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Alpine SPACE
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MANFRED
Management strategies to adapt Alpine Space forests to climate change risk

Regional Report on windthrows, snow damages and abiotic extreme occurrences

SLOVENIA

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Ljubljana 23.2.2012

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The available datasets

Categories of data which are locally available:

	YES	NO
Cuts	X	☐
Damages	X	☐
List of memory sifted events	X	☐

✓ **Definition of forest in Slovenia**

The stewardship of Slovenia's forestlands is being ensured by the legislative framework made-up of **Forest Act** (Official Journal RS, nr. 30/93, 13/98, 56/99, 67/02, 110/02,112/06, 115/06), **Act on changes and completions of Forest Act** (Official Journal RS, nr.110/07, 106/10) and **Forest Development Program** (1996).

In Slovenia **"Forest"** is defined by Act on changes and completions of Forest Act (2007) and is defined as a plot of land overgrown with forest trees in the form of stands. The minimum height of trees must be 5 m and the area must be larger than 0.25 ha. As forest are considerate also lands which area is at least 0.25 ha and were not used for agricultural purpose for the last 20 years. In this case the conditions are also that the area is overgrown with trees which can reach minimum height of at least 5 m and their crown cover should be at least 75 %. Riverside forest corridors and windbreaks are included as forests if their width is at least one tree height and they cover an area of at least 0.25 ha.

Under the term **"Other wooded land"** are includes lands overgrown with forest trees or other vegetation if a minimum size is 0.25 ha. The additional conditions are that the same land is not identified as a forest, and was not used for agriculture for the last 20 years. Other wooded lands also comprise game pans and areas under power lines in forest if the area is larger than 0.25 ha.

According to the third paragraph of the 3rd article of Forest Act, forest infrastructure, if not portioned out, is included in forests. Individually scattered forest trees and groups of forest trees on area smaller than 0.25 ha, avenues planted with trees on one or both sides, parks and forest tree plantations **are not defined as forest**.

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Cuts (logging)

✓ **Time frame** [definition of the **time span** of data availability]

The data used in this report are from the period 2000 to 2010.

✓ Brief description of the methodological approach the **operational practices** are based on

The data on logging (TIMBER) includes information of selected trees that should be felled/logged in the near future. The trees are selected according to the criteria of vitality, adaptability to the site, role in the ecosystem, health condition and quality. The selection is done by district foresters of SFS together with forest owner.

The TIMBER database includes the information on: ID of the forest compartment, month, year, ID of the written order, selection reasons of the trees for logging, tree species, number of trees and volume.

The criteria for selecting the trees for logging can be roughly divided on:

1. regular forests tending and,
2. sanitary felling of damaged or weakened trees.

In this report, we take into account the data on selected trees that should be logged because they were damaged by abiotic factors. The report does not include trees selected to be logged due to their weakness causec by abiotic factors.

The data on logging contains different types of sanitary felling: pests, disease/fungi, game, wind, snow, sleet, landslide/avalanche, fire, atmospheric emission, damage as a result of forestry operations, other.

Selection of trees for logging is done by district foresters of SFS, in co-operation with forest owners. The procecure is mandatory for all forests regardless of their ownership (private and public forests). Consequently the data on logging (TIMBER) includes information for private and public forests.

✓ Description of the **types of parcel** the data are referred to, with indication of average **area**

The data on logging refers to the forest compartment. The average area of compartments in year 2010 was 36.81 ha, median 23.25 ha. The size of forest compartments varied from 0.03 ha to 1966 ha. If we take into account only forest then the average area of forest in compartments was 21.82 ha (min 0.03 ha and max 498.07 ha).

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Damages

✓ **Time frame**

2000 – 2010

✓ Brief description of the methodological approach the **assessment practices** are based on, with evaluations pertaining their **accuracy**

The methodology for assessment of the yearly damages in forests refers also to the data on logging. The assessment does not depend on an event but on the total volume of trees that should be logged because of the damaging factor (pests, fungi, windthrow, sleet, avalanche, snow, game, etc.) per year.

In recent years SFS issued special annual reports, where information on damaged area and volume of damaged trees were collected. The damage factors are classified as biotic (pest species, fungi species, game, other small animals) and abiotic (wind, sleet, avalanche, drought, transport, etc.) factors. Those reports were prepared for Forest Management Regional Units and also for Management Units if the damage was local.

From 1982 onwards special reports on different occurrences of biotic damages are available as well. Those reports are prepared by RDP (Reporting, diagnostic and prognostic services for forest protection), which works within the SFI.

As explained in one of the previous chapters, the selection of trees for logging is done by district foresters of SFS in co-operation with forest owners. The procedure is mandatory for all forests regardless of their ownership (private and public forests).

✓ Definition of the different **types of agent (e.g. wind, snow, whirlwind)** the available data allow to discriminate and deepen

The data on logging (TIMBER) contains different types of causes describing why the tree should be logged. The causes are classified in two minor groups: regular forests tending and sanitary felling of damaged or weakened trees. In this report we take into account the information about selected damaged trees for logging. Trees are classified based on different types of factors such as: pests, disease/fungi, game, wind, snow, sleet, landslide/avalanche, fire, atmospheric emission, damage because of work in forest, other.

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List of memory sifted events

✓ **Time frame**

Time frame is from 2001 to 2010.

✓ Definition of the **geographic units** the results of the census are referred to

Some of the providing results refer to the area of Forest Management Unit (FMU) and some to bigger areas (Forest Management Regional Unit (FMRU).

Not all of the events are limited to one year; some are limited to certain period.

Legislative milestones

✓ **The laws concerning abiotic occurrences in Slovenia**

Law
Act on forests - ZG (Official Journal RS, nr. 30/1993, 13/1998, 67/2002, 110/2007)
Plant Health Act (Official Journal RS, nr. 45/2001, 45/2004-ZdZPKG, 86/2004, 61/2006-ZDru-1, 40/2007 in 36/2010)
Rules on forest protection (Official Journal RS, nr. 114/2009)
Rules on notification and publishing data on the occurrence and spread of organisms harmful to plants in the Republic of Slovenia (Official Journal RS, nr. 104/2009)
Rules on measures and methods with regard to introduction and spread of harmful organisms to plants, plant products and other regulated articles (Official Journal RS, nr. 31/2004, 142/2004, 66/2007, 104/2009 in 13/2010)
Rules on professional training and verification of plant health skills (Official Journal RS, nr. 93/2005)
Other different Rules on phytosanitary measures to prevent the spread of special pests or fungi like: Phytophthora ramorum 2004, Phytophthora ramorum 2007, ect.

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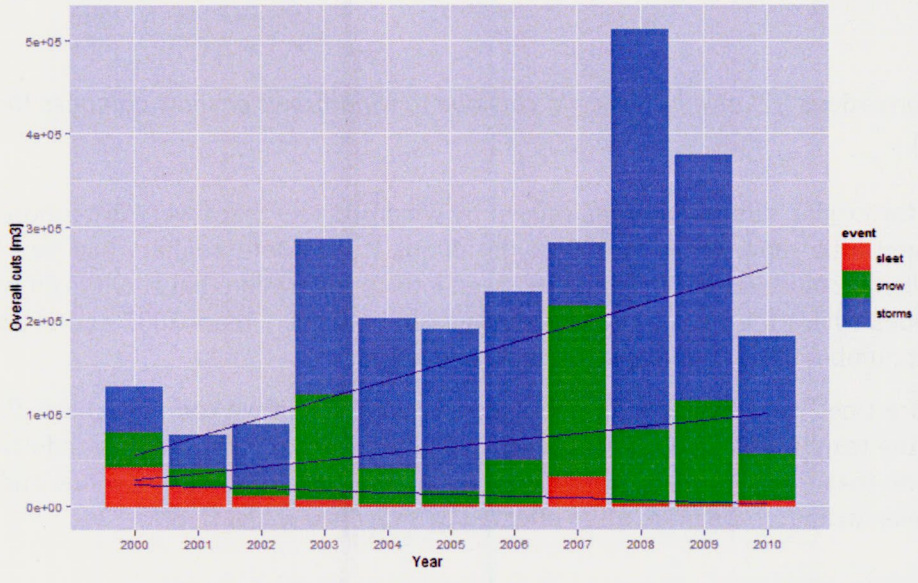
Data analysis

Ongoing trends

Cuts (refers to parcels)

✓ **Overall cuts** [*overall cuts due to windthrows or snow damages / year*].



	year	event	cut.m3	nr.cut.tree
1	2000	sleet	42728.49	116612
2	2000	snow	38254.90	79609
3	2000	storms	46896.95	46085
4	2001	sleet	22949.16	60522
5	2001	snow	18845.64	42196
6	2001	storms	34474.59	35400
7	2002	sleet	11515.73	32381
8	2002	snow	12562.64	26033
9	2002	storms	64243.41	51174
10	2003	sleet	8514.23	19881
11	2003	snow	111762.44	167416
12	2003	storms	165988.64	141465
13	2004	sleet	3658.63	9266
14	2004	snow	37628.83	76109
15	2004	storms	160431.73	129156
16	2005	sleet	3404.32	7056
17	2005	snow	13929.34	29565
18	2005	storms	173330.55	147165
19	2006	sleet	3090.70	7788
20	2006	snow	47321.43	100421
21	2006	storms	180280.41	164482
22	2007	sleet	32841.70	65137
23	2007	snow	182712.91	415059
24	2007	storms	67150.10	63316
25	2008	sleet	4714.66	13562
26	2008	snow	77966.85	219302
27	2008	storms	429210.09	365746
28	2009	sleet	3060.06	6484
29	2009	snow	111467.29	283040
30	2009	storms	262405.57	249095
31	2010	sleet	7435.34	29581
32	2010	snow	50408.06	150245
33	2010	storms	124228.95	112757

In the period from 2000 to 2010 a little more than 3.4 million of trees were selected for logging because they were damaged or weaken by abiotic factors such as winds, sleet or snow.

In the further analysis below we will take into consideration only trees that were damaged by abiotic factors and the owner was obligated to fell the damaged trees. In this case a little more than 2.9 million of trees were selected for logging because they were damaged by winds or snow (the term snow includes snow and sleet) in the period from 2000 to 2010. Concerning year 2008 storm damages were extremely high and in this year 339353 trees were selected for logging. The highest amount of damaged trees due to snow and sleet was in 2007 (443201 trees).

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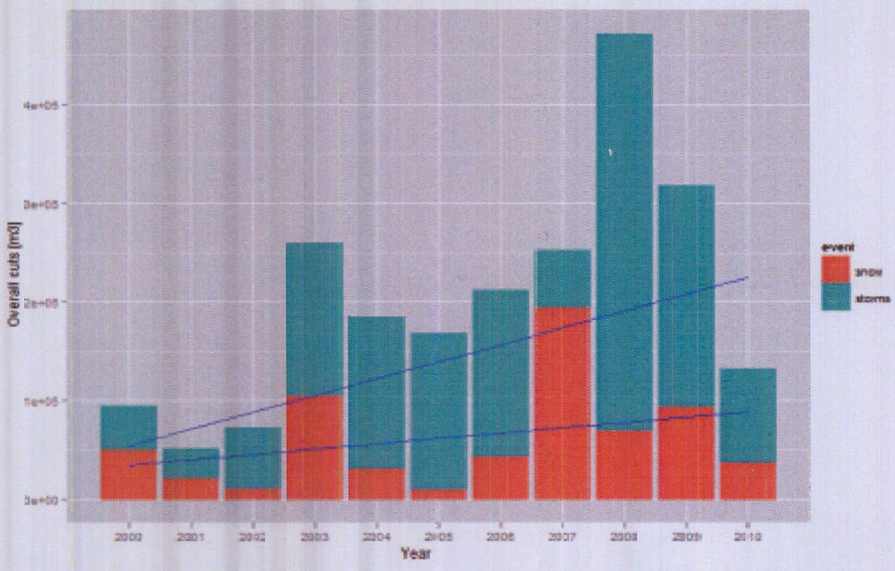
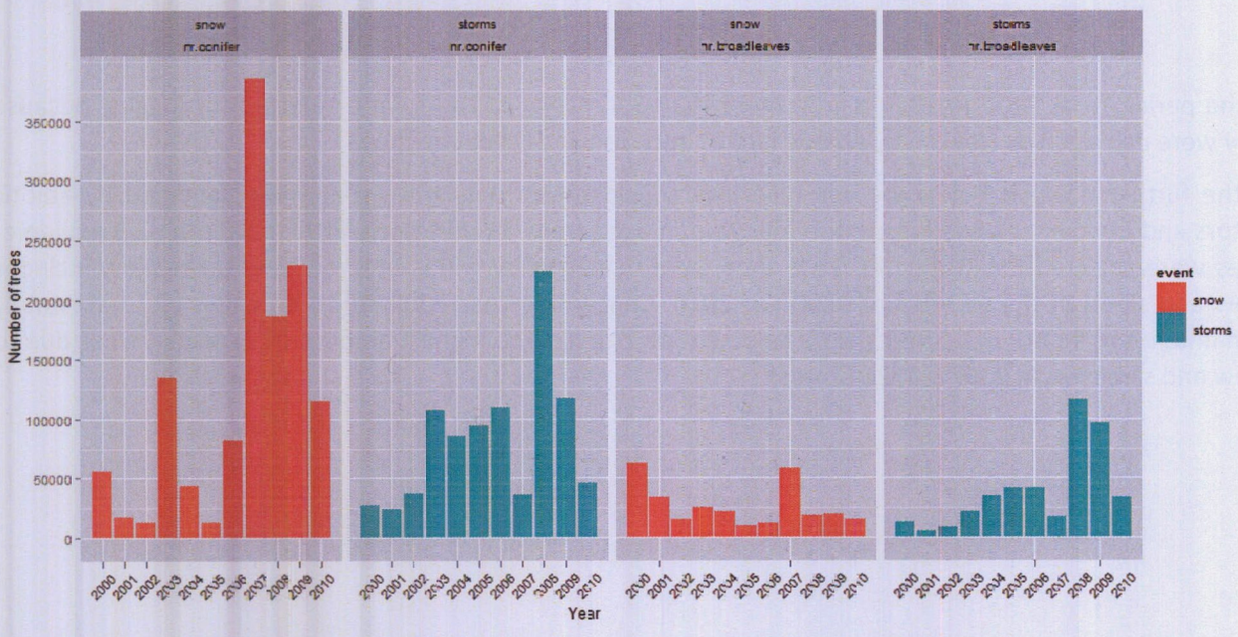


	year	event	cut.m3	nr.cut.tree
1	2000	snow	51352.47	118937
2	2000	storms	42936.65	41373
3	2001	snow	22464.68	52117
4	2001	storms	28771.51	29844
5	2002	snow	12828.81	28582
6	2002	storms	59666.36	45819
7	2003	snow	116228.37	159273
8	2003	storms	153295.72	130016
9	2004	snow	53117.68	66823
10	2004	storms	151272.75	119998
11	2005	snow	10891.70	22984
12	2005	storms	157114.72	135090
13	2006	snow	43993.22	93791
14	2006	storms	167630.62	151138
15	2007	snow	195633.59	443202
16	2007	storms	57023.68	52991
17	2008	snow	71027.50	204965
18	2008	storms	400861.36	339353
19	2009	snow	94312.27	249062
20	2009	storms	224057.22	213718
21	2010	snow	38318.75	130483
22	2010	storms	93683.00	80935

✓ **Most affected forest formations** [*relative incidence of cuts due to windthrows or snow damages for different forest types / year*].

From all of the trees selected for logging due to damages caused by wind or snow there were little more than 2 million of coniferous and little more than 700000 of deciduous trees. More conifers had been damaged by storm and snow than broadleaves but it should be taken into consideration that conifers grow at high altitudes and steep slopes where the risk of abiotic damages can be bigger. Years 2007 and 2008 were the years with the highest number of trees damaged by snow and storms.

In the period 2000 to 2010 more trees were damaged by snow than by wind, but if we compare this with the volume of damaged trees the results are the opposite and the volumes of trees damaged by wind are higher. It is possible to conclude that trees with bigger diameter are more sensitive to strong winds and contrary the trees with the smaller diameter are more often affected by snow (snow and sleet).



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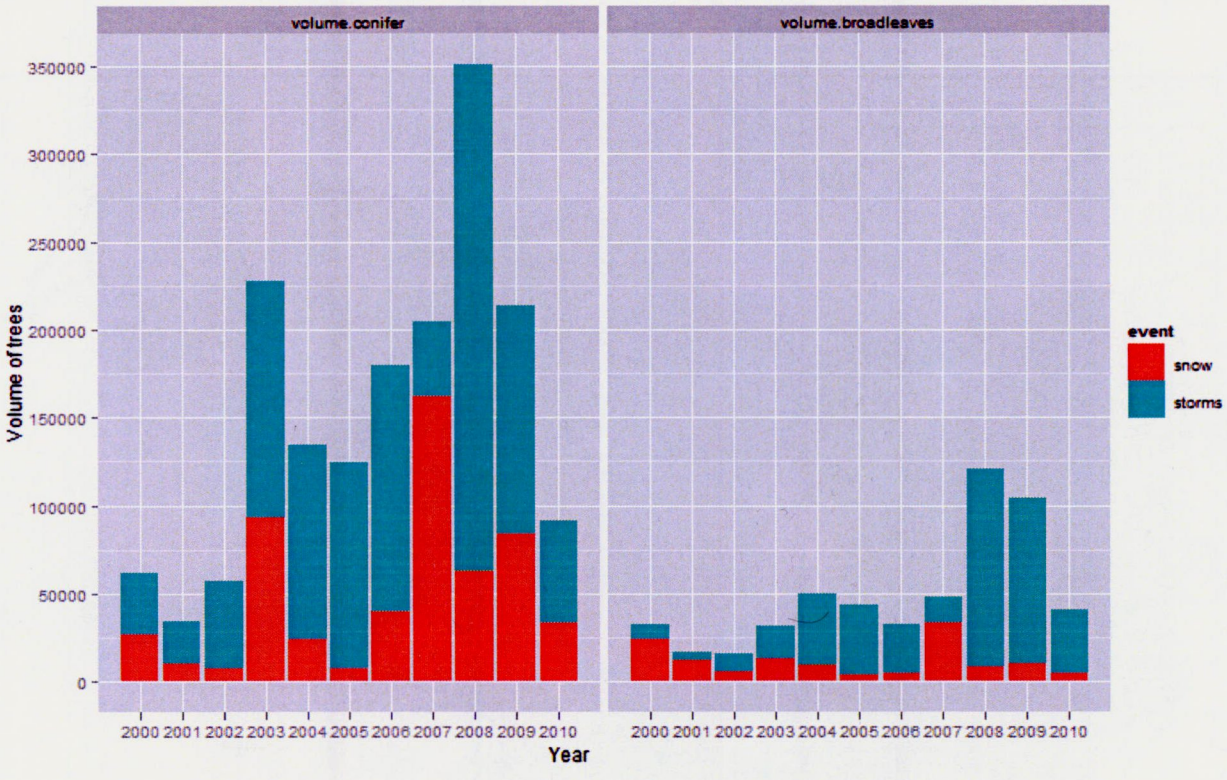
From 2000 to 2010 overall volume of coniferous trees, which were assign to be logged because of abiotic damages, was 1.7 million m^3 (1.1 million m^3 caused by storm damages and 0.6 million m^3 caused by snow damages) and 0.5 million m^3 of broadleaves (0.4 million m^3 caused by storm damages and 0.1 million m^3 caused by snow damages).



