WORKSHOP ABSTRACT

Carbon Stocks and Change in New Zealand's Natural Forest

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Abstract

The natural balance of total stored carbon in natural forests undisturbed by human interference is affected over time by natural disturbances. Such natural disturbances trigger responses such as growth, recruitment, mortality and decay. As New Zealand is placed across two tectonic plates in the stormy South Pacific, large scale disturbances are present and a number of studies have shown the dynamic responses to such disturbances on the balance of forest biomass and therefore carbon. However, quantifying the effect of such disturbances at large scales e.g. nationally, on carbon stocks can only be solved with data from representative National Forest Inventories that capture carbon data accurately or allow the modelling of pools over time.

We analysed plot data from 1051 permanent plots representing the total coverage of natural forests in New Zealand to estimate the carbon stocks in ABG live, BGB live, Dead wood and Litter pools and their changes between two inventory measurement cycles. This allowed us to investigate if New Zealand's natural forest carbon stocks are in balance nationally or if these stocks affected by past disturbances and either are recovering or declining in parts or as a whole.

Our analysis showed that at the national scale New Zealand's forest biomass is in balance. While forest types with lower stocks of live AGB carbon show positive total carbon stock change, plots with high AGB carbon stocks show negative total carbon stock changes through mortality balancing out those positive stock changes in the low AGB carbon forest types at the national level. The forests with large live AGB carbon pools have possibly reached their maximum carrying capacity.

The results show that New Zealand's natural forest have an important role to play as a global carbon pool but could be at risk to become a carbon source.

WORKSHOP ABSTRACT

Although these signs clearly indicate human influence, absence of them does not necessarily indicate lack of human influence (Anderson 1991). With the possible exception of stands of short-lived species, the time necessary for stumps and slash to disappear is much less than the time necessary for the effects of human influence to disappear from the ecosystem. von Oheimb et al. (2005) asserted that several generations, possibly comprising hundreds of years, are necessary for a beech forest with an initial highly differentiated age structure to exhibit characteristics of virgin forests.

WORKSHOP ABSTRACT

Quantitative Prediction of Leaf Traits from First-principles

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Abstract

Plant functional ecology and earth system science requires the quantative prediction of trait variation. However, due to the limited theoretical understanding, empirical relationships with multiple fixed plant functional type parameters have been used extensively in the vegetation models to predict plant physiological and biogeochemical processes. This leads to large and stubborn uncertainties in the our prediction global carbon-climate feedback. Therefore, it is urgent to develop effective theories with parsimonious parameters to generate testable quantitative predictions of left traits.

Based on the first-principles of natural selection, we assume that at a long-term scale plants coordinate and optimize their physiological processes as an adaptation to their surrounding environments. By quantifying the benefits and costs associated with those processes, optimality criterion of maximizing plant carbon use efficiency can be formulated and generate testable predictions on environment-trait relationships. We focused on a set of key leaf traits (the leaf economic traits: leaf mass per area, leaf longevity and leaf nitrogen; photosynthetic capacity, the ratio of leaf-internal to ambient CO_2 concentrations, the rates of photosynthesis and respiration). A series of optimality-based specific hypothesis on those traits have been developed and tested with extensive datasets at regional and global scale. We showed that the responses (both the direction and sensitivity) of leaf traits to changes in temperature, moisture, radiation, CO_2 and air pressure can be very well predicted based on the optimality assumptions without any plant functional type parameters, suggesting that the variations in those traits among plant functional types are a result of the adaptions to their surrounding environments, rather than the fixed properties of plant species as the current vegetation models assumed.

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Those simple models' predictive skills suggest a route towards an improved predictive understanding and modelling approach for terrestrial biogeochemical cycling, while providing a new theoretical framework for the analysis of both environmental and plant morphological influences on leaf traits. By making testable predictions, the optimality approach may lead to a more robust basis for understanding and modelling both the coordination of plant traits among species and biological controls of the emergent functional properties of ecosystems as represented in ESMs.

