Appendix C: Spatial Scale

Table of Contents

List of Figures

1. Introduction

This appendix discusses the importance of spatial scale choice when applying the assessment framework. Spatial scale selection can affect the results of any analysis evaluating GHG emissions and sequestration, regardless of whether that analysis applies a retrospective reference point baseline approach or a future anticipated baseline approach (Galik and Abt, 2012). A range of options for choosing an appropriate spatial scale is explored, along with a discussion of the advantages and disadvantages of each option. This appendix then lays out the technical underpinnings for the use of specific regions for calculating illustrative biogenic assessment factor (*BAF*) equation term values using the retrospective reference point and future anticipated baseline approaches. These regional constructs include: the Resources Planning Act[1] regions (8 regions) are used for the retrospective reference point forest-derived feedstock examples, and the agro-forestry regions used in the U.S. Forest and Agriculture Sector Optimization Model with Greenhouse Gases (FASOM-GHG) (11 regions) are applied for retrospective reference point agricultural feedstock examples and future anticipated baseline agriculture and forestry feedstock examples. Additional information on reference point baseline and future anticipated baseline methods can be found in Appendices H and K. Spatial scale considerations in the composition and management of waste-derived feedstocks are briefly discussed here in Section 2.3.4 and in detail in Appendix N.

2. Considerations and Implications of Spatial Scale Choice

Different spatial scales offer different levels of precision in terms of estimates, can affect depth and breadth of measurement, dictate the availability and verification of data, and limit modeling options. The size of an assessment area can also determine the ability of an assessment system to reflect carbon dynamics in the biogenic feedstock source area and any inter-regional trade of biogenic feedstocks. The choice of spatial scale can allow for broad aggregation of or, conversely, evaluation of differences between, characteristics of the land base (e.g., ownership type, management regimes, soil types), biophysical characteristics of the biogenic feedstock (e.g., species and growth and harvest rates), and feedstock production and market dynamics.[2]

Therefore, it is crucial that any application of the assessment framework consider these trade-offs and implications on results when identifying the most appropriate spatial scale (or scales if more than one scale is appropriate) for use in a particular program or policy. In general, there is no single scientifically correct option or specific method for determining the "appropriate" spatial scale for all analyses: the appropriate spatial scale differs depending on the specific goals and parameters of a specific policy or program application of the framework. The issues related to spatial scale can differ with feedstock type, biophysical and economic factors, and the circumstances for each program that needs to assess biogenic feedstock production and use. Thus, the choice of spatial scale is primarily a function of the stated objective of the specific program or project being developed.

The source of the biogenic feedstock is an important consideration because the biophysical attributes of the biogenic feedstock and land on which it is produced are used to derive input values for use in the framework (reflected as values within the *BAF* equation in the main report Part 2). The biophysical attributes of different biogenic feedstocks can vary between geographic locations because of a number of environmental factors and net primary productivity of the landscape (Beringer et al., 2011). Therefore, unless the global landscape were entirely homogenous, it would be inaccurate to assume the biophysical as well as feedstock production dynamics in one part of the country or world are the same as those in another without evaluation.

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[1] For more information on the USDA Forest Service Resources Planning Act (RPA) Assessment, see www.fs.fed.us/research/rpa/.
[2] Leakage, represented by the *LEAK* term (see Appendix F), can also be influenced by the spatial scale chosen in a specific policy analysis. For additional information on leakage, refer to Appendix E.

Before discussing the range of different spatial scales and related tradeoffs and implications of each, the subsections below first discuss how land base characteristics and geographic location, data availability, and data accuracy can affect the choice of spatial scale.

2.1. Location and Land Base Characteristics

Location of feedstock production dictates important biophysical factors such as temperature, soil type, precipitation, elevation, species type and mix, and growth rates (Eagle et al., 2010). As such, the geographic location of the landscape not only determines, in part, what type of feedstocks can be produced but also the various biogenic CO_2 fluxes associated with feedstock production.

