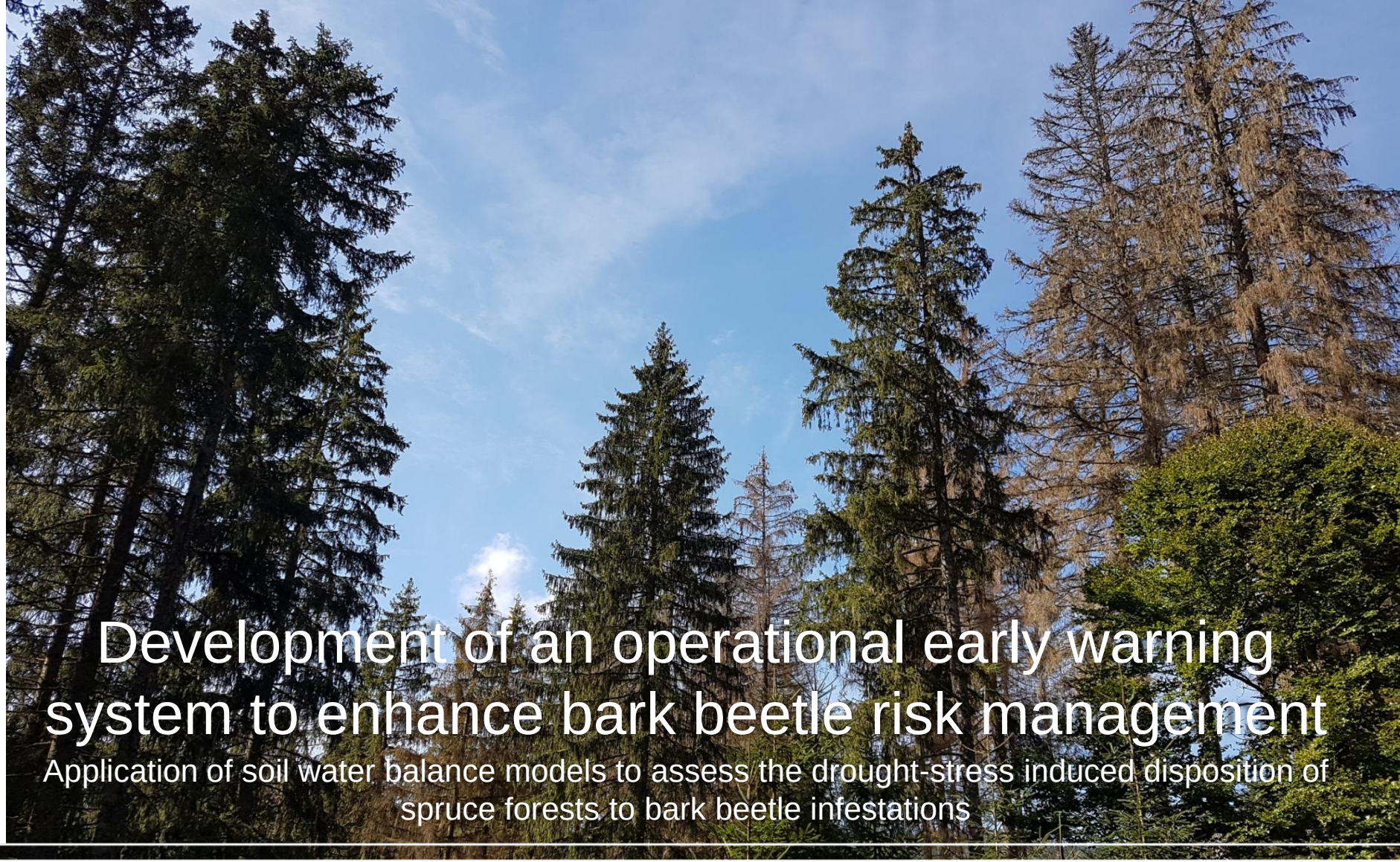
EGU General Assembly 2020 | EGU2020-18323 | HS 4.5



Development of an operational early warning system to enhance bark beetle risk management

Application of soil water balance models to assess the drought-stress induced disposition of spruce forests to bark beetle infestations

Till Hallas[1], Heike Puhlmann[1],
Jan Wehberg[2], Olaf Conrad[2]

[1]Forest Research Institute Baden-Württemberg (FVA), Department Soil & Environment, Freiburg, Germany (Till.Hallas@Forst.bwl.de)
[2]University of Hamburg, Faculty of Mathematics, Informatics and Natural Sciences, Institute of Geography, Hamburg, Germany

IpsPro

The European spruce bark beetle is one of the most important threats to Central European forests. Hence, we'd like to know..

Till Hallas[1], Heike Puhlmann[1],
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IpsPro

Welcome to our Bark Beetle Early Warning System

The IpsPro Joint Research Project

FVA Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg

STAATSBETRIEB SACHSENFORST | Freistaat SACHSEN

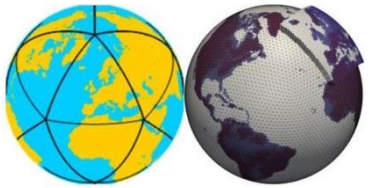
UHH Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

IpsPro

The Bark Beetle Early Warning System

To achieve our ambitious goal, we use…

dynamic weather data:
statistically downscaled data
from the global **ICON**
(Icosahedral Nonhydrostatic)
model



DWD (2020)

static site data:
site & soil mapping
forest inventory data
digital elevation model

& event data:
wind & snow damage
previous infestations
population size

…to assess the partial risks…

The Bark Beetle Early Warning System

IpsPro

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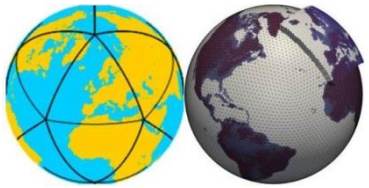


DWD (2020)

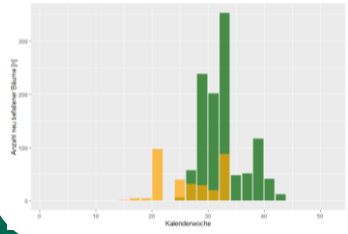
static site data:
site & soil mapping
forest inventory data
digital elevation model

& event data:
wind & snow damage
previous infestations
population size

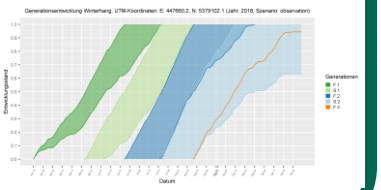
…to assess the partial risks…

site & stand predisposition

population size



swarming activity



drought stress

(semi)static | annually | daily

The Bark Beetle Early Warning System

To combine the models delivering the partial risks, we execute time based scripts using a Cron-Daemon (UNIX).