WORKSHOP ABSTRACT

The Peculiar Mark of Old-Growth: is Sub-Stand Live Tree Structure a Developmental Imprint Unique to Each Natural Douglas-Fir Dominated Stand?

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Abstract

After 150 years, ongoing layering and gap dynamics in natural Douglas-fir dominated forests lead to ever greater horizontal and vertical heterogeneity, which hypothetically differentiates later development stages. We explored if it is possible to identify the structures associated with these stages by quantifying sub-stand live tree structure across a developmental sequence of ten natural Douglas-fir dominated stands. The floating neighborhood sampling method was used to delineate natural tree neighborhoods based on triangulated irregular networks (TINs) in five concentric rings of ever-greater spatial extent (averaging 60–1920 m^2). We then used the common core method summarizing multivariate size structures to identify the most frequently encountered structures among tree neighborhoods with increasing deviation from the common core, resulting in 1–5 diameter distribution types (DDTs). Rotated-sidmoid (RS) tree neighborhoods were observed in all ten stands and but least common at the extremes of the developmental sequence, which demonstrated more distinct DDTs. In later stands, the peak in abundance shifted from smaller to larger trees and bimodal distributions were more frequent. Although the common core RS type was present in early stands across all spatial scales, it was not observed at larger scales in the later stands, in which unusual structures were more localized. Whereas the predominance of homogeneous sub-stand structures in the earliest stand may reflect few and simple early-stage development processes, late old-growth stands had a combination of scalable as well as localized size structures, possibly reflecting the accumulation of mixed processes over time.

WORKSHOP ABSTRACT

Dynamics of Forest Site Index on Permanent Sample Plots in Estonia

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Abstract

Site index is a quantitative measure of forest site productivity and a basic variable in forest management planning. Site index is usually calculated or derived from stand height and stand age using empirical models or curves. In Estonia, we use the models of Andres Kiviste from 1997 for site index determination according to dominant species in the stand. There is a demand to have site index models from repeated height measurements also, omitting the stand age as "difficult to estimate" variable. This can be especially valuable in remote sensing applications, e.g. airborne laser scanning data for forest inventories, to have reliable site index estimations.

The Estonian Network of Forest Research Plots (ENFRP) is an ongoing project for more than 25 years since establishment by Andres Kiviste and Urmas Peterson. The circular permanent sample plots are re-measured with five-year interval. The plots are located throughout Estonia. The plot radius is 15–30 m depending from the tree density in the stand. All trees on the sample plots, that had diameter at breast height over 4 cm, are measured by species, diameter at breast height, vitality status, and tree location within the sample plot.

The dynamics of stand height and site index of Scots pine, Norway spruce and silver birch stands on ENFRP plots is modelled in this study. Repeated tree height measurements with 5–15 year period are used. Age independent site index determination as well as changes in site productivity are aimed and discussed. It is expected that improving the site index determination leads to more reliable stand height growth estimates.

WORKSHOP ABSTRACT

Towards Harmonizing International Reporting of Forest Resources

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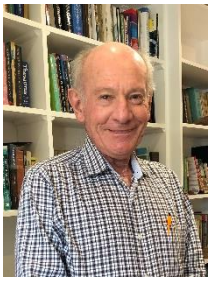
Abstract

Large-scale reporting of forest resources, under the auspices of international environmental agreements is currently expanding. Yet, no comprehensive global efforts and synergies can arise from individual state reports unless the international community engages countries in harmonizing the quality of information available. Following previously published specific recommendations for data quality in reports for climate-related agreements, we evaluate overall country efforts in improved international reporting of forest resource information and suggest paths towards its global harmonization. Issues from sampling design, measurement protocols, quality control routines and uncertainty estimates vary wildly among different countries reporting Forest Reference Levels estimates under the REDD+ mechanism. By highlighting examples from countries that put particular efforts in quality reporting for some of these issues, we conclude that global harmonization is achievable, particularly if driven by south-south international cooperation and continuous financial pledges.

