Additional Information:

Agricultural Residues

Quantity

Agricultural residue is the plant material remaining after the crop is harvested, including leaves, stalks and roots. For BioSAT.net, only the above ground portion of agricultural residue is considered harvestable. Agricultural residues included in BioSAT.net are the following: Barley Straw, Corn Stover, Oat Straw, Sorghum Straw, and Wheat Straw. These crops were chosen based on the availability of the information required for the calculations that determine residue recoverable quantity and cost. The crop residue recoverable quantity and cost estimates are derived from crop production data using various calculations detailed in the following paragraphs.

Annual crop yield and production data by county [1] is published by the Agricultural Statistics Service in bushel or ton units depending on the market use of the crop. Crops sold for food are quoted in bushels. Crops sold for animal feed are quoted in tons. The crops quoted in bushels were converted into pounds using the bushel weight unique to that crop. The bushel weights [2] were obtained from the University of Missouri's Agricultural Publication Data and North Country Organics. Weights were then converted into tons for ease of comparison with other biomass types, such as wood wastes, which are generally quoted in tons.

Once the crop quantity in pounds by county for each crop is calculated, the crop residue quantity can be estimated using the residue (weight) ratio. The residue ratios [3] used came from various literature sources. Not all of the crop residue quantity can be collected from fields due to soil erosion and fertilization concerns. An extensive literature search revealed that the precise, optimal percentage of residue safely removable from any field varies greatly with tillage and crop harvesting methods and equipment, climate and local weather, soil nutrient and erosion conditions, and other circumstances unique to the site. As of yet, there does not seem to be a consensus on a good aggregate estimation, other than it is somewhere between 0 and 90%. Studies on the percent residue recoverable generally give large ranges. The methods for determining the local percent residue recoverable are extremely complex and data intensive. For these reasons the BioSAT.net analysis uses 60% residue recoverable.

At the time of crop harvesting, crop residues are considered ‘green’, meaning some percentage of their weight is water that will need to be removed before commercial use. Because this water weight can significantly overinflate the quantity and energy content of residue recoverable values, they were converted from ‘green tons’ into ‘dry tons’. The moisture content [4] varies with crop type. The values used came from the National Research Council. Crop residues are left to dry naturally in the field before harvesting and baling to avoid the high costs of mechanical drying while minimizing residue rot during storage and transport after baling. Local weather and climate conditions will determine the proper drying time.

Agricultural residue quantity county level data is allocated to ZCTAs by overlaying the ZCTA data map [5], the county data map [6], and the cultivated cropland in the landcover data map [7]. The cultivated

cropland pixels in the landcover data map are aggregated in the unit of county. Then, the pixel ratio of each area part is calculated and the agricultural residue quantity in every area part is derived by this pixel ratio. Finally, the area parts are consolidated by ZCTA.

Costs

After the crop residue recoverable quantity in dry tons by county is calculated, the harvesting costs for each county can be estimated based on the crop type and the residue recoverable quantity per acre. The harvesting cost estimates include the equipment, fuel and labor costs of harvesting agricultural residues with a hay-baler and the soil nutrient replacement costs – i.e., fertilizer costs. The equation[1] and nutrient replacement costs [5] used came from United States Department of Agriculture literature. The nutrient replacement costs were converted from 1997 dollars to 2009 dollars [6] using the Bureau of Labor Statistics' Inflation Calculator.

After the county level quantities and harvesting costs were estimated, they were allocated to the relevant ZCTAs [7] within those counties [8] using ArcGIS. The agricultural residue quantities were then allocated to pixels [9] within those ZCTAs with the cultivated crops land cover class, as defined by the Multi-Resolution Land Characteristics Consortium. By aggregating the cultivate crop pixels in the unit of county, the pixel ratio of each area part was calculated and agricultural residue quantity in every area part was derived by this pixel ratio. At this point, each area part is attached to a proportional agricultural residue quantity of its belonging county. Then, through the ZCTA identifier in each area part, the multiple area parts that share the same ZCTA identifier were assembled. Finally, the agricultural residue quantities of area parts in every ZCTA were summed and the harvesting cost was derived in each ZCTA based on the agricultural quantity.

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[1] **Harvest Cost** = (15.93 / Crop Residue Recoverable Quantity per Acre) + (Fertilizer Replacement Cost + On-Farm Transport Cost)

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