


Pilot course "MRV and Monitoring for REDD+"
FAO Rome 1-3 March 2011

The M & R in MRV

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Objectives of this talk

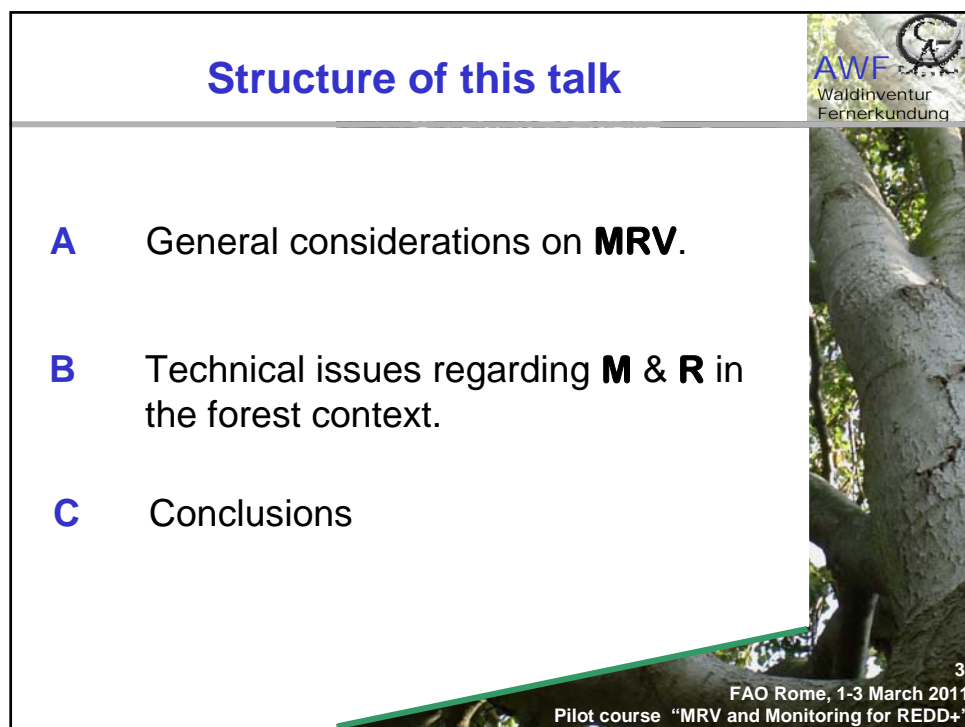
- Address methodological challenges of **M** (measurement) and strategic challenges of **R** (reporting) ;
- Generate a feeling for the complexity of measurements and reporting on the forest resource.

This presentation assumes a technical scientific point of view on M & R.



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2
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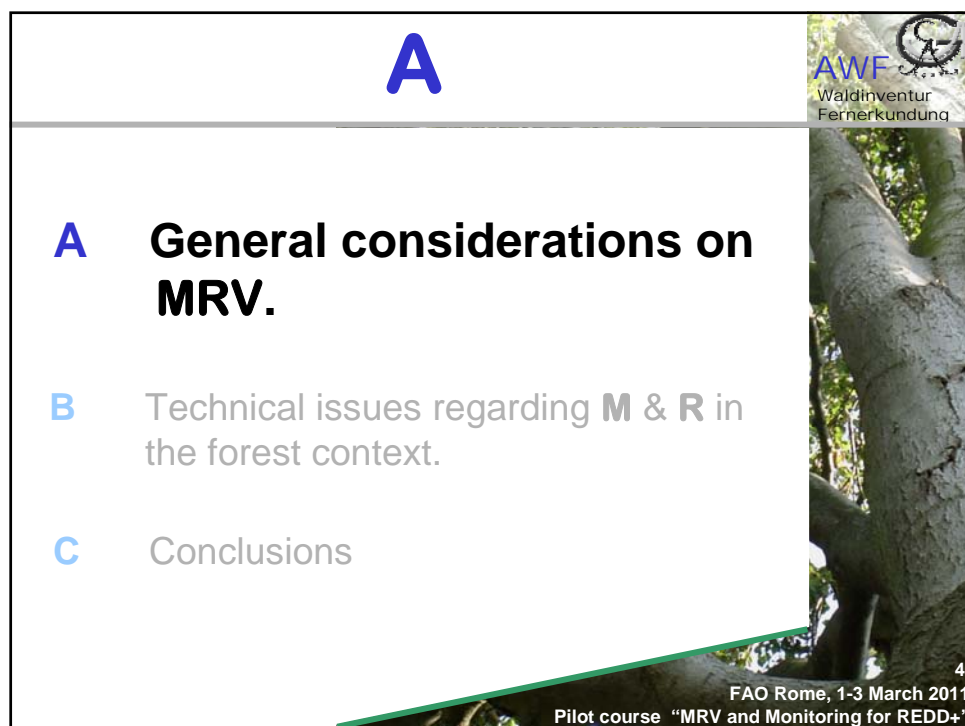
Structure of this talk

- A** General considerations on **MRV**.
- B** Technical issues regarding **M & R** in the forest context.
- C** Conclusions

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3
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This slide features a white content area on the left and a vertical photograph of a tree trunk on the right. The text is in blue and black. The AWF logo is in the top right corner, and the slide number and event information are at the bottom right.