Ownership type also plays a role in determining what feedstocks are grown, how often they are harvested, and related GHG emissions fluxes. For example, although the ratio of forest growth to removals (of woody biomass) at the national scale is roughly 1.72 currently (Smith et al., 2009), it varies substantially with geographic region, species, and ownership. For example, the ratio of forest growth to harvest for private forests in the conterminous United States is 1.3, while the same ratio on public lands is 5.3 (DOE, 2011). An assessment area that includes a large proportion of publicly owned land would therefore be more likely to have lower levels of harvest (and higher levels of growth) than a similar area with more private land ownership (DOE, 2005, 2011). A more detailed discussion of working lands is covered in Appendix H.

Given the transaction data collected and processed when a biogenic feedstock enters a stationary source, it is often possible to determine the precise location of the feedstock harvest site, though it may only be possible to know the broad geographic origin. For example, entities operating primarily on long-term procurement contracts will likely use the same feedstock production sites year after year, and the geographic location of those sites can be known. In such cases, measurement and analysis of production-related biogenic fluxes at a localized scale are possible. On the other hand, for stationary sources operating using aggregated feedstocks (e.g., agricultural residues from multiple landowners piled together at centralized site) or feedstocks that require storage and may become mixed (e.g., forest logging and milling residues), it may be difficult to know the precise origin of the feedstock, so only the broad geographic region could be identified. Also, for some feedstocks, production sites may vary from year to year (e.g., logging residues from harvests that may not return to the same location for decades or crop rotations and fallow cycles).

2.2. Data Availability and Accuracy

The choice of spatial scale can be greatly influenced by the availability and accuracy of data and the precision with which one can model feedstock production and market dynamics. When a stationary source purchases biogenic material for energy production, it is possible to measure every ton of material that is purchased or brought into the stationary source, or subsequently used in a particular process at the stationary source (e.g., using measurement equipment such as scales and monitors). However, when estimating the biogenic resource in a production source area, it is necessary to use sampling approaches, which are inherently less precise than complete measurements due to sampling and measurement errors. For example, to estimate woody biomass in the forests of a region, trees on inventory plots (samples) are measured periodically (FAO, 1997;

USDA, 2014). Tree measurements (e.g., species, diameter, height) are used in conjunction with mathematical models to estimate biomass per tree and then statistically expanded to obtain estimates of biomass per unit area of forest (FAO, 1997; USDA, 2014). Remote sensing approaches (e.g., satellite imagery, aerial photography) are also used to estimate the area of forest cover within a region (FAO, 1997; USDA, 2014).

The level of data accuracy varies with choice of spatial scale. When carbon stocks are estimated at a larger spatial scale (e.g., national, regional) through statistical sampling, the increase in sample size provides more precision (i.e., smaller sampling errors). For smaller land areas, the estimates will be less reliable due to a lack of statistical power associated with small sample size (Westfall et al., 2013). Estimates at these smaller scales must then be derived from other sources such as special inventories or surveys (i.e., thorough inventories conducted as part of a forest management plan).

In addition to primary data collection for retrospective analysis of landscape emissions, geo-referenced land cover and forest inventory data often serve as a primary input to economic models that can be used to project landscape biogenic emissions relative to an anticipated baseline. Thus, models that aggregate land use data to a larger region will reduce the uncertainty associated with those primary model inputs.

2.2.1. Cross-boundary Flows

Another difficulty introduced by defining geographic boundaries for analysis is assessment for transfers across political boundaries (e.g., cross-state or international trade). For example, it is common for wood-using mills in one state to purchase wood from across state or regional boundaries (Teeter et al., 2006). As a result, the emissions from biogenic feedstock consumption for energy production may occur in a different region than the sequestration in the forest-derived feedstock production area. In an assessment framework, transportation across accounting boundaries introduces complexity in that feedstocks of the same type (e.g., trees) acquired from different areas or regions may be accounted for separately as they may have different biophysical attributes (e.g., species, growth rates). Thus, entities using biogenic feedstocks, or another party designated with this responsibility by a program/policy, would need to anticipate and/or monitor the source region for all feedstocks a facility uses to account for regional differences. The data collection and modeling complexities will increase with the number of regions defined in a geographically divided assessment framework.