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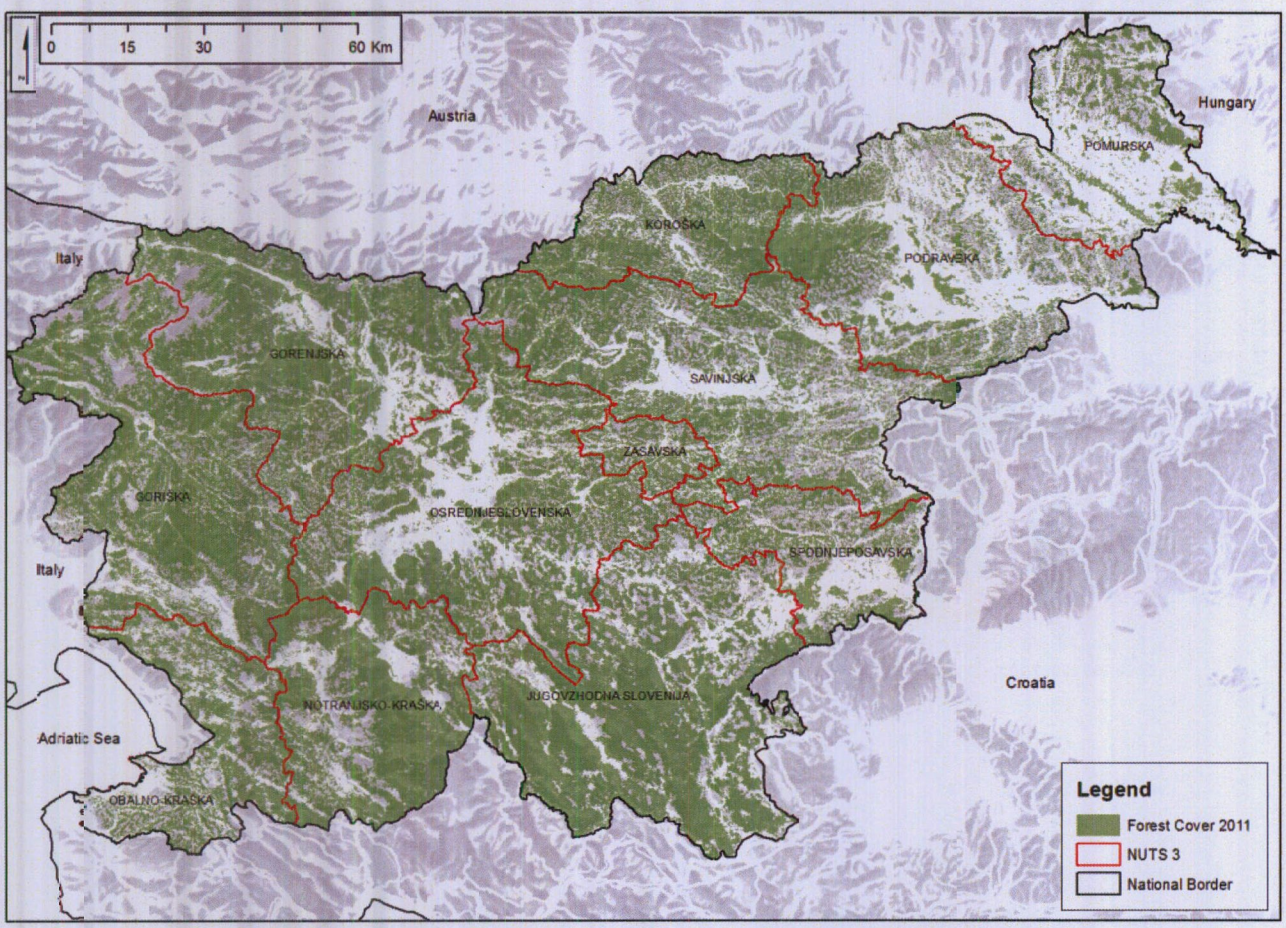
Damages (refers to administrative units)

Slovenia belongs to one of the most forested countries in Europe. Forests cover more than a half of its territory - almost 60 % of the country. Average growing stock in year 2010 was 279 m^3/ha and allowable cut in year 2009 was 5 million m^3 (SFS report).



Map data source: GURS (NUTS3, National Border), MKGP (Forest Cover)

Most of Slovenian forests are located within the area of beech, fir-beech and beech-oak sites (70 %).

Slovenia 2010 data: data source SFS report 2010		
% of forest:	59.8	%
Growing Stock:	330982.374	m^3
	279.3	m^3/ha
Anual increment	8117.325	m^3
	6.85	m^3/ha
Anual allowable cut in 2009:	5321.927	m^3
Coniferous:	2545.110	m^3
Deciduous:	2776.817	m^3

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Slovenia is divided on 2 NUTS2 regions (East Slovenia and West Slovenia) and on 12 NUTS3 regions (see the map above and the table below).

* Data source: map of land use 2010 (MKGP), map of statistical regions			
NUTS1	NUTS1_NAME	Forest Area	
1	Slovenia	1212937.70	ha
	% of forest	59.80	%
NUTS2	NUTS2_NAME		
1	East Slovenia	692624.27	ha
2	West Slovenia	520313.43	ha
NUTS3	NUTS3_NAME		
1	Mura (Pomurska)	42048.35	ha
2	Drava (Podravska)	89862.70	ha
3	Carinthia (Koroška)	75152.64	ha
4	Savinja (Savinjska)	135721.78	ha
5	Central Sava (Zasavska)	16967.05	ha
6	Lower Sava (Spodnjeposavska)	42747.79	ha
7	Southeast Slovenia (Jugovzhodna Slovenija)	186635.13	ha
8	Inner Carniola-Karst (Notranjsko-kraška)	152867.14	ha
9	Central Slovenia (Osrednjeslovenska)	147000.00	ha
10	Upper Carniola (Gorenjska)	103488.82	ha
11	Gorizia (Goriška)	159453.31	ha
12	Coastal-Karst (Obalno-kraška)	60993.00	ha

✓ **Overall damages** [*overall damages due to windthrows or snow damages / year*].

The first and second graph on the next page (page 12) shows the number of all trees and the number of trees per hectare that were assigned to be logged because of abiotic damages during the period from 2000 to 2010. The third and fourth graphs on page 13 are the same but for volume. One graph in a row refers to one NUTS3 regions. The highest damages caused by abiotic factors were observed in the NUTS3 region Upper Carniola. In last few years the number of trees affected by snow (snow and sleet) increased. In NUTS3 regions Central Slovenia and Savinja the volume and the number of trees damaged by storms increased.

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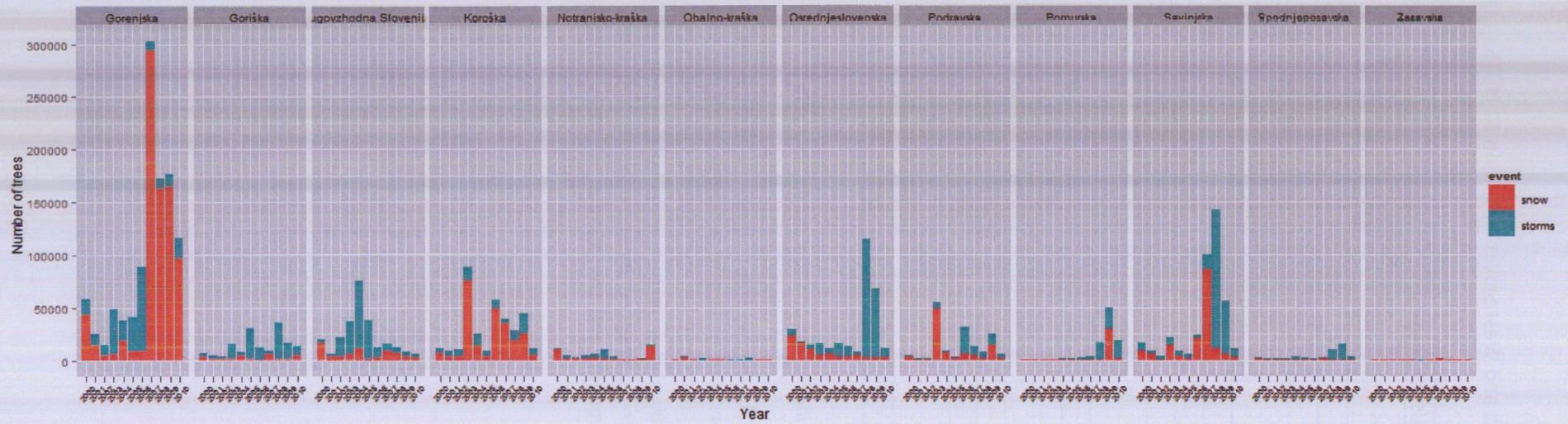

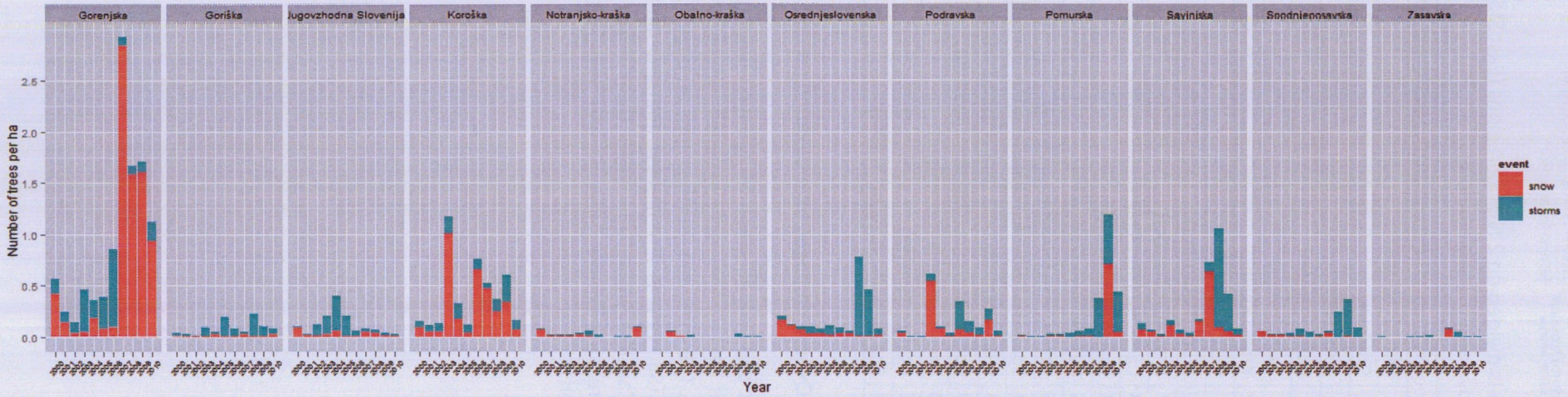

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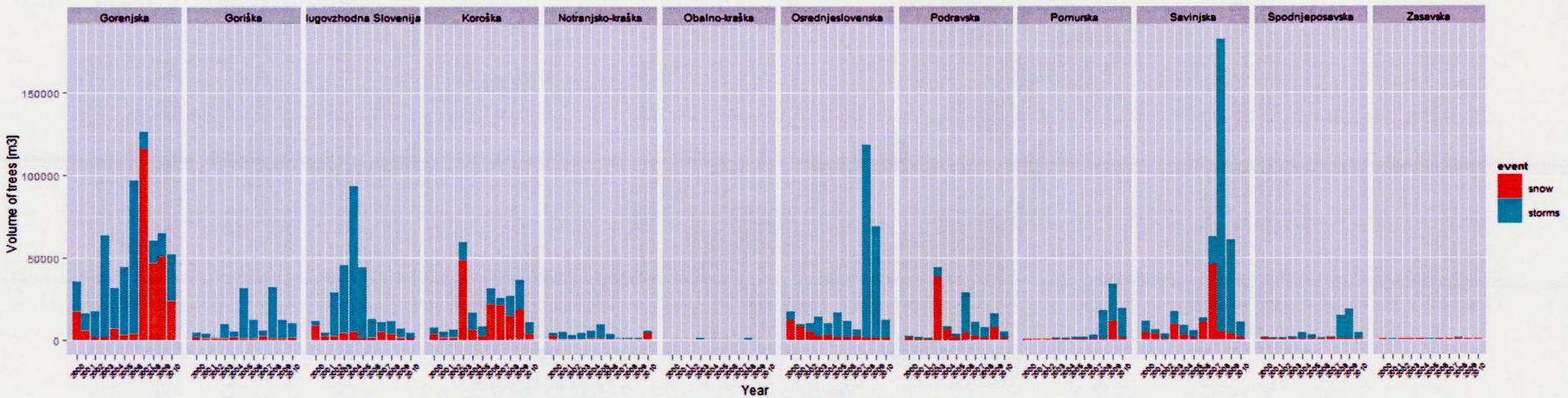

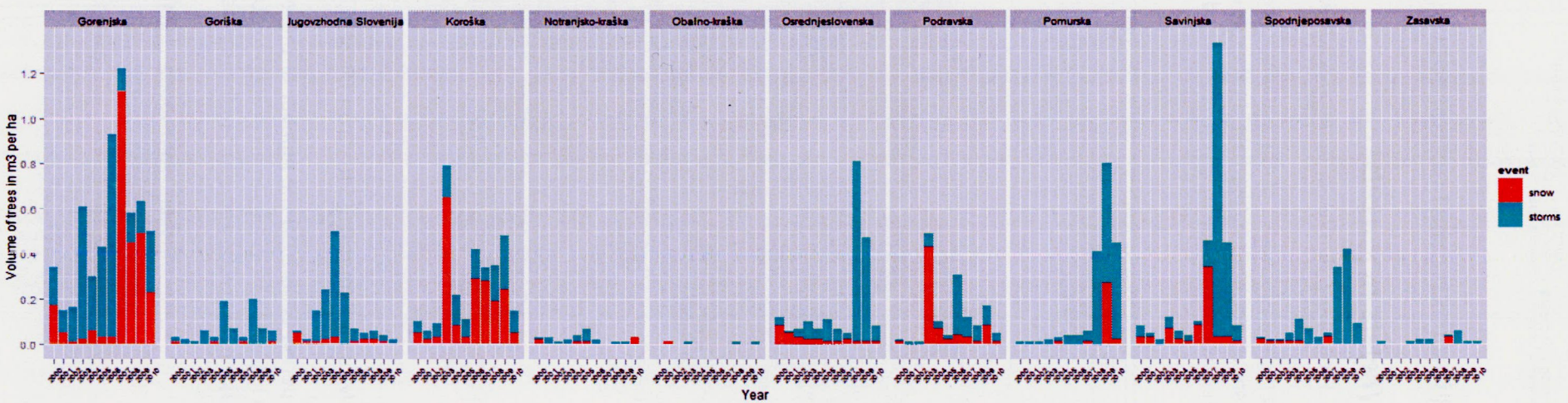

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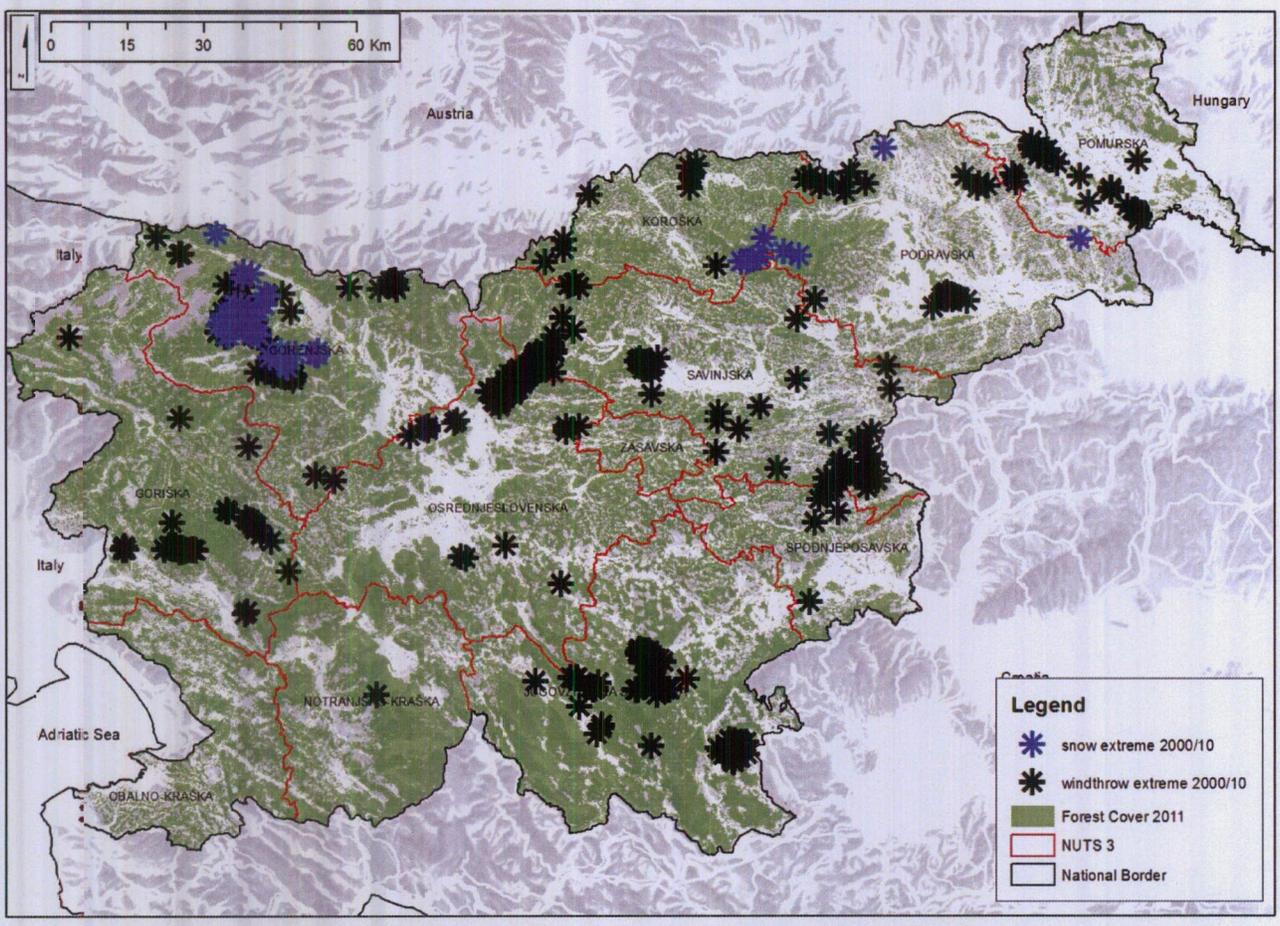
Outlying (extreme) occurrences

Cuts (refers to parcels)

✓ **Frequency** [*number of outlying occurrences / year*].

