AN ESTIMATION PROCEDURE FOR DETERMINING WOODY BIOMASS WITHIN VIRGINIA

Bob Smith and Omid Parhizkar[1]

Summary. This project evaluated the types, quantities, and location of wood residues and other woody materials that could be available for use as bio-energy or other applications in the Commonwealth of Virginia. The residue information was collected through the survey of primary and secondary wood manufacturers, landfills, and loggers in Virginia, and then incorporated into a GIS system so that locations and quantities of various residues were known. By identifying the location and quantities of various woody materials in the most cost efficient manner, this project has the potential to develop new markets and increase jobs in a number of rural areas. From this information, strategies can be developed that will utilize biomass residues. This study provides valuable information toward the expanded use of bio-energy in Virginia.

Keywords. [Forthcoming]

Introduction

One of the major obstacles for locating biomass energy facilities is determining if adequate supplies of raw material are available. Not only is it difficult to estimate the volumes of the various types of residue, most often they are in different measurements (tons, board feet or cubic feet) and in different shapes or forms. This research collected estimations on various types of residues and put the information into useable GIS format, so potential users could readily estimate tons of residues within a region.

---

[1] The authors are Associate Dean and Professor in the College of Natural Resources at Virginia Tech and Research Consultant for the World Bank, Washington DC. Parts of this research have be published in the Forest Products Journal (58:3) pp 71-76.

The forest products industries are both Virginia's largest agricultural sector and its largest industrial sector (Ho 2005). This segment has 228,000 jobs and added nearly $10 billion to the state economy in 2005 (Lee 2005). Approximately 65 percent of Virginia is covered in forest. Natural by-products of the forest products industry are biomass residues such as wood chips, bark, and sawdust coming from a sawing, milling, or chips (including secondary operations such as cabinet making), used material ending in landfills and slash left from logging operations. It may be dry or green, clean or dirty (Cornelis et al. 1997). One popular waste management solution is to use these biomass residues for fuel. There is an increased interest to investigate bio-energy as a way to address several concerns including air-quality issues, residue disposal costs, dumping of wood waste, enhancing the forest management, and renewable energy sources (Kartha and Leach 2001). Biomass residues are "natural" economical alternatives to high fuel costs.

Objectives

The purpose of this project was to evaluate the types, quantities, and location of wood residue and other woody materials that could be available for use as bio-energy or other applications in the Commonwealth of Virginia. The residue information was collected through the survey of primary and secondary wood manufacturers, landfills, and loggers in Virginia, and incorporated into a GIS system so that locations and quantities of various residues were known. From this information, strategies can be developed that will utilize biomass residues.

Estimation Procedures

Manufacturers

After completion of the mail survey, the following steps were used for the extrapolation of the estimation of the total biomass residue volumes produced in Virginia by *wood product manufacturers* for each county by each Standard Industrial Classification (SIC) code.

1). The Virginia State Employment Commission was contacted to attain the number of employees working in the forest products industry by Standard Industrial Classification (SIC) code for each county. These sample frames included sawmills, both hardwood and softwood (SIC 2421), engineered wood manufacturers (SIC 2493), hardwood plywood manufacturers (SIC 2435), paper manufacturers (SIC 2621, 2631), flooring and dimension manufacturers (SIC 2426), mill work manufacturers (SIC 2431), cabinet manufacturers (SIC 2434), pallet manufacturers (SIC 2448),

furniture manufacturers (SIC 2511, 2512, 2519, 2521, 2531, 2599), housing manufacturers (SIC 2439, 2451, 2452), and Other manufacturers (SIC 2429, 2491, 2499).

2.) The reported biomass residue volume of each residue type (e.g., chips, bark, and sawdust) was divided by the reported number of employees of each respondent sample frame to calculate biomass residues production per employee for each SIC code classification. This estimation procedure is similar to that used by (Bush et al. 1997) to estimate pallet production and (Alderman et al. 1999) to estimate the total biomass residues produced in the commonwealth of Virginia.

3.) Average biomass residue production per employee, for each sample frame, was multiplied by total employment within each forest products SIC code by county for each sample frame provided by the Virginia State Employment Commission. For example, responding Virginia pallet manufacturers (SIC 2448) reported producing 8,500 tons of dry chips in 2003. This total was divided by 328 (reported total number of employees for pallet manufacturers), yielding an average of 25.9 tons per employee. The Virginia State Employment Commission reported 56 persons were employed by SIC 2448 in Amelia County in 2003. The average per employee, 25.9 tons, was multiplied by 56, yielding an estimated 1,451 tons of dry chips produced in 2003 in Amelia county for the pallet industy.