A



- A** **General considerations on MRV.**
- B** Technical issues regarding **M & R** in the forest context.
- C** Conclusions

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This slide is similar to slide 3 but with a large blue letter 'A' at the top center. The content area on the left is white, and the tree trunk photograph is on the right. The AWF logo and event information are in the same positions as in slide 3.



Background



- International processes require clear commitments – and the possibility to objectively monitor them.
- Such monitoring needs to happen along variables and indicators that can objectively be analysed and evaluated.
- Assuming that such policy processes have sufficient rational, scientific elements, these variables and indicators need to be *measurable, reportable and verifiable*.

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Background




- Consequently, MRV has developed to a standard in the context of various international conventions.

<p>Measurement: Observation, producing data.</p> <p>↓</p> <p>Reporting: Translating the data into information</p> <p>↓</p> <p>Verification: Independently (!) check both measurement and reporting</p>	}	<p>Requires mainly technical expertise (plus knowledge about the processes)</p>
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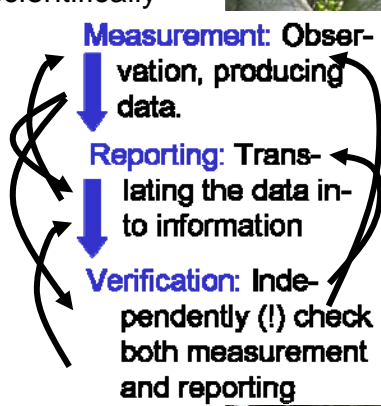
6
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Background



The three components **M**, **R**, **V** are tightly interrelated - if we look at the process “scientifically”

- You can only verify what has been reported.
- You can only report what has been measured.
- You will only measure what is worth to report and relevant to verify.
- You will measure and report such that verification is feasible.




Measurement: Observation, producing data.

Reporting: Translating the data into information

Verification: Independently (!) check both measurement and reporting

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Terminology I: “Measurement”



In science and statistics:



- A measurement is the process of generating a datum which is characterized by just one error source, the measurement error.
- There are various other data generating processes, some of the described later.

MRV carries a much more general and inclusive definition of “measurement”:

- Measuring = generating data
- This comprises ALL the above and probably more.

8
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Terminology II: "Reporting"





- Reporting = translating the data gathered from "measurement" into meaningful information,
... and in the IPCC context:
... information, that allows assessing the Parties' performance regarding their commitments or reference scenarios.

In the general policy context of forest inventories, data should be translated into meaningful information and into meaningful "stories".

9
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B



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10
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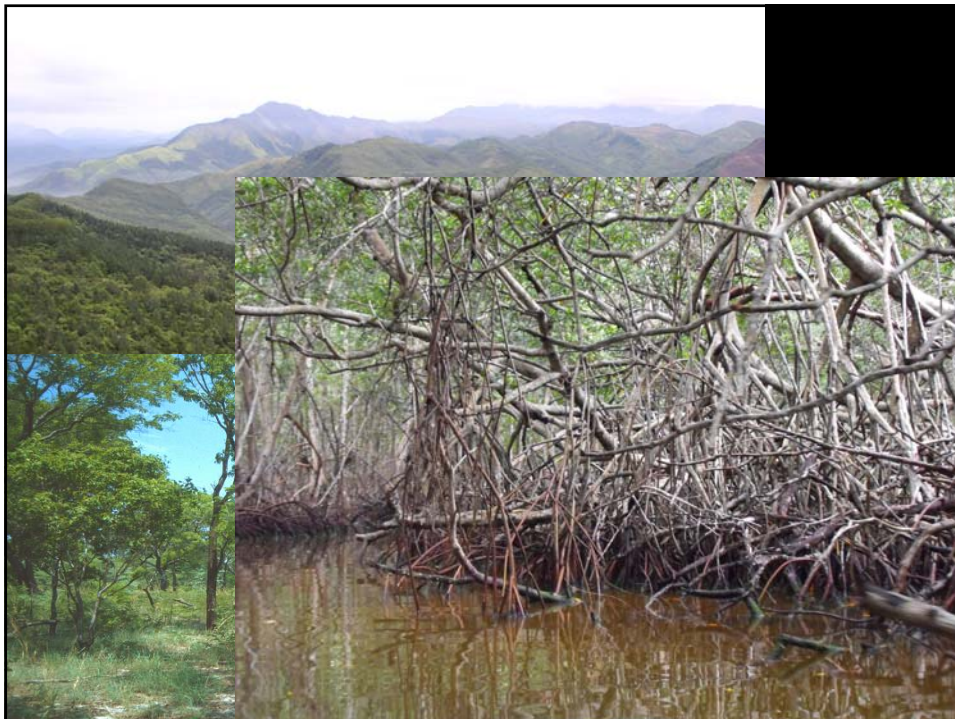
The object of interest: forest