dynamic weather data:

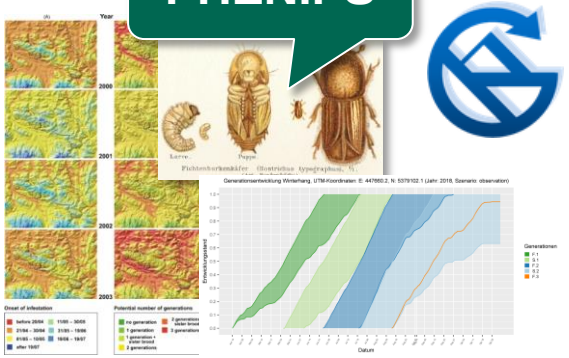
ICON, CDO (Climate Data Operators)

Python / SAGA

CRON

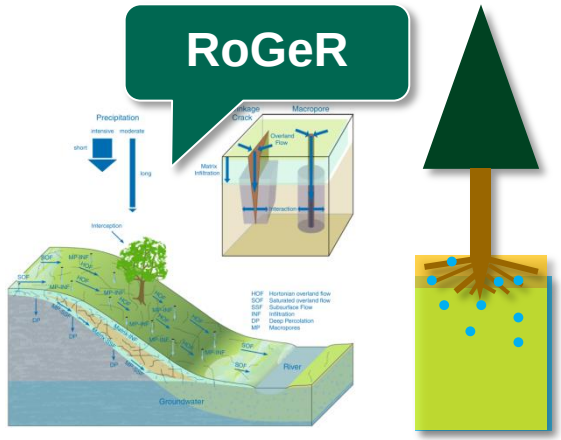
swarming activity

PHENIPS



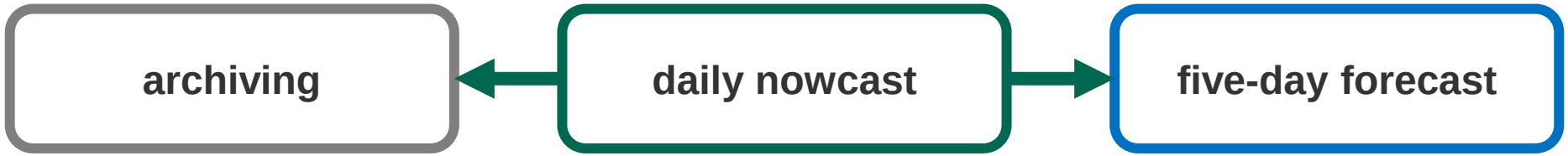
drought stress

RoGeR



The Bark Beetle Early Warning System

In this way, the partial risks are combined into a daily overall infestation risk plus a five-day-forecast, …



The Bark Beetle Early Warning System

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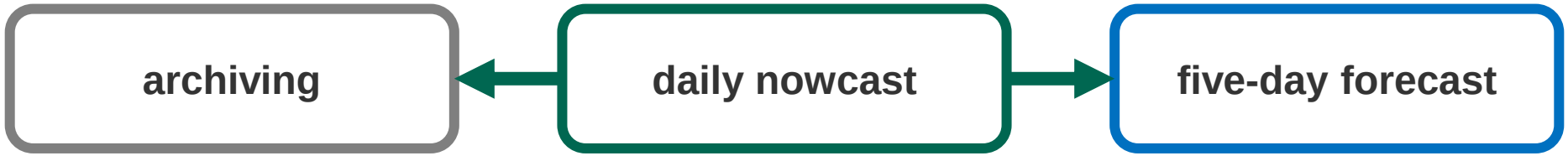
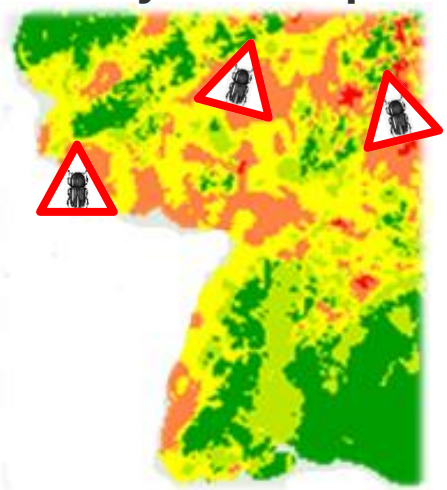


…and made available online to forest owners and managers in form of a daily risk map.

spatial resolution:
at least 250 m x 250 m!

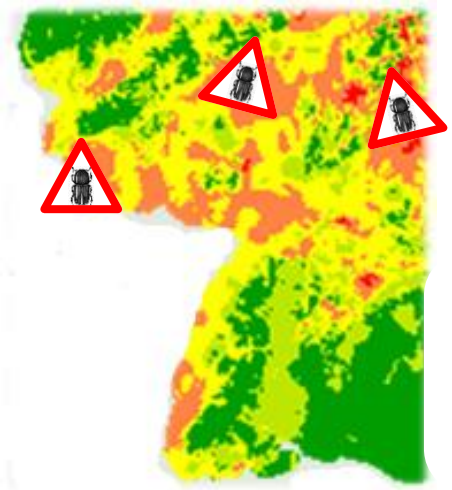
daily risk map



red: high risk
yellow: medium risk
green: low risk

The Bark Beetle Early Warning System

But why this effort?



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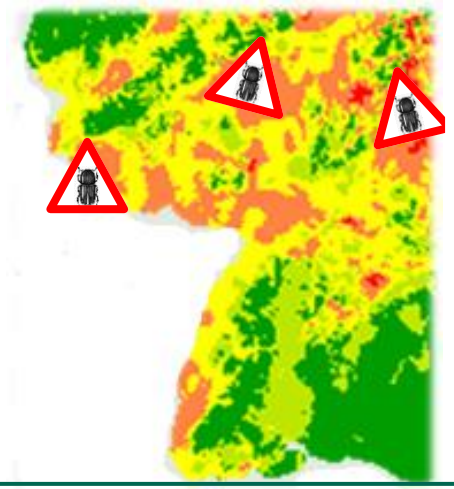
The Bark Beetle Early Warning System