4.) Repeating this calculation for each sample frame and adding up each sample frame provided an estimate of the biomass residue volume produced for each county in Virginia in 2003. Board footage, square footage, lineal footage, tonnage production and consumption estimates, for each sample frame, were made by the same method, with the exception of hardwood and pine sawmills (hardwood and pine sawmill employment data were not compiled separately) (Table 1).

Landfills

A procedure was used to extrapolate an estimation the total waste and solid wood volume entered to Virginia's *landfills*. The following steps outline the procedure used in this extrapolation:

1. The waste facilities total waste volume was divided by the number of responding landfills (of that particular landfill type).

2. The average was multiplied by the number of responding facilities, in addition to the number of non-responding facilities. For example, the average volume received for MSW, 90050 tons was multiplied by 82 (responding plus non-responding MSW facilities), resulting in an estimated 7.4million tons of all waste received by MSW facilities in 2003.

This procedure was repeated for each landfill type for estimating the total solid wood volume and the volume of each residue type. This estimation procedure is similar to that used by Alderman et al. (1999) to estimate residue production and also to Bush et al. (1997) to estimate pallet production. The focus of their research was to estimate the number of pallets disposed in landfills, the wood volume contained in those pallets, and pallet recovery.

Table 1. Total Estimated Virginia Residues Produced by SIC Code

Residue Type	Manufacturers Type										Total/Residue Type
	Sawmills	Paper Mills	Engineered Wood	Cabinet Manufacturer	Furniture Manufacturer	Housing Manufacture	Other Manufactur	Mill work Manufacturer	Pallet Manufacturer	Flooring & Dimension	Total
GCH	3,514,571			6			37,155		3,686		3,555,418
DCH				343	40,656	332		1,953	36,565		79,849
GBA	1,219,402	571,357	3,902				47,464		4,907		1,847,032
GSAW	1,649,038			2,312			30,722		10,259	1,410	1,693,741
DSAW	42,486			51,660	20,295	312		3,086		33,422	151,261
GPL	239,486			349			2,279	590	224	2,915	245,843
DPL	152,836			349	4,062	332		1,113			158,692
GMI	26,132			12					27,553		53,697
DMI	702			341	52,282	8,078	112	352	1,084	1,724	64,675
GCO	72,443			349	1,354	9			14,411	850	89,416
DCO				348	4,075	2,818		511	417	17,454	25,623
P					1,347	331		2	67,756		69,436
GSAN				574							574
DSAN			17,966	573	2,071			395	3,829		24,834
OG							18,664		1,603		20,267
TR-SIC	6,917,096	571,357	21,868	57,216	126,142	12,212	136,396	8,002	172,294	57,775	8,080,358
TR	8,080,358										

Residue Type Codes:							
		Green sawdust	:GSAW	Green mixed residues	:GMI	Pallets	:P
Green chips	:GCH	Dry sawdust	:DSAW	Dry mixed residues	:DMI	Green sanderdust	:GSAN
Dry chips	:DCH	Green planner shavings	:GPL	Green coarse residues	:GCO	Dry sanderdust	:DSAN
Green bark	:GBA	Dry planner shavings	:DPL	Dry coarse residues	:DCO	Other green residues	:OG

This research indicates that Virginia's waste facilities received approximately 10.9 million tons of all wastes in 2003 (Table 2).

Table2. Virginia Landfills Estimated Solid Wood Residues Type

Type of Landfill →	**MSW**		**C&D**		**Other**		**Total**	
Residue Type ↓	Tons	%	Tons	%	Tons	%	Tons	%
Wood pallet	41,773	9	16,899	4.3	629	3.2	59,314	4.7
Construction debris	160,473	23	319,195	54	2,297	3.4	482,042	38.5
Woody brush[1]	239,402	57	246,929	35	178,610	68.0	665,033	53.1
Bark	1,619	1.0	2,988	1.4	0	2	4,609	0.4
Ground debris	10,846	5	4,926	2.2	0	2	15,780	1.3
Preservative treated wood	8,610	2.0	2,306	2.0	2,297	3.6	13,217	1.1
Other Wood	1,416	1.0	0	1	10,715	13.2	12,133	1.0
Total	464,139		593,244		194,548		1,251,931	

1. Woody brush included: tree trimmings, landscaping debris, limbs, branches, shrubbery and logs

Loggers

The wood residue questionnaire was mailed to 1000 *loggers* in Virginia. One hundred four responded. The response was 11 percent. The first section of the logger questionnaire was to identify the region that the facility is located. The second section of the questionnaire used the percentage of harvesting by type of wood residues, annual harvesting in 2003. The final section of the questionnaire utilized categorical questions to identify the best markets and impact of lack of that on their operation, the average selling price, and their comments pertaining to wood residues Thirty-six percent of them stated that they are

located in coastal plain region. Nineteen percent located in northern piedmont region. Sixteen percent located in southern piedmont region. Fifteen percent located in northern mountains, and 14 percent located in southern mountains.