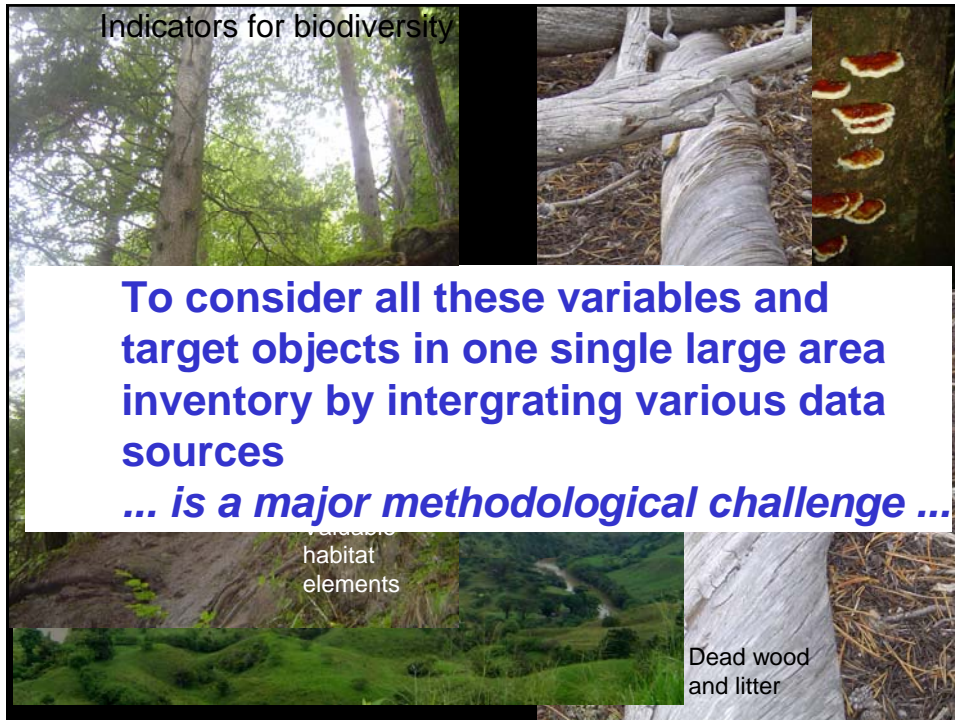
- Forests are complex systems; they occur globally in many variations.
- Not only forests (whatever definition) but all trees are of interest when “carbon” and “sustainability” are assessed .
- The target objects of measurements and inventories are, therefore, also manifold.
- Whatever type of measurement and reporting should be done → it requires a clear and explicit focus.



11
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Indicators for biodiversity

To consider all these variables and target objects in one single large area inventory by intergrating various data sources
... is a major methodological challenge ...

habitat elements

Dead wood and litter


A technical view on Measurements



What needs and can be measured / observed and how?

Different types of *measurements*:

1. Direct measurements
2. Indirect measurements
3. Predictions (model based measurements)
4. Estimates (sample based measurements)
5. Guesses (expert based measurements)



16
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What type of Measurements are there in forest inventories?



1. Direct measurements

- Direct measurements are taken directly at the object of interest, typically with a mechanical or electronic measurement device: e.g. caliper for DBH (diameter at breast height).
- Errors: measurement error (metric variables)
misclassification (categorical variables)
confusion (nominal variables)