red: high risk
yellow: medium risk
green: low risk

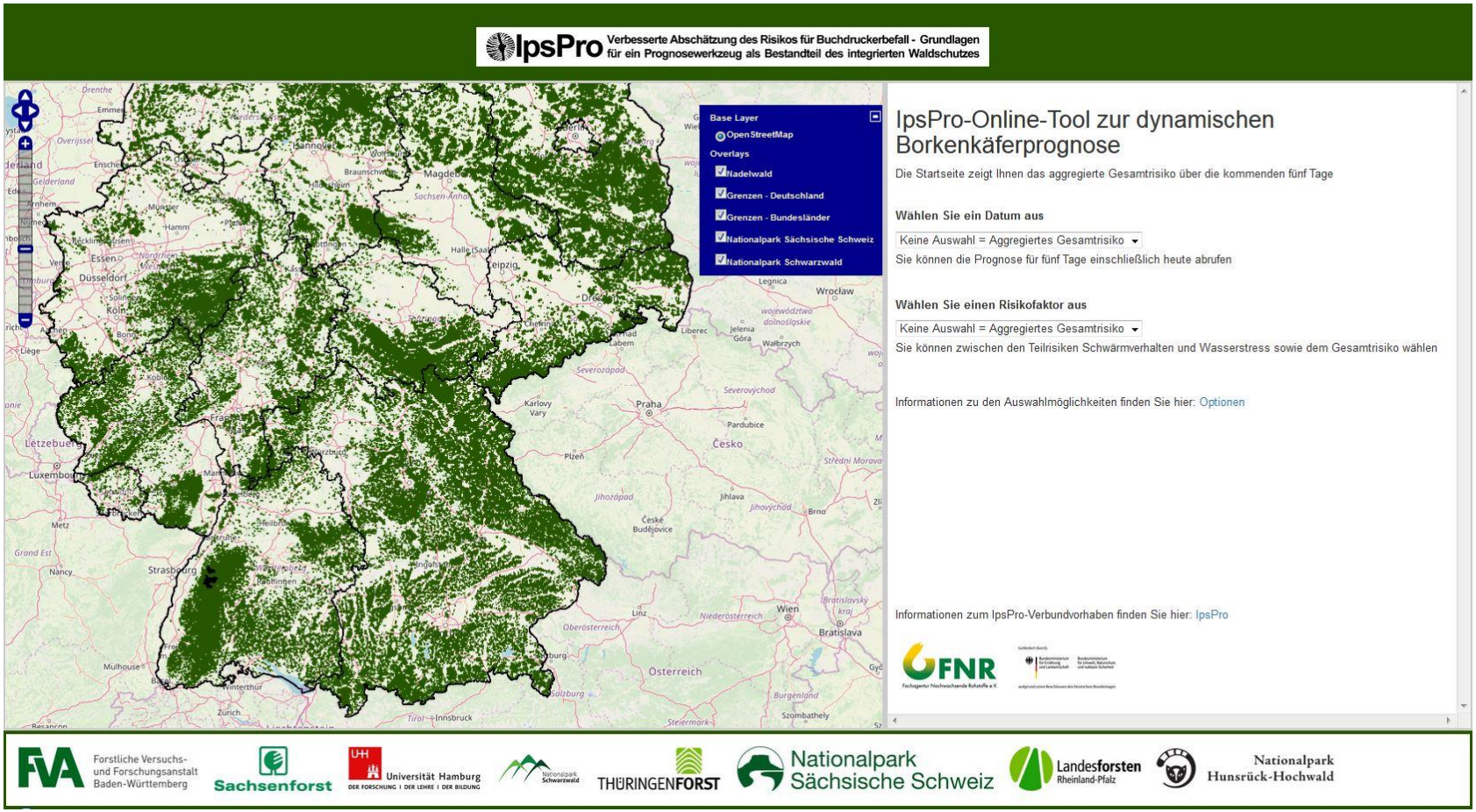
1. We want to be faster than the bark beetle to prevent mass outbreaks! Well, at least we do not want to be much slower ;-)

2. We have to make monitoring more efficient in order to compensate for staff reductions.

3. Climate change is calling, improving the conditions for the beetle, and downgrading those for the spruce! It‘s getting worse!

The Bark Beetle Early Warning System

When it's done, it might be look like this initial outline.



We'll make it available to all interested federal states in Germany. The spatial resolution can be significantly increased if desired.

The Bark Beetle Early Warning System

To address drought stress, we use the grid-based soil water balance model RoGeR at daily resolution to...

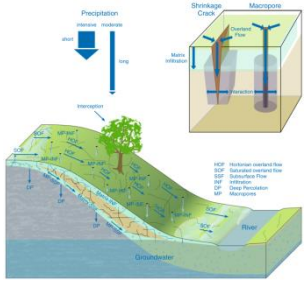
static

- landuse
- soil information
- topography

HYDROLOGY

RoGeR

(University of Freiburg)



Steinbrich et al. (2016)

dynamic

- weather data
- potential evapo-transpiration

The Bark Beetle Early Warning System

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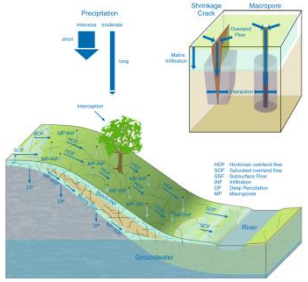
HYDROLOGY

RoGeR

(University of Freiburg)



Steinbrich et al. (2016)

dynamic

- weather data
- potential evapo-transpiration

…estimate the plant available water.

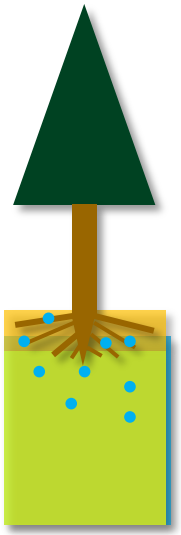
drought stress indicator:

relative plant available water (rpw)