Further, it may not be possible to determine the specific origin of all biogenic feedstocks. In the context of forest-derived biomass, even if the specific site is known, source locations would change annually because of the long-term nature of forest harvesting cycles. For agricultural feedstocks, it may be possible to know the specific locations that supply biomass to a procuring entity. In other cases, aggregators or suppliers may purchase material from a variety of sources, and knowledge of specific origins of feedstock may be lost. When the biogenic feedstock production location is known, it is possible to collect very detailed site-specific data, although this may be costly to collect and verify.

In addition to inter-regional considerations, international feedstock trade flows are important to acknowledge as well. International feedstock production and the imports of those feedstocks can significantly affect overall U.S. biogenic feedstock resource availability and demand pressures on those resources. The pricing and flow of feedstocks and related commodities have the potential to influence domestic supply chains and land use activities. The report acknowledges the significance, but does not include assessment, of international biologically based feedstock production and the role of imports and exports (i.e., the impacts of U.S. feedstock production on international trade flows and resource allocation). Deciding whether to include and therefore craft a means to account for imported and exported biogenic feedstocks would be a decision specific to application of this framework in the context of a particular policy or program requirements and objectives.

2.3. Range of Potential Spatial Scales and Related Implications and Tradeoffs

For purposes of this framework, several spatial scale options were considered: stand/field, fuelshed, state, regional, and national scales. The ordering here is generally in the direction of increasing size; however, there could be instances in which a fuelshed (or woodshed) area may be larger than, for example, an individual state (e.g., a small state such as Rhode Island). Furthermore, some scales may approximate an aggregate of other scales, such as multiple states combining to form one region.

2.3.1. Stand or Fuelshed

The finest spatial scale would be at the specific site of the biogenic feedstock origin (agricultural field, forest stand, etc.). The linkage between feedstock source area carbon dynamics and the net biogenic emissions from an entity using biomass is most direct at finer spatial scales. Accounting at the stand or field level directly links emissions and sequestration on the landscape producing a biogenic feedstock, and the impact of each entity's biogenic feedstock use on the biogenic production site carbon fluxes could be determined. However, an assessment using the reference point baseline approach at these small scales can be challenging because data would need to be collected for every site from which a stationary source procures feedstocks (e.g., feedstock tracking, record keeping), and these data must accompany the movement of the feedstocks around the country. An assessment that uses an anticipated baseline approach would also be difficult, but one could model production systems rather than tracking each production plot.

Next may be an aggregate of areas from which feedstock may be procured for use at a specific entity: the fuelshed.[3] When the location of feedstock production sites is known, the fuelshed can also be known because it would be the aggregate of sites from which feedstocks originate. In the case of unknown source locations, one might be able to generalize a fuelshed into a region encompassing local and likely sources. For example, several analyses have used a circular fuelshed with either a straight-line or road-distance radius to model the impact of increased forest-related feedstocks relative to business-as-usual conditions (50 miles straight-line: Galik and Abt [2012]; 30

[3] Fuelshed is defined as an aggregate of areas from which feedstock may be drawn for a specific facility.

miles road distance: Brinkman and Munsell, [2012]). Thus, fuelsheds are specific to stationary sources procuring biogenic feedstocks, but fuelshed areas for multiple facilities could overlap, and this could change over time as supply and market dynamics change, capital depreciates, and new facilities are built.

An approach at a comparable scale to fuelsheds might be a fixed geographic region that approximates the area of a fuelshed. For example, Galik and Abt (2012) note that 50-mile radius fuelsheds approximate the area of USDA Forest Service Forest Inventory and Analysis (FIA)[4] survey units, which are fixed regions (aggregates of counties) defined to provide forest inventory information at specified precision (USDA Forest Service, 2014). A 50-mile radius circle encompasses about 7,850 square miles (slightly over 5 million acres). This is approximately equal in size to each of the five FIA units within the state of Virginia (Rose, 2009). It is also approximately equal to the area of New Jersey or Massachusetts, or the total area of the three smallest states (Delaware, Connecticut, and Rhode Island) combined. Specification of predefined fuelshed-sized regions enables consistent estimation of biomass production and harvest within a region, but also means that some entities may need to acquire feedstocks from multiple regions.

