

Wind risk management in production forests of Viet Nam

Nicolas Wittmann, Paul Jacovelli, Till Pistorius

UNIQUE forestry and land use GmbH



Key points

- The risk of wind damage to production forests in Viet Nam is a key challenge for increasing high quality sawlog production.
- Climate change is expected to further increase wind damage risks in the North Central Coast region of Viet Nam (NCC VN), and adaptation strategies do not yet exist.
- In early 2017, UNIQUE and Forest Research scientists (UK) have carried out a pilot wind risk mapping project in NCC VN, creating a basis for land use planning that takes into account wind damage risks.

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Plantation forestry and wind in Viet Nam

The Government of Viet Nam (GoV) has successfully increased its national forest cover from 27% in 1990 to 41.5% in 2014 (MARD, 2015). The reforestation has been largely in production forests with Acacia species - and increasingly with the Acacia hybrid (*A. mangium* x *A. auriculiformis*). The hybrid is fast growing and also more tolerant of unfavourable site conditions than either parent species. Acacia spp. cover an estimated 1.1 million hectares in Viet Nam (Nambiar and Harwood, 2014).

A major risk to Acacia hybrid management in the North Central Coast region in Viet Nam (NCC VN) is wind. Damage caused to trees ranges from branch and stem breakages to whole swathes of trees blown down. The reason lies in the country's natural disposition to the occurrence of tropical storms. The North Western Pacific Ocean is one of the world's major tropical cyclones' genesis areas.

NCC VN is most prone to these extreme weather phenomena. On average provinces in this region experience more than 30 tropical storms and typhoons every year, mainly between July and November (Nguyen et al., 2014). The storms can bring gust wind speeds of more than 200 km/h and also heavy rainfall, which can lead to serious flooding. Typhoon Ketsana, for example, affected Central Viet Nam, bringing particularly heavy rains causing extensive floods in 2009. Almost 10,000 houses collapsed because of the strong winds and floods, contributing to the total estimated monetary damage of over 600M US\$ (IMHEN and UNDP, 2015).

Predictions on future effects of climate change to Viet Nam indicate an increase of extreme wind events - i.e. the number of tropical storms and typhoons is expected to further increase in the future (MONRE, 2016).

The chipwood to sawlog transition

Most of Viet Nam's Acacia plantations are managed on short rotations of 4 – 7 years to produce chipwood. While this value chain is well established, rapid increases in labour costs¹ and insecure export markets now challenge its profitability. On the demand side, Viet Nam's furniture industry is growing rapidly, with an important share serving export markets in the US and Europe. Producers of furniture, however, are forced to import up to 80% of their sawlog intake due to shortages in national supply (Phuc and Canby, 2011). As a result the GoV is taking policy measures to promote the implementation of sawlog regimes to boost the national production of large diameter roundwood.

Since 2012, UNIQUE has been developing and implementing sawlog business models to upgrade short rotation Acacia plantations in Viet Nam. A major threat perceived by forest owners and practitioners is an increased risk of wind damage if plantations are managed for sawlogs. Severe tropical cyclones are more likely to damage a stand if rotations are increased to 10 – 15 years.

¹ Minimum wages more than doubled between 2011 and 2016 and are expected to increase by another 42 – 46% by 2020 (MoLISA, 2016)

Wind research and modelling – state of the art

Wind damage to tree plantations has been extensively studied in other parts of the world, with substantial efforts devoted to the development of models predicting wind damage risk and improved management practices to mitigate them (e.g. Hale et al., 2015). One of the most widely used models is ForestGALES. It has been developed by a team at Forest Research (FR), based in windy Scotland. Originally ForestGALES was parameterised for a range of conifer species under typically British growing conditions (Nicoll et al., 2006). It has since been used to better understand typhoon damage in Japan (Kamimura et al., 2008) and has more recently been applied for the first time to a broadleaf species grown on the Iberian peninsula (Locatelli et al., 2016).