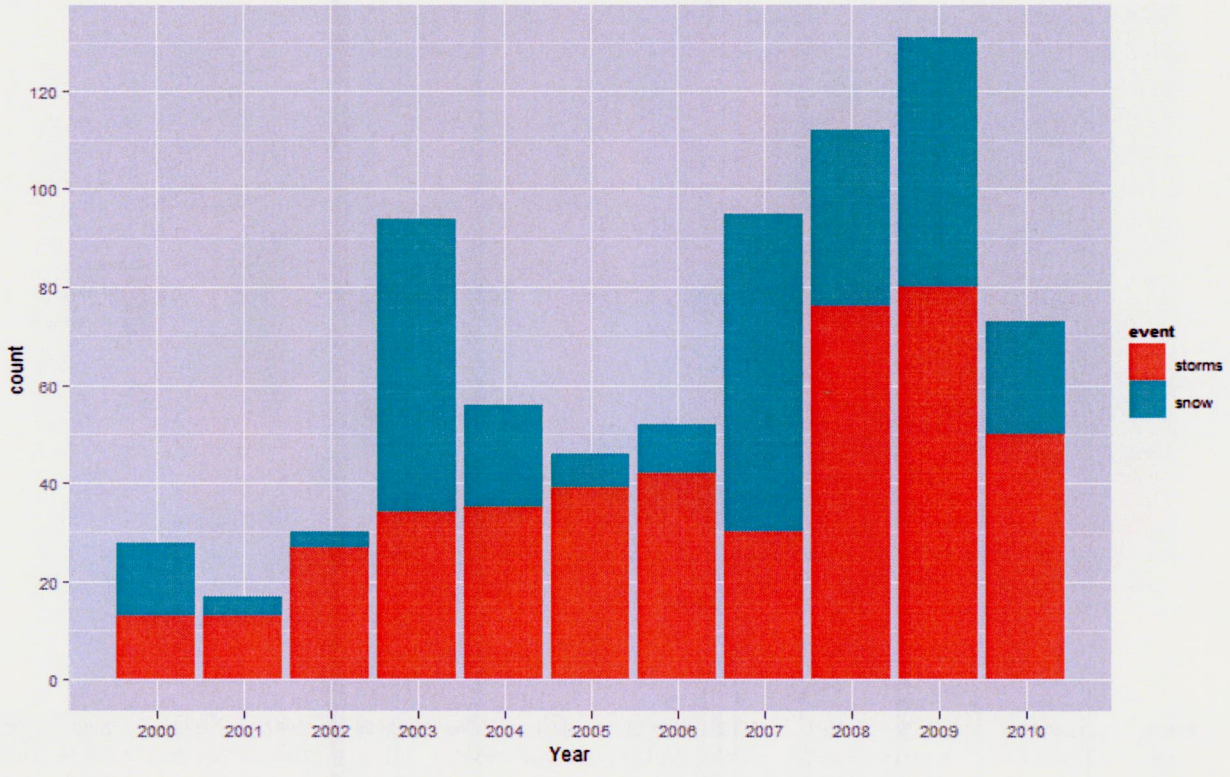
The map shows locations of the outlying parcels, in which extreme damages caused by strong winds or heavy snow, occurred in the past. In the period 2000 to 2010, in total, there was, 439 and 295 parcels extracted as extreme due to severe storms and snow damages, respectively.



Map data source: SFS (data on TIMBER), GURS (NUTS3, National Border), MKGP (Forest Cover)

In the period 2000-2010 the number of those parcels where trees experienced extreme damages due to storms increased from 13 parcels in 2000 to 80 in 2009. From the table and graph below it can be observed two major peaks (2003 and 2007) in the number of parcels in which extreme snow damages occurred.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
storms	13	13	27	34	35	39	42	30	76	80	50
snow	15	4	3	60	21	7	10	65	36	51	23



✓ **Most affected forest formations** [*relative incidence of outlying parcels for different forest types / year*].

If we compare the number and the volume (see the tables and graphs below) of damaged trees in the selected outlying parcels we could see conifers as more endangered relative to broadleaves. The volume and the number of trees increased in the last years of observed period.

	event	species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	snow	nr.conifer	27756	6847	14012	33875	29941	13831	28619	139903	111481	154750	55172
2	storms	nr.conifer	5661	26070	15544	15415	22907	26266	31751	18730	85016	63127	50488
3	snow	nr.broadleaves	3582	830	16	3116	899	260	294	12173	6471	2482	1838
4	storms	nr.broadleaves	803	6781	7514	3758	7753	5458	13754	10008	46216	33427	17719

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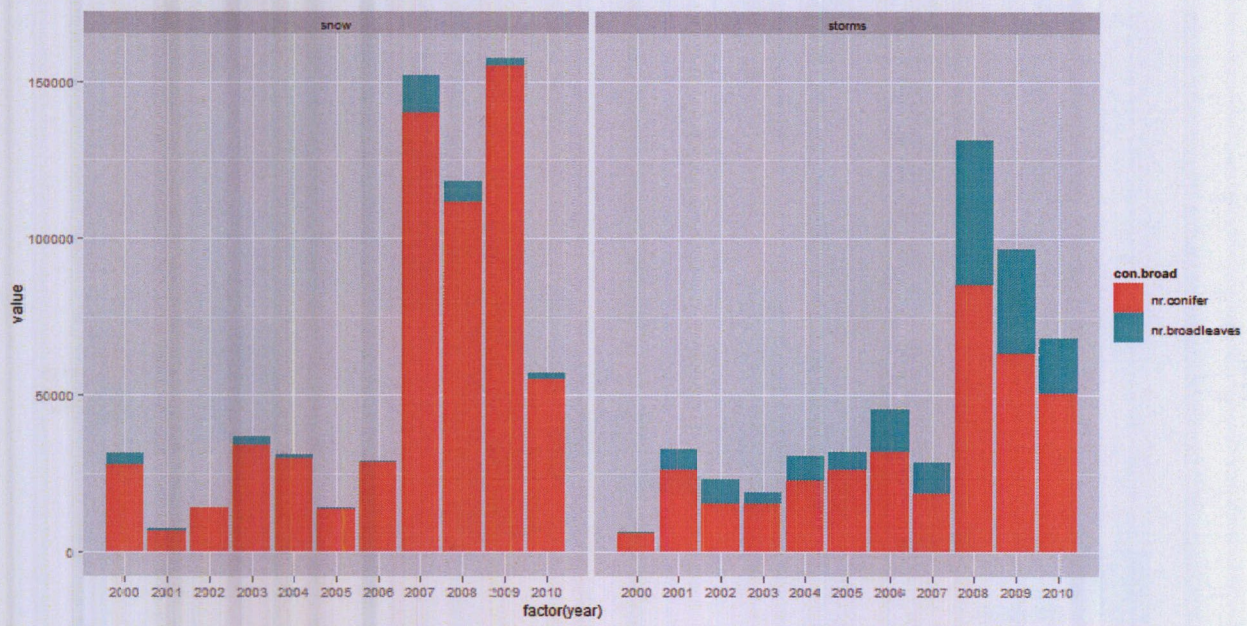
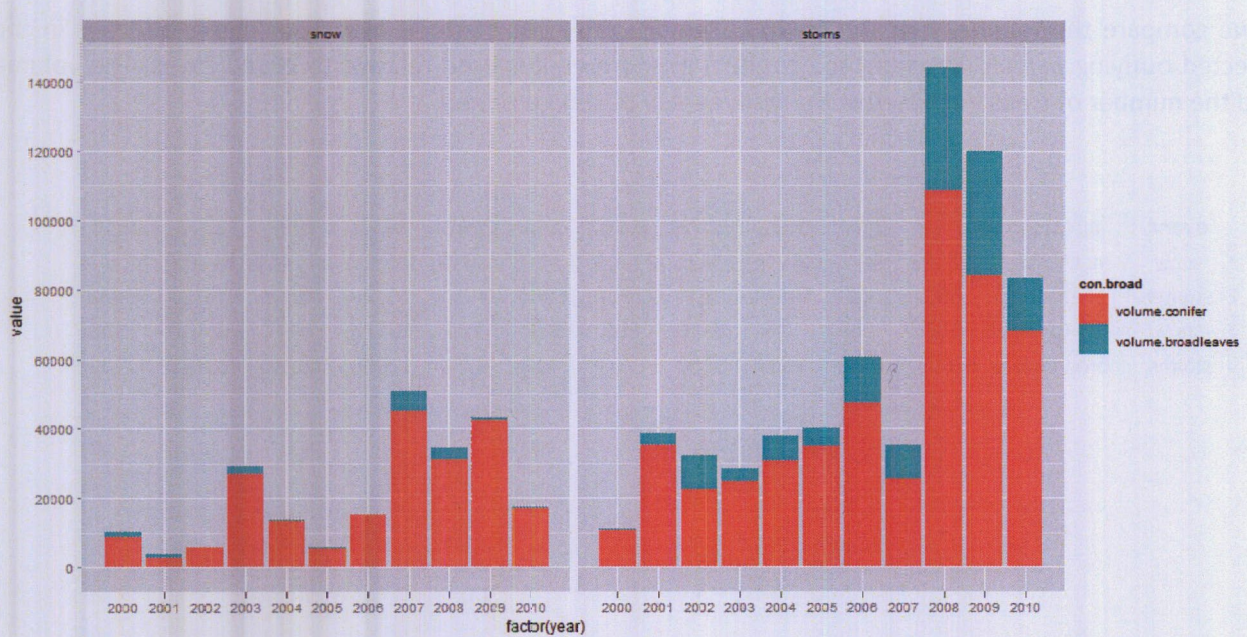


	event	species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	snow	volume.conifer	8908.15	2885.54	5721.36	27072.63	13277.48	5547.07	15129.33	45185.96	31113.43	42595.95	17009.46
2	storms	volume.conifer	10680.24	35203.21	22279.99	24741.88	30721.94	34702.74	47198.88	25260.85	108521.68	84208.21	68038.02
3	snow	volume.broadleaves	1447.84	1046.67	3.40	2110.17	573.39	228.87	143.31	5572.11	3529.43	747.28	537.69
4	storms	volume.broadleaves	538.23	3601.96	10044.21	3534.24	7098.35	5429.17	13305.50	10117.01	35539.16	35665.33	15377.33



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List of memory sifted events

✓ Reference to and description, if the case, of singular **extraordinary meteorological events** that produced the damage (eg. Lothar)

Windthrow Jelovica in 2006

Windthrow Črnivec in 2008

✓ Most **endangering abiotic agents**

Windthrow

✓ Most **affected forest types**

Coniferous trees

✓ **Overall volumes damaged** by windthrows or snow damages per year

	year	event	cut.m3	nr.cut.tree
1	2000	snow	51352.47	118937
2	2000	storms	42936.65	41373
3	2001	snow	22464.68	52117
4	2001	storms	28771.51	29844
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6	2002	storms	59666.36	45819
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8	2003	storms	153295.72	130016
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19	2009	snow	94312.27	249062
20	2009	storms	224057.22	213718
21	2010	snow	38318.75	130483
22	2010	storms	93683.00	80935

Acknowledgement

The report is also part of the CRP project V4-1069 (Improving efficiency of sanitary actions following major forest damages in Slovenian forests) which was financed by the Ministry of agriculture and the environment (MKO) and the Slovenian Research Agency (ARRS).

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MANFRED
Management strategies to adapt Alpine Space forests to climate change risk

Regional Report on pests and biotic extreme occurrences

SLOVENIA

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Ljubljana 23.2.2012

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The available datasets

Categories of data which are locally available:

	YES	NO
Cuts	X	☐
Damages	X	☐
List of memory sifted events	X	☐

✓ **Definition of forest in Slovenia**

The stewardship of Slovenia's forestlands is being ensured by the legislative framework made-up of **Forest Act** (Official Journal RS, nr. 30/93, 13/98, 56/99, 67/02, 110/02,112/06, 115/06), **Act on changes and completions of Forest Act** (Official Journal RS, nr.110/07, 106/10) and **Forest Development Program** (1996).

In Slovenia **"Forest"** is defined by Act on changes and completions of Forest Act (2007) and is defined as a plot of land overgrown with forest trees in the form of stands. The minimum height of trees must be 5 m and the area must be larger than 0.25 ha. As forest are considerate also lands which area is at least 0.25 ha and were not used for agricultural purpose for the last 20 years. In this case the conditions are also that the area is overgrown with trees which can reach minimum height of at least 5 m and their crown cover should be at least 75 %. Riverside forest corridors and windbreaks are included as forests if their width is at least one tree height and they cover an area of at least 0.25 ha.

Under the term **"Other wooded land"** are includes lands overgrown with forest trees or other vegetation if a minimum size is 0.25 ha. The additional conditions are that the same land is not identified as a forest, and was not used for agriculture for the last 20 years. Other wooded lands also comprise game pans and areas under power lines in forest if the area is larger than 0.25 ha.

According to the third paragraph of the 3rd article of Forest Act, forest infrastructure, if not portioned out, is included in forests. Individually scattered forest trees and groups of forest trees on area smaller than 0.25 ha, avenues planted with trees on one or both sides, parks and forest tree plantations **are not defined as forest**.

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Cuts (logging)

✓ **Time frame**

The data used in this report are from the period 2000 to 2010.

✓ Brief description of the methodological approach the **operational practices** are based on

The data on logging (TIMBER) includes information of selected trees that should be felled/logged in the near future. The trees are selected according to the criteria of vitality, adaptability to the site, role in the ecosystem, health condition and quality. The selection is done by district foresters of SFS together with forest owner.

The TIMBER database includes the information on: ID of the forest compartment, month, year, ID of the written order, selection reasons of the trees for logging, tree species, number of trees and volume.

The criteria for selecting the trees for logging can be roughly divided on:

1. regular forests tending and,
2. sanitary felling of damaged or weakened trees.

In this report, we take into account the data on selected trees that should be logged because they were damaged by abiotic factors. The report does not include trees selected to be logged due to their weakness caused by abiotic factors.

The data on logging contains different types of sanitary felling: pests, disease/fungi, game, wind, snow, sleet, landslide/avalanche, fire, atmospheric emission, damage as a result of forestry operations, other.

Selection of trees for logging is done by district foresters of SFS, in co-operation with forest owners. The procedure is mandatory for all forests regardless of their ownership (private and public forests). Consecuently the data on logging (TIMBER) includes information for private and public forests.

✓ Description of the **types of parcel** the data are referred to, with indication of average **area**

The data on logging refers to the forest compartment. The average area of compartments in year 2010 was 36.81 ha, median 23.25 ha. The size of forest compartments varied from 0.03 ha to 1966 ha. If we take into account only forest then the average area of forest in compartments was 21.82 ha (min 0.03 ha and max 498.07 ha).

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Damages

✓ **Time frame**

2000 – 2010

✓ Brief description of the methodological approach the **assessment practices** are based on

The methodology for assessment of the yearly damages in forests refers also to the data on logging. The assessment does not depend on an event but on the total volume of trees that should be logged because of the damaging factor (pests, fungi, windthrow, sleet, avalanche, snow, game, etc.) per year.

In recent years SFS issued special annual reports, where information on damaged area and volume of damaged trees were collected. The damage factors are classified as biotic (pest species, fungi species, game, other small animals) and abiotic (wind, sleet, avalanche, drought, transport, etc.) factors. Those reports were prepared for Forest Management Regional Units and also for Management Units if the damage was local.

From 1982 onwards special reports on different occurrences of biotic damages are available as well. Those reports are prepared by RDP (Reporting, diagnostic and prognostic services for forest protection), which works within the SFI.

As explained in one of the previous chapters, the selection of trees for logging is done by district foresters of SFS in co-operation with forest owners. The procedure is mandatory for all forests regardless of their ownership (private and public forests).