Again, assessment at small scales like the fuelshed level can directly link landscape emissions and sequestration to the use of biogenic feedstock of a specific stationary source, but also necessitates feedstock tracking and other documentation, especially for the retrospective reference point approach.

2.3.2. State

An advantage of using a state-level approach is that they often coincide with other administrative or reporting units. Forest harvests and agricultural yield data can be tracked by state (for tax reporting purposes, for example). State boundaries might be logical when states may implement different policies and regulations pertaining to feedstock production as well as commercial trade. However, certain small states (e.g., Rhode Island) may not be large enough to offer adequate or accurate data on biogenic carbon stocks (i.e., forest growth and removals), thus rendering retrospective and future anticipated modeling unreliable because the associated sampling errors are likely too large or model inputs would not be reliable (Crocker et al., 2011). Furthermore, state lines are political boundaries and do not take into account similar landscape types from one state to the next. State lines can divide landscapes that should be considered as a whole. As discussed earlier in this appendix, another potential difficulty with defining spatial scale with a political boundary is assessment for biogenic feedstock transfers across such boundaries because states may have different laws and regulations.

2.3.3. Regional

Establishing a regional spatial scale could aggregate multiple states into one primary region of assessment. Here, the regional scale of assessment is large enough that accurate data are available (i.e., adequate statistical power), but still small enough to capture important differences in land

[4] For more information on FIA, consult www.fia.fs.fed.us.

base and therefore feedstock characteristics, such as growth and removal rates, decomposition rates, and species mix (Westfall et al., 2013). In other words, regions achieve a balance between preferred statistical precision of larger scale assessments and ability to capture important land base (biogeochemical and ownership types) and market drivers of smaller spatial scales. Regional assessment allows for important distinctions between drivers of changes in land-based biogenic carbon sequestration and resource supply and demand that, using a reference point baseline, could potentially be masked at the national level. However, regional assessment potentially ignores state- or site-level impacts as well as indirect impacts in other regions (which would be inherently captured by a national approach). Also, determining regional boundaries might be related to market characteristics, with multistate regions forming coherent markets for biogenic feedstocks.[5]

Galik and Abt (2012) provide a thorough evaluation of the impact of spatial scale on the GHG balance of biomass energy production from forest sources. They considered assessment scales from individual sites to fuelsheds to the state level (for the state of Virginia) and projected carbon dynamics for a 25-year time frame relative to a baseline scenario. Their conclusion was that "those assessment scales that do not include possible market effects attributable to increased biomass demand, including changes in forest area, forest management intensity, and traditional industry production, generally produce less favorable GHG balances than those that do." They further concluded that the larger spatial assessment scales (in this context, states and regions) "most closely approximate the actual GHG emission implications" for the scenarios and locations they modeled. However, it is important to note that in some cases the regional scale, like the national scale, can also mask important fluxes in landscape emissions.[6]

Regions could be defined on the basis of homogeneity of biophysical characteristics such as, in the case of forest-derived feedstocks, species types, growth rates, and climate. Regional boundaries must be drawn carefully to ensure the region is large enough to offer adequate data accuracy and availability, yet small enough to better reflect landscape biogenic carbon dynamics. One difficulty with choosing this spatial scale is that each region can encompass multiple states with different laws and regulations. For example, states with strong renewable energy incentives (including renewable portfolio standards or state incentives) and high relative biomass use could drive

[5] An example of a fixed regional framework is the EPA Emissions & Generation Resource Integrated Database (eGRID) region structure. EGRID is used for calculating GHG emissions related to electricity generation. Subregions nest within regions defined by North American Electric Reliability Corporation (NERC). Regions vary widely in size from small portions of an individual state to areas encompassing portions of seven large states. For more information on NERC and eGRID regions, consult http://www.epa.gov/egrid.