our indicator will be aggregated over a distinct time period

The Bark Beetle Early Warning System

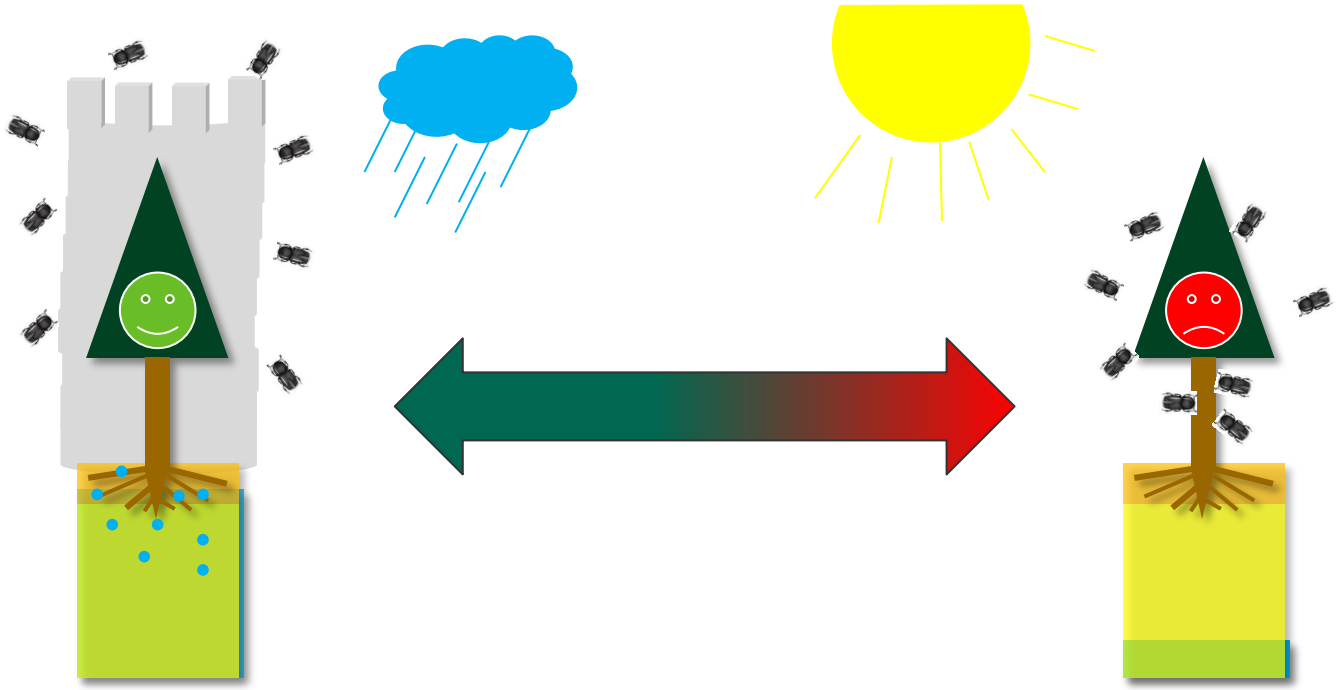
And why does drought stress dispose spruce to bark beetle attack?



The Bark Beetle Early Warning System

Because tree defense decreases due to increasing water shortage!

Netherer et al. (2015 & 2019)

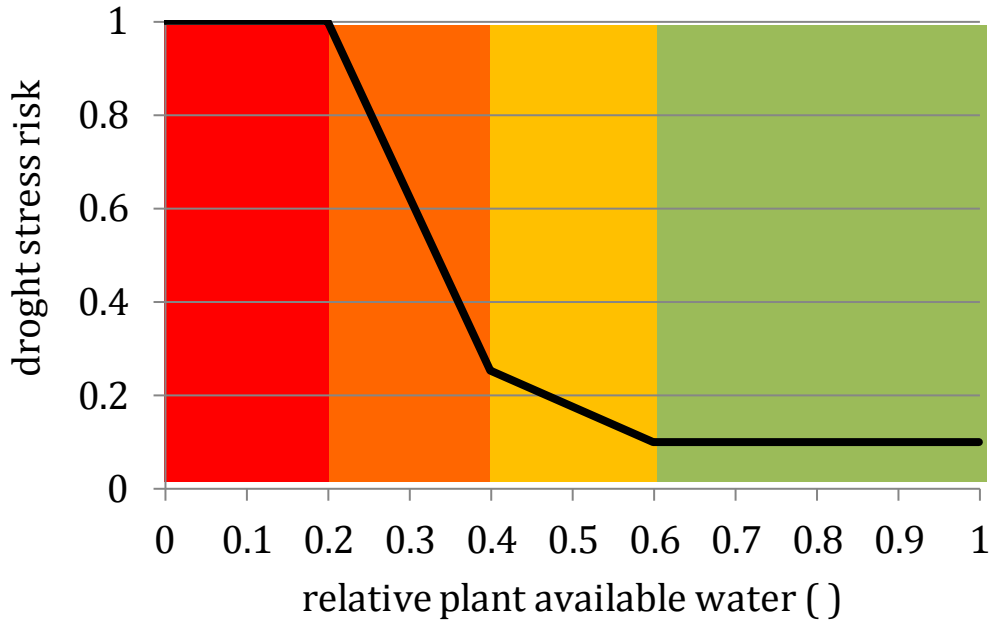


Bark beetles constantly try to attack spruce trees, but they are more successful when their hosts are already weakened.

The Bark Beetle Early Warning System

These exemplary, rough threshold ranges for the relative plant available water are based on previous studies and our own interim results.

- **We transform our indicator into a relative drought stress risk ranging between 0.1 (min) and 1.0 (max).**



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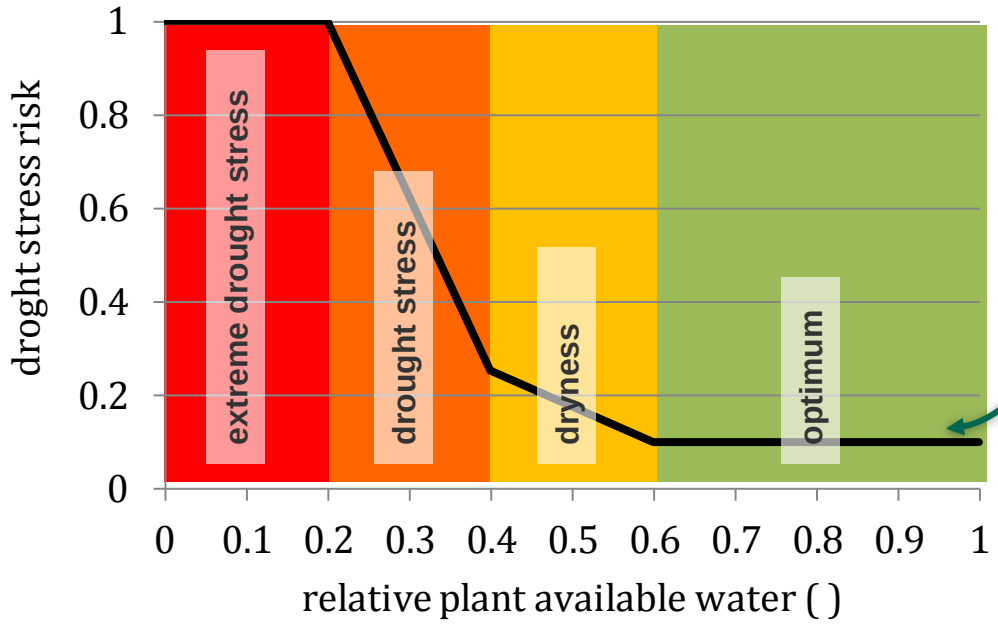

