

Using GIS Cluster Analysis To Quantify Timber Production From Farm Forestry Plantations

Introduction

New research by Teagasc, funded by COFORD seeks to provide a framework for quantifying the wood resource from private forests using high level GIS cluster analysis. The project called "CLUSTER" is being carried by forestry researchers working in the forestry development unit in Athenry, Co. Galway. GIS resources have long been used to store forest information such as inventory details and the new research hopes to develop methods for analysing and compiling forest inventory and growth data in order to quantify the forest resource in distinct geographic locations. This will provide information about the quantity and location of thinning material, facilitate the planning and logistics of thinning operations and maximise the contribution of farm forestry to the local and national economy (Farrelly et al, 2008). It is also hoped that new and existing market opportunities can be identified, such as wood energy markets. Teagasc forestry researchers *Niall Farrelly, Brian Clifford and Stuart Green* explain how this new research will provide a significant stimulus to the farm forestry sector. The project commenced in August 2007, has achieved significant success in its first year, identifying major forestry clusters throughout Ireland. One particular Cluster, centred in Frenchpark, Co. Roscommon is currently being surveyed at the moment with the capture of high level Aerial Lidar data together with on the ground field data, thus providing up to date, reliable inventory information which will be used for forecasting forest production in the area. The research provides a quick, reliable and cost effective method of acquiring forest inventory information to those in the forest industry.

Background to study

Private forestry in Ireland is reaching a point where the possibility exists for it to make a significant contribution to the market for forest products. Forests planted in the late 1980's and 1990's are coming to the age of first thinning. Currently over 106, 000 ha

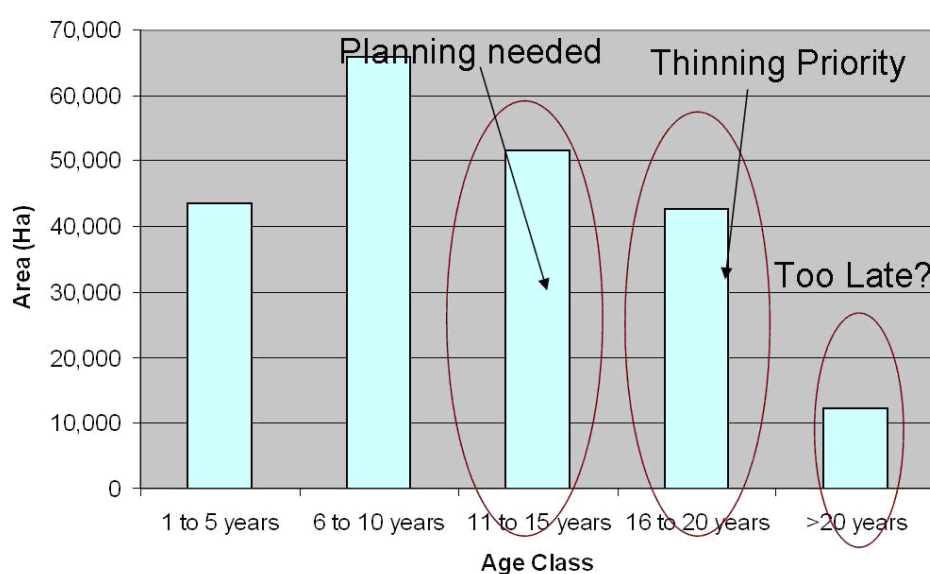


Figure 1 Area distribution by age class of private forests



Figure 2 Farm Forest, Tawnyinah, Co. Mayo

are greater than 10 years of age while some 55,000ha are greater than 15 years of age (Forest Service, 2008). While some areas may be past first thinning (stands (>20 years), the areas that are in the 16 to 20 year category need to be prioritised for thinning and the areas in the 11 to 15 year old category require infrastructure to be put in place to facilitate thinning operations (Figure 1). COFORD (Council for Forest Research and Development) estimate that the private sectors market share will rise to 23 percent by 2015 (Gallagher and O' Carroll, 2001). However, the actual supply from the private sector is still far short of this target, with many farm forest plantations in Ireland currently unthinned. There is however some doubt over whether these predictions can be realised due to issues such as small plantation size, poor access and forest fragmentation.

The fragmented nature of private forestry not only has implications with regard to harvesting and marketing of timber, but also for gathering of forest resource information. There is very little information at a local level as to where geographically volume will come from and which plantations are suitable for thinning in the next five to ten years. This information is necessary in order to create a strategic plan for the harvesting and marketing of timber and ultimately to lead towards a stronger bargaining position for the forest owner. Therefore the challenge is to provide a framework for the quantification of the wood resource from private forests thereby identifying an optimal methodology to obtain the information necessary to create the structures to quantify, locate and market timber for forest owners. The CLUSTER research programme will seek to address these issues by creating a framework for the quantification of wood resources from farm forests.

Methodology

The Cluster methodology involves the capturing and compilation of high level inventory or growth information on forest plantations using Geographic Information Systems (GIS). Various data sources are available in the GIS such as the Forest Inventory and Planning System database (FIPS), provided by the Forest Service, together with various sources of remotely sensed imagery such as aerial photography, satellite imagery and airborne laser scanning (LiDAR). These are used to locate and identify farm forest plantations, and are supplemented by field based measurements.