[6] Depending on the spatial scale considered, changes in forest carbon stock can be dramatically different, as illustrated by the impact of hurricane Hugo on South Carolina's (SC) forest resources. In 1989, Hugo hit SC and caused extensive damage to the state's forests. The hurricane reduced the inventory of softwood (e.g., pine) growing stock by 21% or 1 billion cubic feet (Sheffield and Thompson, 1992), which is equivalent to more than 2 years of the previous average forest harvest across the entire state (Tansey, 1986). After the hurricane, the removals of softwood timber in the state exceeded the net growth by 43% (Conner, 1993), whereas before the hurricane net growth exceeded removals by 2% (Tansey, 1986). However, in the subsequent assessment of forest resources (Haynes et al., 1995), southern softwood net growth exceeded harvests. Thus, the deficit situation in SC resulting from the hurricane impact was not observed in the larger region of the south and applying regional southern assumptions regarding balance between growth and removals to SC could have led to additional pressure on the resource.

landscape biogenic feedstock removals and associated emissions fluxes for an aggregated region. Landscape emissions impacts in neighboring states in the same region could be modest, but a regional assessment could reveal large landscape emissions changes due to policy actions in one state.

2.3.4. National

The next largest spatial scale possible for estimation and reporting would be national. Although a global assessment scale is certainly possible, the highest level of spatial aggregation evaluated in this report is national. The key advantages of a national-level assessment are that it captures market interactions, including domestic leakage effects, and offers high-level insights concerning general emissions fluxes from U.S. carbon stocks in forests and agricultural landscapes. The market interactions component is especially critical, especially for the anticipated baseline approach. A regional assessment of a biogenic feedstock demand shock may not capture emissions changes outside of the assessment region as markets adjust to the shock and production expands or contracts elsewhere. A national assessment using an anticipated baseline modeling approach would capture these interactions and indirect emissions impacts. Furthermore, evaluating landscape emissions in response to a national policy could justify a national assessment scale (Latta et al., 2013).

At the national scale, observing or projecting emissions fluxes from managed terrestrial systems (i.e., from U.S. forests and agricultural lands) can be accomplished using published datasets such as the U.S. GHG Inventory and/or models designed to project emissions from land management activities. At this assessment scale, however, quantifying the relationship between the actions of an entity using biogenic feedstocks (or a group of such entities) (i.e., biogenic feedstock demand) and the carbon dynamics of the feedstock production site (which is defined nationally) (i.e., biogenic feedstock supply) could be difficult, especially for certain feedstocks. Assessing such causality at this scale is difficult as it is hard to differentiate between this driver (biogenic feedstock demand) and other influences on the national landscape (e.g., urbanization, natural disturbances). Also, reporting changes in biogenic CO_2 fluxes at the national scale could mask important regional differences in landscape and feedstock characteristics such as growth rates, species composition, and other environmental conditions, especially when applying a reference point baseline approach.

For example, if one is interested in carbon stock changes associated with a particular forest harvest, reporting and considering the effects of the harvest at a national scale would likely reveal little or no measurable impact on overall carbon stocks at the national level. However, by normalizing the impacts (e.g., CO_2e per ton of feedstock harvested), the national level results can be informative and account for certain impacts that could be lost in a regional-scale analysis (e.g., inter-regional, domestic leakage effects). When using a retrospective approach one might need to establish a causal statistical relationship between the harvest under consideration and resulting emissions changes elsewhere. Ultimately, carbon stocks may be declining in some areas but increasing at a higher rate in other areas, regardless of whether a reference point or future anticipated baseline approach was applied and regardless of biogenic feedstock demand for energy purposes. Reporting changes in carbon stock at the national scale would mask important regional differences in terms of harvest and growth rates, as well as species composition, and climate. The result of a national scale assessment is that the evaluation of one harvest activity could have a very minor or statistically indistinguishable impact on overall national carbon stocks.

Were this same forest harvest reported on a fuelshed scale (the area required to provide continuous forest-derived biogenic feedstock to a specific end user) instead of a national scale, it likely would have a measurable impact because of the smaller area under consideration. However, this impact would potentially ignore other market adjustments and landscape impacts at the state or regional scale. The actual harvest itself is the same in both scenarios, but the measured impact would be different because of the choice of assessment spatial scale.