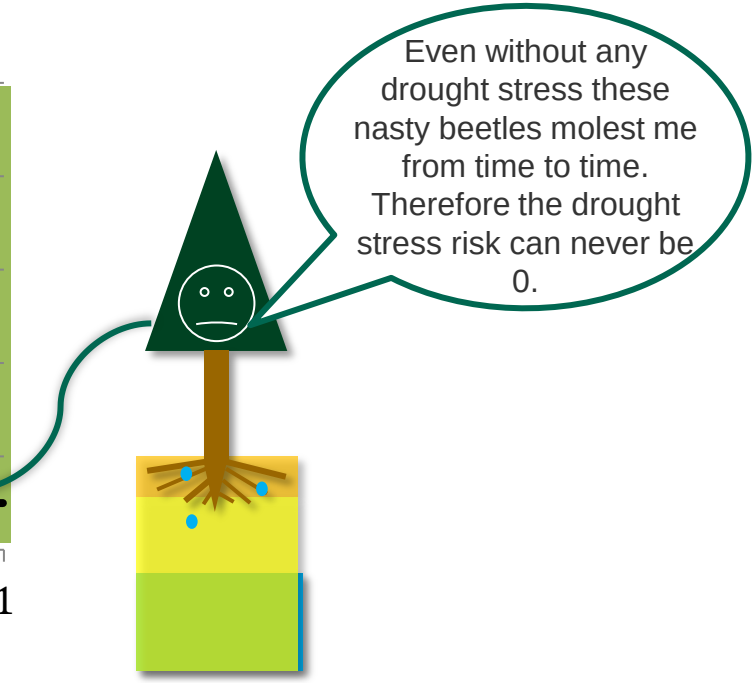

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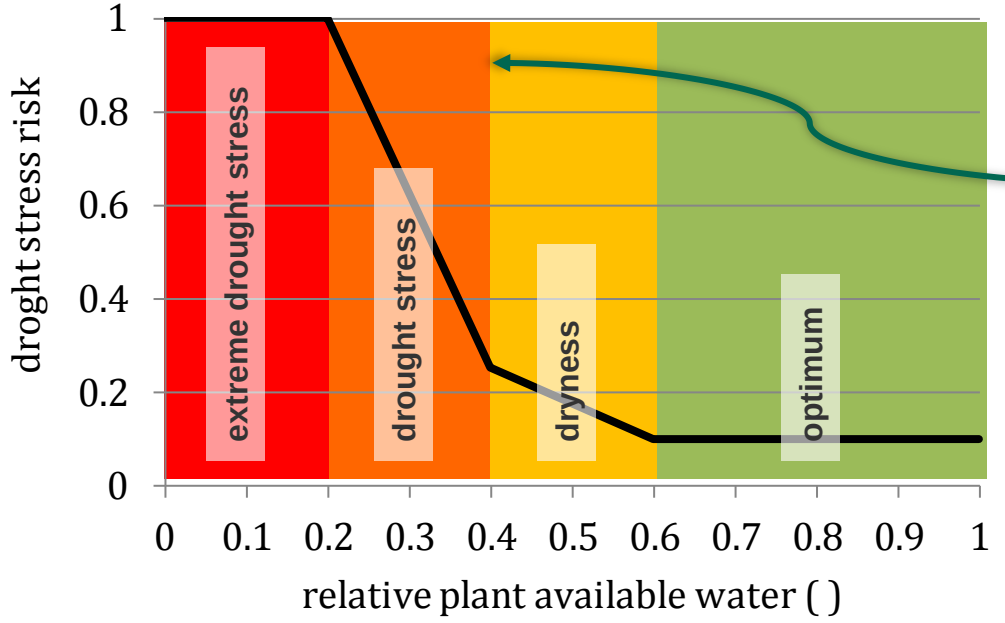
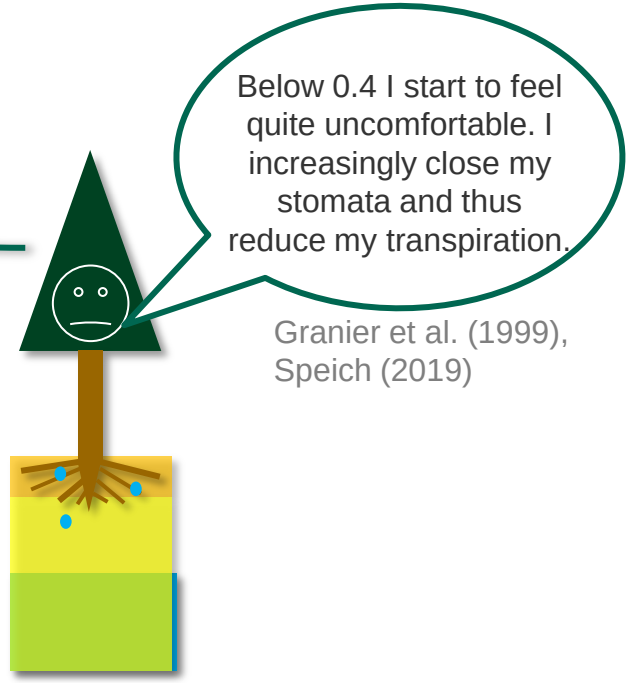




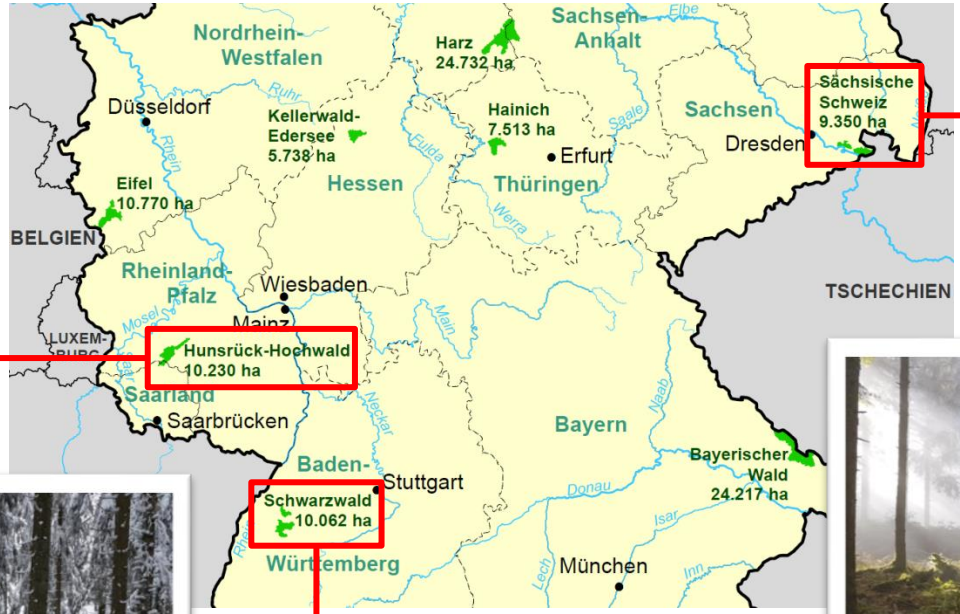
Granier et al. (1999), Speich (2019)

More precise threshold values will be specified in the overall model when we tune and validate our system using detected bark beetle infestations.

