Forest Research

EFIATLANTIC

ForestGALES – Single Tree approach

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Contents:

- History and development of FG-TMC
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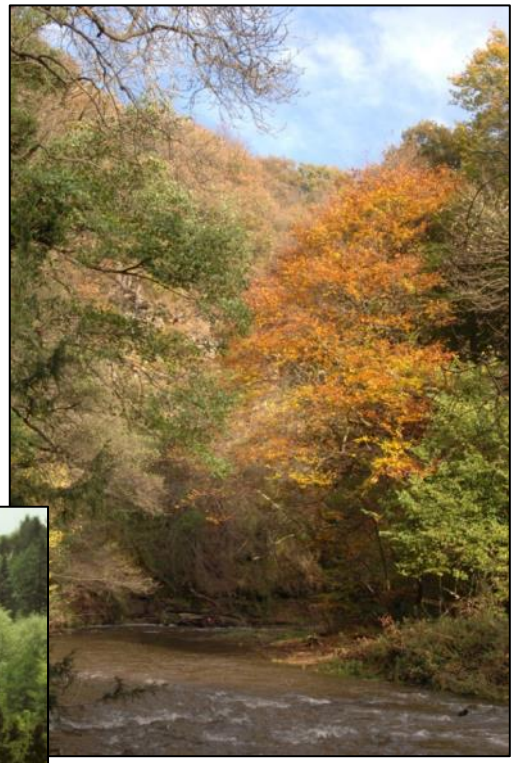
Traditional forestry in Britain

- fast-growing conifers
- large uniform plantations
- clearfelling

Wind damage to uniform conifer forest

Changes in forestry policy and practice

- aesthetics and recreation
- resilience against climate change, pests and diseases
- mixed structure forests
- mixed species forests
- continuous cover forestry



Wind damage modelling: Why change from current method?

ForestGALES '*roughness*' does not work with irregular stands!

even-aged regular

uneven-aged irregular

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What force would be needed to uproot or break the tree?

Uproot

$$M_{crit\_over} = C_{reg} \cdot SW$$

Break

$$M_{crit\_break} = \frac{\pi}{32} \cdot f_{knot} \cdot MOR \cdot diam^3$$

What is the critical wind speed?

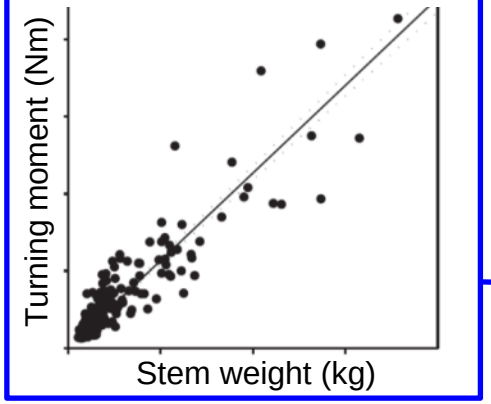
Roughness method – Stand Level:

$$u(h)_{crit\_over} = \frac{1}{kD}\left[\frac{C_{reg} \cdot SW}{\rho G d}\right]^{\frac{1}{2}}\left[\frac{1}{f_{CW}}\right]^{\frac{1}{2}} \ln\left(\frac{h-d}{z_0}\right)$$

$$u(h)_{crit\_break} = \frac{1}{kD}\left[\frac{\pi \cdot MOR \cdot dbh^3}{32\rho G(d-1.3)}\right]^{\frac{1}{2}}\left[\frac{f_{knot}}{f_{CW}}\right]^{\frac{1}{2}} \ln\left(\frac{h-d}{z_0}\right)$$

Roughness method – Stand Level:

Anchorage coefficient



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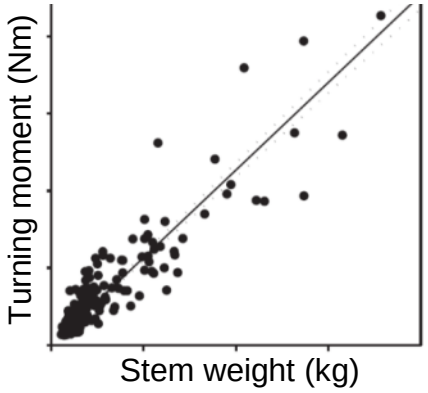

