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Allometric Volume and Biomass Equations for Nepalese Tree Species

Increasing temperature, unpredictable rainfall, pollution, land use change, deforestation and land degradation and their consequences are the major global environmental challenges. To mitigate climate change, global leaders and environmentalists are looking for cost effective ways to incentivize governments, communities, and companies through payment-based mechanisms. Policies, programs and legislative actions such as clean development mechanism (CDM), reduction emission through deforestation and forest degradation (REDD+), and lowering emissions by accelerating forest finance (LEAF) coalition are the some of the examples of payment-based mechanisms. The global leaders have agreed that conservation and sustainable management of the forests could significantly contribute to lowering the GHGs. To estimate carbon sequestration potential of the forests and to optimize emission-caps-and-trade systems, reliable volume and biomass estimates are must. However, Nepal still lacks reliable tools for quantifying volumes and biomasses required for carbon estimation. In this context, allometric volume and biomass equations could be important tools for quantifying tree volumes and biomasses.

Allometric equations use easily measurable variables to estimate the characteristics that are difficult to measure. In forestry, diameter at breast height (DBH) and total tree height (H) are the most frequently used variables to estimate volumes and biomasses and subsequent carbon stocks of trees and forest stands. Considering this, different researchers and forestry practitioners around the world including Nepal, have tried to develop allometric biomass and volume allometric for numerous tree species across several forest biomes.

Allometric tree volume and biomass equations can be prepared using both destructive and non-destructive methods. Destructive methods are more costly as it is time and resource demanding. Above that, direct measurement of tree biomass is impractical for least developed countries like Nepal. On the other hand, non-destructive methods are time and resource efficient but they can hardly provide complete reliable information .Thus, hybrid method combining destructive felling with suitable choice of allometric equations could be an appropriate option for resource limited mountainous countries like Nepal. In this method, sample trees representing all geographic sites are selected randomly, then trees are felled and their volumes are estimated by measuring diameter at different predefined positions along their stems. Densities of the stems are estimated by calculating densities of sub-samples (discs). Then stem biomasses are calculated by multiplying stem volumes and densities. Biomasses of leaves and branches are quantified directly by weighing. Then the total biomass or biomasses of desired components are calculated by adding the biomasses of the components of the trees. Then the candidate models are developed and the best-fit models are chosen as the allometric volume and biomass equations of the tree species.

Under the UNFCCC, countries are required to report the state of their forest resources and forest reference levels. The allometric volume and biomass equations can be used to convert the forest inventory data derived from ground-based inventory and remote sensing into biomass or carbon stock. The accuracy of the biomass estimation depends on the accuracy of the inventory data and the method, choice and errors of the allometric equations used. Generally, country specific rigorous allometric equations are taken as

low uncertainty (tier1) of the carbon estimation. Often due to the high uncertainty associated with the carbon estimation, high buffer percentage is used in carbon trading. Due to such high buffer percentage, countries are losing huge sum of foreign currency from carbon trade. Therefore, to realize full benefit of carbon trade, robust country specific allometric equations are must.

Allometric volume and biomass equations are also equally important for sustainable forest management. Biomass equations of individual trees are required to accurately assess forest productivity, growth performance, nutrient cycling and energy flows. Together with total tree biomass and volume, different tree component and variable-top stem volume and biomass predictions/estimations are necessary for industries and forest product markets. For these reasons, researches on allometric equations have been frequently conducted in developed countries and the research results have been applied in the field that contributes in acquiring high productivity. However, in the least developed countries like Nepal, only few research have been conducted and even available research results are not adequately applied. This is one of the reasons behind low forest productivity in Nepal. We also lack confidence on using existing equations because of their poor prediction accuracy and lack of associate equations such as timber/ fuel wood proportion to total volume. Therefore, allometric tree biomass and volume equations are important for forest researchers and managers. In addition, such equations will also help policy makers in making informed decisions.

Nepal started forest inventory in 1960s, primarily to quantify timber resources for sleeper and saw mills. Later it was extended to national forest inventory (NFI). During that period, different volume equations were prepared, using the data collected through non-destructive method. These equations were then used to calculate extractable timber volume. Likewise, biomass equations were prepared mostly by taking wood density data from different sources especially from the Indian literature. Later, in 1990s, during the second NFI, same equations were converted into metric system, which are still widely used as national level allometric equations in Nepal. However, those equations were based on air-dried weight of wood sample and lack clear sampling method. Besides, it has been almost six decades since the equations were developed. Site quality and tree composition of the forests have changed drastically in the meantime. Therefore, there is clear need for up to date national level allometric equations based on the representative samples from the entire tree population.

Nepal tried to prepare allometric volume and biomass equations for eight tree species during the third National Forest Resources Assessment (2010-2015).Though the project could not complete the task, it sensitized the policy makers and researchers about the importance and necessity of the allometric equations. Consequently, preparation of allometric equations was identified as priority project and included in the project bank of the Ministry of Forest and Soil Conservation. Realizing its importance, Nepal planned to prepare tree level allometric equations for major tree species. During the second phase of REDD readiness project, Nepal identified 16 major tree species (also some genus) to prepare allometric equations based on the proportions of the total tree stem volume. The readiness project could not complete the task but it accomplished some preparatory work with the help of financial support from World Bank. Recently, the World Bank has approved financial grant for allometric equation preparation under the Forest for Prosperity Project. In this context, the Forest Research and Training Centre (FRTC) has started the process for the preparation of allometric equations for seven tree species in cooperation of other departments and provincial ministries. However, difficult physiographic conditions of the country, nearby leaf fall season and cumbersome administrative procedures for tree harvesting are some challenges that FRTC is facing to smoothly run the research. Despite these odds, FRTC is dedicated to complete the task with sound technology and improved/ precise measurement methods. We expect all the stakeholders including the CFUGs, private sector and local communities will help us in successful completion of the mission of preparation of allometric volume and biomass equations for major tree species of Nepal.

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