BIOMASS ESTIMATION

Reasons for Biomass Estimation

- Except for timber, all other parts of trees are measured and required in weight.
- Fire wood, Pulp, fruits, NTFP all are measured in weight.
- Bio-energy plantations measured in weight
- Carbon sequestration is measured in weight

- Biomass is key to :
  - understanding the global carbon cycle,
  - defining policies in the context of the UNFCCC REDD initiative as a climate mitigation strategy,

Biomass of a Tree

- A large forest tree 35-40 cm dia (ob) and 30-35 m ht may have a biomass of 3-5Tons when freshly cut.

- Distribution of wt in such tree will approximately be

  Stem = 2-3 Tons

  Roots = .5-1 Tons

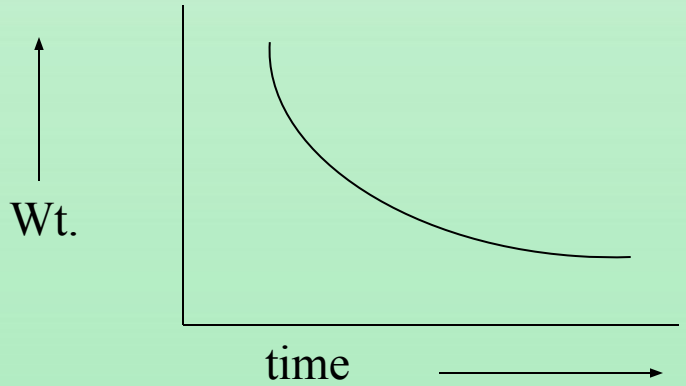
  Leaves and branches = .5-1 Tons

Dry Biomass

- This is the biomass of the tree when water is removed.
- Water usually makes up roughly 50 % of fresh biomass of tree.
- Therefore, fresh biomass varies according to
  - Seasons
  - Species
- In order to standardize the Biomass across all seasons and species we go for dry biomass estimation.

Dry Biomass

- ✔ Dry biomass is obtained by putting freshly cut plant material in the laboratory ovens.
- ✔ Material is kept on 60-70^0 for several days.
- ✔ Material is kept in the oven until the weight of the material becomes constant. This is the dry biomass of the plant.



The Distribution of Dry Matter in Trees

	Forest Trees (%)	Savanna/Woodland trees (%)
Twigs and leaves	**10**	**10**
Branches	**15**	**30**
Bole	**30**	**30**
Roots > 5 cm diam,.	**45**	**30**

Ref:-

"On The Distribution of Dry Matter in Trees & Forests."
Nye, P.H. and Greenland, D.J. (1960).

Vegetation Aboveground Biomass
How to Measure / Estimate?

- Destructive sampling (*in situ*)
  - Harvesting sample trees, drying and weighing them.

- Non-destructive sampling (*in situ*)
  - Sampling measurements such as height and tree trunk diameter that are used in allometric relationships to extrapolate to biomass.

- Inference from Remote Sensing
  - Use of passive optical and/or active radar or lidar observations (land cover, leaf area index, height) that either can be related to biomass and carbon storage or can be used to extend point measurements/estimates to large regions

- Modeling
  - Process models based on multiple environmental variables, calibrated to account for different vegetation types.

Estimating Biomass Branches and Foliage

- 1 Random sampling method
  - Select a representative tree in each dia class
  - Fell the tree
  - Count all the branches emerging from main stem
  - Select a sample from these branches (randomly)
  - Remove all the leaves from sampled branch
  - Cut branch in convenient lengths
  - Take cut material for drying in lab
  - Estimate for whole of the tree taking in to account the number of branches available.

Estimating Biomass Branches and Foliage

- 2. Regression Method (More precise)
- Assumption: shape of the branch must evolve in such a way that it should support its weight.
- It should depend on two parameters i.e. base diameter and length of the branch.
- Steps for developing this method
  - After selection, Fell the tree
  - Sample of branches from tree is selected

Estimating Biomass Branches and Foliage

- Foliage and branch material is removed for drying in lab
- From various samples obtain data for :-

Dry wt Foliage	Dry wt Branch	Base dia branch	Length branch

- Do regression to get relationship for dry wt Foliage and Branch in terms of branch base dia and branch length.

Estimating Biomass - Branches and Foliage

- While using previous method the problem arises whether we should include Dead branches and how to account for branches near tip of the tree ?

- Treat them as a different strata and sample them separately for estimation.

Estimating Biomass ‘Stem’

- We know how to calculate the volume of a tree
- We should have a measure of density in order to get biomass.
- Density varies both longitudinally and transversely, we need an average value.
  - Take slices of stem at various heights
  - Get volume by water displacement
  - Get oven dry wt of slices
  - Get densities of each slice; average all slices densities to get average density

Estimating Biomass-‘Roots’

- ✔ Difficult
  - ✔ Physical Excavation
  - ✔ Overlapping root system
- ✔ Will always remain less precise than biomass estimation of parts above ground
- ✔ A Trench around the tree stump of around 1m with a depth of 1m. Assume all roots in this trench.

Biomass Estimation
Carbon Content

- Plant reduce green house gases by locking carbon through photosynthesis
- It is a specialist laboratory process
- Process involves
  - Get dry biomass
  - Grind biomass to make powder
  - Burning samples of dry biomass and measuring CO_2
  - Mass spectrometer is used to determine the proportion of CO_2 in the biomass to determine carbon content

Biomass Estimation
Carbon Content

- Carbon contents of tree biomass suggests that it does not vary greatly b/n species.
- Extensive studies in Australia show that the above ground bio mass contains 50 % carbon, while roots contain 49 % of carbon.
- The same can be taken as a thumb rule for rough calculation of the carbon contents for tree.

Biomass Estimation Functions

- Allometric Functions
  - These are similar to the functions discussed for volume
  - Example
    - $B = aD^b$
    - $B = aD^bH^c$
    - B tree dry oven weight
    - D Tree dia at BH
    - H height of tree
  - Generally it is observed in bio mass estimation that Ht does not play very important role in biomass estimation.

Biomass Estimation Functions

- Surprisingly biomass studies all over the world suggest
  - b, c differ little across the species.
- Therefore, if developed a Allotropic function for a species for a area it may be applicable for another species and another area.
- Consider a bio mass function
  - $B = 9081D^{2.59}$

Biomass Estimation Functions

- Here B is Tree Biomass above ground
- D is Diameter at BH

This fn. was developed for Canada and was also applicable for a very different area in Australia.

- Though these functions are difficult to obtain their applicability is wide
- Refer various research papers to get hold of such Allometric functions for biomass estimation.

Root Biomass estimation functions

- Data collection is difficult therefore, Allometric functions are more useful for estimating root biomass

  - $B_R = d\ B_A^{\ e}$
  - B_R is root oven dry biomass
  - B_A is above ground oven dry bio mass
  - d and e are parameters of the function.

Leaf Biomass Functions

- Surface area of leaf is more important than leaf biomass
- Get relationship between leaf surface area and dry leaf biomass
  - This gives ‘specific leaf aera’
- Leaf surface area is dependent on sap wood in stem
- Get a measure of stem sapwood from increment boring instruments
- Get a correlation between leaf surface area and stem sapwood width; get a relationship b/n leaf biomass and stem sapwood diameter.

Thank You