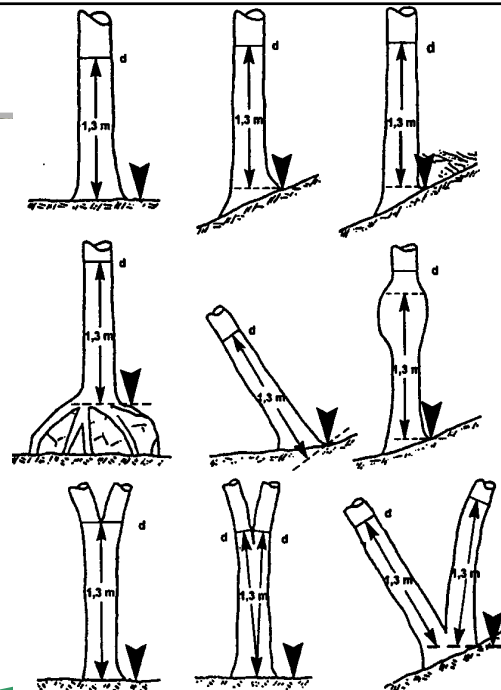


17

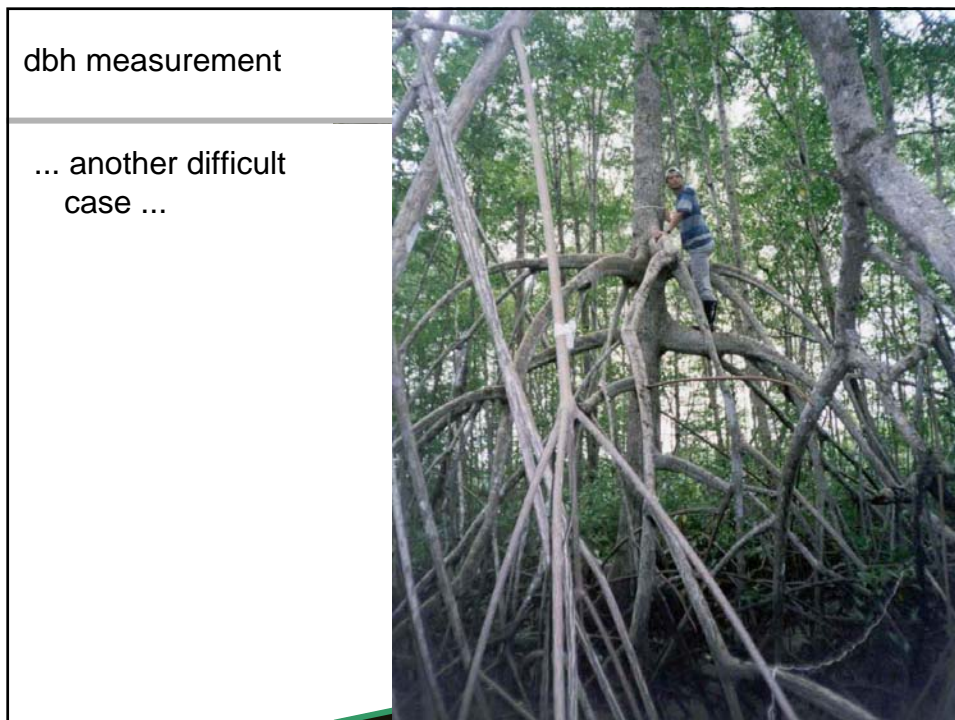
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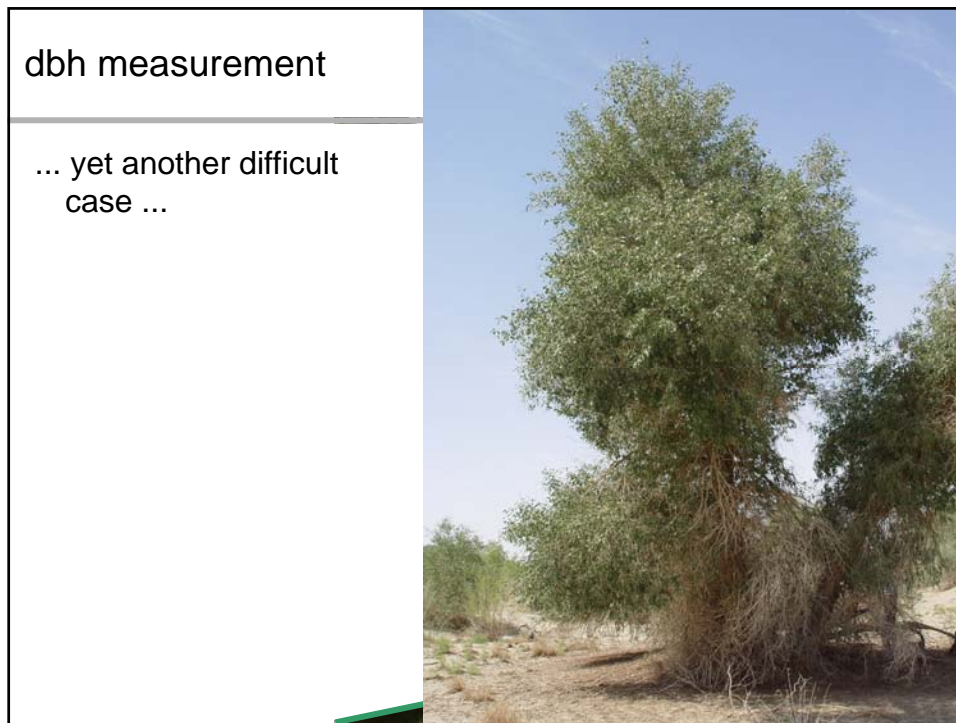
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- Even for the simplest variable, a clear protocol is essential.
- Otherwise: data quality cannot be assessed and consistency of data collection can not be guaranteed!