The first phase of the study involves



Figure 3A & B Area weighted spatial analysis used to identify concentrations of forest cover in Ireland,



Figure 4 (A) A map of the 16 national cluster areas & inset (B) target cluster area in Mayo, Sligo and Roscommon chosen for study

capturing the location of the forest plantations in a GIS to give a picture of the extent, density and composition of the resource. The research has pioneered the use of area weighted spatial analysis to locate spatial trends in forest cover corresponding to large concentrations of private forest cover. This method is extremely efficient, as it identifies where forestry occupies a significant proportion of the landscape and enables the maximum capture of inventory information in contiguous geographic areas ensuring efficiently, productivity and

low cost. In addition it identifies locations where forestry could have potential as an indigenous industry, *i.e.*, an example of the spatial analysis is provided in Figure 3.

Provisional Findings indicate that Private Grant Aided forestry (PGA) covers approximately 3 % of the national land area or 207,897 Ha. Forest clusters were identified at national level based on two parameters;

- Private forestry in excess of 5% of the land area

- Cluster boundary area greater than 10 sq km

Sixteen separate areas matched these requirements spread through out the county (Table 1, Figure 2a). It would appear from this preliminary analysis that private grant aided forestry does have spatial concentrations, 42 % of private grant aided forestry (88,260 ha) occurs within the 16 identified cluster areas, while these cluster areas make up less than 14.5 % of the total national land area.

Cluster No. 3, was chosen as the project study area. This area is located where the counties of Mayo, Leitrim and Sligo meet and includes towns such as Swinford, Kilkelly, Ballaghaderreen, Castlerea and Frenchpark. (Figure 3). It encompasses an area of 1304 sq km which covers approximately 0.02 % of the national land area. Of this PGA forestry covers approximately 97 sq km or 7.5 % of the land area.

The second phase of the study aims to identify forests which may be suitable for thinning within the chosen cluster. An examination of aerial photography identified plantations approaching or having past first thinning stage. During this process forest stands were stratified into four stages based on visual characteristics, "ground preparation" "pre-thicket", "thicket" and "pole". This stratification together with information on planting year from Forest Service planting records is used to select sites due for thinning and that will be visited in the field. During this process forest boundaries visible on aerial photos were re-digitised using the latest aerial photography or satellite imagery to create a new inventory base layer with information about species, area and productive area. From analysis of aerial photography approximately half the forest area within the study area was deemed