H = f(top height)

volume function

Stem density

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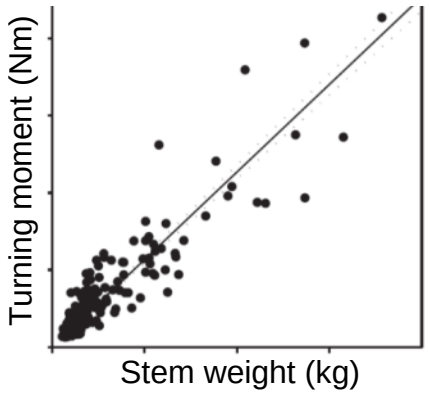

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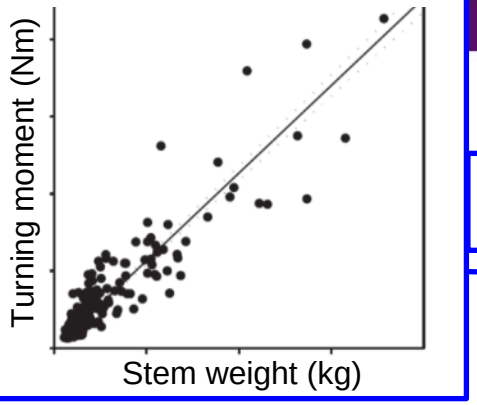

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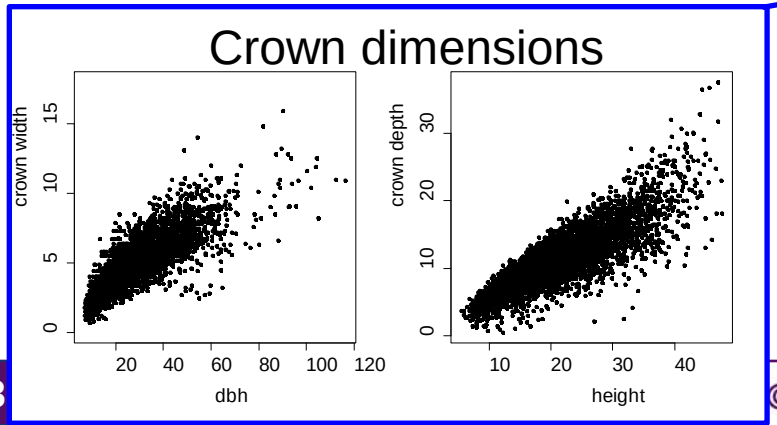

MOE

Crown density

Roughness method – Stand Level:

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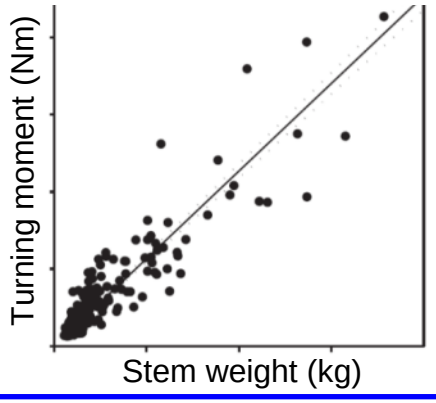

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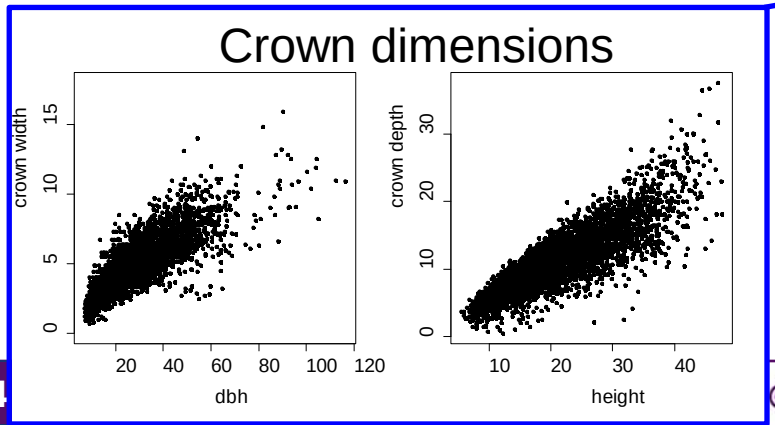