WORKSHOP ABSTRACT



Environmental Rehabilitation of Damaged Land

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Abstract

Background: Much land is subject to damage by construction, development and exploitation with consequent loss of environmental function and services. How might the loss be recovered?

Results: This article develops principles of environmental rehabilitation. Key issues include the following. Rehabilitation means restoring the previous condition. Whether or not to restore is not a technical but a value judgement. It is subject to adopting the sustainability ethic. If the ethic is followed under rule of law then rehabilitation must be done always to 'the high standard' which means handing down unimpaired environmental function and no extra land management. The elements of the former condition that it is intended to restore must be specified. Restoring these in any given case is the purpose of that rehabilitation project. The specified restoration elements must be easily measurable with a few simple powerful metrics. Some land damage is not fixable so restraint must be exercised in what construction, development and exploitation are permitted. If sustainability is adopted then cost benefit analysis is not a valid form of project appraisal because trading off present benefits against future losses relies on subjectively decided discount rates, and because natural capital is hard to price, indispensable, irreplaceable and non-substitutable. Elements often to be restored include agricultural land capability, landscape form and environmental function. Land capability is a widely used convention and, with landscape form, encapsulate many key land factors, and are easily measurable. Restoring soil and thereby environmental function provides the necessary base for an ecological pyramid.

Conclusions: The need for rehabilitation is not to be justified by cost-benefit or scientific and technological proof, but rests on a value judgement to sustain natural capital for present and future generations. Decision on what activities and projects to permit should be based on what is physically and financially fixable on current knowledge. Business and government must be proactive, develop rehabilitation standards, work out how to meet the standards, design simple powerful metrics to measure performance against the standards, embark on continuous improvement, and report.

WORKSHOP ABSTRACT

Simulating the Impact of Climate Change on Miscanthus Yield in the UK

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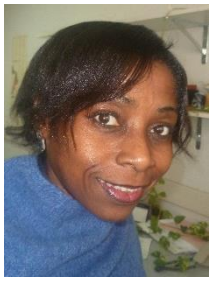
Abstract

In the UK, long-term average harvestable yields from a mature crop Miscanthus, have exceeded 16 t DM $ha^{-1}{\cdot}y^{-1}$ at the most productive experimental sites. These high yields suggest that the crop has the potential to make an important contribution to the UK's commitments to energy generation from renewable sources. Planting the perennial biomass crop Miscanthus could offset 2–13 Mt oil eq. yr^{-1}, contributing up to 10% of current energy use in the UK. Other markets for Miscanthus also exist apart from that for the energy market. These include high value equine bedding and sustainable composite materials for markets such as the production of biodegradable plastics and fibres for car parts. Miscanthus is planted in spring and once planted can remain in the ground for at least fifteen to twenty years. Although its yield under historic weather conditions can be observed through experiments, it would be difficult to assess the impact of future climate change on it with any designed experiments because of uncertainties of future climate. However, modelling would be an ideal assessment tool to achieve the goal. The well-developed SPACSYS model was used to assess yield changes of Miscanthus under future climate change scenarios, being represented by four Representative Concentration Pathways (RCP), namely RCP2.6, RCP4.5, RCP6, and RCP8.5. Firstly, the model was parameterised and validated with a dataset, collected at Rothamsted Research in the East of England over 13 years of field research on Miscanthus. Secondly daily weather data along with temporal changes of atmospheric CO_2 concentration from 2006 to 2099 were generated under the RCPs. Then the model was run under the RCPs kept the current agronomic practices unchanged. The simulated results showed that average yields over the simulation period were 13.7, 12.8, 12.6 and 11.9 t DM $ha^{-1}{\cdot}y^{-1}$ under RCP2.6, RCP4.5, RCP6, and RCP8.5, respectively. Further, the yield uncertainty could increase with the radiative forcing value. This suggested that the contribution of the bioenergy crop to renewable energy in the UK should take account of the negative impact of climate change.

