HARVESTING TECHNICAL NOTE

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Results of a Residue Volume Study on Steepland Harvest Sites

Summary

Woody residues that are generated during the harvest of plantation forests are subject to increasing demand. Residues in many regions previously had little or no market opportunity, leading to abandonment on the cutover and at landings where extraction would be unprofitable. This project quantified the volumes of cutover and landing residues currently left on steepland harvest sites after harvest. 17 separate landing sites were investigated, finding the average bulk volume of residues produced and piled at the landing was 180 m^3 per hectare harvested, or 0.23 m^3 (bulk volume) for every tonne harvested where log outturn data was available. On cutovers, across 18 sites and using 193 plots, all residues >25 mm diameter were measured, and plot volumes varied widely from 0 to 580 m^3/ha. The median volume was 88 m^3/ha, with 28 m^3/ha of that determined to be of 'binwood' specifications, or better. While harvesting feasibility and cartage cost remain important to the economic viability of uplifting the product, there is no doubt that there is a sizable resource available in harvested steepland forests.

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Introduction

Demand for bioenergy to replace fossil fuels is increasing. The residues that accumulate on forest harvesting sites are available and typically fit for bioenergy applications, but the developing market needs supply security. As a potential customer the following questions are important to answer to be able to invest in boiler technology and storage/feed systems to handle the change of fuel. These can only be answered by forest owners/managers:

- How much energy could potentially be on the market at different pricing points?
- How will energy supply change over months/years?

Woody residue from harvesting has seen little active measurement in recent years. To open discussions with this developing domestic bioenergy market and enable investment decisions in plant and equipment to be made, an up-to-date inventory of woody residues on harvesting sites is required. This project sought to introduce methods that could be used to quantify the production on a site, or across a forest estate, and quantify what a typical volume of harvest residues was from a cross-section of New Zealand's steepland harvesting sites.

Methods

Accumulations of harvest residues on harvesting sites can be broadly divided into two categories, landing residue piles and cutover residues. Landing residue piles offer the most readily available source of biomass, being generally located adjacent to forest infrastructure. Cutover residues (in steepland settings) are a by-product of the falling and extraction processes, typically too small or dispersed to be harvested for profit (by logger or forest owner). The two categories lend themselves to separate measurement methods as briefly outlined below. More detail on the methods is available from Harvey (2022a and 2022b) and Harvey & Visser (2022).

Bioenergy customers would prefer to pay for energy. However, the typical measurements for 'raw' forest products, volume or mass remain necessary, but must be paired with a measure (or else a reliable estimate) of the material's moisture content to predict the energy delivered from the product. The methods here focus on volume only. Changes in moisture content with time since harvest, different piling methods, and weather conditions is subject to ongoing research.

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Landing Residue Piles:

Using UAV imagery coupled with ground control points, photogrammetric models were constructed of each slash pile. Volume was measured by computing the difference in two surfaces for each pile in RoadEng Terrain (v9); the first surface being the original (Figure 1 – Middle), and the second being a duplicate of the original with the sub-pile terrain surface interpreted from the landform surrounding the pile (Figure 1 – Bottom). The pre-harvest terrain surface provided the datum surface for the analysis where early capture was available.