In order to map wind damage risk, ForestGALES first needs to be parameterised for a specific species through a number of uprooting and other mechanical experiments. After this stage ForestGALES combines empirical (i.e. inventory) data and engineering principles to predict the critical wind speed at which a tree or a stand is uprooted or breaks. Together with historical local meteorological data on average and top wind speeds,

ForestGALES is able to calculate the average return period in which the critical wind speeds occur. The larger the difference between a planned rotation period and the specific return period of the critical wind speed, the lower is the wind damage risk. Table 1 shows the input variables needed for determining a site-specific wind damage risk.

Due largely to the rough topography in NCC VN, wind micro-climate may vary considerably depending on the degree of exposure to the main wind direction. Therefore, ForestGALES' predictions are particularly useful when combined with air flow modelling. In the past WAsP (Wind Atlas Analysis and Application Program) has successfully been combined with ForestGALES to account for the influence of topography on the meso and micro scale.

By applying these two models wind damage risk can be modelled for any given site as well as for any given stand structure. The results can then be translated into practical management guidelines.

Table: ForestGALES input variables

Variable name	Variable description
Top height	Height of the tallest tree(s) in a stand
DBH	Mean diameter at breast height (1.3m)
SPH	Stocking density
Soil type	Predominant soil type in a stand
Rooting depth	Predominant depth of rooting system in a stand
Gap size	Size of largest upwind gap adjacent to the stand
Wind speed distribution parameters	An estimate of the prevailing winds

Developing wind risk maps in Viet Nam

Since 2014 UNIQUE and the Institute of Natural Resources of Hue University (IREN) have supported several State Forest Companies (SFCs) and Forest Protection Management Boards (PFMBs) in NCC VN. The aim is to support them in transitioning from short rotations to longer rotations, with increased biomass stocks and higher value generation. In order to maximise synergies the focus lies on NCC VN where FCPF currently develops an emission reduction programme for the Carbon Fund².

After developing respective business models and completing a feasibility study (Locatelli & Nicoll, 2017), UNIQUE and FR are

currently assessing wind damage risks and respective maps for a pilot area in Thua Thien Hue province. Subject to the availability of funding, the aim is to further extend this approach to various tree species, and larger regions exposed to wind damage risk in Viet Nam.

As part of the planned pilot study, ForestGALES will be parameterised for the Acacia hybrid. The goal is to develop practical maps which guide plantation managers in the decision where it is safer to plant Acacia for longer rotations, i.e. for sawlog production. The following page shows an example of a wind risk map developed for a plantation in Scotland.

