Institute for Technology Assessment and Systems Analysis

Research group “Sylvanus – Increasing resilience and reducing trade-offs during forest transformations”

Measuring devices in the research group

1. Tree inventory

To survey trees and their immediate environment we possess a range of different measuring devices and tools. From a simple measuring tape to high-quality binoculars, to spot microhabitats on trees to the sophisticated laser measuring device for the integrated length and angle measurement to measure tree dimensions.

Item name	*Category*	*Manufacturer*	*Comments*
TruPulse 360B & TruPulse 360R	Laser measuring device	Laser Technology	
eTrex 20x & eTrex Touch 35	GPS device	GARMIN	20x: with joystick; Touch 35: with touchscreen
10X handheld	Outdoor tablet PC	Algiz	For digital data entry in the field
Kestrel 5400	Heat stress tracker	Kestrel	Allows for simultaneous measurements of e.g. temp., wind speed & humidity
PeakTech 2802	Laser distance meter	PeakTech	
Terra ED 8x42 & Conquest 15x56 HD	Binoculars	Zeiss	
KB 14 & KB 20	Compass	Suunto	
PM-5/1520	Altimeter/clinometer	Suunto	
Diameter tape (3 m & 5m)	Diameter measuring tape	David Dominicus	
Tree caliper (40 cm)	Caliper	Nestle	
Tree caliper (80 cm)	Caliper	Haglöf	
Measuring tape (25 m)	Measuring tape	Richter	
Measuring tape (50 m)	Measuring tape	Richter	

2. Hemispherical photography and light measurements

Measurement devices to record light conditions and light quality, as well as tree crown measurement through hemispherical camera with specialized software are available.

Item name	*Category*	*Manufacturer*	*Comments*
WinSCANOPY	Canopy analyzer	Regent Instruments	Camera with calibrated fisheye lens & software
LAI-2200C Plant Canopy Analyzer	Canopy analyzer	LI-COR	Particularly for Leaf Area Index
LI-180 Spectrometer	Spectrometer	LI-COR	Portable, sensor head detachable, connected by cable
LI-191R Line Quantum Sensor	Light quantum sensor	LI-COR	integrated light measurement over a length of 1 m

3. Photosynthesis, fluorescence and leaf gas exchange measurements

We have chosen measuring devices available, suited for photosynthetic performance measurements, transpiration, and other important parameters which give insights into plant stress. They enable us to conduct measurements ranging from very complex to simpler ones. The LI-6800 allows for the most complex scenarios, while the OS30p+ is the simplest of our photosynthesis devices, able to measure fast chlorophyll fluorescence induction curves (OJIP). This makes it possible to gain different depths of insights. Based on the scientific question and sample size, adapted measuring protocols and experimental designs can be developed making use of the respective device.

Item name	*Category*	*Manufacturer*	*Comments*
LI-6800 Portable Photosynthesis system	Photosynthesis Measurement device	LI-COR	Measurements under controlled environmental conditions
LI-600 Porometer/ Fluorometer	Fluorometer/ Porometer	LI-COR	
OS30p+	Fluorometer	Opti-Sciences	

4. Dendroecology

Tree cores allow for in-depth analysis of many parameters such as tree age, tree growth and wood quality. Our tree ring corers of different diameter ensure a minimally invasive sampling of living and dead trees of different sizes. The WinDENDRO software (see 7.) can be used for in depth analysis of wood structure. Chemical and Isotope analyses can be done in cooperation with a specialized lab we are in contact with.

Item name	*Category*	*Manufacturer*	*Comments*
Mora Coretax Increment borer (12 mm diameter, 450 mm length)	Tree Increment borer	Haglöf	2-threaded version, fit for hardwood
Mora Coretax Increment borer (12 mm diameter, 300 mm length)	Tree Increment borer	Haglöf	2-threaded version, fit for hardwood

5. Tree internal damage analyses

Two devices for wood analysis enable us to get insights into the condition of the wood of standing trees, without the need to fell or cut them open. The drilling resistance measuring device “Resistograph” lets us determine tree annual ring breadth and wood strength. And the sonic tomograph “Arbotom“, which enables to create 2D images of tree trunks to recognize damage areas. 3D imaging can be approximated by conducting a series of stacked measurements of one trunk.