✓ Definition of the different **types of agent (e.g. wind, snow, whirlwind)** the available data allow to discriminate and deepen

The data on logging (TIMBER) contains different types of causes describing why the tree should be logged. The causes are classified in two minor groups: regular forests tending and sanitary felling of damaged or weakened trees. In this report we take into account the information about selected damaged trees for logging. Trees are classified based on different types of factors such as: pests, disease/fungi, game, wind, snow, sleet, landslide/avalanche, fire, atmospheric emission, damage because of work in forest, other.

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List of memory sifted events

✓ **Time frame**

Time frame is from 2001 to 2010.

✓ Definition of the **geographic units** the results of the census are referred to

Some of the providing results refer to the area of Forest Management Unit (FMU) and some to bigger areas (Forest Management Regional Unit (FMRU).

Not all of the events are limited to one year; some are limited to certain period.

Legislative milestones

✓ **The laws concerning in pests and biotic occurrences in Slovenia**

Law
Act on forests - ZG (Official Journal RS, nr. 30/1993, 13/1998, 67/2002, 110/2007)
Plant Health Act (Official Journal RS, nr. 45/2001, 45/2004-ZdZPKG, 86/2004, 61/2006-ZDru-1, 40/2007 in 35/2010)
Rules on forest protection (Official Journal RS, nr. 114/2009)
Rules on notification and publishing data on the occurrence and spread of organisms harmful to plants in the Republic of Slovenia (Official Journal RS, nr. 104/2009)
Rules on measures and methods with regard to introduction and spread of harmful organisms to plants, plant products and other regulated articles (Official Journal RS, nr. 31/2004, 142/2004, 66/2007, 104/2009 in 13/2010)
Rules on professional training and verification of plant health skills (Official Journal RS, nr. 93/2005)
Other different Rules on phytosanitary measures to prevent the spread of special pests or fungi like: Phytophthora ramorum 2004, Phytophthora ramorum 2007, ect.

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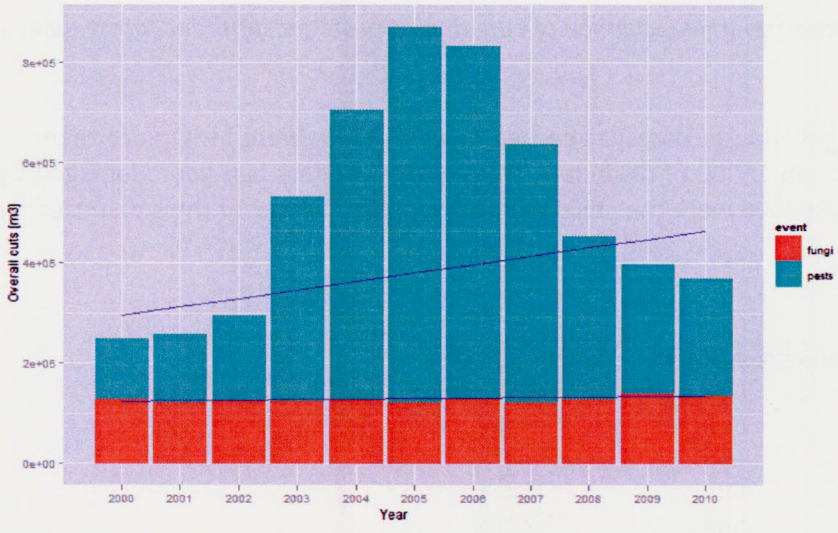
Data analysis

Ongoing trends

Cuts (refers to parcels)

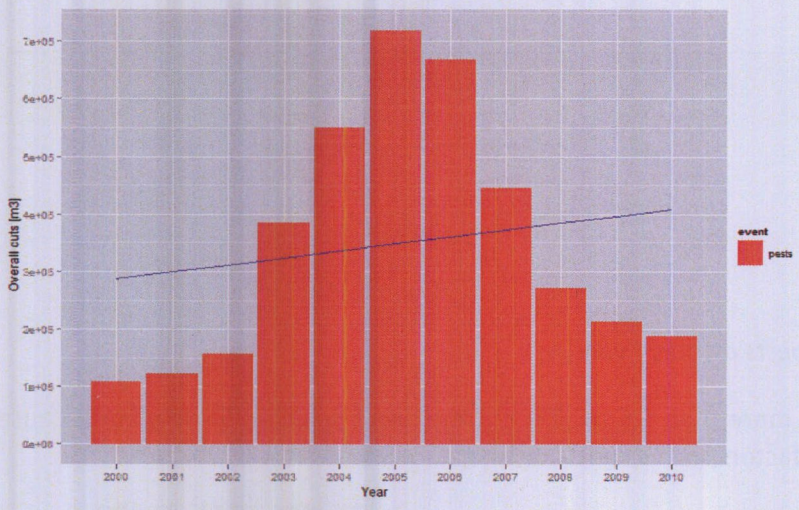
- ✓ **Overall cuts** [*overall cuts due to pests attacks / year*].

In the period from 2000 to 2010 a little more than 5.6 million of trees were selected for logging because they were damaged or weaken by biotic factors such as pests or fungi.



	year	event	cut.m3	nr.cut.tree
1	2000	fungi	130271.7	175922
2	2000	pests	118802.1	116952
3	2001	fungi	123994.0	152300
4	2001	pests	132729.0	135190
5	2002	fungi	125433.5	157653
6	2002	pests	169382.3	147258
7	2003	fungi	125024.6	151166
8	2003	pests	406567.3	344307
9	2004	fungi	130518.1	148760
10	2004	pests	573566.6	483592
11	2005	fungi	123487.4	137543
12	2005	pests	747109.1	621072
13	2006	fungi	130417.9	154943
14	2006	pests	702700.4	608775
15	2007	fungi	123808.3	138310
16	2007	pests	512160.2	441683
17	2008	fungi	131167.6	148611
18	2008	pests	322116.7	268996
19	2009	fungi	141972.1	185807
20	2009	pests	256793.1	210650
21	2010	fungi	137604.3	159286
22	2010	pests	231538.4	200909

In the further analysis below we will take into consideration only trees that were damaged by biotic factor pest and the owner was obligated to fell the damaged trees. In this case a little more than 3.2 million of trees were selected for logging because they were damaged by pests. Concerning year 2005 damages by pests were extremely high and in this year 597458 trees were selected for logging. The reasons for big changes between the volumes of damaged trees (2002 to 2005) could be that year 2003 was extremely dry and hot and these circumstances were very favorable for the gradation of pests.

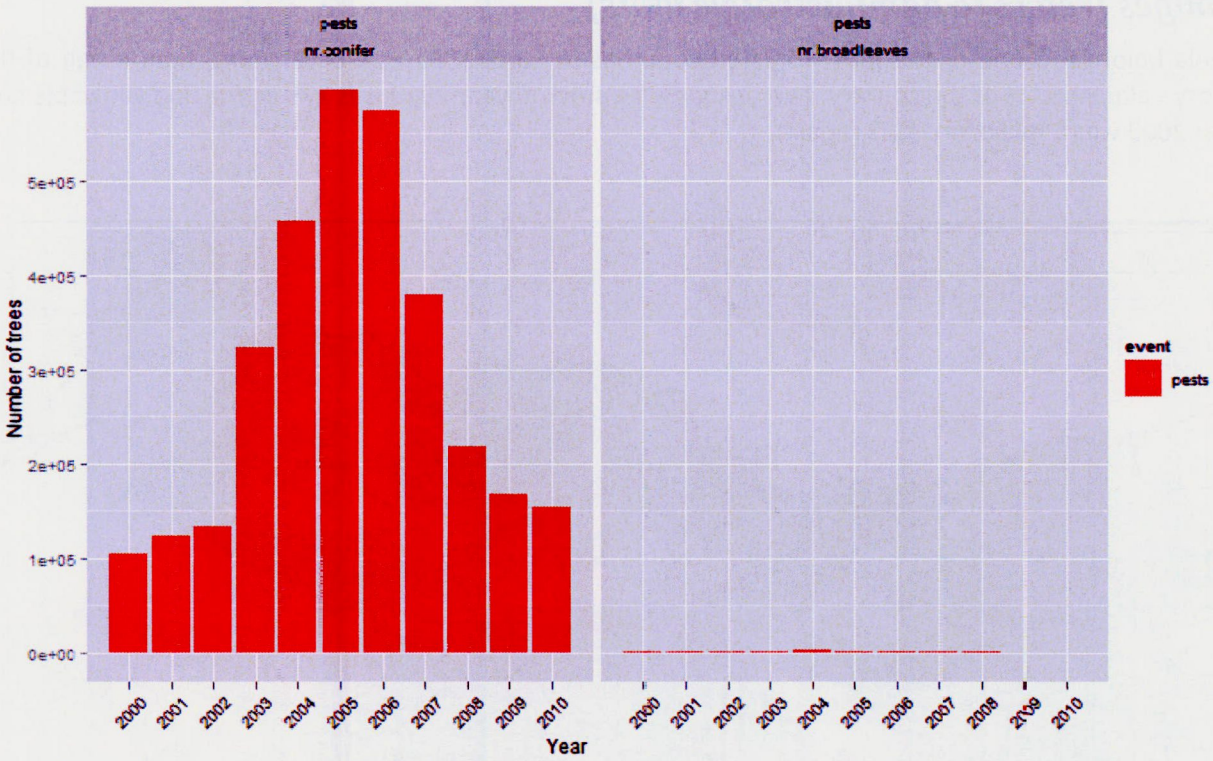


	year	event	cut.m3	nr.cut.tree
1	2000	pests	107511.1	106692
2	2001	pests	122350.9	124154
3	2002	pests	157404.9	134306
4	2003	pests	385788.0	324384
5	2004	pests	550444.8	462050
6	2005	pests	719575.9	597458
7	2006	pests	667782.2	576678
8	2007	pests	445411.6	381288
9	2008	pests	270586.6	219127
10	2009	pests	213609.0	168749
11	2010	pests	187712.5	154708

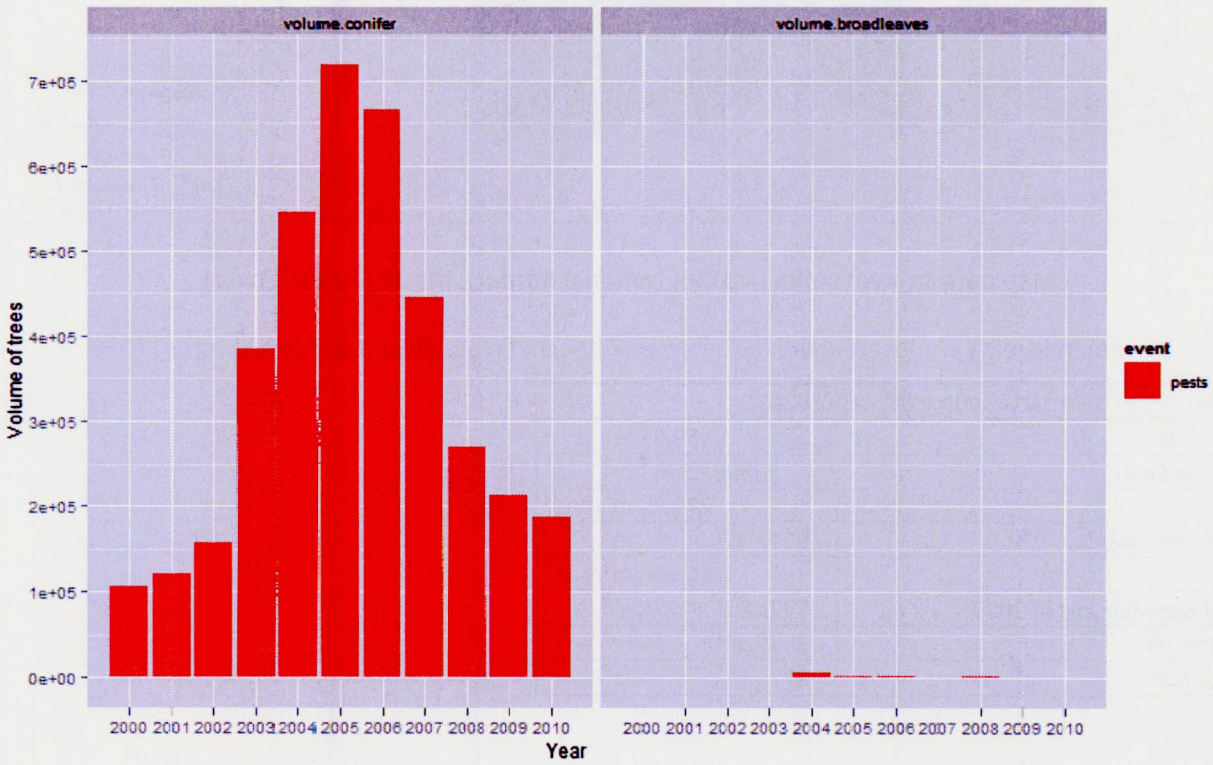
✓ **Most affected forest formations** [*relative incidence of cuts due to pests for different forest types / year*].

From all of the trees selected for logging due to damages caused by pests there were little more than 3.2 million of coniferous and little more than 16000 of deciduous trees. More conifers had been damaged by pests than broadleaves. Years 2005 and 2006 were the years with the highest number of trees damaged by pests.

	year	event	nr.conifer	volume.conifer	nr.broadleaves	volume.broadleaves
1	2000	pests	105443	106773.4	1249	737.68
2	2001	pests	123132	121733.5	1022	617.35
3	2002	pests	133361	156732.6	945	672.31
4	2003	pests	323311	385071.7	1073	716.33
5	2004	pests	457996	544190.0	4054	6254.80
6	2005	pests	595508	717788.9	1950	1786.92
7	2006	pests	574977	666110.3	1731	1697.76
8	2007	pests	380059	444351.5	1229	1060.05
9	2008	pests	217704	269209.0	1423	1377.51
10	2009	pests	168113	213151.8	636	457.21
11	2010	pests	153896	187226.8	812	485.78



From 2000 to 2010 overall volume of coniferous trees, which were assign to be logged because of pests damages, was 3.8 million m^3 and 15864 m^3 of broadleaves.



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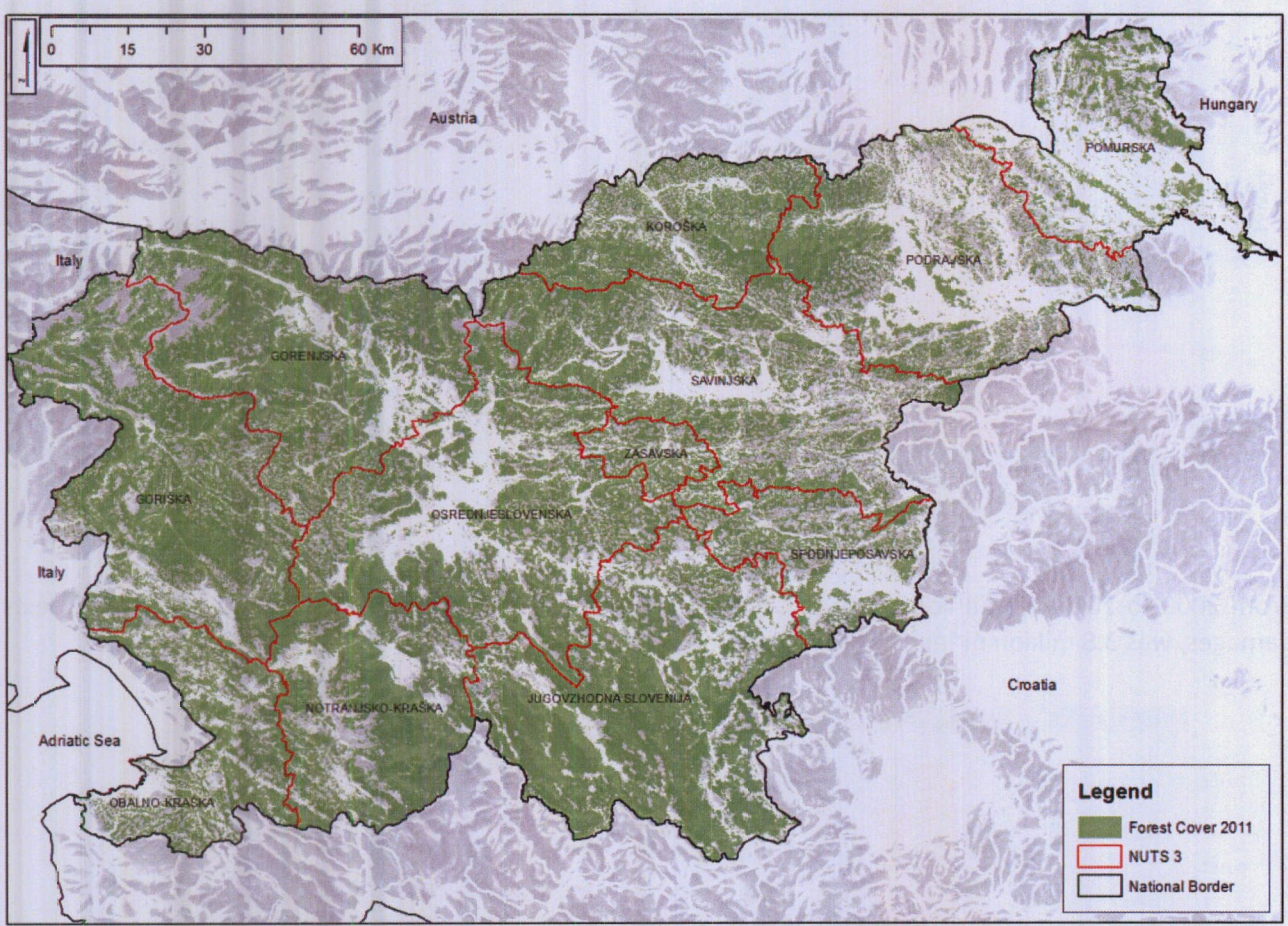
Damages (refers to administrative units)

Slovenia belongs to one of the most forested countries in Europe. Forests cover more than a half of its territory - almost 60 % of the country. Average growing stock in year 2010 was 279 m^3/ha and allowable cut in year 2009 was 5 million m^3 (SFS report).