Similarly, waste-derived materials also may have some regional variability, including the composition of waste (which can vary from community to community within a region) and regional climate factors that affect methane (CH_4) oxidation via cover soils at managed landfills (Bogner et al., 2007; EPA, 2009; Spokas and Bogner, 2011). However, there is a lack of literature describing the degree to which composition of municipal solid waste (MSW) can vary from region to region, and thus this analysis uses a national average composition based on EPA data through 2012 in the illustrative calculations in Appendix N (EPA, 2014). Although composition of MSW may vary from region to region, this mainly contributes to potential generation *amounts* of CO_2 and CH_4 in a given landfill, whereas the goal of the framework methodology for waste-derived feedstocks is ultimately concerned with *how* the CO_2 and CH_4 from MSW are treated and used in one activity versus another. From this perspective, CO_2 and CH_4 from MSW can be treated similarly across the United States.

2.4. Spatial Scale in the Framework

A spatial scale should be small enough to recognize changes (e.g., carbon stock changes, emissions fluxes), drivers, and trends and large enough to offer accurate data and be capable of dealing with large stochastic events such as storms. It should have the ability to recognize cross-boundary flows. Too large an area and important local or regional trends could be masked; too small an area and limited data will preclude accurate estimation or would overestimate or underestimate the net landscape emissions impacts by ignoring changes in land management at a regional scale. The spatial scale should be determined by a trade-off between the statistical precision and data availability for larger regions, against the local specificity and accurate depiction of biophysical attributes of smaller regions.

Ultimately, the choice will depend on the specific context and program, and it may be possible to use different or nested spatial scales within the same set of analyses.[7] This framework explores the regional scale further in the sections below to derive proof-of-concept values.

[7] This framework can be customized so individual entities using biogenic feedstocks can derive and input entity-specific values into the framework's equation to calculate an individualized *BAF* (see the main report Part 3 for more on customized feedstock approaches). However, in some policy or program applications or for some entities, this customized approach will not be appropriate or feasible so the framework can be applied at different scales.

2.4.1. Assessment at the Regional Scale

The *location* of regional boundaries should reflect land base characteristics and the spatial distribution of biogenic feedstock characteristics such as species, rates of productivity, similarity of management practices, ownership patterns, and market attributes. Regional boundaries can coincide with other administrative or reporting units, because this may increase the likelihood that other relevant data or model outcomes would be summarized for the regions. Because it is further likely that forest harvests would be tracked by state (for tax reporting purposes, for example), the use of state boundaries as regions, where possible, may be advantageous.

The *size* of the regions should be determined by a trade-off between the statistical and modeling precision offered by larger regions with improved biophysical information and local specificity of smaller regions. However, the practical implementation of an assessment framework must also be a consideration: it is recognized that at larger spatial scales, implementation becomes simpler.

The actual regional delineations applied to the reference point and future anticipated baseline supporting appendices apply slightly different regional scales, as discussed below.