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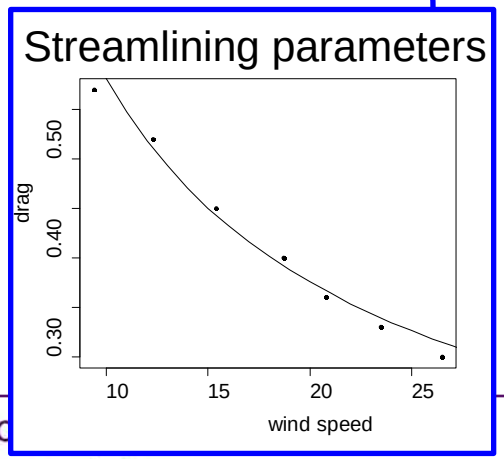

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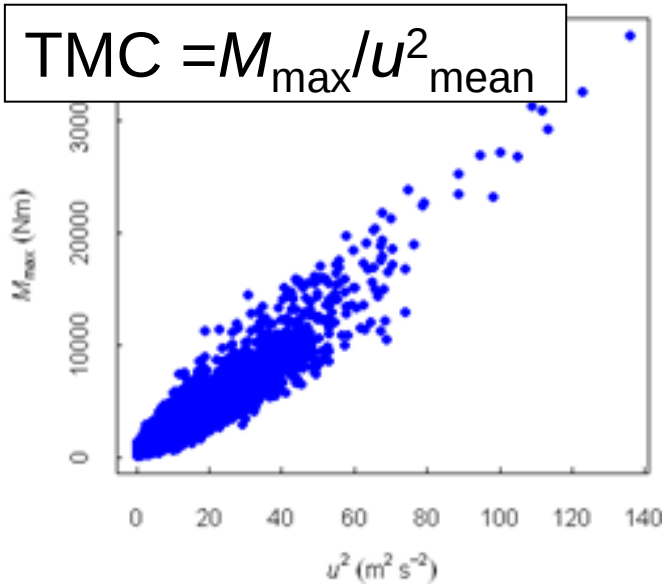
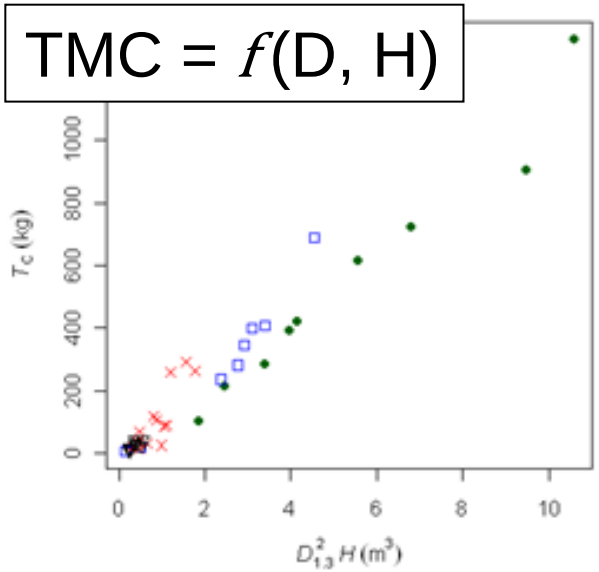
New Method: Turning Moment Coefficient – Tree Level