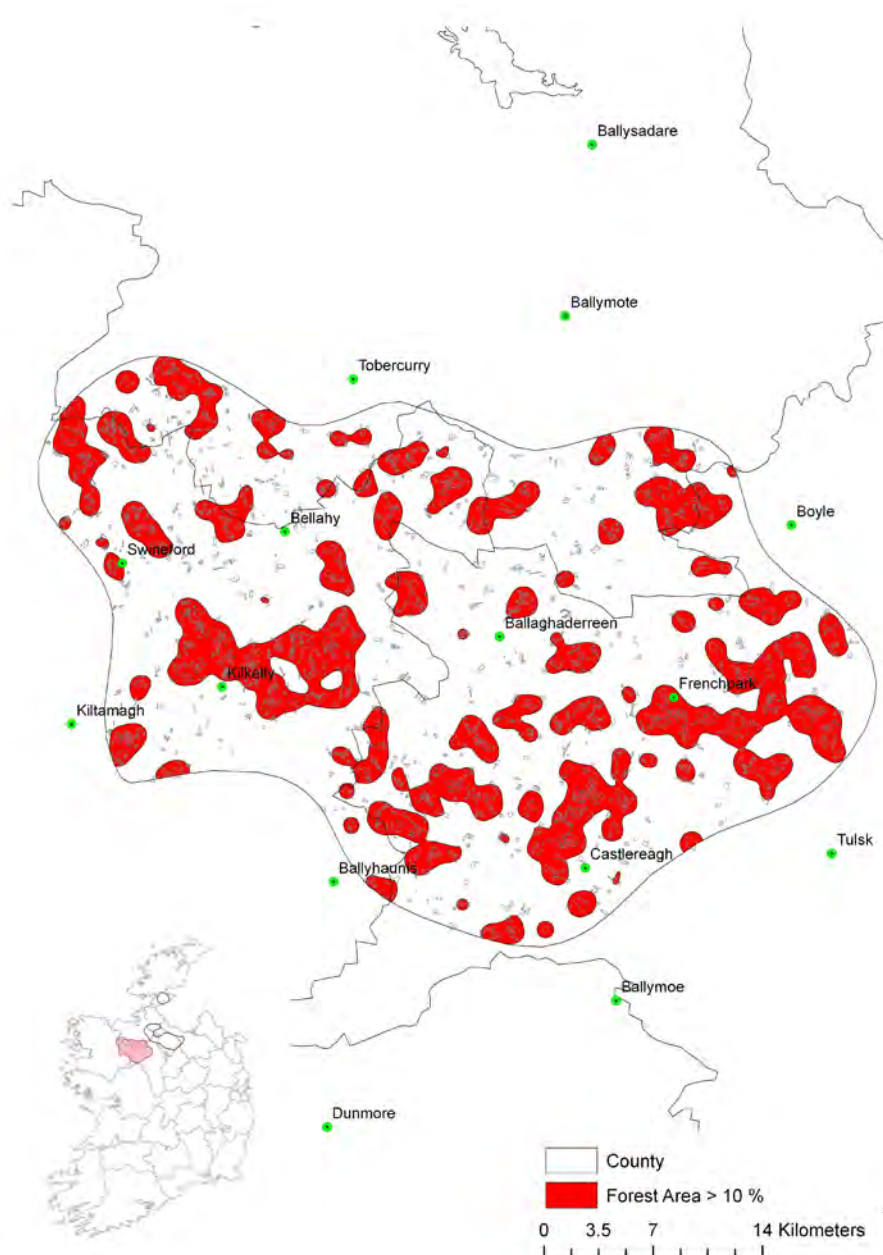


Figure 5 The Mayo, Sligo and Roscommon cluster centered around Frenchpark and Ballaghaderreen, Co. Roscommon. Areas marked in red indicate PGA forestry in excess of 10 % of land cover

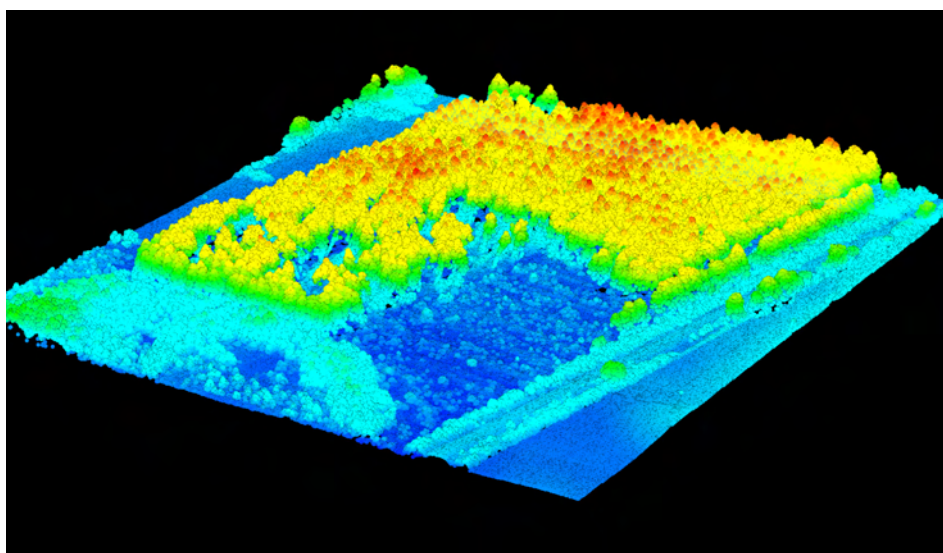


Figure 6 (A) Orthophotograph of a selected Sitka Spruce stand in Frenchpark Co. Roscommon and (B) A LiDAR image of the same area.

suitable for a site visit. A letter was issued to each forest owners whose plantation met these criteria requesting permission to carry out an assessment of timber quality volume. A 37 % response rate was received. These forest stands are now being visited in the field where a rapid inventory assessment is being carried out.

The study also aims to evaluate remote sensing options for obtaining forest resource information in tandem with field collection methods. Field surveys are time consuming and costly, while assessing private forest plantations have the added difficulty of contacting forest owners and gaining access to their plantations. Obtaining accurate information on forest productivity using remote sensing imagery



Orothophotograph supplied under License No. 6155 from the Ordnance Survey Ireland.

LiDAR data processed using FUSION version 2.64 (USDA).

Table 1 the location of 16 forest clusters with the area of PGA forest and as a % of the cluster land area

Cluster No.	County Location	PGA Forest Area (Sq Km)	% PGA Forest in Cluster
1	Limerick, Kerry, Cork	284	9.6
2	Galway, Limerick, Tipperary	135	8.2
3	Mayo, Sligo, Roscommon	97	7.4
4	Clare	89	8.5
5	Leitrim, Sligo, Cavan	89	11.0
6	Donegal	43	7.9
7	Westmeath, Laois	35	7.2
8	Donegal	22	8.4
9	Kilkenny, Laois	20	9.1
10	Mayo	14	8.0
11	Donegal	12	8.8
12	Waterford, Tipperary	11	8.9
13	Cork	9	8.1
14	Longford, Westmeath	8	7.1
15	Mayo	7	6.8
16	Wicklow	7	6.9

could aid in overcoming these obstacles, thus improving the data capture process. Satellite imagery and LiDAR (Light Imaging Detection and Ranging) data have been obtained for the study area and are currently being evaluated as a tool to aid forest resource inventory (Figure 4). In

addition another Teagasc project running in parallel to this study aims to use forest productivity models to populate forest parcels with estimates of forest production. All in all, this information aims to provide details so that forecast of timber production from a particular location can be achieved.



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