Example from the inventory manual for the German NFI



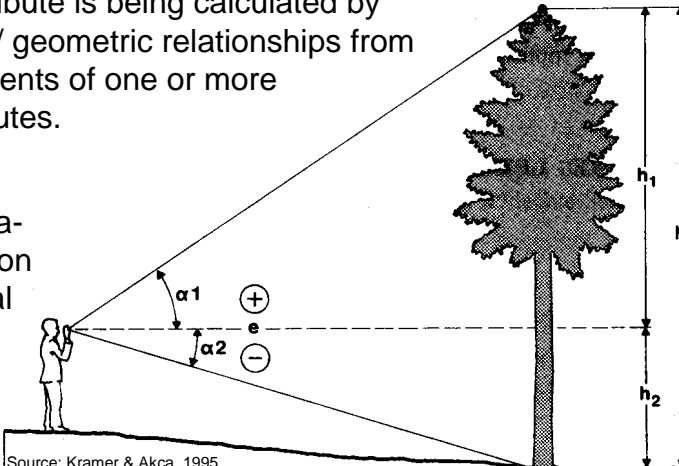


What type of Measurements are there in forest inventories?

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2. Indirect (remote) measurements

- The target attribute is being calculated by mathematical / geometric relationships from the measurements of one or more auxiliary attributes.
- Error: combination/propagation of all individual measurement errors.

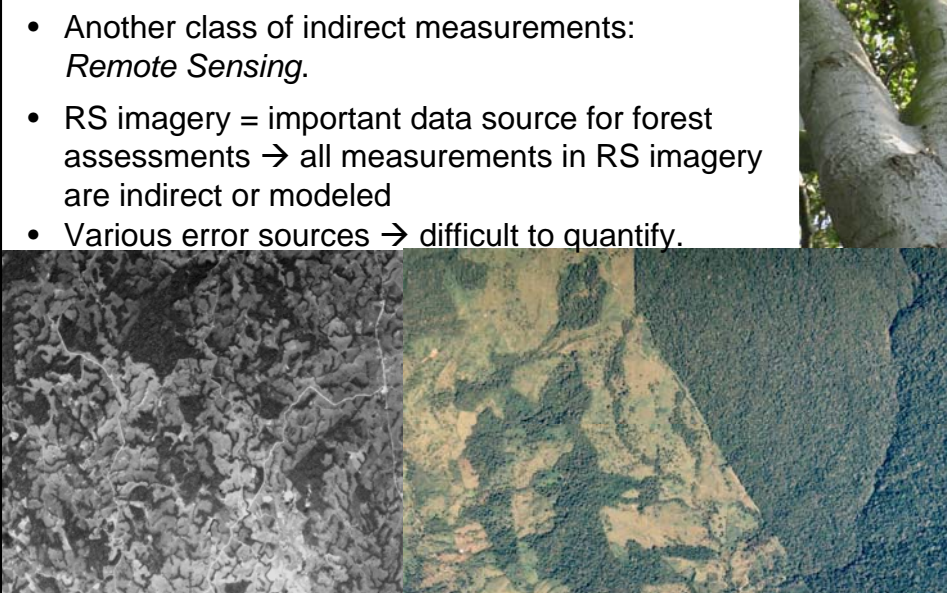


Source: Kramer & Akca, 1995

What type of Measurements are there in forest inventories?

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- Another class of indirect measurements: *Remote Sensing*.
- RS imagery = important data source for forest assessments → all measurements in RS imagery are indirect or modeled
- Various error sources → difficult to quantify.




What type of Measurements are there in forest inventories?

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3. Model based predictions

- For example “carbon content of a tree stem” **C**: By directly measuring **DBH** and indirectly measuring **height**, carbon content **C** can be predicted, when a model exists $C = f(DBH, height)$.
- Such models need to be available – and building them is a typical research task.
- Statistical models are extremely important in forest monitoring – and some times underestimated.
- Remote sensing image analysis does also involve quite some modeling.

24
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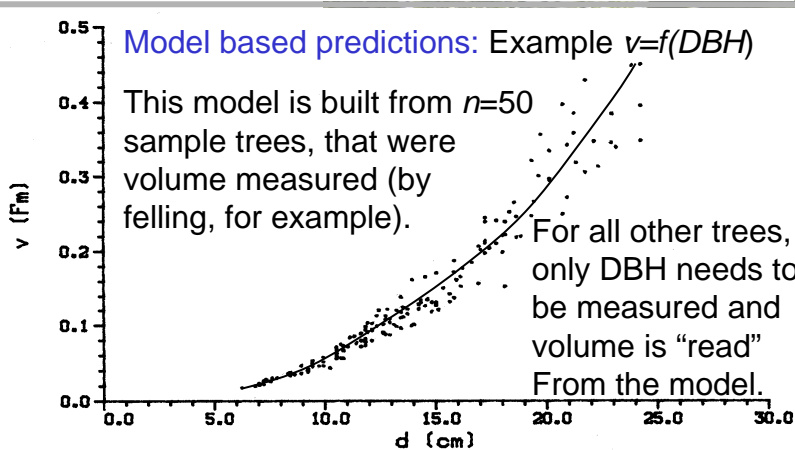
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Model based predictions: Example $v=f(DBH)$

This model is built from $n=50$ sample trees, that were volume measured (by felling, for example).

