Simulation of potential natural spread of pine wilt nematode in Slovenia 2000–2100

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Aim

To develop a stochastic cellular automata model for potential natural spread of pine wilt nematode (PWN, *Bursaphelenchus xylophilus*) in Slovenia.

Methods

Type of model: stochastic cellular automata.

Spatial resolution of the model: 1 km.

Several rules were incorporated into the model:

(1) spread distance (function of host density)

(2) probability of establishment (function of drought stress and mean temperature of July)

(3) density of *Monochamus* (disease vector) populations (rule of +1 year)

(4) outbreak and measures (outbreak size is a function of host density; all outbreak locations are recognized and eradicated; probability of eradication was set to 99.5 %)

(5) incubation period (parameter was set to three years).

We simulated a spread of PWN from three locations. The simulations were repeated for 300 times and calculated for three climate conditions (current and two climate change scenarios).

Results

- The potential natural spread of PWN was relatively slow process.
- The spread rate was dependent on the point of introduction.
- Warmer climate speeded the spread rate of PWN significantly (almost up to twice).
- Simulation in the case of taking measures lasted up to 30 years' tops.
- Average speed of spread was 0.65–0.92 km per year in the current climate conditions and 0.84–1.64 km per year in the case of warmer climate.
- PWN would potentially damage up to 1.9 Mm^3 of wood on 40,324 ha in 25 years.
- Two natural barriers were found: temperature (SW) and lack of host (NE).

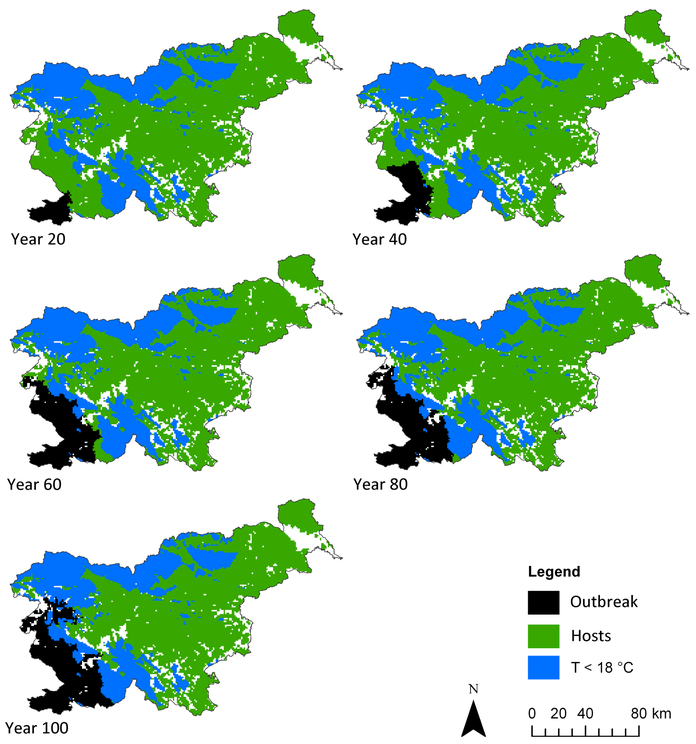

Figure 1: Map of potential natural spread of PWN in Slovenia. Simulated from port Koper on the basis of climate 1971-2000 for 20, 40, 60, 80 and 100 years after introduction.

