Integrate+ Marteloscopes

Description of parameters and assessment procedures

1. Aim and applications of Marteloscopes

The objective of this document is to compile in a 'Marteloscope manual' all needed information and the corresponding methodology for establishing and evaluating Marteloscopes. It will describe which Marteloscope parameters/variables need to be assessed and how they are set-up. The Marteloscopes have a wide range of applications. They can be used:

- as didactic tool for silvicultural training (virtual tree selection exercises); the availability of stand data on mobile devices in combination with a well-designed software ('I+ ') allows direct feedback on silvicultural decisions and resulting ecological and economic effects
- for supporting exchange of experiences; on the basis of transparent data, different management strategies and their consequences can be objectively discussed
- for supporting improved decision making capabilities addressing the integration of biodiversity aspects into forest management
- as show cases, and use for field visits or other forest educational programs; demonstration of on-site information on management approaches and targets including biodiversity aspects
- for raising awareness and creating visibility for integrative forest management concepts and implementation
- for supporting the policy dialogue between different interest groups
- for addressing a broad variety of target groups including forest practitioners, decision makers and scientists from different sectors, students as well as other potentially interested/relevant communities

Photo: Frank Krumm

2. Basic information assessed in each Marteloscope

2.1. Selection of the site and forest stand

When planning to establish a Marteloscope the selection of the site and the corresponding forest stand should be given thorough attention. The following aspects need to be taken into consideration:

- representativeness should be given attention (forest type, stand characteristics and management applied)
- the Integrate+ project strives to have a representative set of Marteloscopes covering a wide range of different forest types; this aspect should be considered during the selection process
- the selected forest stand needs to show a certain “need” for management action and be suitable for virtual tree selection exercises (‘interesting sites’)
- ownership and future expectations towards the forest stand need to be clarified
- the continuance/ life time of a Marteloscope needs to be guaranteed
    - management operations should be renounced for a time-span of at least 5-15 years so that the expenses of set-up are justified and the usability for training exercises ensured
    - in case management operations take place soon after Marteloscope establishment the suitability for training may be lost (at least for some years). Alternatively, a second, very similar Marteloscope can be established in close vicinity to the first so that one of the areas can be used for training while the other may serve as control case (after intervention)

Photo: U. Mergner

- preferred terrain is such that allows effective set-up of a Marteloscope; flat terrain is thus favored but it is not a requirement (e.g. mountain forests)
- further aspects to be considered are:
  - ease of accessability for training
  - safety issues (e.g. rock fall in mountainous forests)

2.2. Size and form of an Marteloscope

The size of a Marteloscope should be fixed to 1 hectare with side lengths of 100 x 100 m. Size and form should be tailored to the planned use of the Marteloscope and the geography and local conditions. So they may in exceptional cases differ from the regular rectangular shape.

The following description has been applied by the Integarte+ team to delineate the Marteloscope square of 100 x 100 m and the geo referencing of the individual trees. The center of the square is determined and subdivided into four quadrants (**see *Fig. 1***). Following the division into quadrants, the azimuth for each tree is measured to the center points of each of the quadrants. Angles and distances are then converted to 'x' and 'y' coordinates through 'sin' and 'cos' functions.

There are of course other approaches and equipment that can be applied for setting up the Marteloscope plot and the geo-referencing of the individual trees. One example is Field Map (for more information visit: http://www.fieldmap.cz/).

