DEVELOPMENT OF ENVIRONMENTAL ROUTEING STRATEGIES FOR THE MANAGEMENT OF FOREST ACCESS ROADS USING GIS AND GPS

This thesis deals with the use of Geographical Information Systems (GIS) and the Global Positioning System (GPS), for the establishment of environmentally friendly routeing strategies to manage forest access road networks. The overall aim of the study was to investigate timber haulage strategies on low quality forest access roads based on pavement serviceability and pavement maintenance costs.

Analysis of the pavement serviceability of forest access roads, by classification using current pavement condition and by pavement deflection, established that surface quality was largely dependent on drainage conditions. Pavement strength was found to depend significantly on the subgrade type, with peat based roads exhibiting significantly higher critical deflections (5.6 mm) than pavements with mineral subgrades (1 mm). It was shown that increasing the vehicle payload 10% would result in a 20% increase in Equivalent Standard Axle Loads. Seasonal effects were also evaluated.

Within ArcView® GIS, geo-referenced pavement attributes and forest inventory data were integrated to determine the capability of forest access roads with weak subgrades to support timber extraction. The potential damage caused by a typical timber haulage truck indicated that significant reductions (16 and 44 %) in the serviceability of forest access roads would result from small overload margins (3 and 8 tonnes, respectively). The re-routeing of timber to avoid critical and failed road sections was found to significantly increase the transportation costs therefore, assessment of respective routeing strategies will require an extension of the GIS database to include specific costings of pavement maintenance.

A record of timber haulage routes with independent verification will be required in the future. DGPS provides a suitable technology but performance can be influenced by trees. A protocol to determine peripheral canopy obstruction on typical Irish forest access roads was established and applied to 20 forest road sites. DGPS performance was quantified at each experimental site and three distinct classes of obstruction were defined (Class I: 100-66 %; Class II: 65-33 %; Class III: 32-0 % obstruction). Both DGPS accuracy (3.70m, 3.23m, 1.91m) and precision (4.10m, 2.43m, 0.83m) improved with decreasing peripheral obstruction class. The peripheral canopy classes determined allow for estimation of DGPS accuracy and precision on Irish forest roads.

Within ArcView Network Analyst® timber transportation routes were designated on the basis of shortest distance, and road maintenance costs. Direct cost comparisons of 76 routes revealed that 46% of the current designated transportation routes were the optimum (shortest distance) routes. The unit cost associated with maintenance of the optimum route networks was found to be higher (12,873 euro/km) than those associated with the designated haulage routes (12,401 euro/km), due to the increase in proportion, of lower standard roads which increased the unit maintenance costs by 390 euro/km. Therefore, for environmentally friendly timber haulage to be economical, timber transportation should be routed to the nearest higher-class roads.

The study has shown that environmentally friendly haulage strategies, which minimise the damage imposed on the road network, will enable Sustainable Forestry Management programs to anticipate future road pavements problems and analyse various routeing scenarios thereby, reducing the overall cost in the wood supply chain.

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