WORKSHOP ABSTRACT



How Forest Management May Impact on Soil Organic Matter and Environment in the Congolese Coastal Plains?

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Abstract

Providing wood pulp for industry, fuel energy for the local population and preserve natural forests were the primary goals of afforesting savannas with eucalyptus in the Congolese coastal plains. Nitrogen fixing species (NFS) *Acacia mangium* was afterward introduced (i) to sustain productivity (ii) improve soil fertility and (iii) mitigate climate change by sequestering carbon (C) in both soil and biomass. Soil phosphorus (P) status also improves through an increased soil available P in the coarse fraction of particulate organic matter **(**POM) (cPOM; 4000–250 µm) of afforested stands with acacia or/and eucalyptus at 3 years of the second rotation relative to the native savannas. However, the well-known high P demand of *A. mangium*, as NFS to sustain symbiotic root nodules and atmospheric N_2 fixation processes, induces a decrease in soil available P beneath stands containing acacia relative to eucalyptus at the end of the first 7 year-first rotation.

Previous studies on N and C status along rotations revealed increased N and C concentrations and stock at the end of the first rotation and at 2 years of the second rotation. How does soil quality change in the length of the rotation in that fragile ecosystem following land-use changes (afforestation of native savannas) and forest management (introduction of acacia in the eucalyptus plantations)? How may this change impact on the potential to improve soil fertility and mitigate climate change? To respond to these questions the following analyses were performed: (1) Soil organic matter (SOM) characterization through C and N concentration and available phosphorus in bulk soil and POM fractions beneath these plantations at 5 years of the second rotation; (2) Estimation of soil microbiota or bacterial community composition using 16S rRNA gene amplicon sequencing and its link to nutrient cycling (N, C and P status); (3)

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Characterization of SOM quality through chemical recalcitrance and P status via its organic form using thermal analysis (differential scanning calorimetry- DSG and thermogravimetry-TGA), and ^{31}P nuclear magnetic resonance (^{31}P-NMR). Even though more chemical recalcitrant organic matter was noticed in eucalyptus relative to the other stands, overall studies revealed a more labile SOM status through a decrease in N and C concentrations in POM fractions along with a decrease in both soil pH, P availability and a potential to increase soil fertility and mitigate climate change.

WORKSHOP ABSTRACT

Applications of Gap Models across Micro- to Mega-scales of Time and Space: Examples of Tansley's Original Ecosystem Concept

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Abstract

Gap models are individual-based models that have been used to simulate mixed-species and mixed-age forests. Compared to individual-based growth-and-yield models, they differ by their emphases on multispecies assemblages and compositional change; on multiple tree-generation dynamics; in testing against independent data; and in predicting responses to altered environmental conditions. The determination of the appropriate time- and space-scales of the external environmental drivers, designation of the significant biological and ecological processes, and expected response-scales are in accord with A.G. Tansley's original definition of "the ecosystem". At the micro-scale, forest gap models applied to problems involving the magnitude of photosynthesis and other leaf biochemistry vertically through the canopy include a reallocation of the canopy photosynthate-production to the individual trees whose leaves comprise the canopy. Such reallocation is a vexing problem when simulating canopy processes using aggregate "big-leaf" canopy process models. Performances of forest gap model have been tested against eddy-covariance over canopies at sub-daily resolution.

WORKSHOP ABSTRACT

At the mesoscale, a new example of predicting pest-insect demonstrates the actions of changes in climate (warming) both on the trees comprising a forest and on the insect populations. This example is but one of many cases that involve using a gap model to simulate changes in spatial units typical of sampling plots and scaling these to landscape and regional levels. This is a typical application method for gap models and other examples will be identified. At the macro or regional scale, the insect/climate-change example scales to regional-scale consequences. The most straight-forward approach to such applications is to simulate survey plots across a continental or subcontinental zone, Forest inventories at these scales are often conducted using independent survey plots distributed across a region. When the lack of contagion assumed in such inventory systems is manifest in regional model construction, the difficulties involved in including the effects of spatial interactions need not be included for many applications. However, simulation at these large scales with contagion effects also discussed. At the global-scale, successful simulations have used functional types of plants, rather than tree species. We present a recent application in which the fine-scale predictions of a gap model are checked against data from micrometeorological eddy-covariance towers across a wide range of sites as a prerequisite to up-scaling to produce maps of global patterns of evapotranspiration, net primary production, gross primary production and respiration. We will close by discussing the opportunities to test these predictions using new-active-remote-sensing instruments.