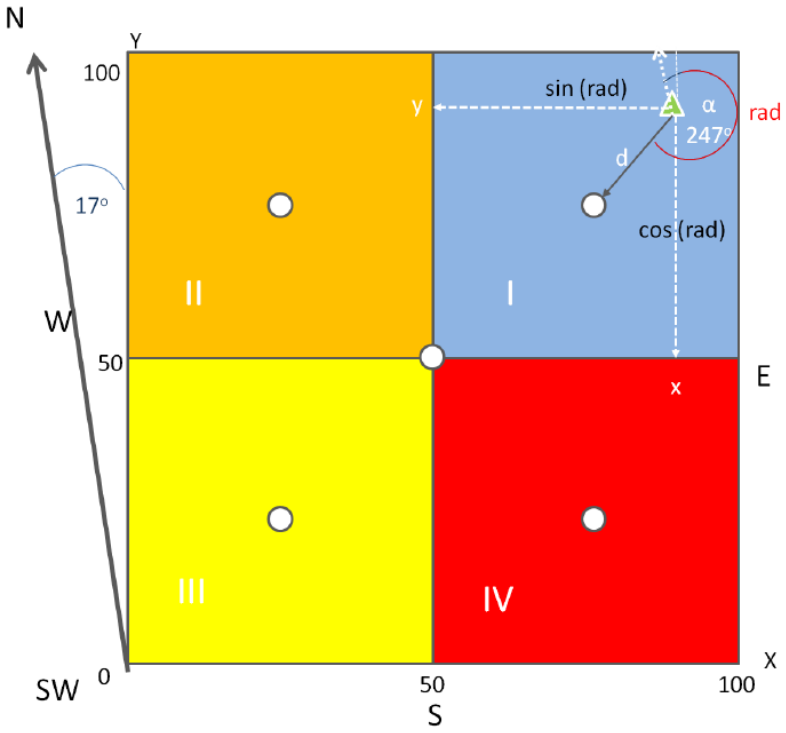

Figure 1. Setting up the Marteloscope site.

2.3. Minimum requirements (common ‘basis’ version) for assessed parameters/variables

The essential and mandatory parameters/variables that need to be assessed in each Marteloscope are the following:

- tree-ID (tree number)
- tree position (polar co-ordinates)
- tree species
- dbh (diameter breast height)
- tree height
- crown base height (initiation of crown)

Photo: F. Krumm

On the basis of the collected data further parameters can be derived by tree species for each single tree and a Marteloscope stand. For some of the derived parameters local site conditions, growth models and tree species specific calculation formulas will need to be taken into consideration:

- diameter (class)-distribution
- basal area
- volume for single tree
- annual increment

2.4. Extended Marteloscope variables

Optional other parameters/variables can be added, depending on the questions that want to be addressed with a Marteloscope. Also the expectations can be incorporated towards the degree of specificity/validity, capacity and goals of the forest owner or a project-partner.

The additional parameters/variables may then allow further analysis and give room for formulating new questions for training exercises. Of particular relevance for Integrate+ are the following:

- evaluation of timber assortments for single tree
- based on timber assortments estimate of revenue for timber sales (use of local price lists)
- assessment of habitat structures/microhabitats for the single tree (based on an available catalogue provided by a microhabitat expert group)

3. Set-up and analysis of Marteloscopes

Subsequently all parameters/variables that have to be assessed (‚basic'-version) for each Marteloscope are listed in ***Table 3.1 and 3.2***. Further parameters that can be assessed in addition are also provided. The list is thought only for giving a general overview and is seen as a living document undergoing regular updating.