Map data source: GURS (NUTS3, National Border), MKGP (Forest Cover)

Most of Slovenian forests are located within the area of beech, fir-beech and beech-oak sites (70 %).

Slovenia 2010 data: data source SFS report 2010		
% of forest:	59.8	%
Growing Stock:	330982.374	m^3
	279.3	m^3/ha
Anual increment	8117.325	m^3
	6.85	m^3/ha
Anual alowable cut in 2009:	5321.927	m^3
Coniferous:	2545.110	m^3
Deciduous:	2776.817	m^3

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Slovenia is divided on 2 NUTS2 regions (East Slovenia and West Slovenia) and on 12 NUTS3 regions (see the map above and the table below).

* Data source: map of land use 2010 (MKGP), map of statistical regions			
NUTS1	NUTS1_NAME	Forest Area	
1	Slovenia	1212937.70	ha
	% of forest	59.80	%
NUTS2	NUTS2_NAME		
1	East Slovenia	692624.27	ha
2	West Slovenia	520313.43	ha
NUTS3	NUTS3_NAME		
1	Mura (Pomurska)	42048.35	ha
2	Drava (Podravska)	89862.70	ha
3	Carinthia (Koroška)	75152.64	ha
4	Savinja (Savinjska)	135721.78	ha
5	Central Sava (Zasavska)	16967.05	ha
6	Lower Sava (Spodnjeposavska)	42747.79	ha
7	Southeast Slovenia (Jugovzhodna Slovenija)	186635.13	ha
8	Inner Carniola-Karst (Notranjsko-kraška)	152867.14	ha
9	Central Slovenia (Osrednjeslovenska)	147000.00	ha
10	Upper Carniola (Gorenjska)	103488.82	ha
11	Gorizia (Goriška)	159453.31	ha
12	Coastal-Karst (Obalno-kraška)	60993.00	ha

✓ **Overall damages** [*overall damages due to pests attacks / year*]. Comments on **ongoing trends**

The first and second graph on the next page (page 12) shows the number of all trees and the number of trees per hectare that were, during the period from 2000 to 2010, assigned to be logged because of pests. The third and fourth graphs on page 13 are the same but for volume of damaged trees. One graph in a row refers to one NUTS3 regions. The highest damages caused by biotic factors were observed in the NUTS3 region Southeast Slovenia and NUTS3 Central Slovenia. In the period from 2003 to 2005 the number of trees affected by pests increased and after year 2005 started to decrease.

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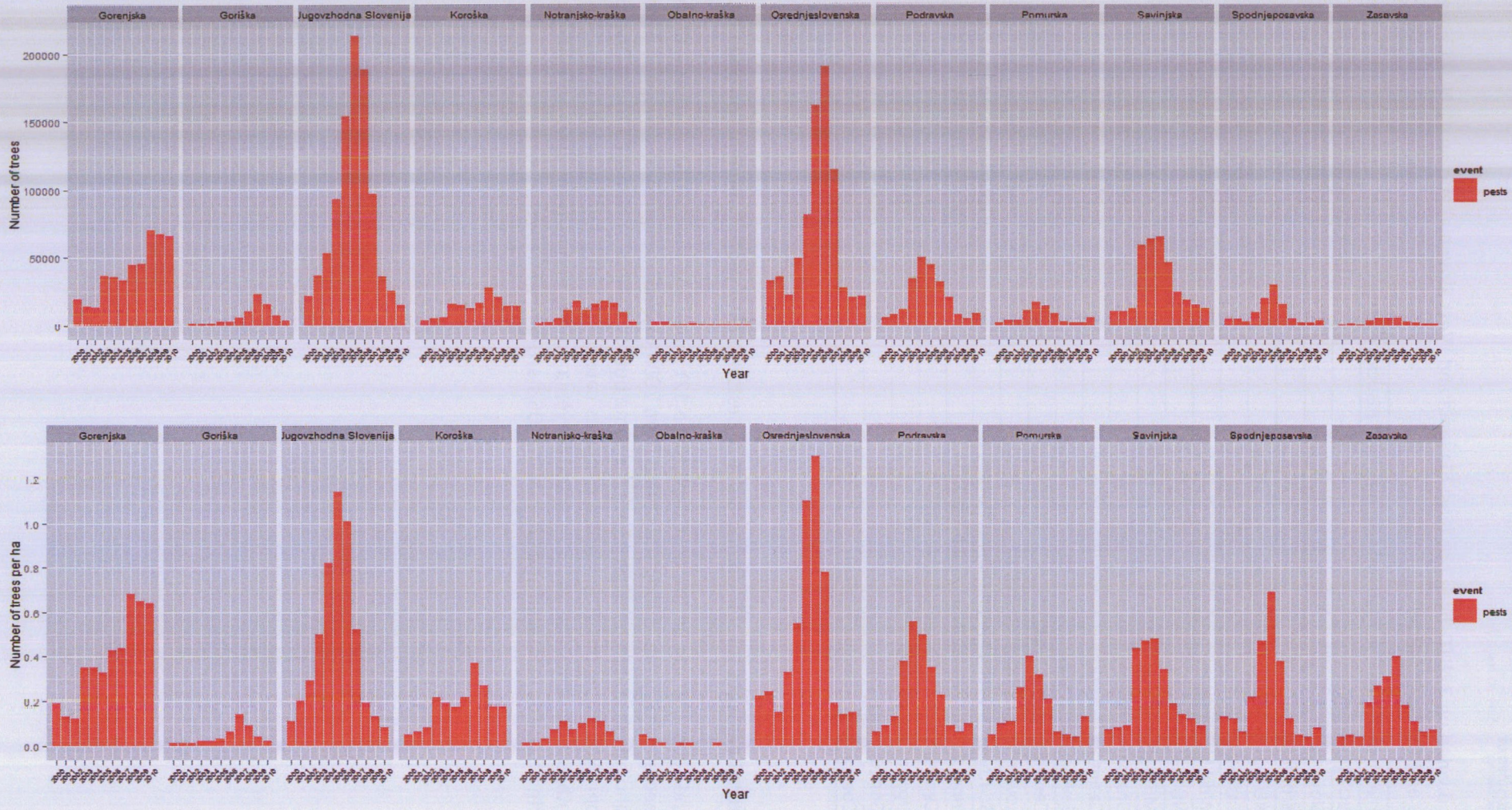

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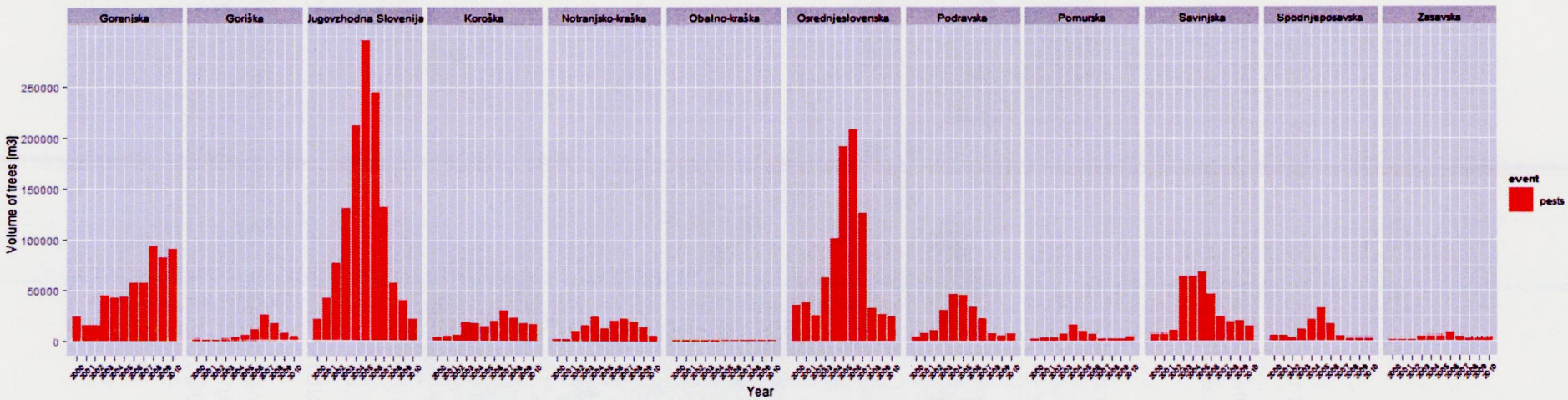

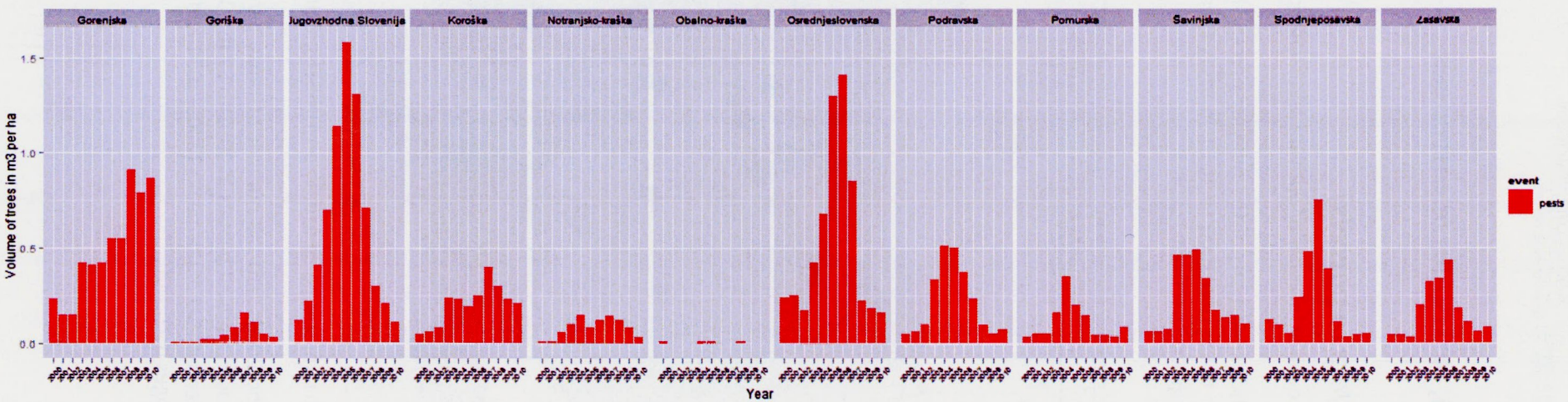

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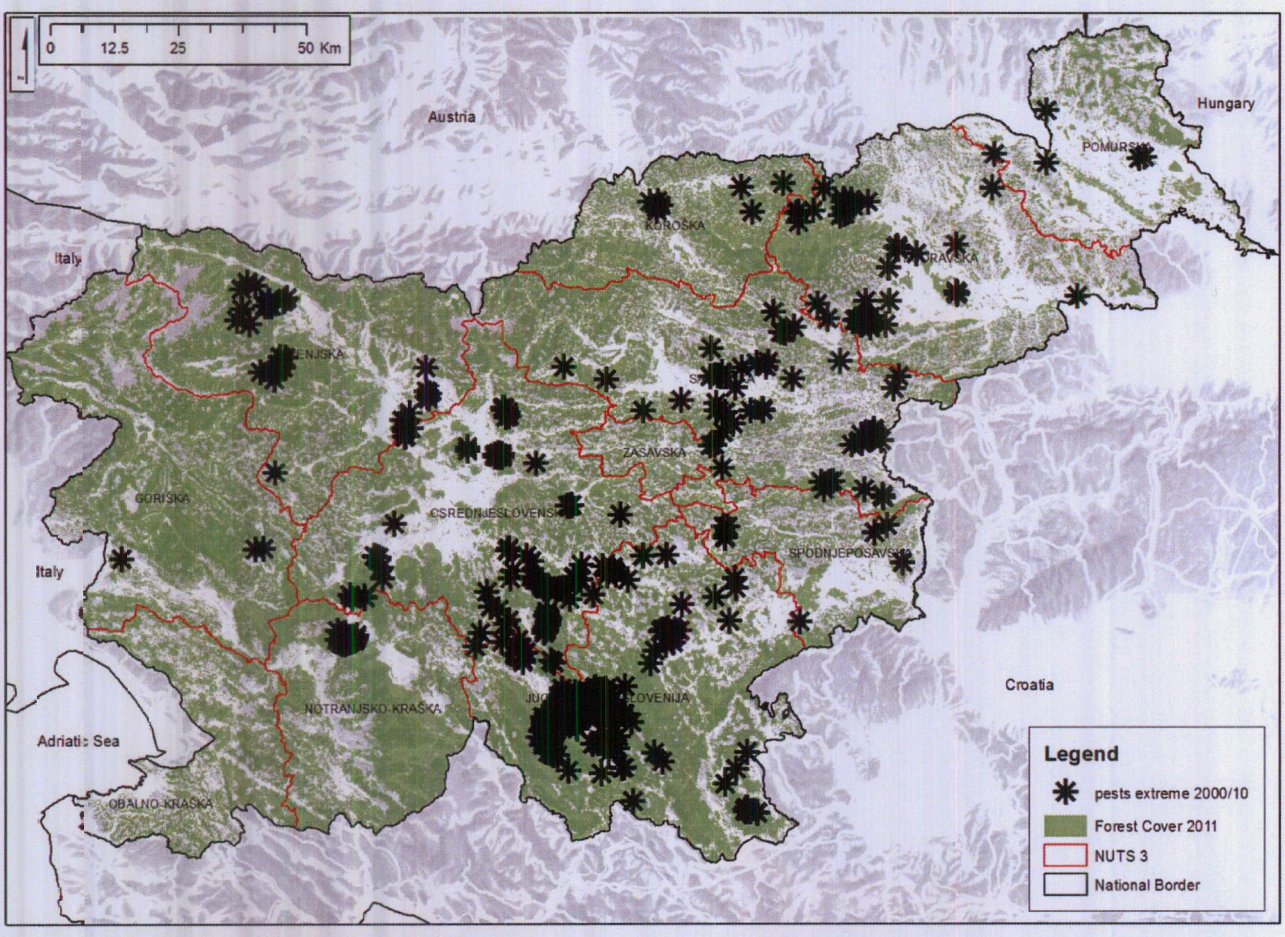
Outlying (extreme) occurrences

Cuts (refers to parcels)

- ✓ **Frequency** [*number of outlying occurrences / year*].

The map shows locations of the outlying parcels, in which extreme damages caused by pests occurred in the past. In the period 2000 to 2010, in total, there was, 461 parcels extracted as extreme due to severe pests damages, respectively.



Map data source: SFS (data on TIMBER), GURS (NUTS3, Nationa Border), MKGP (Forest Cover)

In the period 2000-2010 the number of those parcels where trees experienced extreme damages due to pests increased from 37 parcels in 2002 to 57 in 2003 and to 61 in 2006. From the table and graph below it can be observed two major peaks (2003/2004 and 2006/2007) in the number of parcels in which extreme pests damages occurred.

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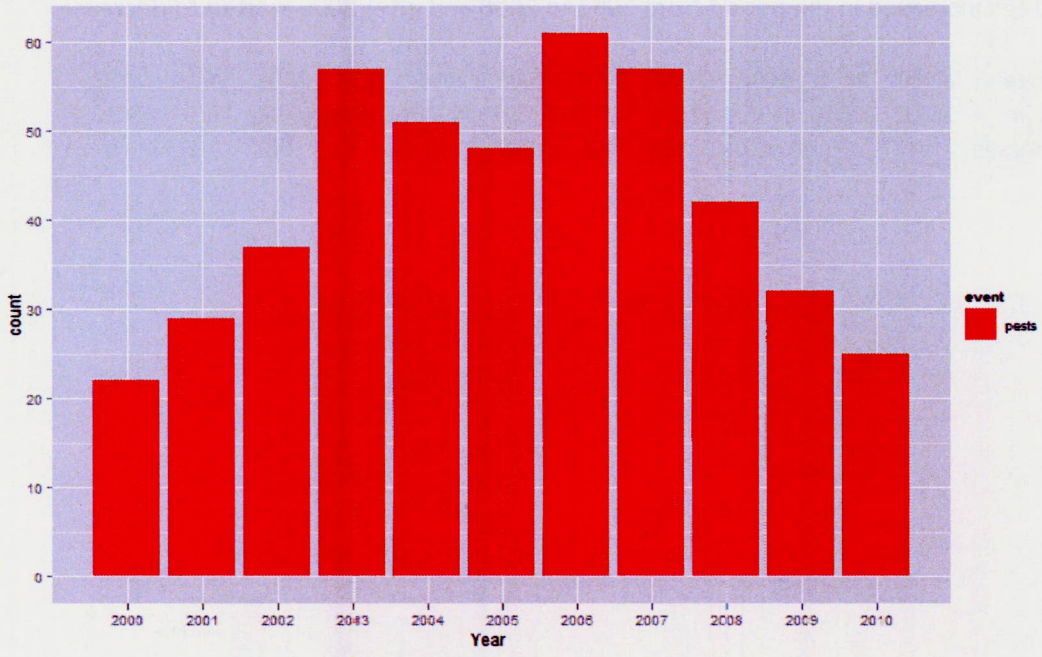
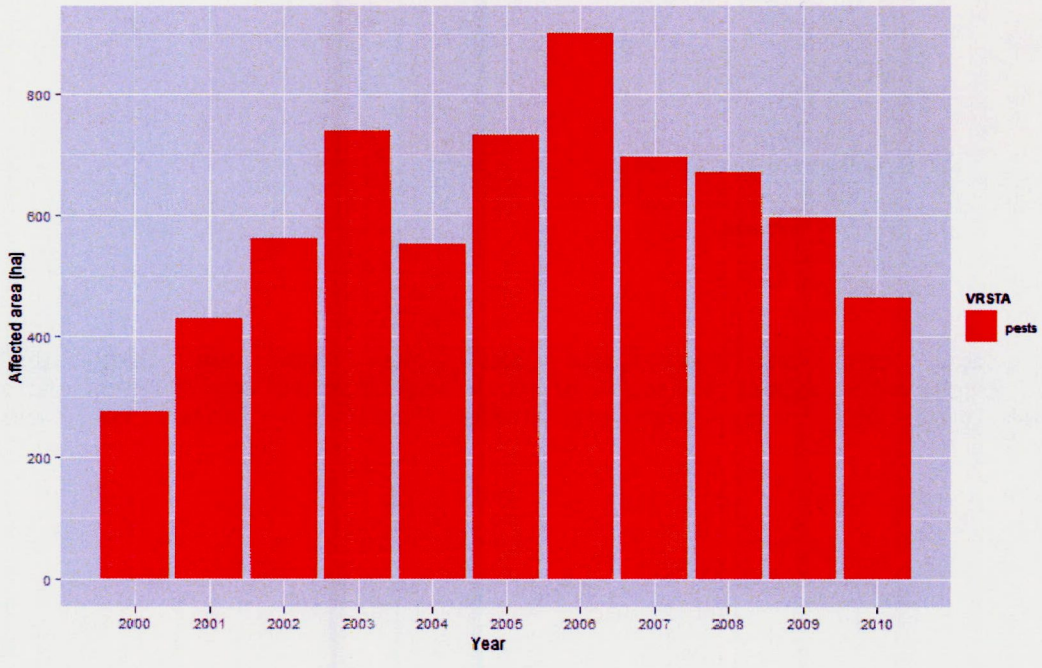
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
pests	22	29	37	57	51	48	61	57	42	32	25



✓ **Affected area** [*overall area of outlying parcels / year*].