²www.forestcarbonpartnership.org/vietnam

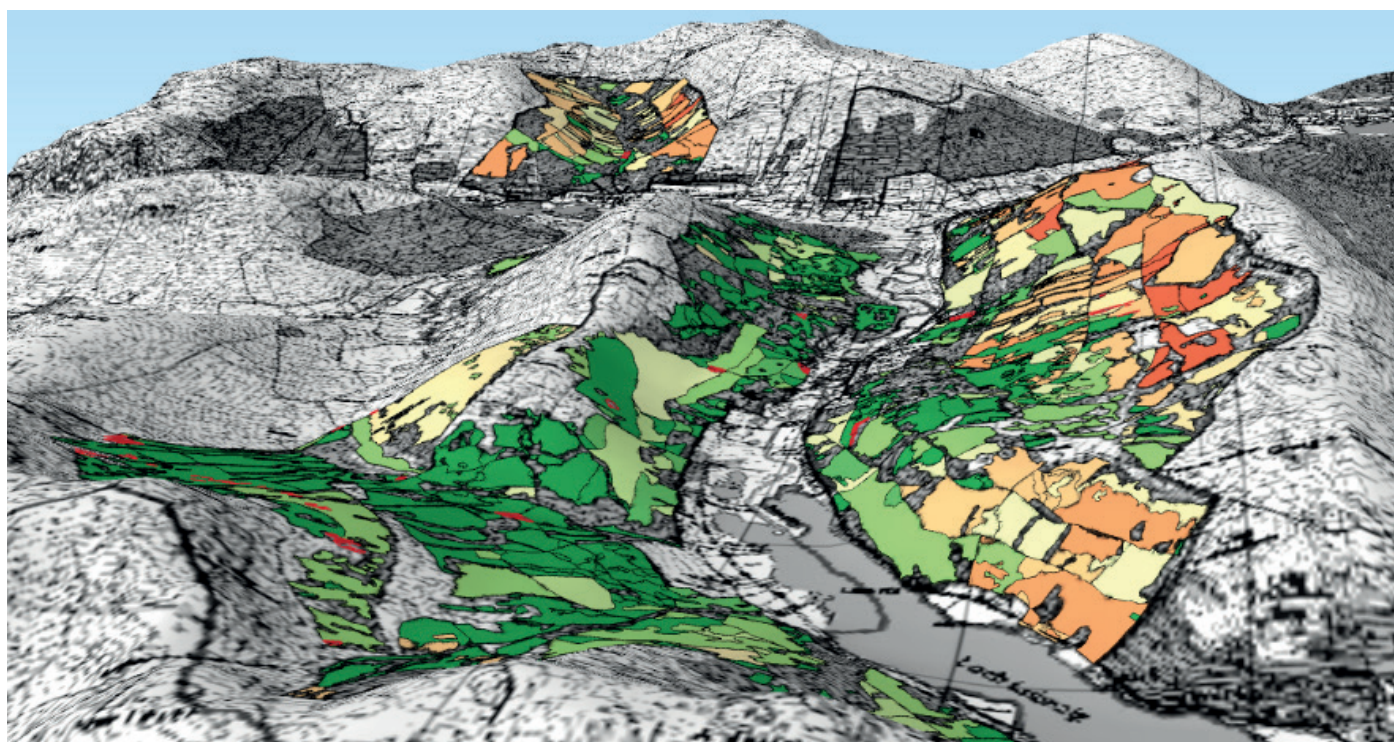


Figure: 3D wind damage risk map of a *Picea sitchensis* plantation in Scotland.

Red stands indicate high risk, where shorter rotations are recommended; dark green coloured stands are the least prone to wind damage, where longer rotations are feasible.

Source: Forest Research, unpublished

Outlook

In countries increasingly threatened by severe tropical cyclones such as Viet Nam, wind damage risk mapping is expected to become a valuable forest management tool in the future. The GoV will continue to make substantial efforts for promoting sawlog production on a large scale throughout the country. The initial study carried out by FR indicates that the development of a sophisticated tool to assess wind damage risk is feasible. The study, however, has identified areas for further work.

One weakness is currently the lack of reliable - and local - growth models for the species being assessed. Such models are needed to estimate DBH and dominant height development of each stand, which are core input parameters for ForestGALES (Locatelli et al., 2017). The growth models existing for Viet Nam to date are largely focussed on predicting biomass increment in order to estimate chipwood yields or Carbon sequestration potentials. UNIQUE is currently identifying a regional *Acacia* growth model applicable in the context of Thua Thien Hue province. However, further efforts will be necessary to develop respective growth models specifically for Viet Nam.

Another issue that needs to be addressed is the availability of meteorological data. In Viet Nam more than 150 state-run meteorological stations exist, most of them continuously recording data for more than 40 years. This wealth of data, however, is not freely accessible. Therefore cooperation with governmental institutions should reach agreements on how best to use this data for the benefit of the national plans to increase sawlog production.

In summary, the policy shift towards increasing sawlog production from Viet Nam's *Acacia* plantations, comes with a risk of serious wind damage: this is largely because the rotations will be longer and thinning must be carried out. This risk, however, can be mitigated by identifying the high risk areas and introducing appropriate management practices on specific areas that will reduce the likelihood of serious damage to the crops. Viet Nam has enormous potential to increase its internal sawlog production to supply its national furniture industry: the *Acacia* wind study described in this paper will support this transition and will benefit Viet Nam's many forest owners.

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