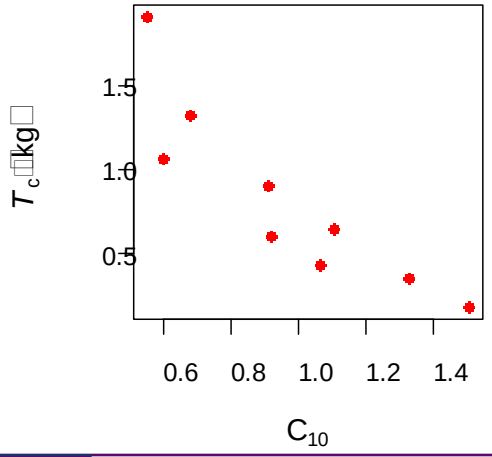
TMC = M_{max}/u^2_{mean}

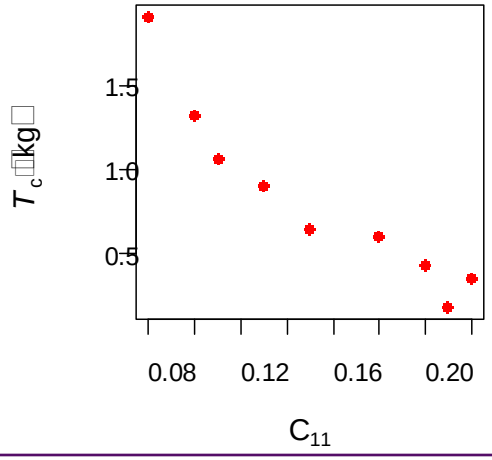


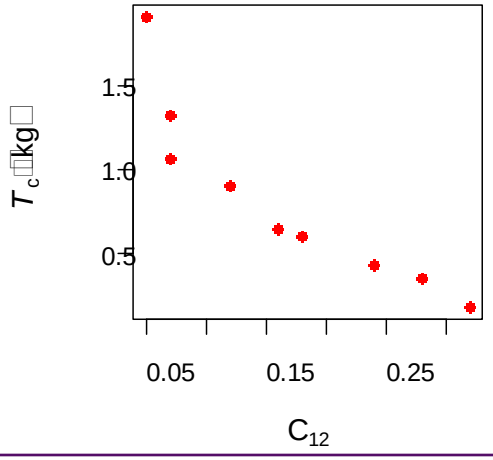
TMC = f(D, H)



TMC related to competition index







What is the critical wind speed?

TMC method – Tree Level:

$$u(h)_{crit\_over\_TMC} = \left[\frac{C_{reg} \cdot SW}{111.7 \cdot dbh^2 h}\right]^{\frac{1}{2}} \left[\frac{1}{1.136}\right]^{\frac{1}{2}} \left[\frac{1}{TMC\_Ratio}\right]^{\frac{1}{2}}$$

$$u(h)_{crit\_break\_TMC} = \left[\frac{\pi \cdot MOR \cdot d_0^3}{32 \cdot 111.7 \cdot dbh^2 h}\right]^{\frac{1}{2}} \left[\frac{f_{knot}}{1.136}\right]^{\frac{1}{2}} \left[\frac{1}{TMC\_Ratio}\right]^{\frac{1}{2}}$$

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DLF = M_{tot} / M_{appl}

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TMC

DLF = M_{tot} / M_{appl}

$$TMC_{Ratio} = 0.99 \cdot Spacing\_Ratio$$

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Advantages of TMC method:

- Forest management: Different forest structures; Species-mosaic; Thinnings;
- Allows for Competition Indices;
- Technology: Computationally faster, Can make better use of tree-level LiDAR data; Higher resolution spatial modelling.

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Disadvantages of TMC method:

- Not fully tested yet
- Requires more scenario testing
- More empiricism introduced

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Applications of TMC method:

- Seidl et al. (2014): Simulations of wind disturbance propagation within a stand during a storm

  Simulations within iLand landscape simulator to model effects on forest ecosystem (carbon balance of trees and soil);

  Used a distance-dependant CI to calculate TMC;

  High spatial resolution (10m cells);

  Dynamic spread of damage during storm;

  Successful validation against extensive storm damage (Gudrun).

