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Estimating the amount of forest damages in Finland by the maximum wind gust speed

Hannu Valta, Ilari Lehtonen, Terhi Laurila, Ari Venäläinen, Mikko Laapas, and Hilppa Gregow
Finnish Meteorological Institute, Helsinki, Finland (ilari.lehtonen@fmi.fi)

Windstorms are among the most important abiotic disturbances affecting the Finnish forests. During a typical year, approximately 10–25 windstorms hit Finland and the most intense windstorms within a few recent decades have caused damages scale of 2–7 million cubic metres of wood in the Finnish forests. Additionally, windstorms are the most important factor disturbing the functionality of the national power grid. For example, approximately 570,000 households were left without electricity after the Saint Stephen's Day storm in 2011.

Late autumn and early winter are the stormiest times of year. Most windstorms hitting Finland develop over the North Atlantic and thus arrive to Finland from west or southwest. Hence, it can be concluded that in a typical windstorm hitting Finland, wind direction is from south or west and in most of the cases within the recent decade the soil has not yet been frozen. Consequently, soil frost has rarely increased the anchorage of trees.

Here, we have compared the amount of forest damages caused by the most vigorous windstorms in Finland after 2010. It was found out that the volume of forest damages follows approximately a power relation as a function of wind gust speed with a power of $\sim$10. I.e., a 10% increase in wind speed leads to almost three times larger forest damages. This rough estimate holds only for typical windstorms hitting southern or central parts of Finland. In northern Finland, the volume of forest damages remain much smaller, apparently because the amount of timber per surface area unit is smaller. Similarly, frozen soil conditions reduce the wind induced forest damages substantially. On the contrary, windstorms with easterly or northerly winds cause much greater damages than windstorms with similar intensity having southerly or westerly winds. This is presumably because south-westerly winds are most common in Finland and the root systems of trees have adapted to this typical wind direction.

We moreover note that our time series is very short and the set of windstorms is thus small. Also the observational network for wind gust speed is sparse. Despite of these and other large uncertainties involved, our results demonstrate the steep increase in the impacts of windstorms as a function of the windstorm intensity.