WORKSHOP ABSTRACT

New Nearest-Neighbour Characteristics for Individual-Based Forest Ecology

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Abstract

Plant diversity influences ecosystem productivity and stability and is related to several population traits. With ongoing climate change interest in understanding the mechanisms of natural maintenance of biodiversity is increasing. China has a wealth of natural woodlands with high species and size diversity that stretch over several climate zones. For monitoring species and size diversity it is crucial to rely on meaningful summary characteristics that offer sufficient information to make correct decisions in conservation. Recently Pommerening and Uria-Diez (2017) and Pommerening et al. (2019) introduced new types of nearest-neighbour summary characteristics for spatial species mingling and spatial size inequality where either multiple numbers of neighbours k or the dependence of structural characteristics on size/or on other characteristics are simultaneously used in the estimation. In this paper, all these separate approaches are presented together along with applications to Chinese data. Our work will demonstrate how effectively these nearest-neighbour approaches characterise complex forest stand structure if used in combination. At the same time we will introduce methods of statistical tests for these characteristics. Analyses of correlation and allometry will reveal how these characteristics are related.

WORKSHOP ABSTRACT

Combining Spatial and Economic Criteria in Tree Level Harvest Planning

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Abstract

Modern remote sensing methods enable the prediction of tree-level forest resource data. There is, however, only a limited amount of research on how to benefit from tree-level data in forest or harvest planning. Particularly, there is need for tree-level methods that simultaneously account for the spatial distribution of trees and other objectives. We developed a spatial tree selection method that has local (spatial variables and relative value increment) and global objectives (cutting targets) in the priority function. We partitioned the whole surface area of the stand to trees assuming that a large tree occupies larger area than a small tree. This was implemented using a power diagram. We also utilized spatially explicit tree-level growth models that accounted neighboring trees and the change in the neighborhood. Optimization was conducted with a variant of cellular automata. The proposed method was tested in Central Spain in Stone pine (*Pinus pinea* L.) stands having two different spatial distributions of trees. First we implemented a basic individual tree detection and tree attribute estimation with sample plot measurements and Airborne Laser Scanning data. We mimicked four different spatial distributions of cut trees using alternative weights of objective variables. *Non-spatia*l selection did not aim at any particular spatial layout, *Single-tree* selection dispersed trees to be cut, and *Tree group* and *Clearcut* selections clustered harvested trees to different magnitudes. The results showed that the proposed method can be used to control different spatial distributions of trees in tree-level spatial harvest or forest planning.

WORKSHOP ABSTRACT

Trade-offs between Wood Production and Forest Grouse Habitats in two Regions with Distinctive Landscapes

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Abstract

Forest management affects the viability of forest grouse populations, causing alterations to habitat quality. At the regional level, common targets for wood production and safeguarding of specific habitats are negotiated between various stakeholders. Analysing potential trade-offs between forest grouse habitats and wood production in the region could support resource-smart decision making.