The following steps were the procedure used to estimate the total residues left in woods as forest residue produced in Virginia by Loggers:

1. The Virginia Department of Forestry was contacted to provide the total harvest by each region. The provided list was from 2002 data.
2. The average percentage of forest residue by each region was calculated from the survey results.
3. The estimated forest residue was calculated by multiplying the total harvest by each region by the average percentage of residues left in woods for that region.

The total estimated forest residue production from Virginia was 756,000 tons in 2003. Of this, the estimated production from Southern Piedmont was 304,000 tons of forest residues. The estimated production from Coastal Plain was 242,000 tons of forest residues. The estimated production from Southern Mountain was 97,000 tons of forest residues. The estimated production from Northern Piedmont was 62,000 tons of forest residues. The
estimated production from Northern Mountain was 51,000 tons of forest residues. The average percentage of the total harvest left in woods (forest residue) for all regions was 11 percent.

GIS Estimation

Mapping all residue information into a geographic information system (GIS) was one of the main objectives of this study. The final GIS map for available biomass in Virginia contains four layers including: wood manufacturers, landfills, loggers (for forest residue), and the total volume for biomass growing information from forest inventory data.

The primary Virginia GIS map data was provided by the Virginia Economic Development Partnership. The final GIS map with regarding biomass data was produced using ArcView GIS 8.3.0 software. The GIS map is capable to get the quantity of biomass residue types i.e., chips, bark, sawdust, etc. from wood manufacturers, landfills, loggers, and/or by county in the Virginia.

Results

The residue information was incorporated into a GIS system so that locations and quantities of various residues were known. The GIS map is capable to get the quantity of biomass residue types i.e., chips, bark, sawdust, etc from wood manufacturers and/or by county in the Virginia. The GIS map helped to operate the amount of residue biomass produced by specific SIC code by county in the state.

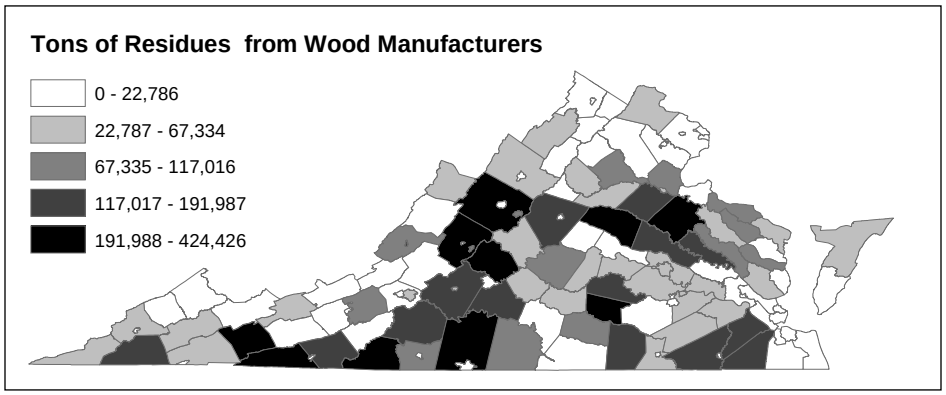

Figure 1. GIS Analysis for Estimated Total Tons of Residues from Wood Manufacturers by County in Virginia.

GIS Map for Landfills

Solid wood residues received by landfills were: wood pallet, construction debris, woody brush, bark, ground debris, preservative treated wood, and other wood. The GIS map was developed to visualize the availability of these residues in Virginia.

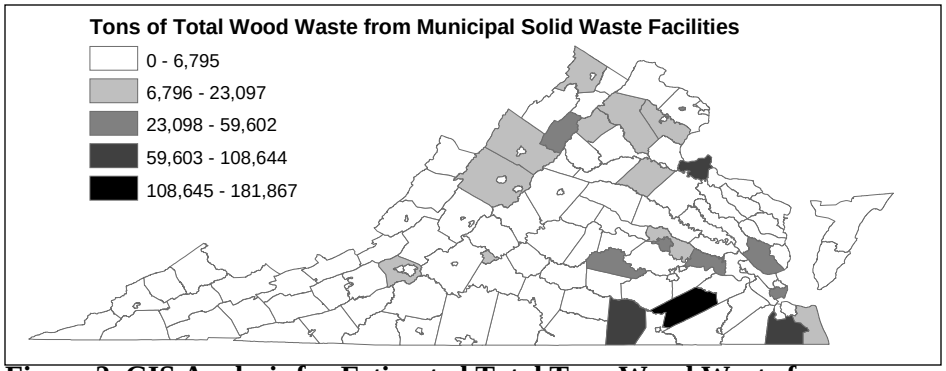

Figure 2. GIS Analysis for Estimated Total Tons Wood Waste from Municipal Solid Waste Facilities by County in Virginia.