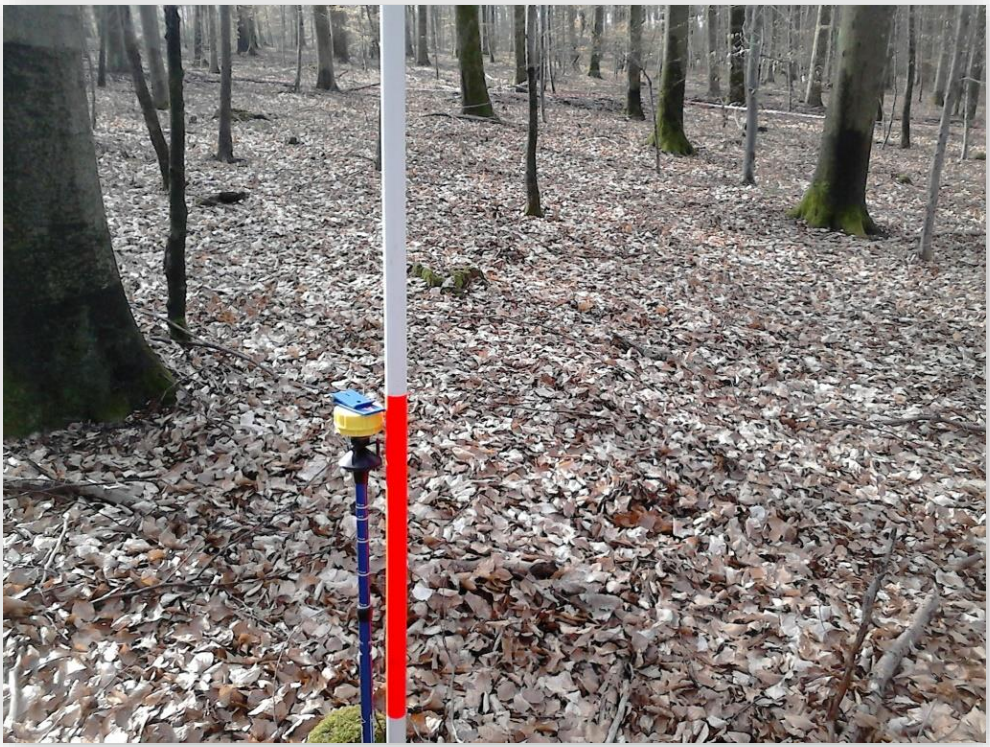

Photo: A. Held

Table 3.1. Overview on Marteloscope related parameters and their use/application.

Parameter	Use/application
Tree-ID*	Labelling and identification of trees (tree number)
Tree species*	Tree species composition and distribution, share of broadleaved/coniferous species etc.
dbh*	Threshold for dbh is recommended at 7.5 cm but may vary between countries; allows to develop dbh distribution; input for calculation of tree volume; important parameter for virtual tree selection exercises
Tree position*	Visualisation of the forest stand, assumptions about competition, locating of individual trees
Tree height*	Stand height, height/diameter-ratio; input for calculation of tree volume
Site description/ site condition*	Describing site (including e.g. location, m.a.l., mean annual temperature; annual precipitation, forest type/community)
Volume and basal area*	Calculated
Tree microhabitats (including assessment of potential tree microhabitats)**	Assessment and calculation of ecological value (individual trees and stand); allows for comparison of Marteloscopes; option for demonstrating effects that virtual interventions with „I+“ software have on the present and future stand in terms of microhabitat availability/development (ecological points)
Timber quality and timber assortments (including assessment of expected quality and assortments in 20/30 years)**	Assessment and calculation of economic value (individual trees and stand), allows for comparison of Marteloscopes; option for demonstrating effects that virtual interventions with „I+“ software have on the present and future stand in terms of economic revenue/development
Deadwood**	Important stand parameter; input to the calculation of the overall ecological value of a stand; effects on stand vitality and protective function in mountainous regions

Increment**	Allows to give indications on tree/stand growth (m^3/ha) including tree/stand development based on virtual tree selections with „I+“ software; provides input to the development of timber quality and value
Light regime	Relevant aspect for future stand development within virtual tree selections
Natural regeneration/formations	Describing the actual situation of natural regeneration; can be used if interventions promoting natural regeneration are foreseen; The information can be integrated as additional map layer in „I+“ software
Stability of individual trees/ small groups	Describing the actual situation of stand stability; can be used to investigate the effects of virtual interventions on stability if increased or decreased

** Parameters that need to be assessed in every Marteloscope („must-haves“)*
*** Parameters that should be assessed in each Marteloscope to allow for more detailed analysis in virtual tree selection exercises („should haves“)*

Photo: A. Held

Subsequently recommended data collection methods and assessment procedures are listed. There may be alternative collection methods and assessment procedures which would best be shared with the Integrate+ project in order to ensure compatibility of the collected data. ***Table 3.2*** gives an overview on the set-up procedure for a Marteloscope as suggested by Integrate+.

Table 3.2 Recommended data collection methods and assessment procedures.

Parameter	Recommended methods/procedures for data collection
Tree-ID*	Terrestrial in the field (numbering of trees): Labelling trees with continuous numbers using number templates, number seals, aluminium or plastic number plates (attached to the individual trees with aluminium nails (giving enough space so plates are not overgrown); good visibility of the numbers and durability of the colour should be ensured (blue colour can be recommended, labelling always on the same side/cardinal direction, hill/ or downhill side or both)
Tree species*	Terrestrial in the field
dbh*	Terrestrial in the field: use of measurement tape or slide caliper
Tree position*	Terrestrial in the field: measurement of azimuth and distance using e.g. Vertex or laser measurement devices
Tree height*	Terrestrial in the field: use Vertex or other altimeter
Site description/condition*	Terrestrial in the field (vegetation); site maps
Volume and basal area*	Calculated using collected field data; for volume height curves can be used if available
Tree microhabitats (including assessment of potential tree microhabitats)**	Terrestrial in the field: assessment by expert for each tree in the Marteloscope (from ground level to top of crown); use of binoculars is needed; assessment is implemented using the Integrate+ ‚catalogue of microhabitats'