Applications of TMC method:

- Kamimura et al. (2017): effect of early thinnings on tree stability

  FG-TMC parameterised for *Larix kaempferi* using standing trees after a 2006 storm in Japan;

  Used FG-TMC to calculate the critical wind speeds and compared them with the storm's wind speeds;

  Low agreement between FG-TMC and recorded wind speeds;

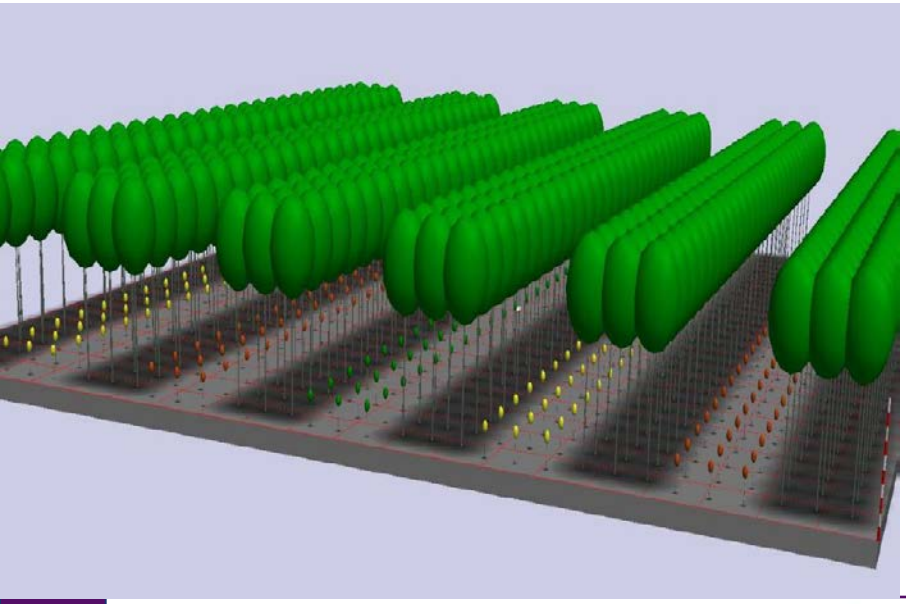
  Might be due to difficulty in describing local sheltering and acclimation to wind;

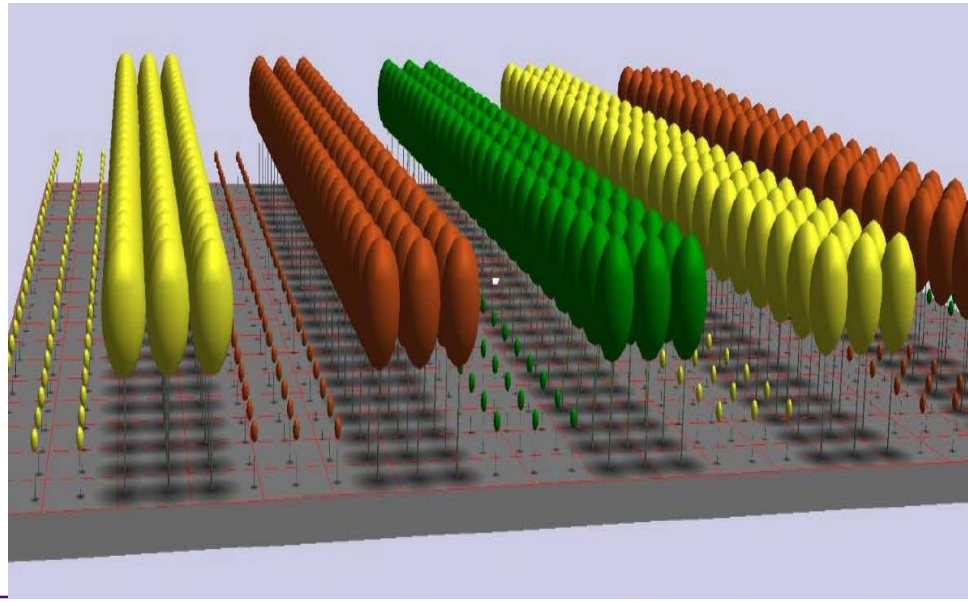
  Or might be due to biased data from tree-pulling.

Applications of TMC method:

- Work in Vietnam – possibilities with TMC:

  More complex stand management = more complex business models;
  Customer aims at re-introducing native hardwood species for timber and veneer;
  Use of nurse crops:





Conclusions:

More testing and parametrising needed!