The Bark Beetle Early Warning System

To make things more credible and to check the plausibility of our model results, we measure soil moisture in three study areas in Germany.

Bundesamt für Naturschutz (2019)



Sachsenforst

Forstbezirk Bärenfels

2 soil moisture plots

Nationalpark Hunsrück-Hochwald

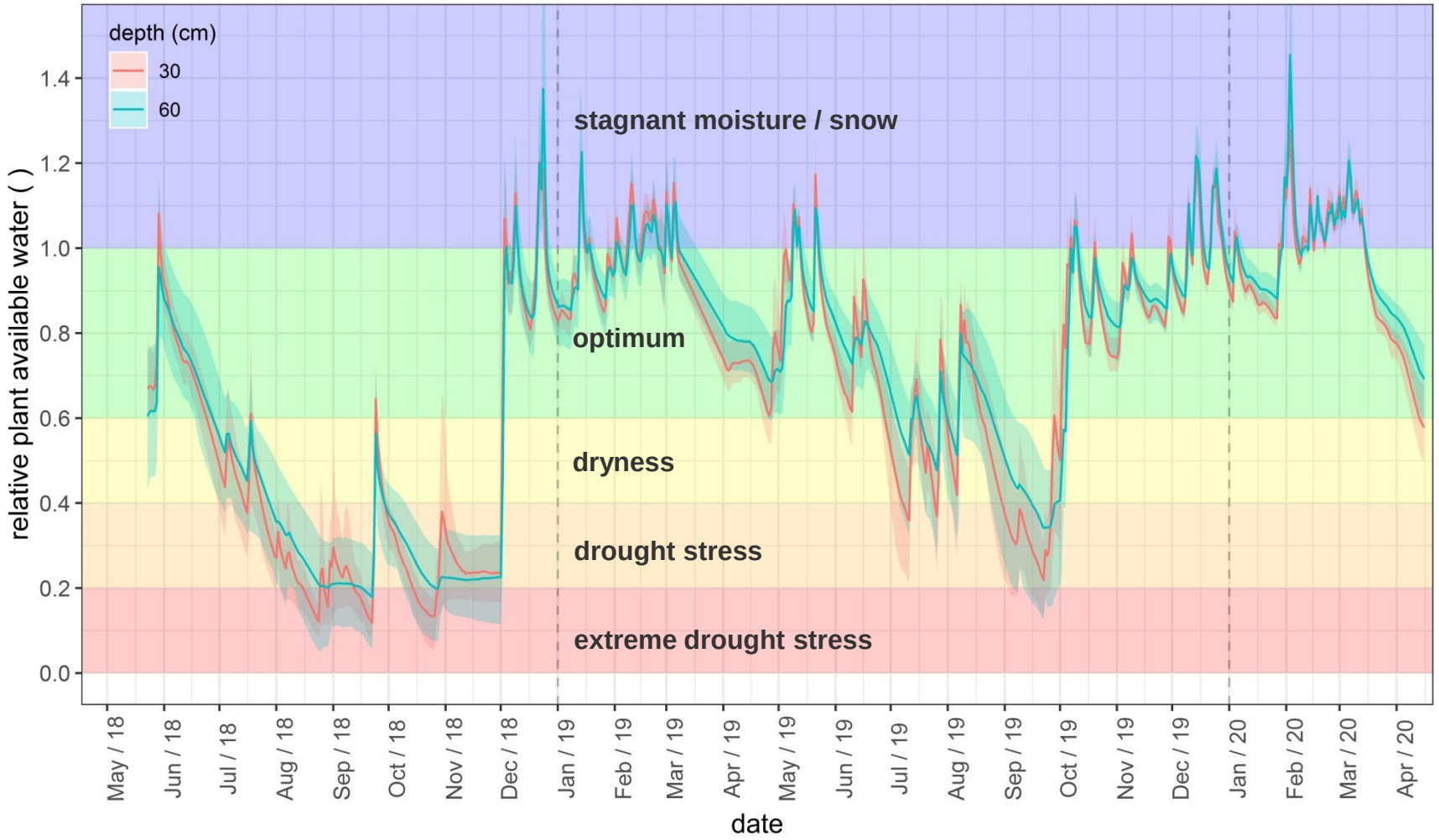
3 soil moisture plots

Nationalpark Schwarzwald

7 soil moisture plots

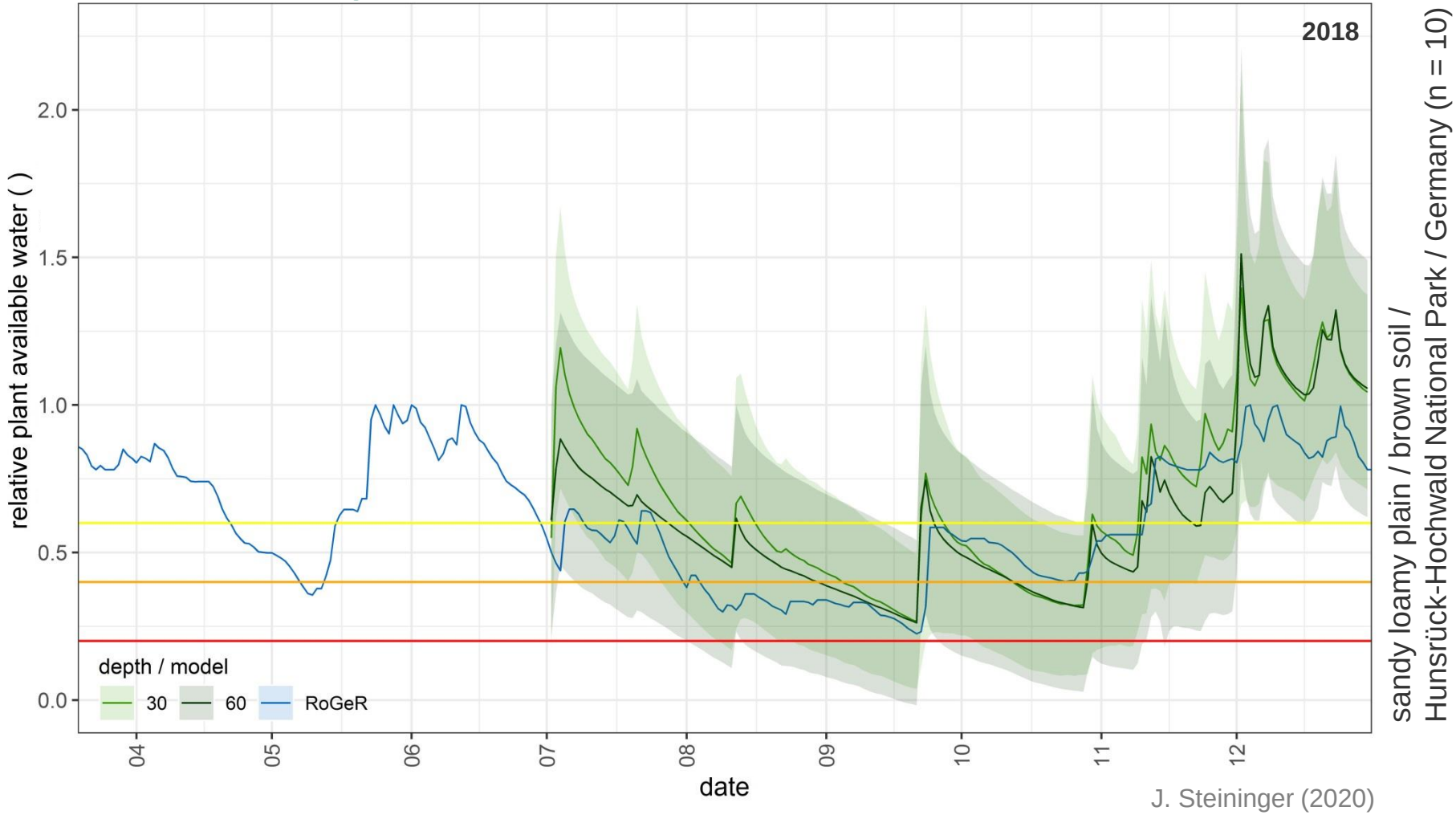
The Bark Beetle Early Warning System

Well, even in the German low mountain ranges with very high precipitation (> 2000 mm a^{-1}) drought stress has been of relevance in recent years!