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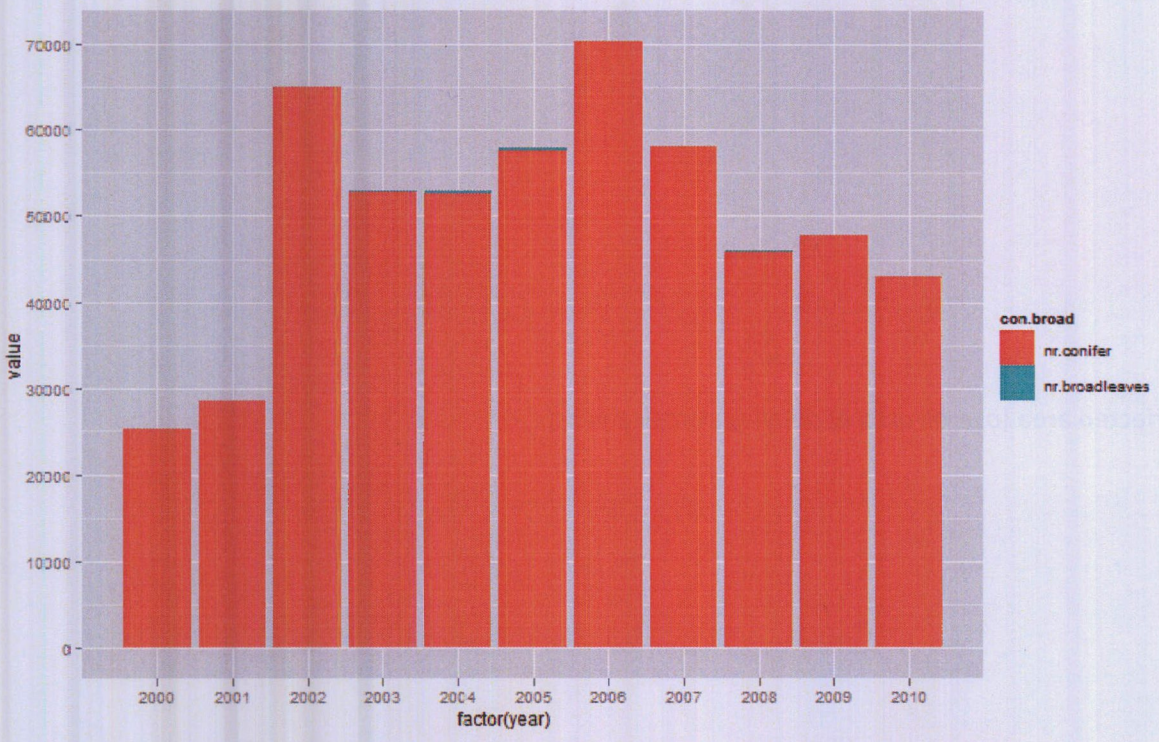
✓ **Most affected forest formations** [*relative incidence of outlying parcels for different forest types/ year*]. Comments on **ongoing trends**

If we compare the number and the volume (see the tables and graphs below) of damaged trees in the selected outlying parcels we could see conifers as more endangered relative to broadleaves. The volume and the number of trees increased in the period from 2002 to 2006 and after 2006 started to decrease.

	event	species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	pests	nr.conifer	25332	28669	64977	52794	52653	57597	70386	58143	45896	47799	43013
2	pests	nr.broadleaves	1	6	29	58	196	379	3	8	142	2	0



	event	species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	pests	volume.conifer	42702.84	44658.63	63028.61	74640.88	69922.97	87121.85	113919.07	79293.93	84210.47	72258.89	66283.27
2	pests	volume.broadleaves	0.76	2.32	11.12	12.72	64.22	1125.33	1.86	8.61	269.54	1.68	0.00

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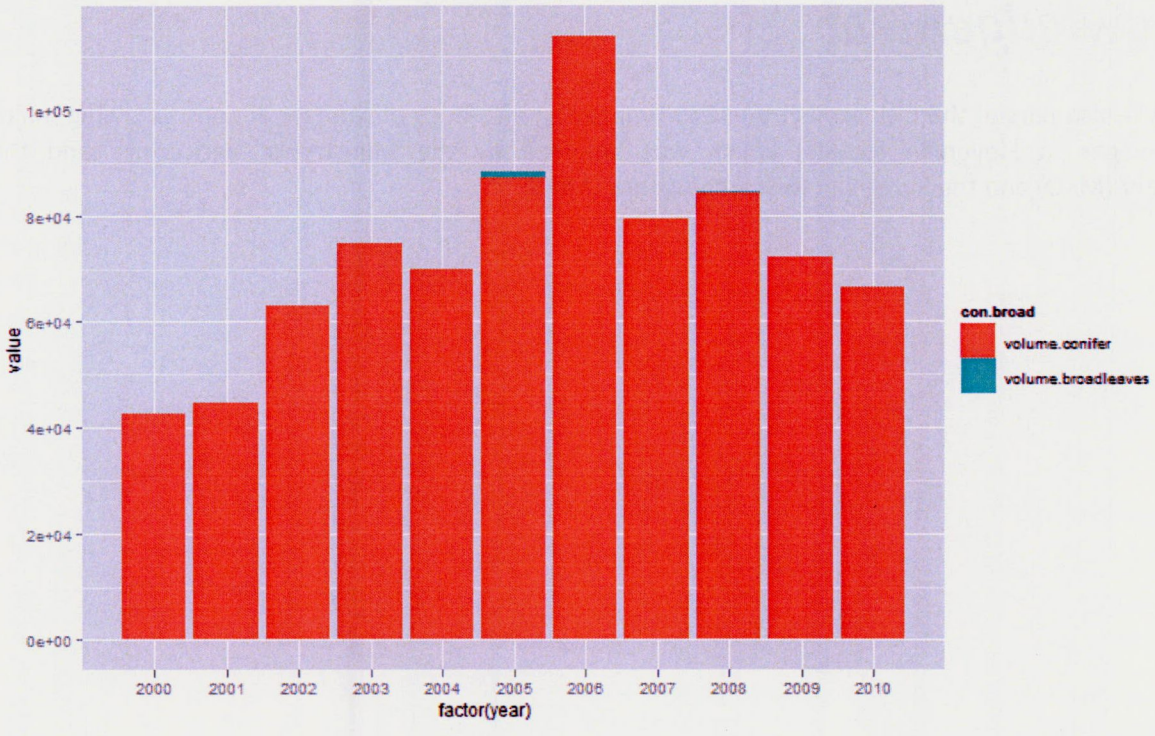

List of memory sifted events

- ✓ **Most endangering biotic agents**

Pests - especially bark beetle

- ✓ **Most affected forest types**

Coniferous forests

- ✓ **Overall volumes damaged by pest attacks per year**

	year	event	cut.m3	nr.cut.tree
1	2000	pests	107511.1	106692
2	2001	pests	122350.9	124154
3	2002	pests	157404.9	134306
4	2003	pests	385788.0	324384
5	2004	pests	550444.8	462050
6	2005	pests	719575.9	597458
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Regional Report on extreme fire occurrences

SLOVENIA

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Additional info: Marija Kolšek (marija.kolsek@zgs.gov.si)

Ljubljana 23.2.2012

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The available dataset

✓ **Definition of forest in Slovenia**

The stewardship of Slovenia's forestlands is being ensured by the legislative framework made-up of **Forest Act** (Official Journal RS, nr. 30/93, 13/98, 56/99, 67/02, 110/02,112/06, 115/06), **Act on changes and completions of Forest Act** (Official Journal RS, nr.110/07, 106/10) and **Forest Development Program** (1996).

In Slovenia **"Forest"** is defined by Act on changes and completions of Forest Act (2007) and is defined as a plot of land overgrown with forest trees in the form of stands. The minimum height of trees must be 5 m and the area must be larger than 0.25 ha. As forest are considerate also lands which area is at least 0.25 ha and were not used for agricultural purpose for the last 20 years. In this case the conditions are also that the area is overgrown with trees which can reach minimum height of at least 5 m and their crown cover should be at least 75 %. Riverside forest corridors and windbreaks are included as forests if their width is at least one tree height and they cover an area of at least 0.25 ha.

Under the term **"Other wooded land"** are includes lands overgrown with forest trees or other vegetation if a minimum size is 0.25 ha. The additional conditions are that the same land is not identified as a forest, and was not used for agriculture for the last 20 years. Other wooded lands also comprise game pans and areas under power lines in forest if the area is larger than 0.25 ha.

According to the third paragraph of the 3rd article of Forest Act, forest infrastructure, if not portioned out, is included in forests. Individually scattered forest trees and groups of forest trees on area smaller than 0.25 ha, avenues planted with trees on one or both sides, parks and forest tree plantations **are not defined as forest**.

✓ **Time span of fire data availability**

In Slovenia the registration of forest fires occurrences started before the year 1985. From year 1985 onward the occurrence of forest fires is systematically registered by the Slovenia Forest Service. In this study (Manfred project) we have analysed the data from the period 1995 to 2009.

✓ **Monitored attributes in Slovenia**

The monitored attributes, done by the SFS, could be divided into two groups:

1. General information about the fire: region, coordinates of ignition point or location of fire (X, Y), local name of the area, name of the municipality, date and time of fire ignition and end, cause (natural, human, unknown), altitude, aspect, type of relief, weather conditions, degree of fire hazard, location in the region, type of fire.
2. Information concerning the burned area: total burnt area (ha) divided on private and public forest and on the type of burned forest (even aged forest (coniferous, broadleaved, mixed), shrubs, other wooded land etc.), dominant development phase of forest, mixture (coniferous, broadleaved), volume of damage trees, estimation of damage (€), perimeter of burned area.

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- ✓ **Idle attributes** [identification of the attributes that cannot be used for extreme fires selection, due to **inherent problems in filling** (i.e. incompleteness, high uncertainty, etc.)]

There is one important attribute that was missing in the fire database - there are no digital shape files of burned area for last years.

Legislative milestones

- ✓ **The evolution of fire fighting laws in Slovenia**

Year	Law
1976	Fire Protection act
1993	Fire Service Act
2005	National emergency response plan in case of major forest fires
2006	Decree on fire protection in the natural environment
2006	Regulation on Protection against fire in the natural environment
2010	Rules of the fire service

Historical fire occurrences

- ✓ Fire **frequency** [*number of fires / year*]

From 1995 to the end of 2009 there had been 1344 fire occurrences in Slovenian forests and agricultural lands. Out of 1344 registered fires there are 31 fire events for which there is no data on the size of burned area and 181 fires had made some damage only on agricultural land.

For the same period (1995-2009) 1132 fires (graph and table) had made damage in forests and/or in other wooded lands. The highest number of fires in forest occurred in 2003 (227 events) and the second highest in 1998 with 143 fire events.

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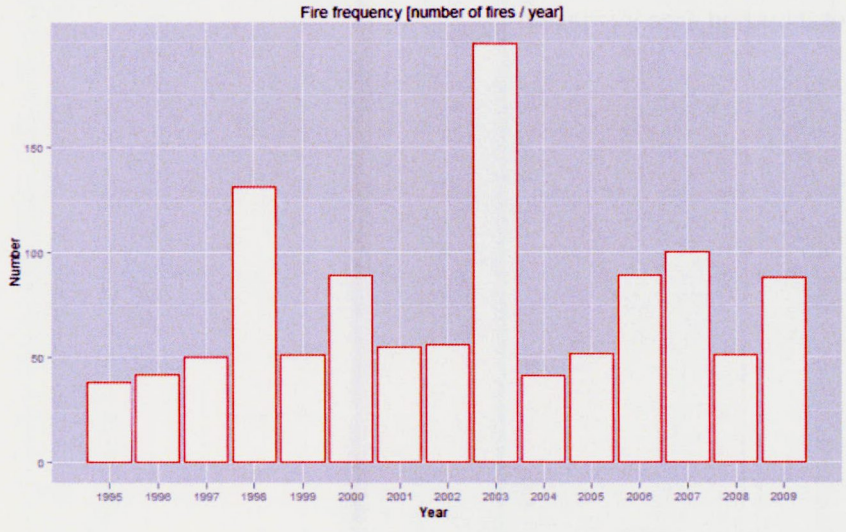
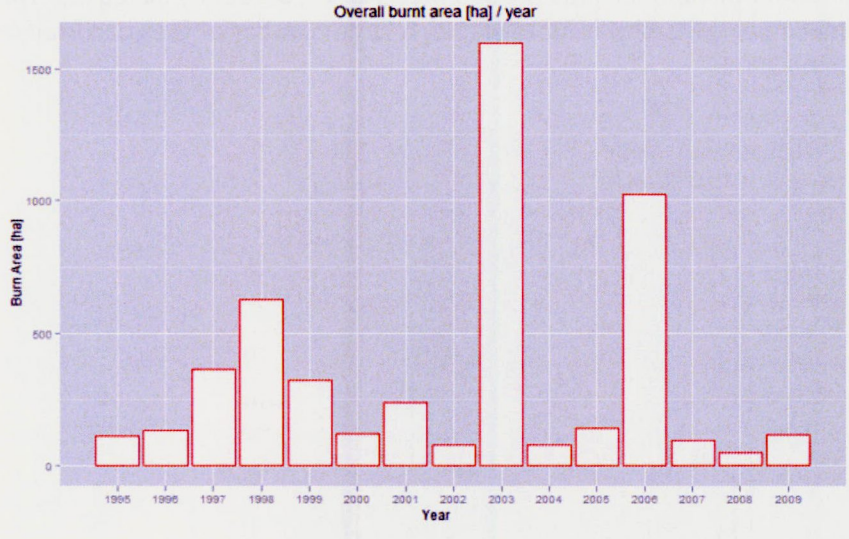


	Year	Number
1	1995	38
2	1996	42
3	1997	50
4	1998	131
5	1999	51
6	2000	89
7	2001	55
8	2002	56
9	2003	199
10	2004	41
11	2005	52
12	2006	89
13	2007	100
14	2008	51
15	2009	88

✓ **Affected area - Intensity** [*overall burnt area / year*] AND [*mean of total burnt area / year*] AND [*kurtosis of total burnt area / year*]

In terms of extreme years concerning the overall burnt area years 2003 and 2006 stand out. In those two years the two biggest fire events occurred, one in 2003 when 1048 ha of land was burned (from that 958 ha of forest) and one in 2006 when 950 ha was damaged (of which 707 ha of forests).