Figure 3. GIS Analysis for Estimated Total Tons Forest Residue from Loggers by County in Virginia.

GIS Map for Biomass Growing from Forest Inventory Data

The Virginia Department of Forestry provided us the biomass information data by county from forest inventory. The county code was the standard FIP code. This information was incorporated into the GIS format. The total volume of biomass information by county from forest inventory was used for non-merchantable wood data.

The amount of biomass were determined which are in small trees, pulpwood, sawtimber, topwood, along with the main groups that most users of biomass are interested in, soft and hard hardwoods, pine and other softwoods. Pine includes all of the pines, while other softwood is made up mostly of eastern red cedar, bald cypress and eastern hemlock.

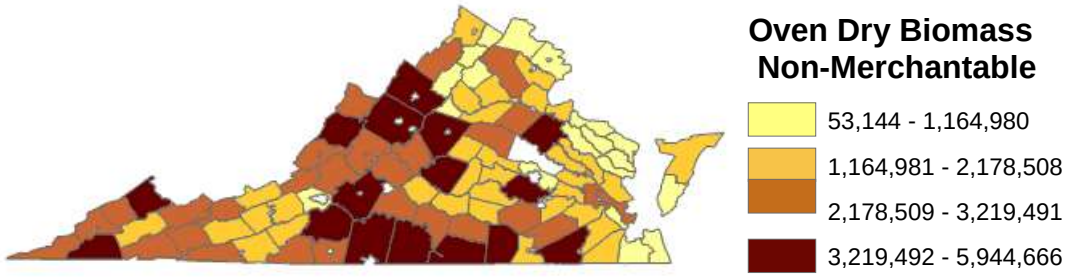

Figure 4. GIS Analysis for Estimated Total Tons of All Non-Merchantable Biomass Data Available from Forest Inventory

Virginia's Biomass Residues Mapping

A final GIS map was developed that included six layers: Wood manufacturers, loggers, municipal solid waste facilities, construction and demolition facilities, other waste facilities, and Virginia's biomass non-merchantable timber. The estimated total residue production in Virginia from wood manufacturers, landfills, and loggers was approximately 10 million tons of residues in 2003, including: Wood industries (8,000,000), landfills (1,252,000), and loggers (770,000) tons of residues. The geographic distribution of residues is presented in Figure 5.

Figure 5. GIS Analysis for Estimated Total Tons of Residues from Wood Industries, Loggers, and Landfills by County in Virginia.

Conclusion

This research demonstrated that there is a methodology to collect and present woody biomass in a useable format for decision makers to determine resource needs and use for energy or other applications. This project provided valuable information toward the expanded use of bio-energy in Virginia. Identified locations and quantities of various woody materials by GIS will have the potential to develop new markets and increase jobs in a number of rural areas. Since completion of this project, a number of new companies have requested and located facilities in Virginia with the assistance from this work. One local power company has decided to co-fire a new coal facility with up to 10% wood residues to help reduce emissions. One of the most important factors in location of a new facility is ensuring an adequate supply of biomass and this research presents a methodology for others to use for their states.

Acknowledgements

This research was sponsored by the Virginia Department of Forestry, and the Virginia Department of Mines Minerals and Energy and the Virginia Forest Products Association. We would like to thank these organizations for their support of this research.

References

Alderman, D.R., R.L. Smith, and V. Reddy. 1999. Assessing the Availability of Wood Residues and Residue Markets in Virginia. Forest Products Journal 49(4):47-55.

Bush, Robert J., Vijay S. Reddy, Matthew S. Bumgardner, James L. Chamberlain and Philip A. Araman. 1997. *Recycling in the U.S. Pallet Industry: 1995.* Center for Forest Products Marketing and Management, Department of Wood Science and Forest Products, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. August 1997. pp. 13, 14.

Cornelis, F. de Hoop, Susan Kleit, S. Joseph Chang, Rado Gazo, and Michael E. Buchart (1997), "Survey and mapping of wood residue users and producers in Louisiana," Forest Products Journal, 47 (3), 7.

Ho, Sookhan (2005), "Virginia Tech receives Sloan Foundation grant for new forest industries center."

Kartha, S., and G. Leach. 2001. Using Modern Bioenergy to Reduce Rural Poverty. Stockholm Environment Institute.

Lee, Bob (2005), "Land Conservation in Virginia," Piedmont Research Institute.