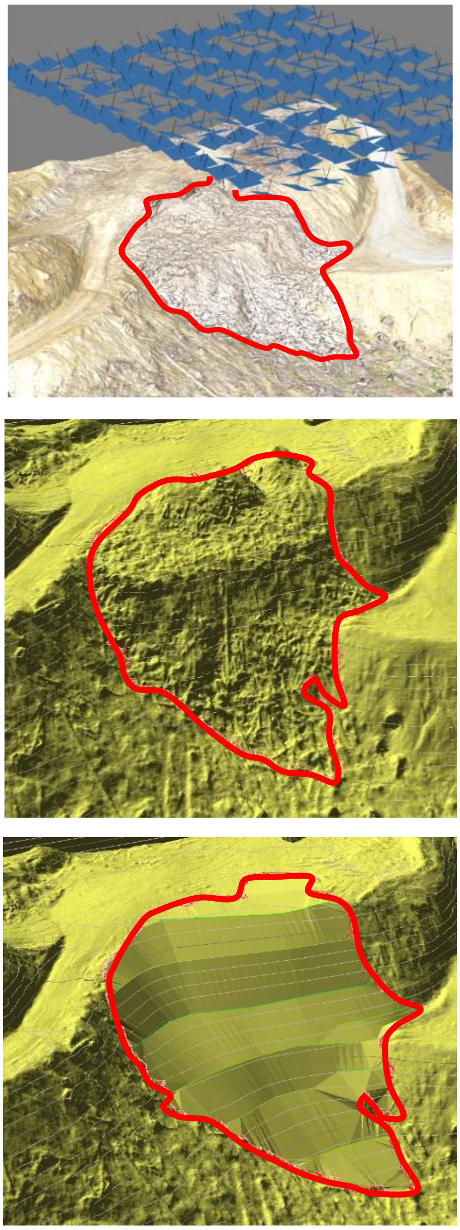

Figure 1: ***Top:*** *Photogrammetric model with camera positions (in blue).* ***Middle:*** *Original surface with pile delineated.* ***Bottom:*** *interpreted sub-pile surface with pile edge delineated.*

Distributed Cutover Residues:

Cutover residues were measured using a manual plotting method, similar to the Wagner Waste Assessment historically used in New Zealand plantations. Each cutover was covered with a grid of plots, and each plot consisted of three 20m transects radiating out from the centre peg. Woody residues >25 mm in diameter were measured and recorded along each transect, along with further details of larger 'merchantable' residues. The result is a residue density in m^3/ha for each plot.

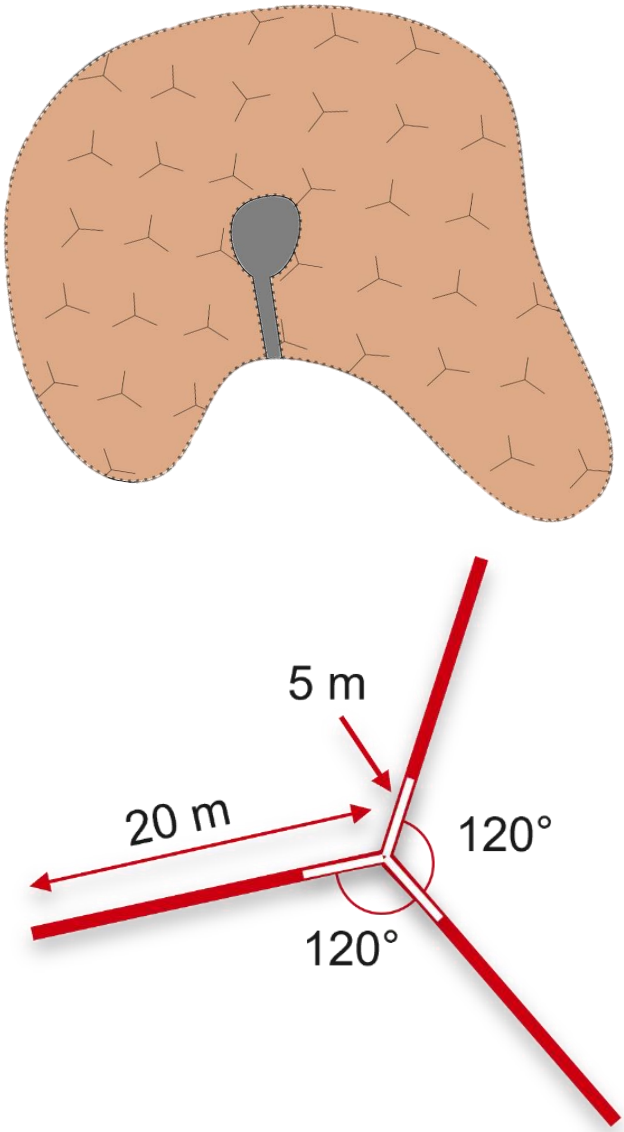

Figure 2: ***Top:*** *Example of a grid of plots over a cutover.* ***Bottom:*** *Geometry of a cutover residue sampling plot.*

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Results

Landing Residues:

In total, 39 landing residue piles were measured across 17 harvest sites. The cutovers servicing the landings ranged in area from 4.8 to 41.1 ha, with an average of 18.1 ha. Bulk volumes (solids plus air voids) of these piles averaged 180 m^3 per hectare harvested. In order to convert to tonnes, the volume must be multiplied by a density (generally green slash is taken as approximately 0.25-0.3 tonnes/m^3), for a measure of pile mass.