The Bark Beetle Early Warning System

Of course, our measurement and model values do not (yet) fit perfectly, but we are on the right track.

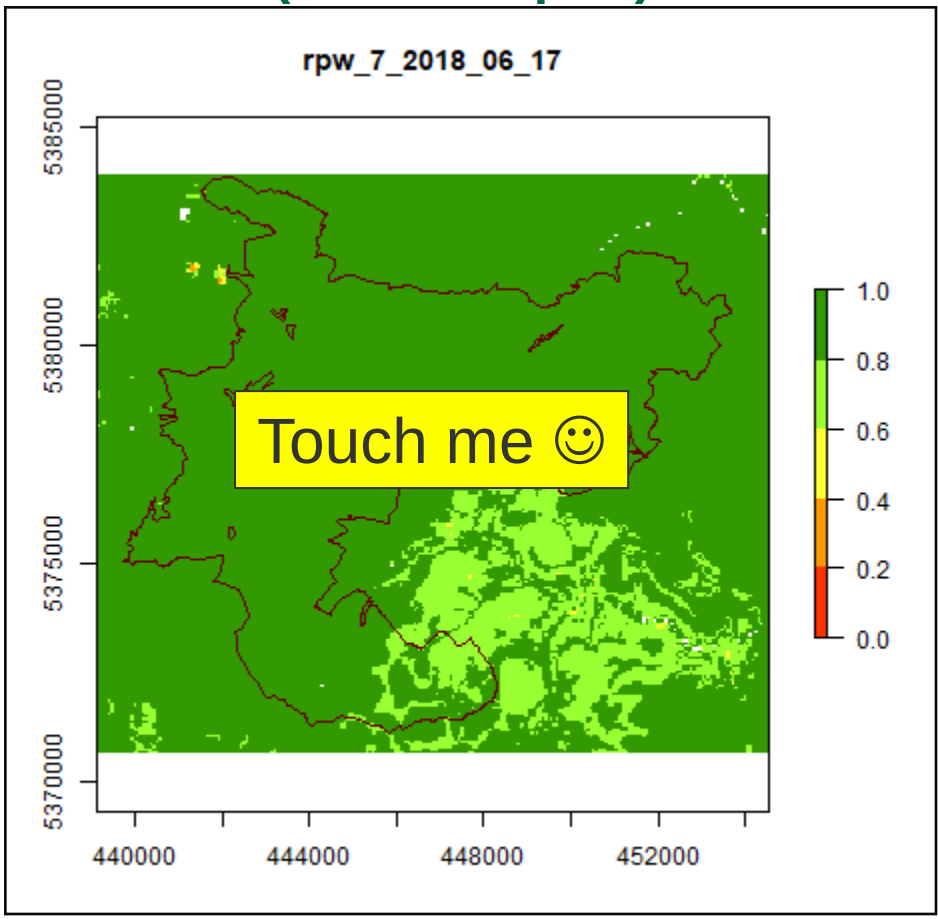


J. Steininger (2020)

The Bark Beetle Early Warning System

Finally, we take a look at this animated map, which shows the plant available water of the Black Forest National Park (southern part).

- here we use the aggregated average of the relative plant available water of the last 7 days only as an example
- it's animated from mid June until mid of September 2018
- the drought stress risk increases with decreasing water availability from green, to orange, to red