For all other trees, only DBH needs to be measured and volume is "read" From the model.



The scatter plot shows a positive correlation between diameter d (cm) on the x-axis and volume v (Fm) on the y-axis. The x-axis ranges from 0.0 to 30.0 with major ticks every 5.0 units. The y-axis ranges from 0.0 to 0.5 with major ticks every 0.1 units. A solid black curve is fitted to the data points, showing an exponential-like growth. The data points are small black dots scattered around the curve.

Error sources: measurement errors of DBH, and model error.

25
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Model based predictions:

The quality of a model for a particular purpose depends on many factors, including

- Where come the data from ?
- How many data were used ?

It is very difficult to judge the quality of a model for a particular application – in particular if it is not yours !!

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What type of Measurements are there in forest inventories?


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4. Sample based estimates

- When the whole of the population of interest cannot be observed: samples are taken.
- Any result from a sample based study is an estimation.

Error sources: measurement errors of the attributes, and sampling error.

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Inlet: what type of Measurements are there in forest inventories?

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5. Expert guesses (guesstimates)

- Not commonly employed in large area forest assessments.
- Expert guesses can be useful in the pilot phase of an assessment.
- Errors: an error assessment is not possible; expert guesses are a matter of trust and belief (and verification must base on just that).

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Attributes to be measured for REDD+

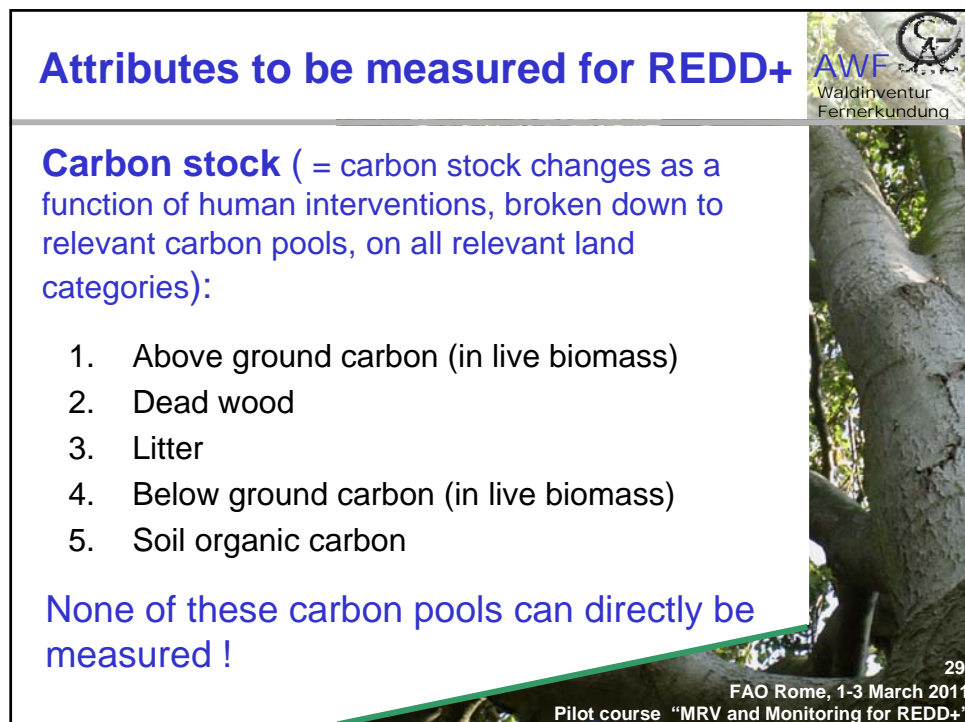
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Carbon stock (= carbon stock changes as a function of human interventions, broken down to relevant carbon pools, on all relevant land categories):

1. Above ground carbon (in live biomass)
2. Dead wood
3. Litter
4. Below ground carbon (in live biomass)
5. Soil organic carbon

None of these carbon pools can directly be measured !

