ACCESSING BIOENERGY POTENTIAL USING GIS-BASED METHODOLOGY CASE STUDY: LOBLOLLY PINE (*Pinus Taeda*) BIOMASS IN VIRGINIA

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Rationale

Developing renewable energy sources has been mandated by the US government (2002 & 2008 Farm Bill, 2005 Energy Policy Act, and 2007 Energy Independence Security Act)

The bill sets a renewable fuel standard (RFS) of 36 billion gallons by 2022, of which 21 billion gallons must be cellulosic biofuels (RFS, 2018)

Cellulosic bioenergy is expected to play a dominant role in bioenergy market development in the country (Gelfand et al. 2013)

The pulp and paper industry in North America has significantly declined over the past decade (Hetemaki et al., 2013)

Paper companies are reducing capacity (closing mills and paper machines) and looking for alternative markets such as forest-based biorefineries (FBB) for fuels, electricity, power, and chemicals along with paper, pulp and sawdust (Hetemaki et al., 2013)

FIG 2. WOODY RESIDUE SOURCES IN VIRGINIA

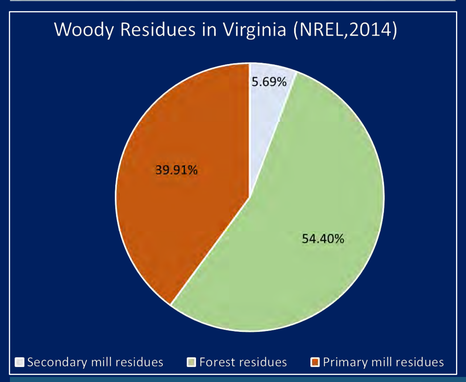
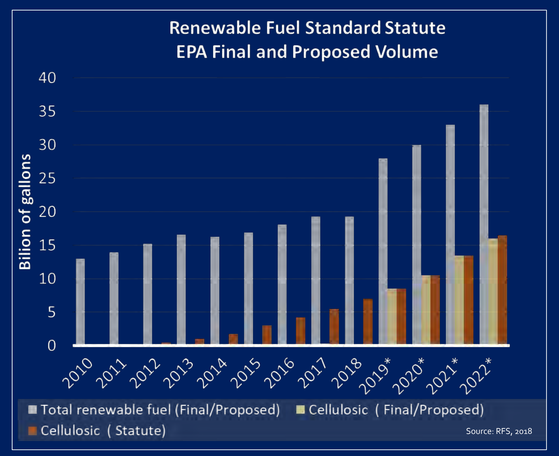


FIG 1. RENEWABLE FUEL STANDARD MANDATED BY THE US



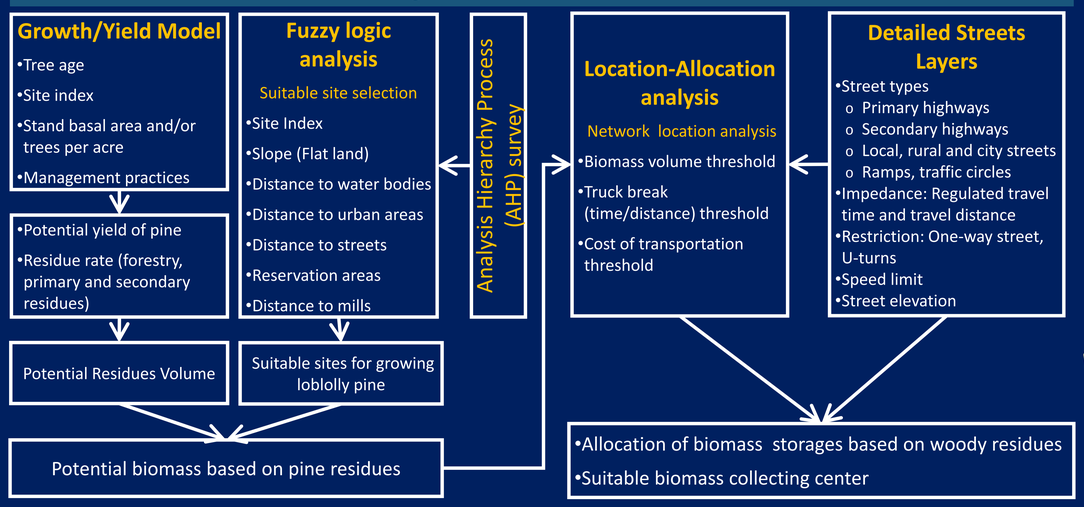
Virginia governance promotes the use of woody biomass for small-scale heat and/or power generation. Community Wood Energy Programs provide education and outreach to communities on their energy potential (Becker, 2014)

4.7 million dry tons of woody residues available for bioenergy feedstocks (Becker, 2014)

The Southern states have around 5 million private landowners with 75% of forest plantations being primarily loblolly pine (Pinus taeda) (McKeand et al., 2003)

Pine species adapt well in nutrient-deficient systems, require few fertilizers and pesticides, and have a variety of ecosystem services such as soil conservation and carbon sequestration

