+0.33089x^5-782.39x^4+1.1838e+06x^3-1.1193e+09x^2+6.0465e+11x^1-1.4288e+14						0.6236	- 1
9877		+1.2115e-12x^8-1.8262e-08x^7+0.00012041x^6-0.45359x^5+1067.7x^4-1.6081e+06x^3+1.5134e+09x^2-8.1373e+11x^1+1.9138e+14						
9878		+9.1854e-12x^8-	1.395	9e-07x^7+0.00092799x^6-3.5248x^5+8367x^4-1.2709e+07x'	^3+1	.2065e+10x^2-6.5436e+12x^1+1.5526e+15	0.6678	
9879		-	1.855	3e-09x^7-2.4795e-05x^6+0.142x^5-451.76x^4+8.6224e+05x	^3-9	.8732e+08x^2+6.2802e+11x^1-1.7119e+14	0.8437	

Figure 22Country and location choice

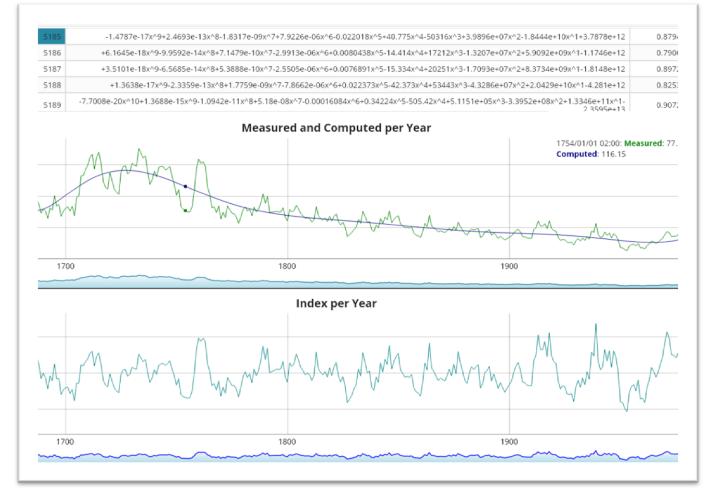


Figure 23Graphics per selected sequence id.