Item name	*Category*	*Manufacturer*	*Comments*
Arbotom	Sonic tomograph	Rinntech	
Resistograph	Drilling resistance measuring device	Rinntech	

6. Soil respiration, soil physical and chemical analyses

Since soil properties have great influence on the growth and health of plants, soil analysis is a crucial part of field inventories. For this purpose, our soil respiration system (LI-870 & LI-8200-01S) measures CO_2 and water vapor emitted by the soil. Our soil analysis kit with test kits for comprehensive analyses of soil samples, a Munsell soil color chart for soil classification and a penetrometer for soil compaction determination help to investigate soil qualities of research sites.

Item name	*Category*	*Manufacturer*	*Comments*
LI-870 CO_2/H_2O Gas Analyzer & LI-8200-01S Smart soil chamber	Soil Gas Flux Analyzer	LI-COR	Semi-Automated system consisting of a smart chamber and a gas analyzer
Visocolor soil analysis kit with PF-3	Soil analysis	Macherey-Nagel	Fully equipped soil analysis kit
Munsell soil color chart	Soil analysis	Munsell Color	Internationally known classification and determination tool for soil and rock samples
Penetrometer	Soil compaction	Step Systems	

7. Hardware and Software Suite for detailed tree measurements

A suite consisting of hardware and software of Regent Instruments for a range of analyses of different tree organs (from root to crown) offers a wide range of complementary measurements and analyses. The analysis via software is based on scans and digital photographs of the respective sample. (WinSCANOPY: see “2. Hemispherical photography and light measurements”)

Item name	*Category*	*Manufacturer*	*Comments*
WinRHIZO	Root analysis	Regent Instruments	For morphology, topology, etc.
WinDENDRO	Wood analysis	Regent Instruments	Tree-rings & wood density
WinCELL	Wood analysis	Regent Instruments	Wood structure & wood cells
WinFOLIA	Broad leaf analysis	Regent Instruments	Area, morphology, and disease symptoms

WinSEEDLE	Needle and seed analysis	Regent Instruments	Area, morphology, and disease symptoms

8. Thermal imaging

To take and evaluate thermal images we possess a professional thermal infrared camera.

Item name	*Category*	*Manufacturer*	*Comments*
FLIR T530	Infrared camera	Teledyne FLIR	Pivotable objective

9. Occupational safety

To check for hazardous metal objects and obstructions by metal, be it for soil analyses, tree trunk coring, or marking of plots with poles, our metal detector can be used to see whether the site in question is safe. To reach elevated places (e.g. on trees), we have two ladders with safe stand. One smaller leaning ladder and one free standing ladder which also reaches to the crown of many city trees. We also possess safety helmets, hearing protection, safety goggles, safety work gloves and safety work shoes to avoid injuries as well as a first aid kit, should an injury occur.

Item name	*Category*	*Manufacturer*	*Comments*
Equinox 600	Metal detector	Minelab	waterproof (up to 3 m underwater)
“Monto Sprossen-Mehrzweckleiter Tribilo”	Rung ladder	Krause Systems	up to 5,45 m working height (in A-configuration) or 7,65 m working height respectively (leaning configuration)
Telescopic ladder	Rung ladder	Hailo	1,11 - 3,80 m
3M Safety helmets	Head protection	N/A	
3M Ear protection	Ear protection	N/A	
Safety goggles	Eye protection	N/A	
Safety work shoes	Foot protection	Engelbert Strauss	
Leather work gloves	Hand protection	Keiler Forst	
Fabric & rubber work gloves	Hand protection	Towa	
First aid kit	First aid	Holthaus Medical	