In this paper, we compiled trade-off curves represented as production possibility frontiers demonstrating the relationship between forest grouse habitat area and wood removal, using a Finnish forestry dynamics model and the Finnish Multi-Source National Forest Inventory. For the modelling of forest grouse habitats, a landscape-level occurrence model based on nationwide wildlife triangle census data was used. Five alternative forest scenarios in terms of wood removal were compiled for two study areas in Finland representing two different landscape structures. Results showed that impacts on forest grouse habitats were case-specific. In the southern study area, increasing the roundwood harvesting rate affected grouse habitats more strongly as forests were already fragmented for other land uses and became more spruce-dominated over time. If the maximum sustainable removal rate was implemented, predicted grouse habitat area was 56% less than in a no-removal scenario. In the eastern study area, a more heavily forested region, the decrease was far lower at 24%. Scenario results were also compared to levels of current wood removal and that envisaged by current regional forestry programmes, and their sustainability in terms of grouse habitat area was discussed. The production possibility frontiers calculated in this

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study support the evaluation of the loss of suitable habitat reflected by different forest felling rates, as well as the economic cost of increasing habitat areas.

Keywords: Forest grouse, Forest landscape, Habitat model, Production possibilities frontier, Scenario analyses, Wood production

WORKSHOP ABSTRACT

Can Thin-only Treatment Improve Pine Stands' Fire Resilience in the Mid-Term in NW Spain?

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Abstract

There is an increasing interest in the effectiveness of fuel management on reducing fire severity and thus achieving forest structures more resilient to wildfires. In commercial pine stands in NW of Spain, thinning is the main management strategy applied for reducing fire severity through decreasing quantity and continuity of canopy forest fuels.

Thinning alone can have conflicting effects on the variables that influence wildfire behaviour. On one hand, it is well stablished that canopy fuel load (CFL) and canopy bulk density (CBD) decrease and canopy base height (CBH) increases immediately after a thinning from below, reducing the likelihood of initiation and spread of crown fires. On the other hand, most studies indicate thinning only, without removing, burning or crushing debris, has little efficiency in reducing the intensity of a wildfire affecting the treated area due, among others, to two main factors related to fire hazard: 1) thinning favours a greater incident solar energy in the understory and forest floor, increasing understory cover and biomass; and 2) within-stand wind speed is usually increased when canopy cover decreases.

WORKSHOP ABSTRACT

In crown fires, and high intensity fires in general, post-fire tree mortality usually reaches the 100%; however, fires of low or variable intensity may leave a stand damaged with variable percentages of tree mortality depending on the percentage of tree crown volume scorched. The needles of these partially burnt trees generally fall to the ground shortly after the fire and provide a natural mulch ground cover, reducing the area susceptible to raindrop impact, decreasing over ground flow velocities and favouring sediment deposition.

Therefore, the interrelations between surface fire behaviour, crown volume scorched and post-fire stand resilience (expressed in terms of tree survival probability and in terms of the ability of dropping soil erosion) are contradictory. On one hand, since crown volume scorched is directly related with tree mortality, a reduction of this volume will result on stands more resilient to wildfires. On the other hand, increasing crown volume scorched could increase post-fire needle cast, thus allowing post-fire rehabilitation treatments to be excluded for areas where dead needles provide sufficient ground cover to avoid soil erosion.

Thinning from below is usually advocated to reduce crown volume scorched because it raises the canopy base, decreases the canopy bulk density while preserving the large fire-resistant trees. Therefore, this fuel treatment alone is expected to favour a more resilient structure in pine stands in terms of reducing post-fire mortality, but to what extent it would influence the post-fire ground cover by needle cast is largely unknown.

The main objective of this work is two-fold. Firstly, we aimed to evaluate the mid-term effects of thinning on surface and canopy fuel complex variables of Pinus pinaster and Pinus radiata stands. We used data from 41 thinning trial locations installed in pure, even-aged stands of P. pinaster (22 locations) and P. radiata (19 locations). At each location, three rectangular plots were established, and a different treatment was applied to each plot: control (unthinned), low thinning (20% of the basal area removed), and heavy thinning (40% of the basal area removed). Subsequently, we focused on the role of crown volume scorched (estimated by simulation modelling) for analysing the interrelationships between thinning and post-fire stand resilience expressed in terms of tree survival and soil erosion reduction. These interrelationships becomes of practical interest for improving burning prescriptions, application of post-fire restoration and management of affected stands.