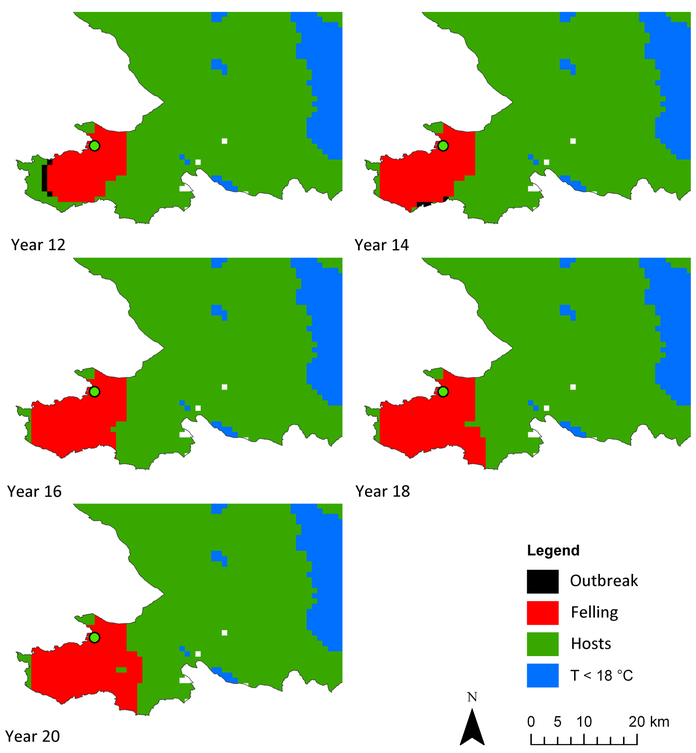

Figure 2: Map of potential natural spread of PWN in Slovenia in the case of taking measures. Simulated from port Koper on the basis of climate 1971-2000 for 12, 14, 16, 18 and 20 years after introduction.

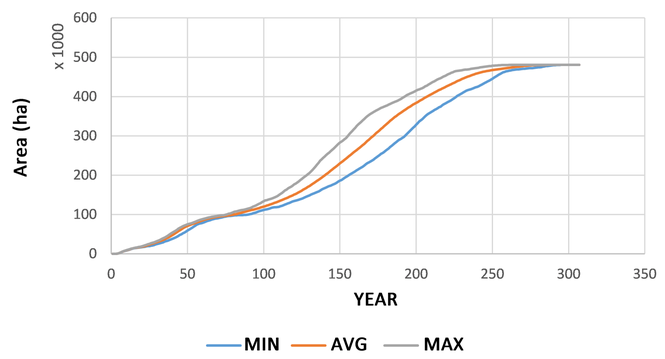

Figure 3: Potential damaged area due to potential natural spread of PWN in Slovenia. Simulated from port Koper on the basis of climate 1971-2000.

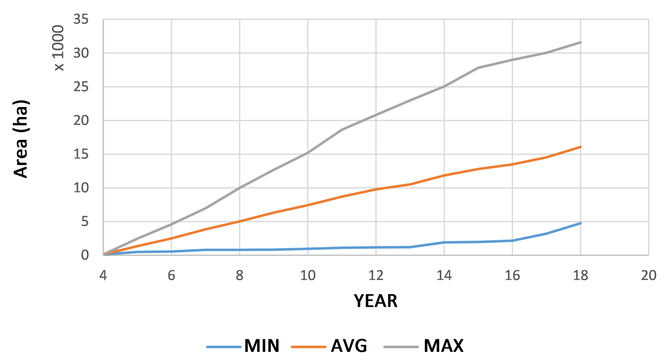

Figure 4: Potential damaged area due to potential natural spread of PWN in Slovenia in the case of taking measures. Simulated from port Koper on the basis of climate 1971-2000.

Table 1: Duration of potential natural spread of PWN in Slovenia. Simulated from port Koper.

Simulation variant		Duration (years)			No. repetition	StDev
Climate	Measure	Min	Avg	Max		
1971–2000	No	276	291.5	307	30	8.3
1971–2000	Yes	3	4.7	17	300	3
2021–2050	No	177	199.5	222	30	10.4
2021–2050	Yes	3	4.8	22	300	3.3
2061–2090	No	148	150.1	157	30	2.1
2061–2090	Yes	3	5	18	300	3.2

Table 2: Potential spread rate of natural spread of PWN in Slovenia. Simulated from port Koper.

Simulation variant		Spread (km/year)		
Climate	Measure	Min	Avg	Max
1971–2000	No	0.73	0.77	0.81
1971–2000	Yes	0	0.53	1.03
2021–2050	No	1.01	1.12	1.26
2021–2050	Yes	0	0.54	0.89
2061–2090	No	1.42	1.49	1.51
2061–2090	Yes	0	0.61	0.89

Live simulations available at

http://www.zdravgozd.si/karta.aspx?idprognoza=10

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