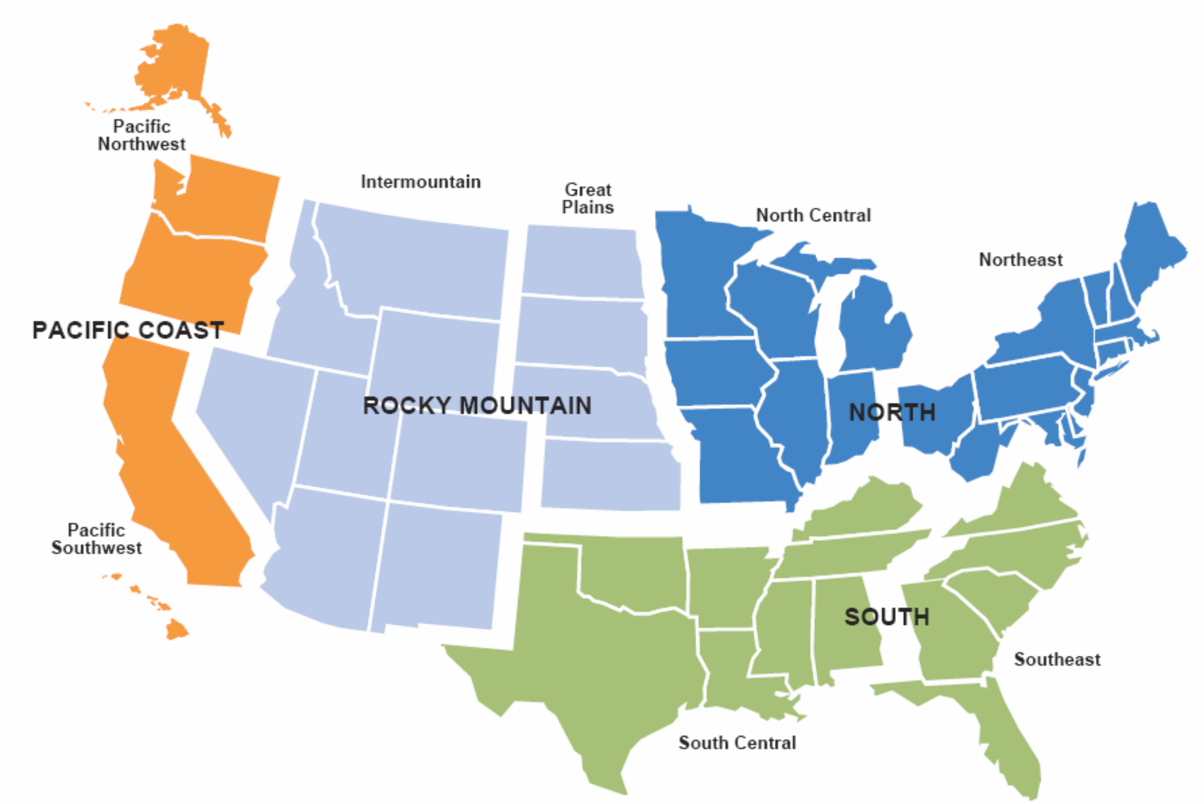

Figure C-1. RPA Regions (USDA Forest Service, 2012).

2.4.1.1. RPA Regions

For the retrospective reference point baseline approach illustrative examples for forest-derived feedstocks provided in subsequent appendices, the regions follow the region boundaries developed by the USDA Forest Service for the Resources Planning Act (RPA), resulting in eight regions as shown in Figure C-1.

The RPA regions are based on publicly available data on forest resource stock dynamics (inventory, growth, harvest) generated by the FIA program of USDA Forest Service. These regions are designed to reflect the spatial distribution of forest characteristics (forest types, rates of productivity, management practices) and follow state boundaries to increase the likelihood that other relevant data are reported at the same administrative level. The RPA regions form the basis for a wide array of reports on forest resources conditions, markets, and trends (see USDA Forest Service, 2012).

For forest-based operations, one important source of publicly available data on forest stock dynamics (inventory, growth, harvest) comes from the FIA. FIA collects and provides information on hundreds of thousands of sample plots nationwide on all types of forest ownerships. FIA data can be used to assess availability of forest-derived feedstocks and estimate production of harvest residues (Conner and Johnson, 2011; Johnson, 2001). These data can be used to estimate several terms in the *BAF* equation using the reference point baseline approach.

For forest-derived feedstocks, the smallest spatial scale at which FIA data are reliable may be somewhat larger than a fuelshed. It is possible to use FIA data to narrow down the forestland base within prospective regions to a working forest for each region and then compute variables such as gross growth, removals, and excess growth, along with their sampling errors. Sampling errors for basic estimates of overall biomass may be within a few percent at this scale. However, sampling errors on other variables of interest—such as growth and harvest—will be much higher. For example, the state of New Jersey is about 7,500 square miles in size, approximately the size of a 50-mile radius circle that might approximate a fuelshed. In a recent report (Crocker et al., 2011), the sampling error for the volume of New Jersey's growing stock was 4.6%, but sampling errors for growth and removals were 9.62% and 29.5%, respectively.

Therefore, although the precision of the basic volume estimate may be acceptable at fuelshed scales, growth and removal metrics related to the balance of carbon emissions and sequestration will be less reliable, and for that reason larger spatial scales are preferred. At the RPA regional level, the spatial scale provides estimates within acceptable uncertainty ranges.