	Year	BurntArea	Mean	Kurtosis
1	1995	110.22	2.90	15.36
2	1996	133.59	3.18	10.38
3	1997	365.24	7.30	40.78
4	1998	626.82	4.78	14.38
5	1999	321.59	6.31	20.09
6	2000	118.63	1.33	25.33
7	2001	239.10	4.35	41.39
8	2002	77.44	1.38	22.95
9	2003	1596.14	8.02	187.39
10	2004	76.42	1.86	29.69
11	2005	139.63	2.69	36.46
12	2006	1021.59	11.48	77.31
13	2007	95.21	0.95	24.47
14	2008	46.09	0.90	7.78
15	2009	114.74	1.30	20.57

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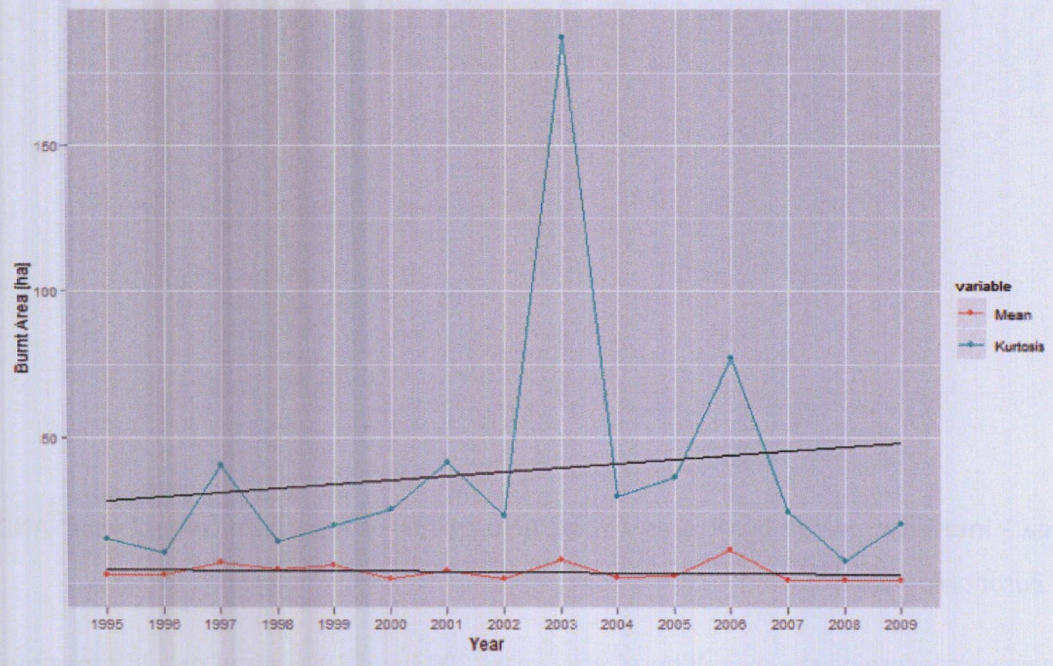
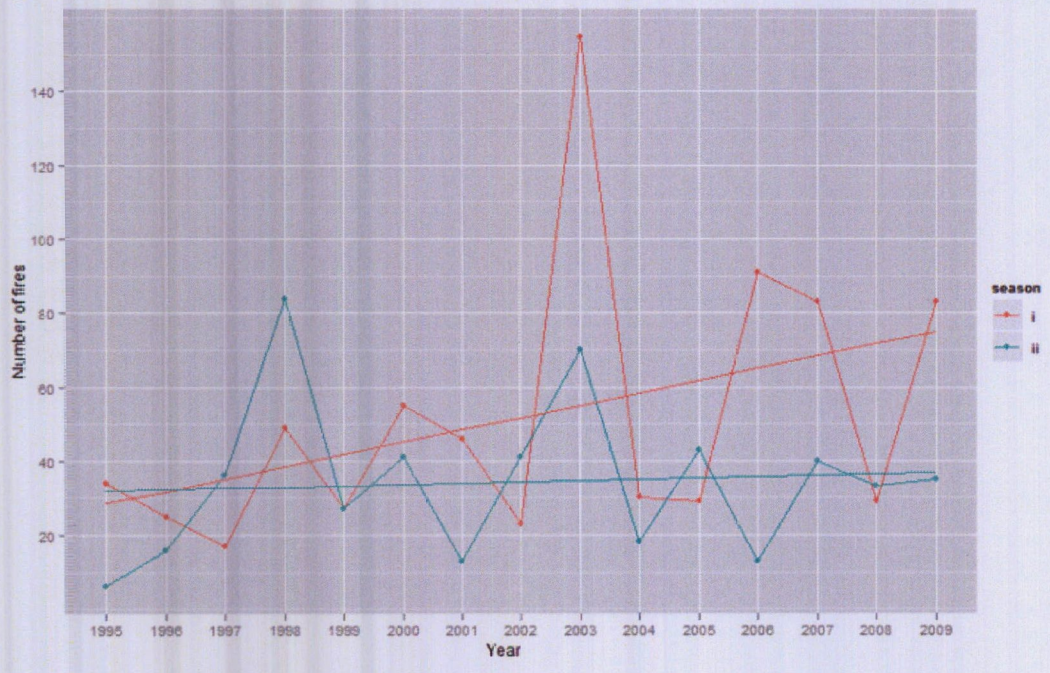
The analyses of the mean burned area per year show that the average burned area decreased a bit in the last period, contrary the kurtosis of total burned area increased.



✓ **Seasonality** [*overall number of winter fires / year*] AND [*overall number of summer fires / year*].

During the period 1995 to 2009 the number of summer fires (i – summer (April – October)) increased. The number of winter fires (ii – winter (November – March)) is more stable. A large number of fires occurred in very dry years such as the years 2003 and 2006.



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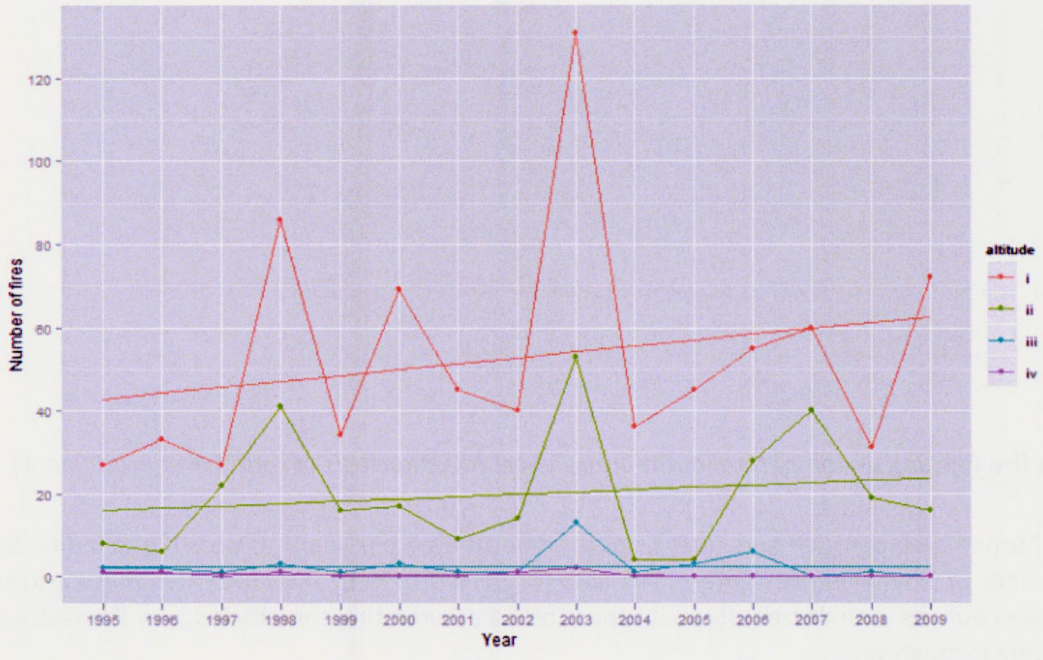
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
i	34	25	17	49	27	55	46	23	155	30	29	91	83	29	83
ii	6	16	36	84	27	41	13	41	70	18	43	13	40	33	35

✓ **Altitude class** [*overall number of fires per altitude class / year*].

Concerning the altitudes it is possible to see the increase in the number of fires in lower altitudes (class: i – 0 to 500 m asl and class ii – 500 to 1000 m asl). In higher altitudes the number of fires for this period is steady (iii – 1000 to 1500 m asl, iv – more than 1500 m asl). There were not a lot of fires in higher altitudes in Slovenia.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
i	27	33	27	86	34	69	45	40	131	36	45	55	60	31	72
ii	8	6	22	41	16	17	9	14	53	4	4	28	40	19	16
iii	2	2	1	3	1	3	1	1	13	1	3	6	0	1	0
iv	1	1	0	1	0	0	0	1	2	0	0	0	0	0	0

✓ **Anthropic influence** [*overall number of anthropic fires / overall number of fires * year*]

Considering the cause of fires in Slovenia we can see that the main reasons for fire occurrences are people. Through the years the number of fires lighted by the people is increasing (iii – anthropic), same is with fires with unknown (ii) cause of ignition. Lots of fires occurred near the railways. During the period 1995-2009 there were 103 natural (i) fires.

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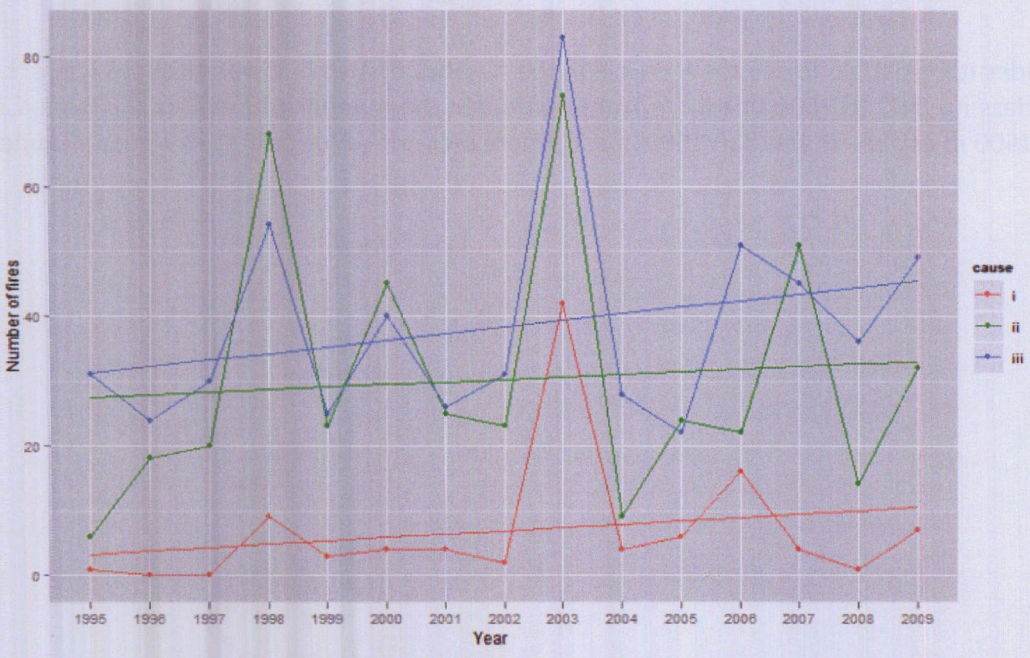
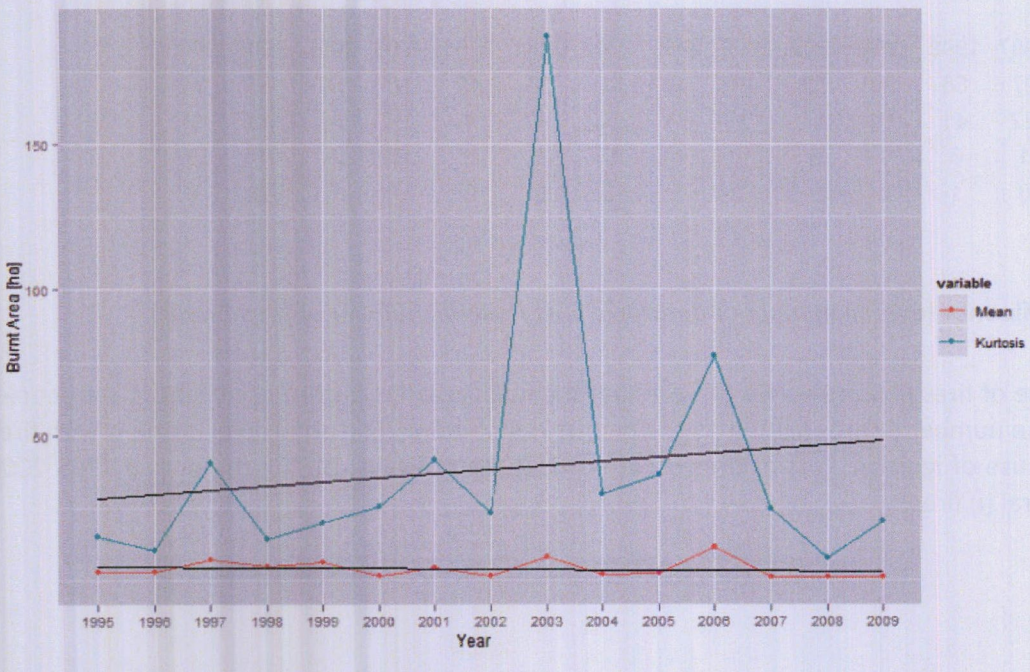
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
i	1	0	0	9	3	4	4	2	42	4	6	16	4	1	7
ii	6	18	20	68	23	45	25	23	74	9	24	22	51	14	32
iii	31	24	30	54	25	40	26	31	83	28	22	51	45	36	49



✓ **Efficiency in fire fighting** [*mean of total burnt area / year*] AND [*kurtosis of total burnt area / year*]

With mean of total burned area per year and kurtosis of total burnt area per year it is possible to indirectly assume on the efficiency of Slovenian fire fighters. The data for period 1995 to 2009 indicates that kurtosis increases and the mean burned area decreases. So it is possible to assume that the efficiency of fire fighting in Slovenia is improving through years.



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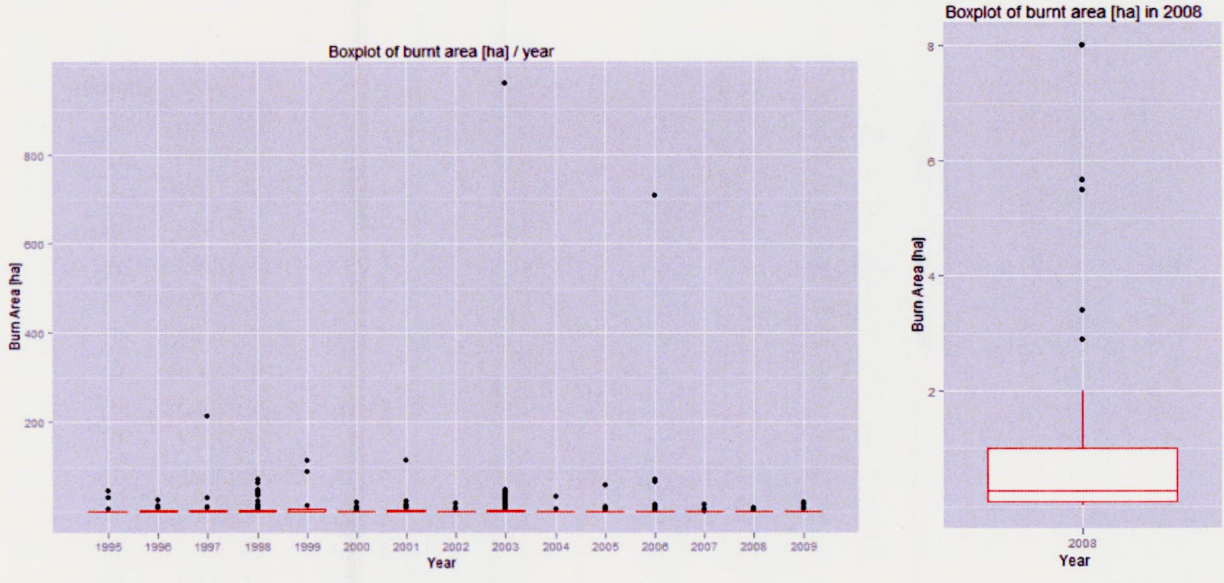
Extreme fires selection methodology

The extreme fires selection methodology bases on integration of two methods - outliers and percentile:

1. Outliers are defined as observations that are numerically distant from the rest of the data. More statistical definition is that the value is outlier if it is higher than threshold Mean + 2б and for extreme outliers Mean + 3б.



2. Percentile is the value of a variable below which a certain percent of observations falls. The 25th percentile is also known as the first quartile (Q1), the 50th percentile as the median or second quartile (Q2), and the 75th percentile as the third quartile (Q3).

The adopted methodology to select extreme fire events was the combination of both mentioned methods as:

- Mean + 2σ (97.8 percentile)
- Mean + 2.5σ (98.8 percentile) → **99th percentile**
- Mean + 3σ (99.9 percentile)

So as extreme fire events were selected those events for which total burned area was bigger than the 99th percentile of burned area for all the years. In this case the threshold for the Alpine space data on fire was 115 ha and for Slovenian data 85.5 ha.