	Besides currently visible mircohabitat structures an assessment of structural elements with high future ecological potential is performed (20 - 30 years - may vary depending on the Marteloscope site; it may be omitted depending on site aim/use)
Timber quality and timber assortments (including assessment of expected quality and assortments in 20/30 years)**	Terrestrial in the field: assessment by expert for each tree in the Marteloscope; vvisual examination of timber quality of each single tree above the dbh threshold and classification into one or several commonly used timber assortments (stem partition lengths should be >3m); inner wood characteristics are not taken into account Additionally, the expected future development for each stem partition is estimated (following the same procedure); Time frame is 20 -30 years (may vary depending on the Marteloscope site; it may be omitted depending on Marteloscope aim/use) *Note:* It is advisable to contact the local foresters in advance of the assessment to discuss the regional quality classification system and regional timber sale conditions. In the ideal case a full assessment is implemented jointly with the local forester
Deadwood**	t.b.d.
Increment**	Use of supporting sources is most efficient and thus recommended (e.g. increment rates/data from forest owner directly; from planning data, growth models (e.g. BWIN Pro) If not available: terrestrial in the field (dendro-drillings; dbh measurements over several years (long-term)
Light regime	t.b.d
Natural regeneration/ formations	Terrestrial in the field: assessment by expert (especially relevant in mountainous forest); if possible assess at small scale favouring/hindering conditions for natural regeneration
Stability (single tree/small groups)	Single tree: terrestrial in the field by expert (possible criteria depend on site conditions aim e.g. height/diameter-ratio, hang-up tree,

	anchorage, rot, cancer, crown shape, etc.) Small groups: terrestrial in the field by expert Possible classification can base on ‚0' or ‚1' values (contributing to stability: yes/no)
Other	**Photos**** Photos are very important and should be part of the data collection process. Defining exact points for taking photos (if possible geo-reference). Documentation of Marteloscope development/habitat structure over time may be useful **360° photographs (Silvotheque/Moti)** Advanced photography with panorama views; allows virtual visit of the Marteloscope. Images can visualise forest stand characteristics and assist for defining training options

** Parameters that need to be assessed in every Marteloscope („must-haves")*
*** Parameters that should be assessed in each Marteloscope to allow for more detailed analysis in virtual tree selection exercises („should haves")*

Photo. Lucie Vitkova

4. Measuring devices and material

Table 4.1 lists the measuring devices and additional material that a field crews will need to set up a Marteloscope. The list below builds on the experiences gained by the Integrate+ project team while setting up Marteloscope sites.

Table 4.1. Proposed measuring devices and material for setting up a Marteloscope.

Devices/ material	Illustration
Vertex; if there are two teams available then provide two devices for measuring the distance from each tree to the center point of a quadrant and also to measure tree heights	
2 compasses (e.g. Suunto) for measuring the angles of each tree	
Measuring tape or caliper (80 cm) for tree diameters	 

Distance measuring tape (50 meters, if available 100 meters)	
15 line poles (2.20 meters) for aligning the Marteloscope 100 x 100 meters square and the 4 quadrants	
Plastic ribbon (red/white) 500 meters to delineate the area temporary	
Nine wooden or metal poles to mark the Marteloscope edges and centre point as well as the quadrant centres points permanently (1-meter length)	
Binoculars for the microhabitat assessment	

Hammer or axe	
Two writing boards	
Tree numbering tags	
Water proof pens	
Spray paint	

Aluminium nails or screws

Integrate+ is a demonstration project funded by the German Federal Ministry of Food and Agriculture (BMEL) to establish a European network of demonstration sites for the integration of biodiversity conservation into forest management.

The Integrate+ project runs from December 2013 to December 2016 and builds on a partner network from research and practice with a focus on implementation of integrative management and enhancing transnational exchange of experiences.

Schuck, A., Krumm, F., Kraus, D., 2015. Integrate+ Marteloscopes - Description of parameters and assessment procedures. Integrate+ Technical Paper No. 18. 16 p.

European Forest Institute, 2015

www.integrateplus.org