

Science

B R I E F I N G

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FOREST BIOMASS UTILIZATION AND WATERSHED PROCESSES

BACKGROUND

Forest biomass is an energy source that is underutilized. Expanding forest biomass utilization can improve our nation's energy security while reducing greenhouse gas emissions from fossil fuels. However, there is a risk that water resources may be adversely affected with increased biomass removal. Our research aims to assist land managers to evaluate watershed impacts of biomass removal.

RESEARCH

Impacts of Biomass Removal

Biomass removal can increase runoff and erosion from forested watersheds because of compaction, mineral soil exposure, and decreased evapotranspiration.

Compaction

Removing biomass frequently requires wheeled or tracked equipment, which may cause soil compaction, especially when soils are wet. Compaction can remain for many decades following forest biomass operations. On all but sandy soils, compaction reduces infiltration rates and the amount of available soil water for plant growth, while increasing surface runoff.

Duff Integrity

Biomass removal can disturb the duff layer, exposing bare mineral soil to wind, rain, and overland flow. As woody biomass is removed, fewer trees will remain to generate organic material and replenish duff material, especially in warmer climates where decomposition may exceed replenishment from younger trees. It may take several years of regrowth to restore a duff cover to what it was before a biomass operation.



Forest biomass operation.

Infiltration

Compaction and loss of duff reduce soil infiltration rate, leading to increased surface runoff. Surface runoff generally only occurs from disturbed areas, such as roads and skid trails. Small changes in infiltration rates don't affect total runoff rates significantly. Increase in surface runoff will bring decrease in lateral flow; therefore, offsetting the increase in surface runoff.

Surface Erosion

Biomass operations can reduce surface cover. Loss of surface cover not only increases runoff, but increases the exposure of soil to wind, raindrops, and overland flow. This leads to increased erosion on the hillslopes and sediment delivery from the watersheds.

Wildfire

Erosion following wildfire produces the greatest amount of sediment. Peak erosion rates following wildfire are 10 to 1,000 times greater than what they were before the wildfire. The wildfire return interval ranges from 20 to more than 300 years depending on forest health and climate. A positive aspect of biomass removal is that it can reduce the severity and/or frequency of wildfire.

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Water Yield

Biomass operations remove trees, reducing rain and snow interception, and evapotranspiration, therefore, increasing downstream water yield from small watersheds. This is particularly true in wetter years. At the regional scale, effects biomass utilization on water yield are unlikely to be discernible, however.

Watershed Analysis Approach

Before proceeding with a biomass removal project, forest managers and federal agencies are often required to carry out a watershed impact analysis to compare the watershed impacts of biomass removal to undisturbed natural conditions. RMRS has developed an online tool for such an analysis (WEPP FuME). The analysis includes the following four steps.

- 1) Estimate the erosion associated with natural processes for the undisturbed condition and the erosion associated with wildfire.
- 2) Determine the effects of road network on sediment delivery.
- 3) Consider the erosion associated with biomass removal from harvesting and post-harvesting treatment activities.
- 4) Synthesize the results, considering a decrease in long term sediment production from biomass removal because wildfires are less frequent or less severe.

Sediment from landslides may also be considered in some areas as both a road network and higher soil moistures can cause instability. Managers often carry out similar analyses for runoff.

MANAGEMENT IMPLICATIONS

Biomass utilization can be used to improve forest health and decrease the risk of wildfire, both of which improve watershed health. Harvesting biomass requires a road network and onsite disturbances. Well-established management practices are necessary to minimize erosion both from the road network, and from the harvest areas.

MORE INFORMATION

- www.forest.moscowfsl.wsu.edu
- www.fs.usda.gov/rmrs
- www.fs.usda.gov/treesearch

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KEY POINTS



- As society looks to our nation's forests as sources of energy, there is a risk of increased runoff and erosion.
- Compacting and displacing soil in forests and increased traffic on forest roads may increase runoff amounts and rates and soil displacement.
- Following well-established management practices can minimize these risks.
- When evaluating the risks of erosion associated with biomass use, managers should also consider erosion risk associated with wildfire, as that risk will decline as forest fuels are removed.



Silt fences used to study biomass impacts.

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