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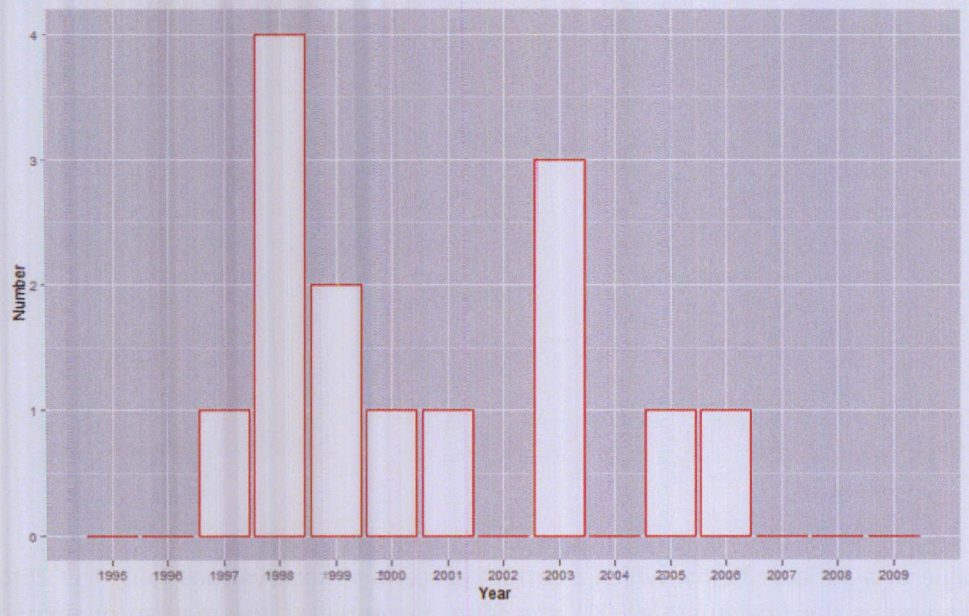
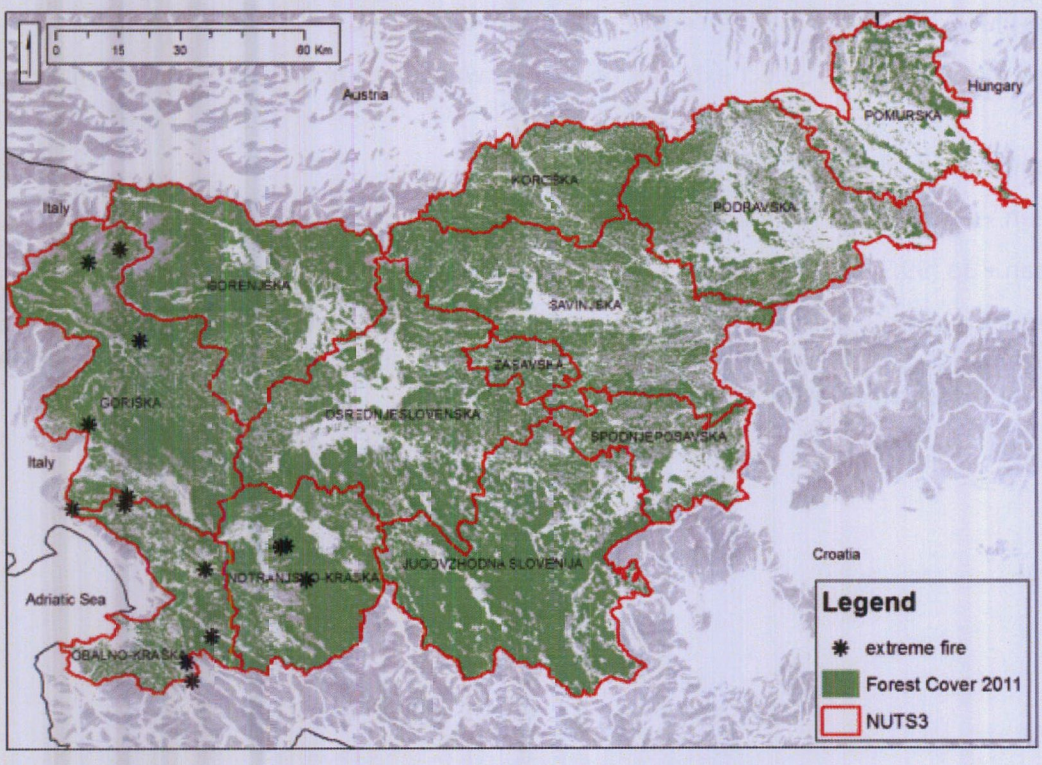
Trends in extreme fires occurrences

✓ **Frequency** [*number of extreme fires / year*]

In the period from 1995 to 2009 fourteen fires were extremely large in comparison to other fires (larger then calculated threshold of 99th percentile which is 85.5 %). Four of them occurred in 1998, three in 2003, two in 1999 and one in years 1997, 2000, 2001, 2005 and 2006. In last three years there were no extreme fire events.



	year	Number
1	1995	0
2	1996	0
3	1997	1
4	1998	4
5	1999	2
6	2000	1
7	2001	1
8	2002	0
9	2003	3
10	2004	0
11	2005	1
12	2006	1
13	2007	0
14	2008	0
15	2009	0



Map data source: MKGP, GURS, SFS

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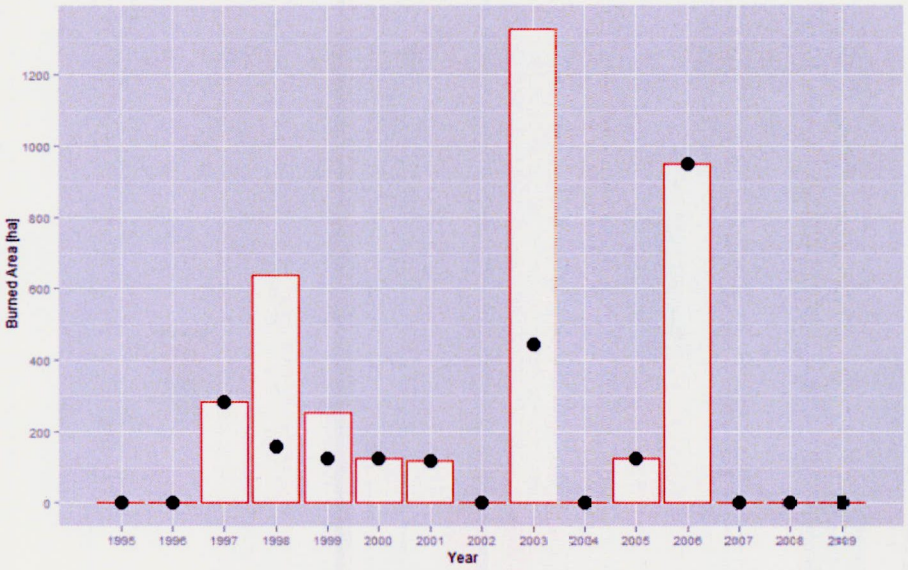
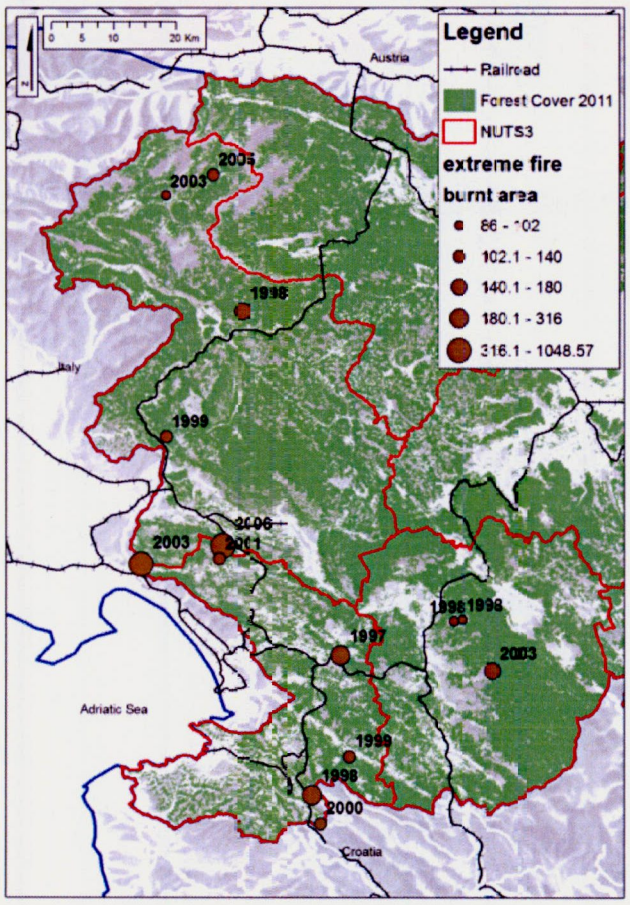
✓ **Affected area** [*overall burnt area in extreme fires / year*] AND [*mean area of extreme fires / year*]

In year 2003 three fires affected 1330 ha of land. This was extreme year concerning the size of burned areas in Slovenian history. The mean burnt area for this year was 443.5 ha. There was one big fire event in this year that made damage to 1048 ha of land other two were much smaller (102 ha and 180 ha). In year 2006 only one extreme event occurred and the damaged area was 950 ha.



	year	area.burnd	mean.area
1	1995	0	0
2	1996	0	0
3	1997	281.7	281.7
4	1998	638	159.5
5	1999	252.5	126.2
6	2000	125.5	125.5
7	2001	117	117
8	2002	0	0
9	2003	1330.6	443.5
10	2004	0	0
11	2005	126	126
12	2006	950	950
13	2007	0	0
14	2008	0	0
15	2009	0	0



Map data source: MKGP, GURS, SFS

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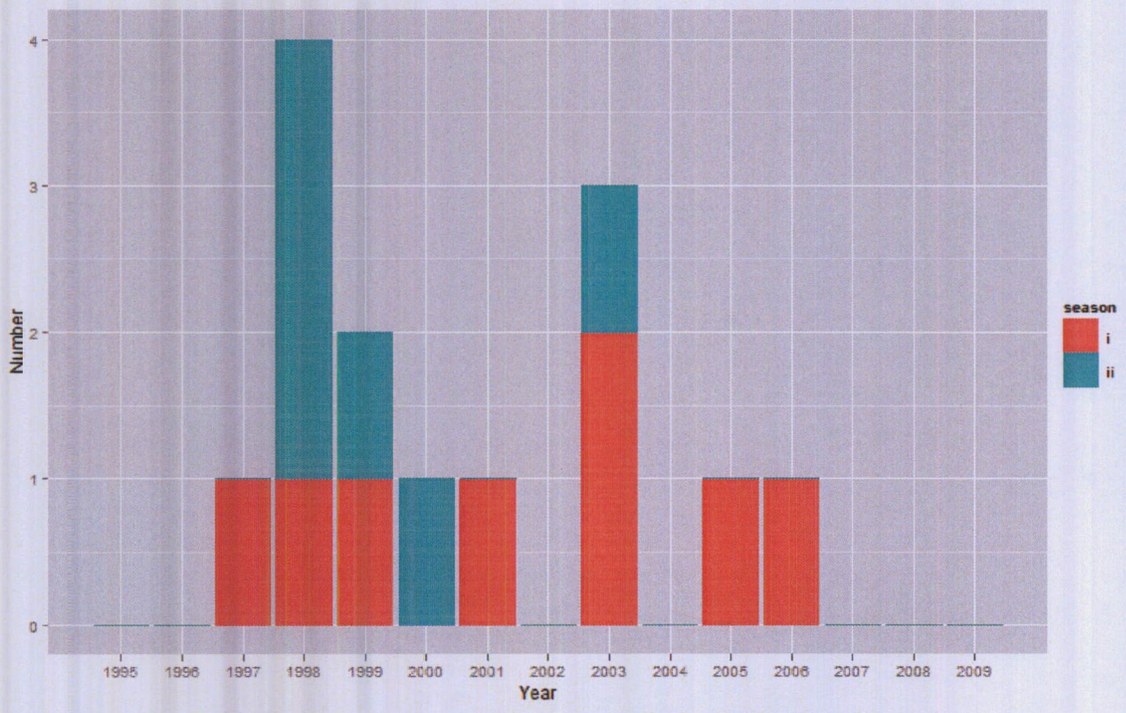
✓ **Seasonality** [*overall number of winter extreme fires / year*] AND [*overall number of extreme summer fires / year*].

Eight of the extreme fire events occurred during the summer (i – April to October)) and six during the winter (ii – November to March). With the exceptions of years 1998 and 2000 most of the extreme fire events occurred during the summer. In the year 1999 there was one winter and one summer fire.



X	season	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	i	0	0	1	1	1	0	1	0	2	0	1	1	0	0	0
2	ii	0	0	0	3	1	1	0	0	1	0	0	0	0	0	0

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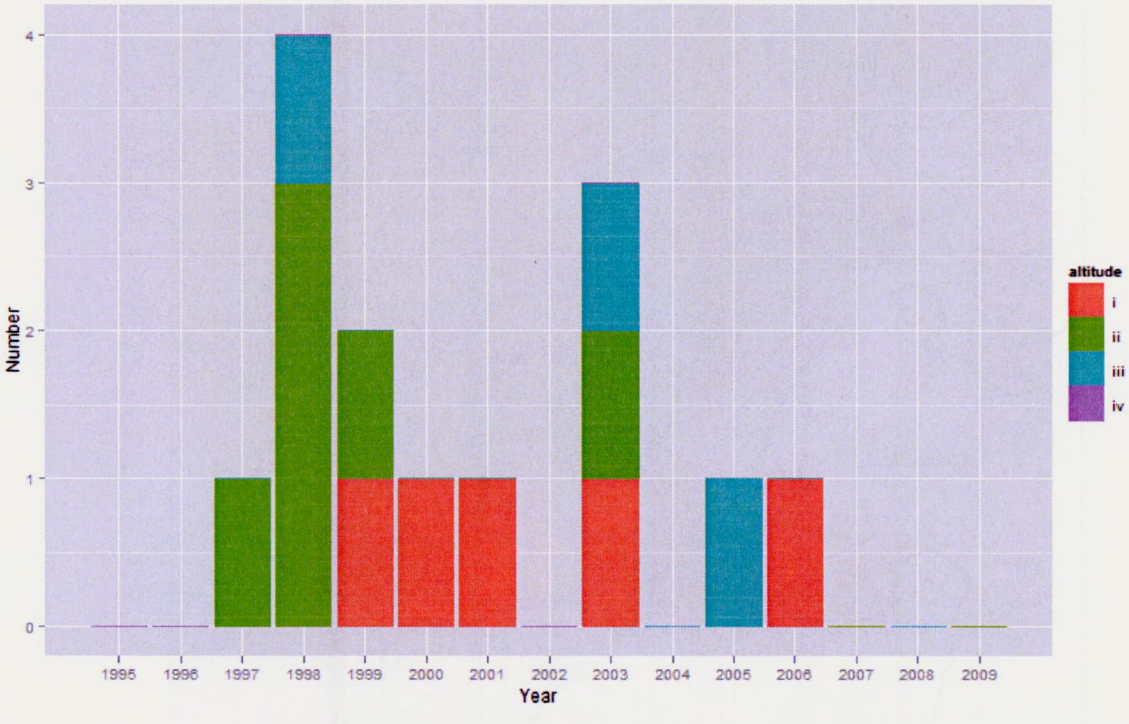
✓ **Altitude class** [*overall number of extreme fires per altitude class / year*] AND [*relative frequency of extreme fires per altitude class / year*].

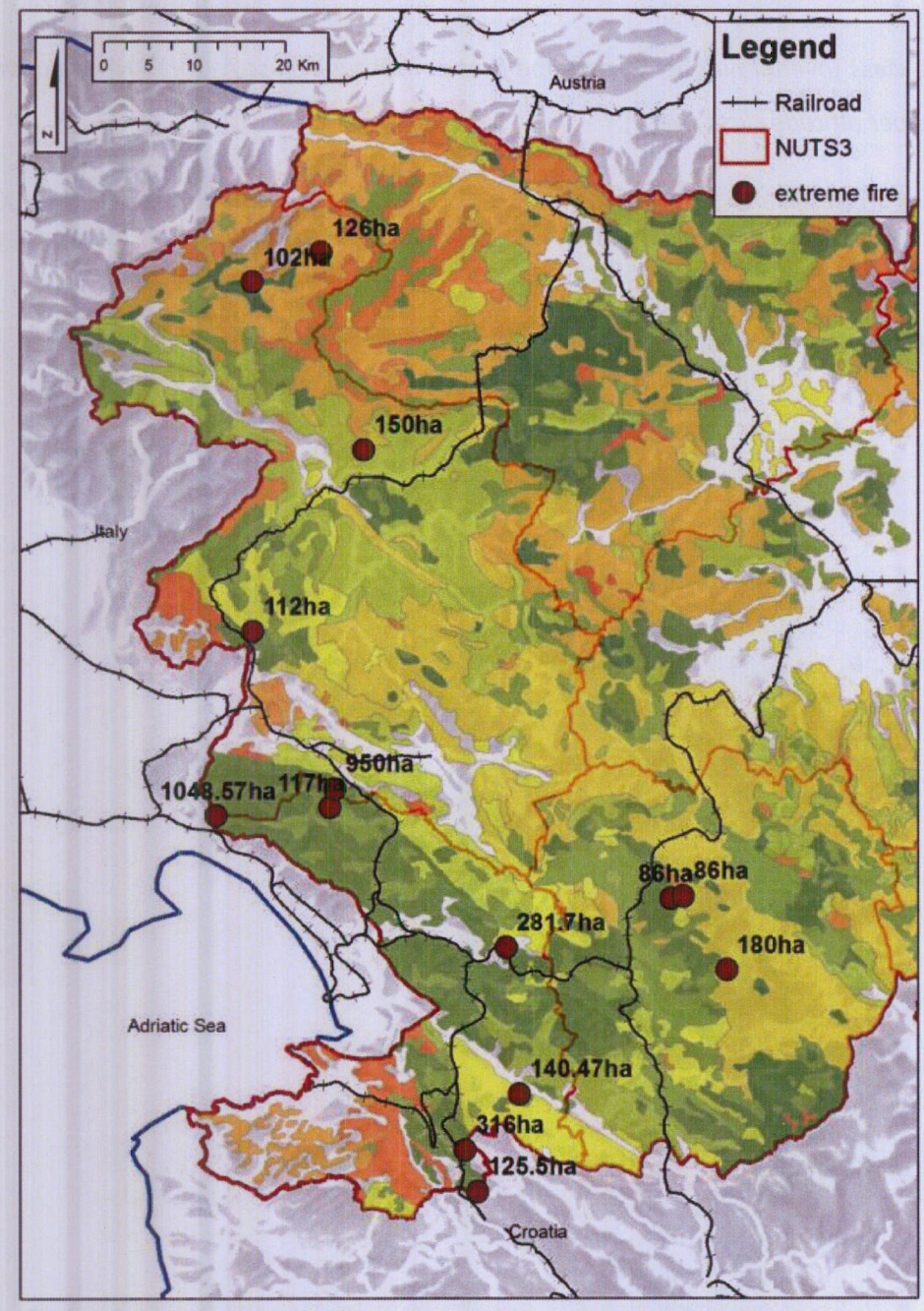
During the period from 1995 to 2009 5 extreme fires occurred in the first altitude class (0-500 m asl), 6 of them in the second altitude class (500 – 1000 m asl), 3 in the third class (1000 – 1500 m asl) and there was no extreme fires at the altitude above 1500 m asl.

	altitude	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	i	0	0	0	0	1	1	1	0	1	0	0	1	0	0	0
2	ii	0	0	1	3	1	0	0	0	1	0	0	0	0	0	0
3	iii	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
4	iv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



✓ **Most concerned forest categories**. An attempt should be made to highlight the forest categories **most endangered** in extreme fires, with evaluations on ongoing trends and eventual identification of highly vulnerable forest formations

Most of the extreme fires occurred in the Western part of Slovenia especially in forests of *Ostryo carpinifoliae-Quercetum pubescentis.* In this vegetation type 8 of 14 extreme fire events occurred and we can represent this type as the most endangered (see the map of vegetation on page 15). Two extreme fires had made damage in vegetation type *Anemono trifoliate-Fagetum* and two in the *Seslerio autumnalis-Fagetum*. In the vegetation type *Ostryo-Fagetum* and *Omphalodo-Fagetum* one extreme fire occurred.



Map data source: ZRC-SAZU, SFS, GURS

Acknowledgement

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