Bulk Pile Volume per Hectare Harvested (m^3/ha)	180
Bulk Vol. / tonne harvested (m^3/t) *14 sites	0.23

Cutover Residues:

A total of 193 plots were measured across 18 cutovers to establish the distribution of volumes in Figure 3. The median volume was 88 m^3/ha where the minimum size was 25 mm diameter (see example Figure 5). 55% of plots yielded between 50 – 150 m^3/ha total volume. Considering only timber that is typically 'merchantable' if it were at the landing (>4 m long & >10 cm SED), the median volume was 9 m^3/ha, with an additional 19 m^3/ha of timber meeting binwood specifications (>0.8 m long & >10 cm SED). 50% of plots yielded between 25 – 100 m^3/ha of these merchantable residues. Figure 4 details the distribution of merchantable volumes. At the median plot, 60 m^3/ha does not meet the binwood specification or higher, therefore is branch material or deadwood.

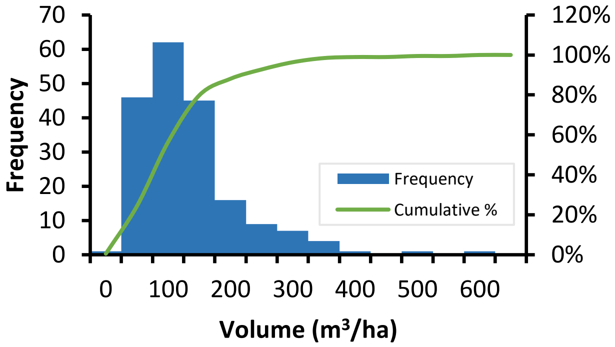

Figure 3: *Right-skewed distribution of total residue volume (>25 mm DIA.) on steepland cutovers.*

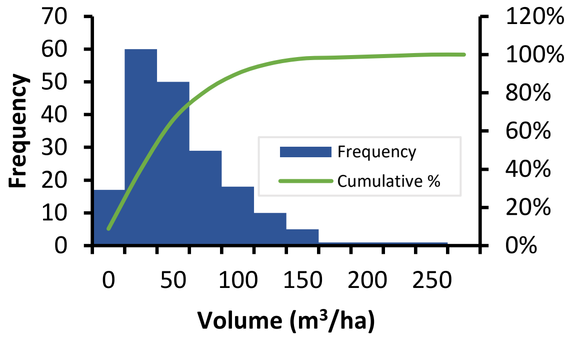

Figure 4: *Right-skewed distribution of residue volume binwood + pulp or higher grade (merchantable timber) on steepland cutovers.*

Figure 5: *Example of a near-median residue coverage on a cutover.*

Conclusion

New Zealand harvest sites hold large resources of wood fibre that may become economically viable to harvest soon. The available volumes are evidenced by this study. These volume figures serve as an important benchmark for work to expand the opportunities for supplying biomass to the regional markets. The methods also provide an opportunity to build datasets at a site or estate level to better understand a forest's ability to supply.

References

Harvey, C. (2022a) Measuring woody residues on steepland harvest sites. Harvesting Technical Note HTN15-04. Forest Growers Research Ltd, Rotorua, New Zealand.

Harvey, C. (2022b). Measuring harvest residue accumulations at New Zealand's steepland log-making sites. New Zealand journal of forestry science, 52(12), 11. doi: https://doi.org/10.33494/nzjfs522022x186x

Harvey, C., & Visser, R. (2022). Characterisation of harvest residues on New Zealand's steepland plantation cutovers. New Zealand journal of forestry science, 52(7), 12. doi: https://doi.org/10.33494/nzjfs522022x174x

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