29
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Attributes to be measured for REDD+

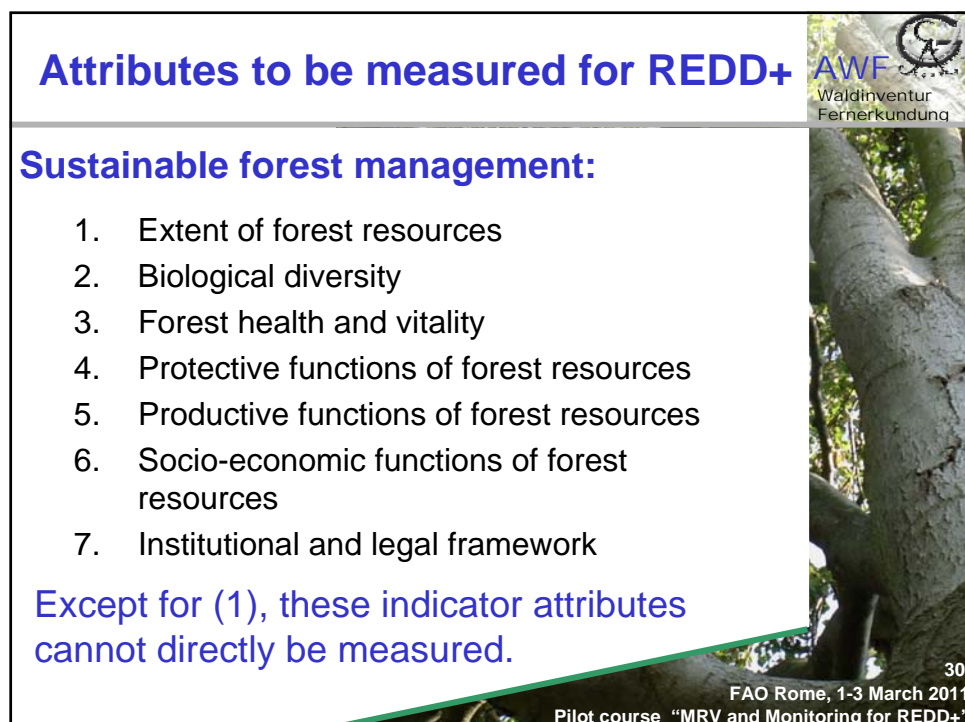
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Sustainable forest management:

1. Extent of forest resources
2. Biological diversity
3. Forest health and vitality
4. Protective functions of forest resources
5. Productive functions of forest resources
6. Socio-economic functions of forest resources
7. Institutional and legal framework



Except for (1), these indicator attributes cannot directly be measured.

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Measurements

... obviously, a multi-facetted issue !





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A technical view on Reporting

Reporting - for what:

1. Informing the government
2. Informing the processes
3. Prepare and allow verification
4. Informing the science and research community!
5. Informing future generations!

Reporting - how:
Such that all interested parties can extract the relevant information



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Reporting - principles



More specific - Reporting principles according to UNFCCC:

1. Transparency: methodology must be clearly stated so that anybody may verify the correctness
2. Consistency: same definitions and methodologies shall be used over time.
3. Comparability: across countries.
4. Completeness: all relevant information shall be given; gaps explicitly documented.
5. Accuracy: estimates shall not systematically over- or underestimate.

These definitions are from UNFCCC. In other fields, other definitions of these terms exist.

33

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Reporting: structure



In general, a national inventory of GHG anthropogenic emissions and removals has to parts:

1. **Reporting tables:** on all land-use categories, per unit area and total.
Along a defined structure.
Level of detail is defined by the methodological approaches chosen:
Tiers: level of "precision" of estimates
Stratification: level of "subject matter resolution" = data and reporting on *how many relevant forest classes*
2. **Inventory report,** describing methodology, assumptions, data sources (and why they were used), and tier level chosen.

34

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A technical view on Reporting



Different levels of detail / precision / accuracy:

Results can be reported on different levels of detail, depending also on the availability of models and the resources invested:

3 tier levels

Despite the significant differences in tiers they all adhere (according to the Sourcebook) to the IPCC good practice concepts of transparency, completeness, consistency, comparability and accuracy.

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Harmonization and standardization - to allow for comparability ?



Intensive efforts for decades (recently: COST E43)

It is important to accept that perfect definitions are extremely difficult for many forestry attributes – if they are possible at all.