Project framework



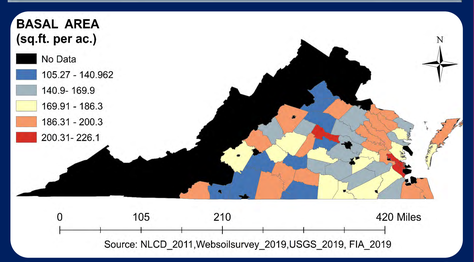
Methods and Materials

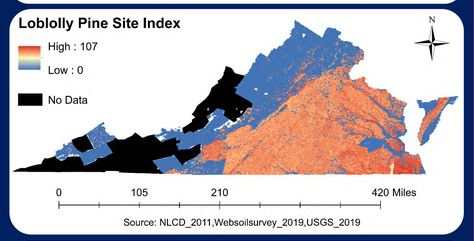
Growth/Yield Model

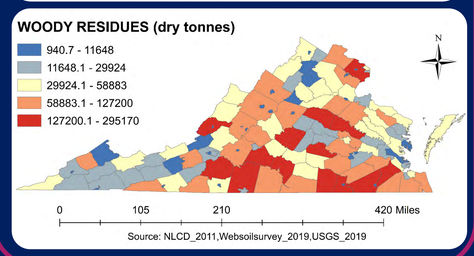
GYST/FASTLOB is a growth and yield model for thinned and fertilized loblolly pine plantations (Virginial Tech, 2019). Requirements include:

- Tree age
- Site index (or dominant height) in Virginia
- Stand basal area and/or trees per acre
- Thinning and fertilization information

FIG 3. GYST/FASTLOB DATA INPUTS







Suitable site selection

FIG 4. FUZZY LOGIC ALGORITHM

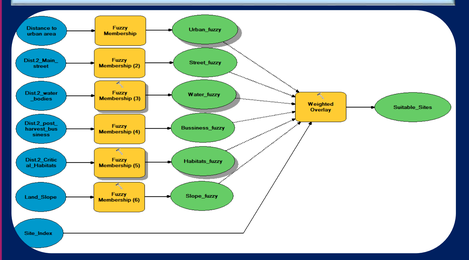
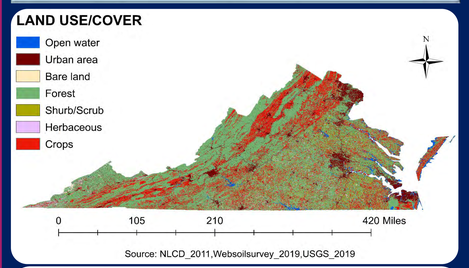
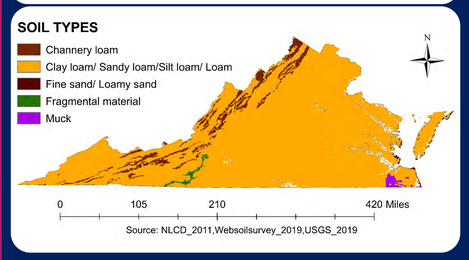


FIG 5. FUZZY LOGIC DATA INPUTS

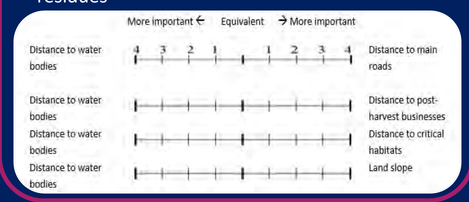




AHP survey

Conducting a survey at Virginia Forestry Summit to define

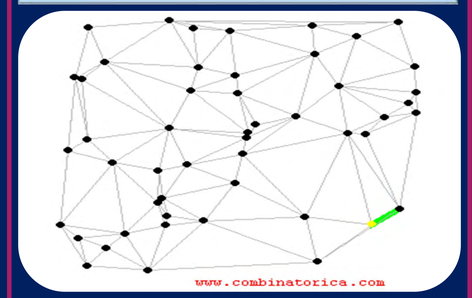
- Pair comparison factors
- Actual loblolly pine site locations in Virginia
- Management practices relating to thinning and fertilization
- The portion of loblolly pine in the wood supply at existing mills
- Willingness to travel for collecting woody residues



Network analysis

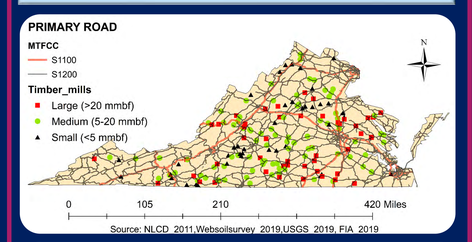
The network analysis is built based on Dijkstra's algorithm to find the **single-source, shortest-path** connecting a **source** and a **destination** in a **weighted graph** (Cormen et al., 2009).

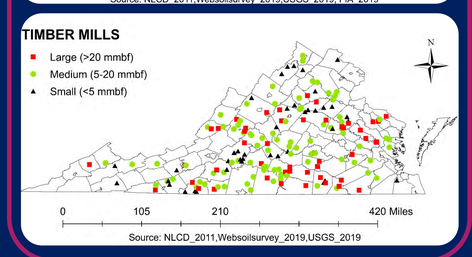
FIG 6. DIJKSTRA'S ALGORITHM



- Using **suitable regions** for growing loblolly pine as source nodes
- Using **existing mills** as potential centers for collecting biomass as **destination nodes for** 176 mills distributed throughout Virginia (Becker et al., 2014)
- Using **detailed street** systems in Virginia as a weighted graph with speed limits as weights (Esri, 2019)
- Optimizing to rank suitable centers for allocation feedstock based on:
  - Transportation cost
  - Potential residues volumes, and
  - Willingness to travel for collecting residues

FIG 7. NETWORK ANALYST DATA INPUTS





Ongoing work

- Identifying criteria thresholds for fuzzy logic analysis including distances to points of interest, residue volume, and furthest distances that collectors are willing to travel for feedstock
- Conducting AHP survey at Virginia Forestry Summit in early May
- Incorporate socioeconomic factors such as transportation costs, feedstock prices, and forest landowner's willingness to supply biomass for energy production

Acknowledgments

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