Black Forest National Park (southern part) / Germany

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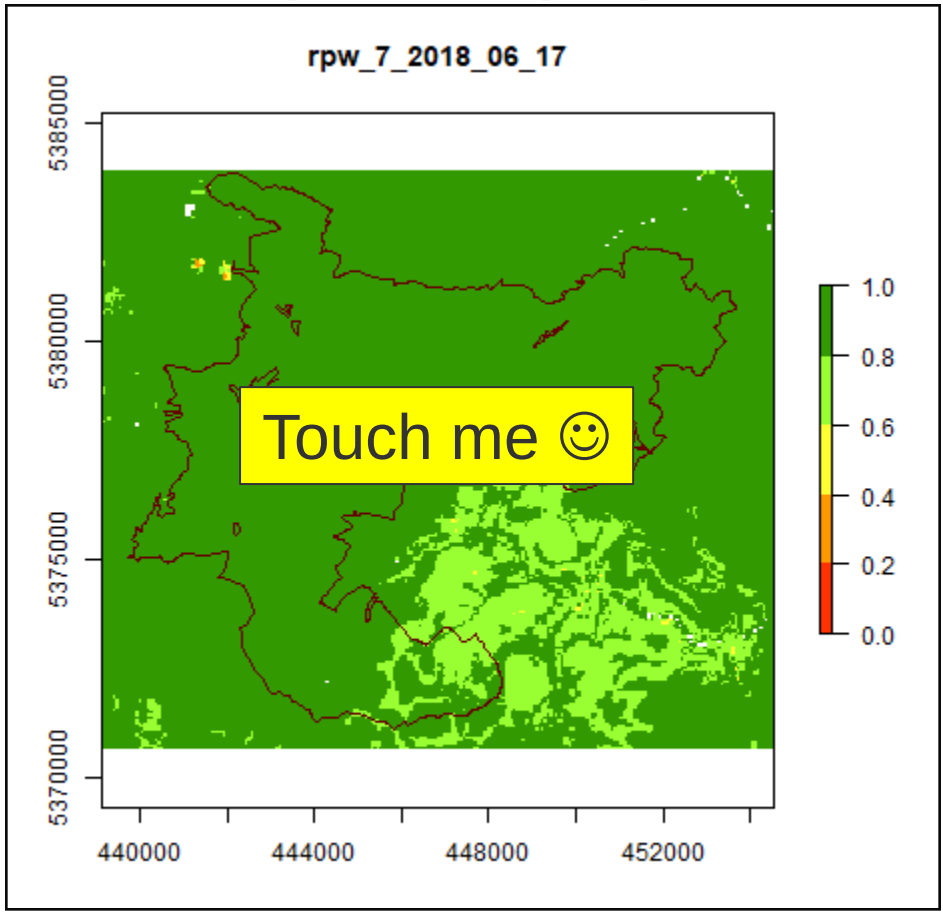
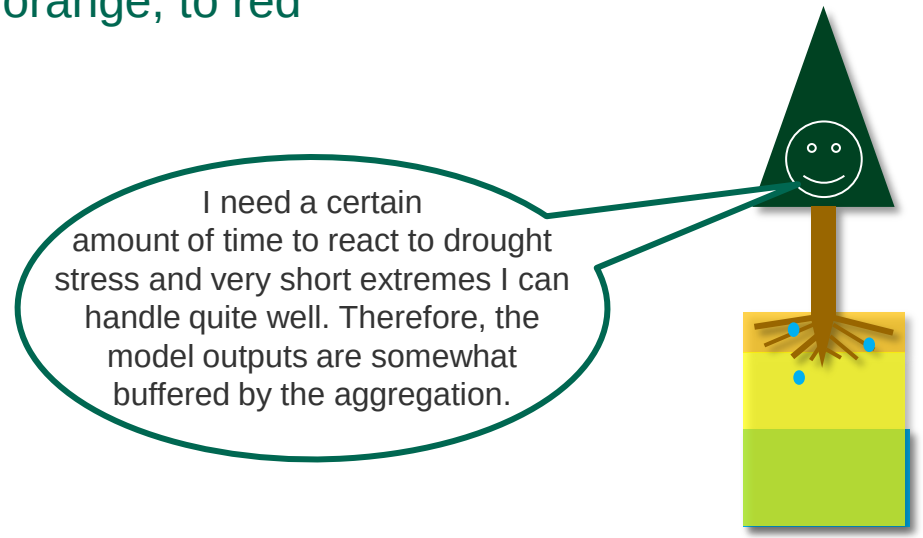
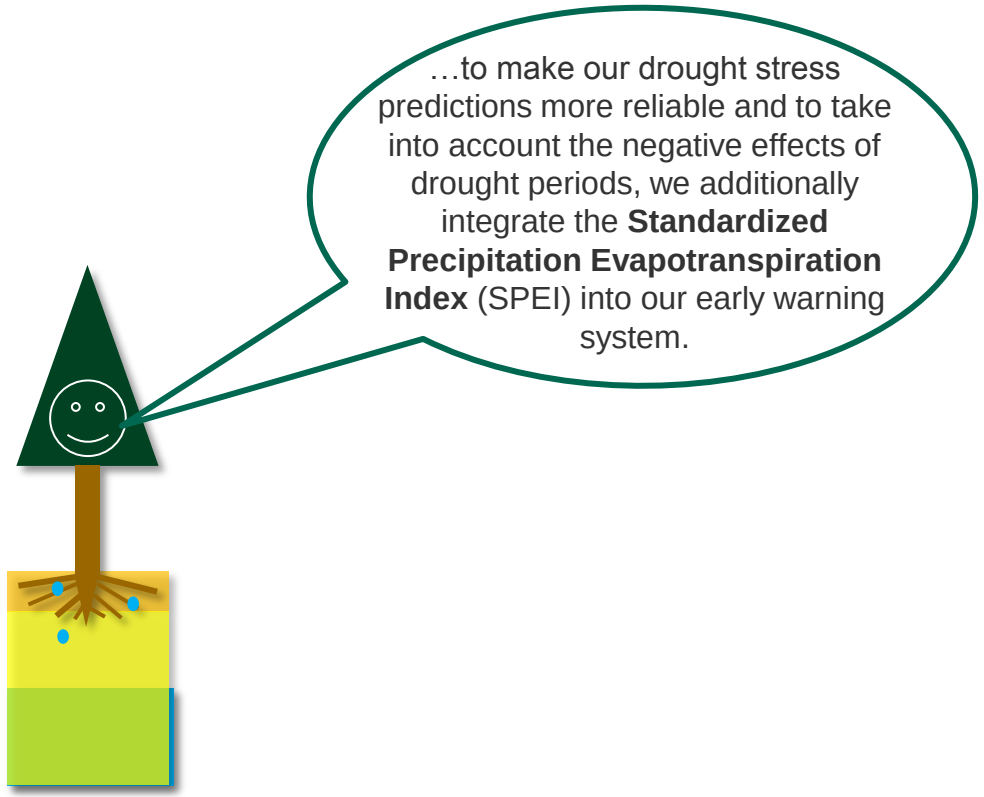


Black Forest National Park (southern part) / Germany



The Bark Beetle Early Warning System

Drought stress is of course not only a short-term effect. Thus, ...



That‘s it! Let‘s make the beetle bark!

Thank you for watching!

If you have further questions or comments
you‘ll find me in the chat,
or feel free to contact me via mail!

IpsPro

Thanks for your attention!

Funding:

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Fachagentur Nachwachsende Rohstoffe e.V.

Gefördert durch:
Bundesministerium für Ernährung und Landwirtschaft
aufgrund eines Beschlusses des Deutschen Bundestages

Project partners:

FVA Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg

STAATSBETRIEB SACHSENFORST | Freistaat SACHSEN

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DER FORSCHUNG | DER LEHRE | DER BILDUNG

Cooperation partners:

Nationalpark Schwarzwald

Nationalpark Hunsrück-Hochwald

Nationalpark Sächsische Schweiz

Landesforsten Rheinland-Pfalz

THÜRINGENFORST

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