As part of the Stability of Altered Forest Ecosystems (SAFE) Project in Sabah (Malaysian Borneo), we used a laser technology to study structure and fine-scale spatial distribution of trees in two-digit and logged forest.

Field-Mapping technology:

**Laser rangefinder**

Measures distances and vertical angles (can be also used to measure targets). Principle: Measures distances, horizons, and vertical angles between two points. Laser light is emitted from the rangefinder, and the time it takes for the light to return after being reflected back from a target is measured to determine distance. Laser rangefinders are useful for tasks such as surveying, land measurement, and mapping.

**Electronic compass**

Measures horizontal angles. Hardware specifications:
- **Size:** 6 x 3 x 1.5 cm (2.4 x 1.2 x 0.6 in)
- **Weight:** 120 g (4.2 oz)
- **Power Supply:** 2 x AAA batteries (2-3 V, 1.5 V alkaline or lithium)
- **Accuracy:** ±0.5°
- **Environmental:** Operating temperature: 0° to 50°C (32° to 122°F), Humidity: 0-80% RH, Shock: 100 G (axial, 0°)

**Laser rangefinder combined with electronic compass**

TruPulse (Laser Technology Inc., USA)

- **Accuracy (Max):** ±0.3 mm (0.01 mm)
- **Accuracy (Typical):** ±0.5 mm (0.02 mm)
- **Measurement Range:** 0.76 m to ∞
- **Dimensions:** 6 x 3 x 1.5 cm (2.4 x 1.2 x 0.6 in, 2.4 x 1.5 x 0.6 in)
- **Weight:** 222 g (0.5 lb)
- **Power Supply:** 3 x AAA batteries (9 V, 3 x 9 V, 1.5 V alkaline or lithium, 3 x 6 V, 1.2 V alkaline or lithium, 3 x 6 V, 1.2 V lithium)
- **Accuracy:** ±2 mm (0.1 mm)
- **Environmental:** Temperature: -20° to 50°C (-4° to 122°F), Humidity: 0-90% RH, Shock: 100 G (axial, 0°)

**Rugged laptop**

E100 - NotePAC

Hardware specifications:
- **Weight:** 1.0 kg
- **Power supply:** 100-240 VAC, 50/60 Hz (72 W, 13.8 V DC, 2.1 A)
- **Dimensions:** 335 x 235 x 37 mm (13 x 9.2 x 1.5 in)
- **Environmental:** Temperature: -10° to 60°C (-14° to 140°F), Humidity: 0-95% RH

**Czech person**

Basu features:
- **Weight:** 78.6 kg
- **Power supply:** 100-240 VAC, 50/60 Hz (72 W, 13.8 V DC, 2.1 A)
- **Dimensions:** 335 x 235 x 37 mm (13 x 9.2 x 1.5 in)
- **Environmental:** Temperature: -10° to 60°C (-14° to 140°F), Humidity: 0-95% RH

Field-Mapping software v. 1.0

**Field-Mapping Project Manager & Field-Mapping Data Collector**

Field-Mapping Project Manager defines a database structure of a Field-Mapping Project. Data fields include points, trees, polygons, transects, etc. Field-Mapping Data Collector uses the Field-Mapping Project to collect data from laser rangefinders, electronic compasses, GPS, electronic calipers, etc.

Principles of field data collection using the Field-Mapping software:

1. **Laser beam**: A laser beam is emitted from the laser rangefinder and reflects off a target (e.g., a tree). The time it takes for the laser beam to return is measured to determine distance.
2. **Accuracy**: The accuracy of the rangefinder depends on factors such as the distance to the target, the quality of the laser, and the environment. Typically, accuracies range from ±0.3 mm to ±2 mm depending on the type of rangefinder.
3. **Environmental conditions**: The accuracy of the rangefinder can be affected by environmental conditions such as temperature, humidity, and atmospheric pressure. It is recommended to calibrate the rangefinder regularly.

**Additional features of Field-Mapping Data Collector**

- **Tree layer - stem profile and DBH-H form**: Measuring horizontal projections of vertical profiles. The horizontal projection is measured at the perimeter of the crown projection.
- **Hemispherical photos**: Measuring the hemispherical projection of the canopy.

**Output examples from Field-Mapping the SAFE Project**

- **Plot 600**: Two-dimensional map in Data Collector
- **Plot 601**: Two-dimensional map in Data Collector
- **Plot 602**: 3D visualisation in ArcScene
- **Plot 603**: 3D visualisation in ArcScene
- **Plot 604**: Hemispherical photographs
- **Plot 605**: DBH distribution and DBH-H graph in Data Collector

The data (tree positions, DBH, height, species, and light conditions) which were collected by pre-logging Field-Mapping will serve as a baseline for future re-measurements. Repeated Field-Mapping of 25x25 m ‘vegetation’ plots is planned every year to capture the effect of forest fragmentation on the dynamics of (especially small) trees at the fragment edges and centres.