ECO-CLIMATIC ASSESSMENT OF THE POTENTIAL ESTABLISHMENT AND SPREAD OF PHYTOPHTHORA RAMORUM IN SLOVENIA

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INTRODUCTION

Phytophthora ramorum Werres, De Cock & Man in 't Veld (Peronosporaceae) is a harmful organism, which infects several tree species as: oak (*Quercus spp.),* larch (*Larix spp*.), chestnut (*Castanea sativa*), beech (*Fagus sylvatica*) and others. In Slovenia, a survey of *Phytophthora ramorum (P. ramorum)* has been ongoing since 2003, when also the first interception of infected ornamental plant was noticed. Since then interceptions of infected ornamental plants in containers were recorded every year. Only in 5 cases infected plants were planted and later on found in parks or gardens. All necessary measures aiming to eradicate the disease were taken and no infection of potential host trees was noticed at those sites. Due to intensive debate at EU level about further status of *P. ramorum*, Slovenian eco-climatic conditions for potential establishment and spread were assessed.

Some facts which form the frame of the study:

- Based on references the survival of *P. ramorum* in Slovenian climate conditions is not questionable: in culture media the organism can survive up to 30 °C and at -5 °C for a day. Inside the leaves it can tolerate even more extreme conditions.
- Overwintering of *P. ramorum* in soil was confirmed with baiting technique in central part of Slovenia in winter 2006, when daily average temperatures for 5 day period were around minus 10°C and with some shorter periods of minimum temperature below -15 °C.
- Mycelium is able to grow in a temperature range from 2 to 28 °C, however optimum is in range of 15(16) – 21(26) °C.
- The optimum temperature range for sporulation is between 16 to 22 °C; however depending on different isolate origin (EU or USA) sporulation can take place from 6 to 30 °C. Sporulation can occur at 10 °C in 24 hours of almost saturated relative humidity (95 to 100%).
- Sporangium and zoospores could germinate at minimum leaf wetness period of 6 h.
- Ability of sporangium for germination rapidly decreases when relative humidity is bellow 90 %.

MATERIAL AND METHODS

The modeling of potential infection development of *P. ramorum* was done by using weather datasets of 16 selected weather stations of Slovenian agrometeorological network for a period 2010 – 2015.

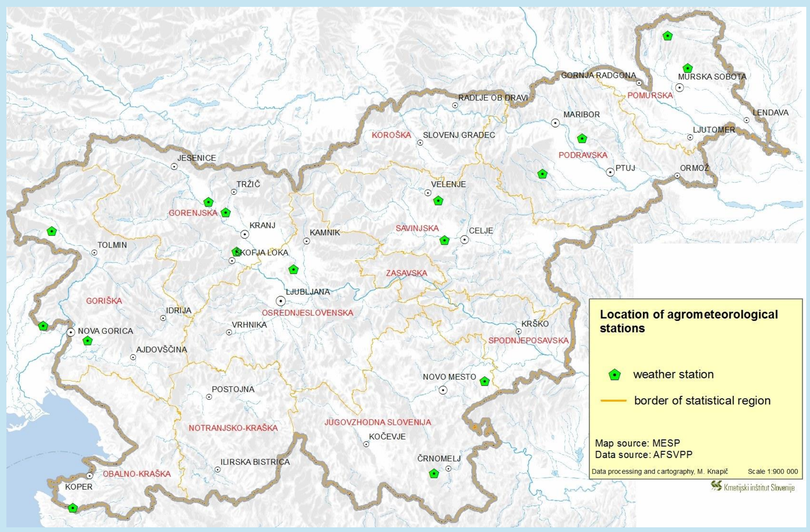

Figure 1: Locations of agrometeorological weather stations

All weather stations were assembled with at least sensors for air temperature, precipitation , relative humidity and leaf wetness. The vegetation period from April to November was taken into consideration.

Due to biology of *P. ramorum* we have looked for consecutive 30 hours periods, when air temperature was above 9.5 °C and leaf wetness sensor value above 2. Based on literature data with that period the minimum conditions for sporulation and germination were fulfilled. In second step of the modelling we replaced leaf wetness data with relative humidity data and set the condition of relative humidity higher than 95 %. This modelling was done on limited number of weather stations (10 stations).

Modelling was done by Access 2010 software.

To evaluate probability for establishment and spread the host species were ranked according to their capability for sporulation and susceptibility for *P. ramorum* infection:

1. high risk - *Larix decidua (*European larch) – high rate of sporulation
2. medium risk - *Castanea sativa* (sweet chesnut) – due to recent data of disease spread in England
3. lower risk – *Fagus sylvatica* with undergrowth of *Vaccinium myrtilus* – necessary contact between host species; lower probability to long distance dispersal

RESULTS

According to dataset results different regions were distinguished regarding potential for *P. ramorum* establishment. Two regions, Goriška region with submediterranean climate bordering Italy and South east region with continental climate bordering Croatia exhibit relatively high potential for establishment and eventual spread of *P. ramorum*. A PR index was calculated, which combines proportion of years in which infection was possible during investigated period and an average number of infections per year. Both regions have an index 2 or more (an average index of all weather station in the region), which actually means that there were 2 or more possible infections per year in the period 2010 to 2015. In the central part of Slovenia: in Gorenjska region, Osrednjeslovenska and Savinjska region indices were 1.3, 1.1 and 1, respectively (Figure 2, Table 1). Very similar results were obtained in case leaf wetness data were replaced by relative humidity data.