2.4.1.2. FASOM-GHG Regions

The regional delineation used for the illustrative *BAF* equation applications for agriculture-derived feedstocks under the retrospective reference point baseline approach and for forest-derived and agriculture-derived feedstocks under the future anticipated baseline approach (Appendices H through M) is the delineation as used within the U.S. FASOM-GHG. These 11 regions are shown in Figure C-2.

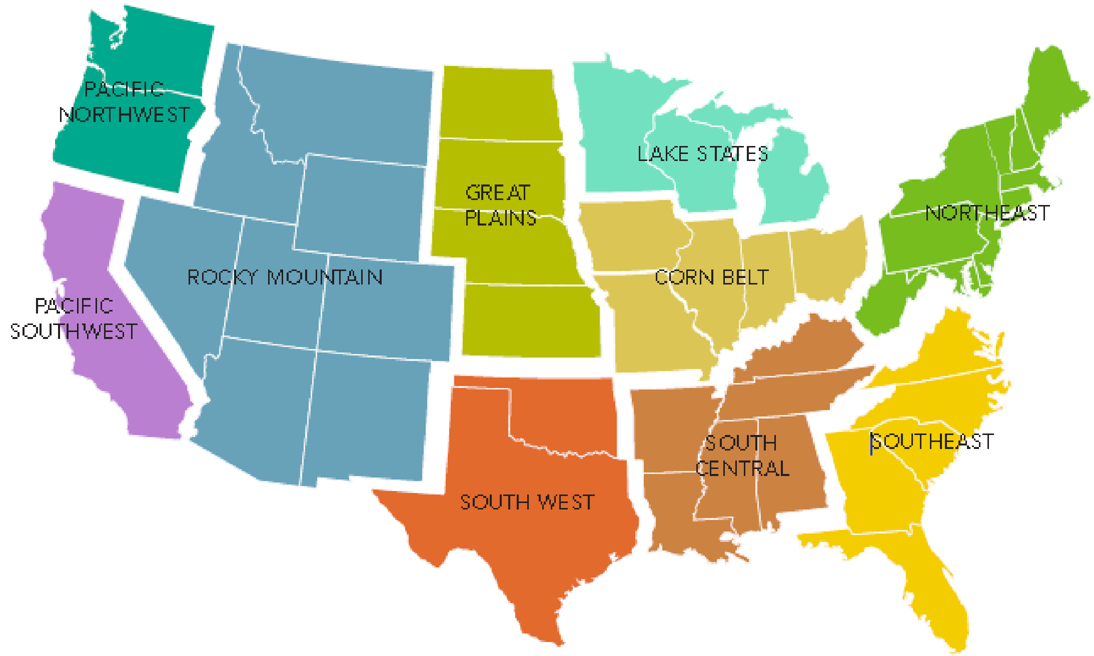

Figure C-2. FASOM-GHG Regions.

The FASOM-GHG regions are based on the underlying datasets used in the FASOM-GHG model.[8] Many of the datasets are resolved at the state and/or county level and aggregated up to the various FASOM-GHG regions for reporting. Forest-sector data are based on a number of relevant datasets, including the FIA. As noted, the FASOM-GHG regions are similar to the RPA regions in general size and geographical location. Specifically, the FASOM-GHG regions reflect areas that exhibit similar land characteristics, crop types, existing forest resources, forest/crop yields, forest/agricultural management alternatives, soil types, rainfall, and climate patterns (see Beach and McCarl, 2010).

3. Conclusion

The RPA and FASOM-GHG regions are examples of spatial scales that address some of the tradeoffs previously discussed in this appendix. The regions are small enough to recognize trends and changes in growth and removals, yet large enough to offer widely available data and adequate statistical power. Furthermore, the RPA and FASOM-GHG regions are well established in the literature and not as complex as alternative regional delineations (e.g., the eco-regions previously developed by EPA for ecological applications [see Bryce et al., 1999]). The regions also largely follow state boundaries, which allows for easier reporting and greater recognition of cross-boundary flows.

That said, although the RPA and FASOM-GHG regions are used in this report to road test the framework, they are selected for illustrative purposes only. Ultimately, any final choice of regional

[8] Additional information on the FASOM-GHG model and its application for the technical appendices of this report can be found in Appendix L.

delineation is a decision for policy makers and should reflect the requirements for a particular program.

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