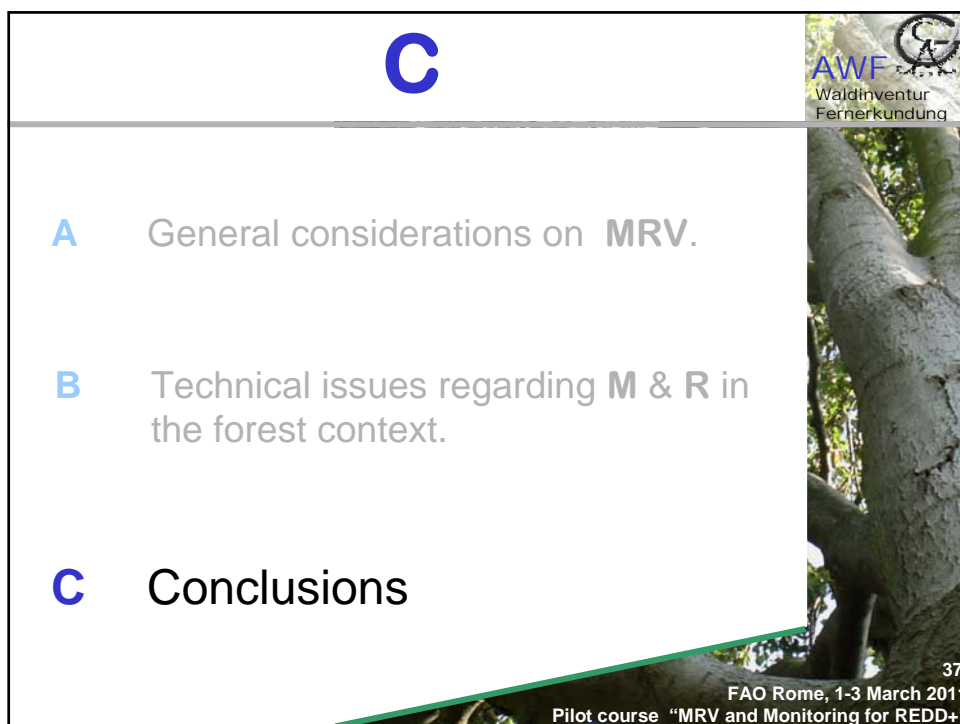
Example: issues from the definition of "forest land":

- Using a "minimum crown cover > 20%" is not unequivocal!
- Applying the minimum area criterion is meaningless if not "forest edge" is clearly defined.

Important:

- Develop approaches to make results compatible with a common definitions for reporting;
- Knowing how to deal with differences in definitions.

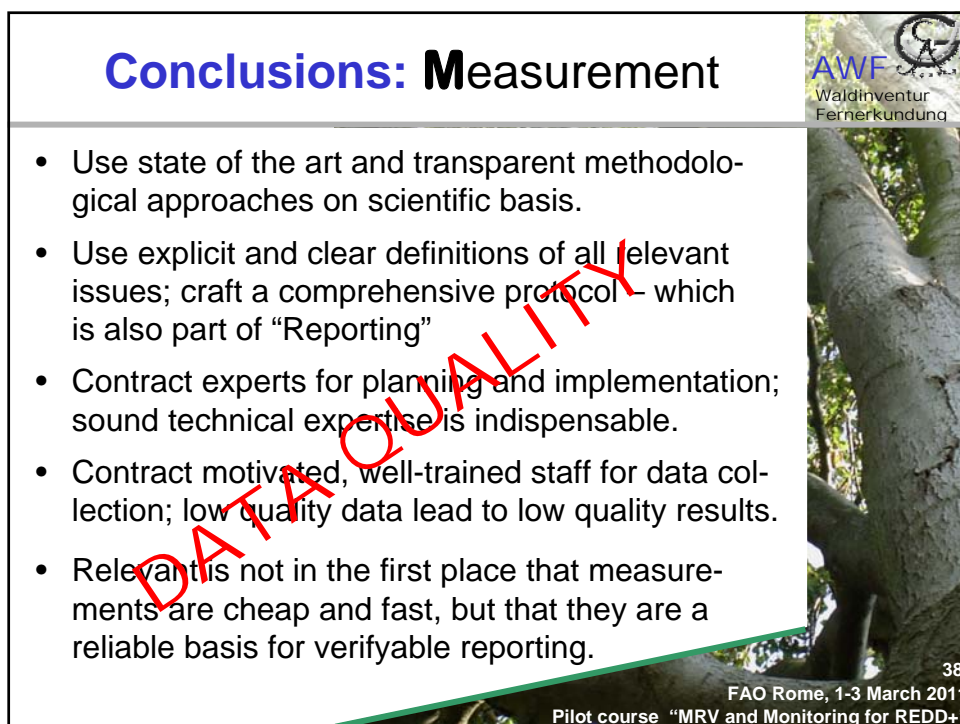
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Conclusions: Measurement

- Use state of the art and transparent methodological approaches on scientific basis.
- Use explicit and clear definitions of all relevant issues; craft a comprehensive protocol – which is also part of "Reporting"
- Contract experts for planning and implementation; sound technical expertise is indispensable.
- Contract motivated, well-trained staff for data collection; low quality data lead to low quality results.
- Relevant is not in the first place that measurements are cheap and fast, but that they are a reliable basis for verifiable reporting.

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Conclusions: Reporting



- All methods applied need to be reported. At least an expert needs to fully be able to follow
→ any question mark remaining is a weakness.
- Results should be based on scientific methods (it is impossible to do verification if one does not follow generally accepted approaches)
- Any gaps or weaknesses should be frankly addressed - and serve as lesson for improvement of the assessment system.

CLEAR MESSAGES



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Conclusions: M & R



- Both Measurement and Reporting have a complex technical dimension.
- Technical knowledge and understanding is required to be able to properly implement and evaluate both.
- Research and development plays an important role in further developing assessment techniques and techniques for quality control.



40

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Thank you!



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