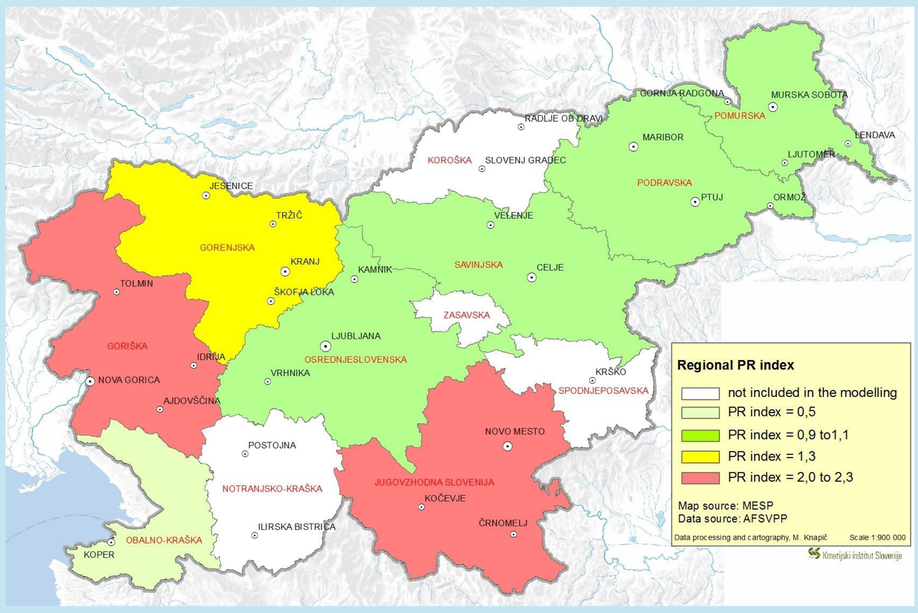

Figure 2: Regional PR index

Table 1: Modelling results using temperature and leaf wetness sensor data

Region	Station	Yearly frequency of the infection in the period	No. of infection in the year	PR index	Regional PR index
Gorenjska	Dorfarje	0,5	2,3	1,2	1,2
Goriška	Sužid	0,8	4,2	3,5	2,3
Goriška	Vipolže	0,8	2,0	1,7	2,3
Goriška	Vogrsko	0,8	2,2	1,8	2,3
Gorenjska	Podbrezje	0,7	1,5	1,0	1,2
Gorenjska	Resje	0,6	2,2	1,3	1,2
Osrednjeslovenska	Jable	0,7	1,7	1,1	1,1
Jugovzhodna	Črnomelj	0,7	2,5	1,7	2,0
Jugovzhodna	Šentjernej	0,75	3,0	2,3	2,0
Savinjska	Kasaze	0,7	1,3	0,9	1,0
Savinjska	Črnova	0,7	1,7	1,1	1,0
Podravska	Ritoznoj	0,5	0,7	0,3	0,9
Podravska	Zimica	0,8	1,7	1,4	0,9
Pomurska	Sebeborci	0,5	1,7	0,8	0,9
Pomurska	Vidonci	0,7	1,5	1,0	0,9
Obalno kraška	Dragonja, Paridisiol	0,5	1,0	0,5	0,5

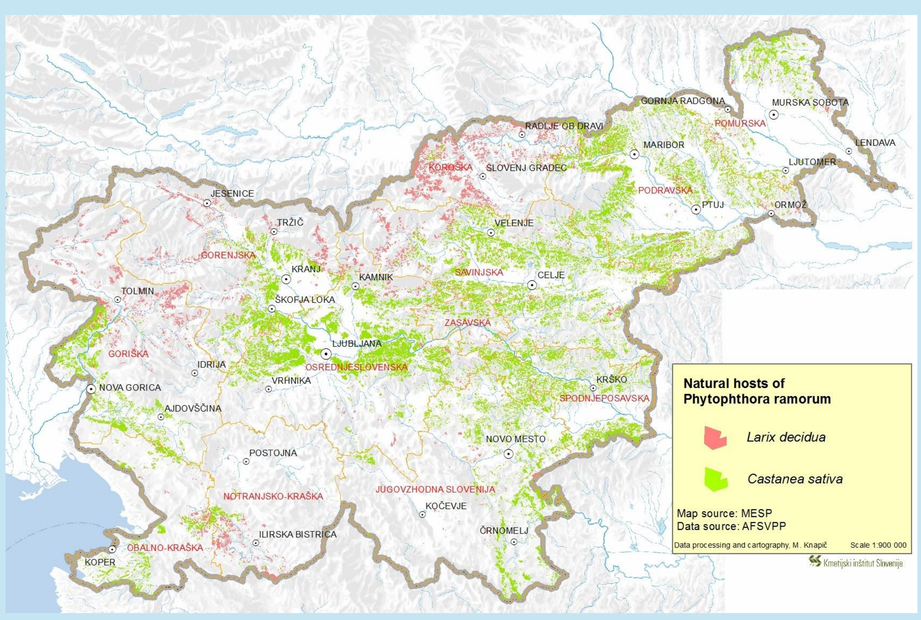

Figure 3: Distribution of ranked natural hosts without *Fagus sylvatica* (without spatial data of *Vaccinium myrtilus* data could be misleading)

CONCLUSIONS

Almost whole teritory of Slovenia is suitable for establishment of *P. ramorum*. However, Goriška region shows higher risk for establishment and spread, because in addition to favorable climate conditions both important natural hosts are present: European larch and sweet chestnut.

Literature

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