"KNOWLEDGES FROM TWO-YEARS APPLICATION OF THE FIELD-MAP TECHNOLOGY IN NFI IN SLOVAKIA"

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1. NFI IN SLOVAKIA

National forest inventory in Slovakia is realized for the first time. During 2005-2006 field data collection is performed in grid 4x4 km. The sampling units are inventory plots (IP) and their number is 1485. Four types of plots are used: A a constant circle with the radius of r = 12,62 m for detecting terrain, site, stand and ecological characteristics, B two concentric circles (r = 3 m and 12.62 m) for detecting tree characteristics of $d_{1,3}$ diameter $d_{1,3}$ = 7 - 12 cm and $d_{1,3}$ 12 cm, C a variable circle for thin trees with diameter $d_{1,3}$ < 7cm, (r = 1.0 m, 1.41 m or 2.0 m will be chosen according to the concrete tree density), D an enlarged constant circle with the radius of 25 m established for the inventory of forest edges, forest roads and water resources.

In field works 6 configurations of Field-Map (FM) were utilized, whereof one of them served to control measurements. Applied software was Project manager and Data Collector, version 5. Basal technology was used in addition with GPSmap 60C. Field-Map was permanently used during whole season from April to October yearly.

2. TECHNOLÓGIA FIELD-MAP

It presents current highest technology for data collection of forest ecosystems. It is being developed at the Institute of Forest Ecosystem Research, Ltd. (IFER) Monitoring and Mapping Solutions (Czech republic) from 1992.

http://www.fieldmap.cz/

1: Against traditional technologies, Field-Map considerably relieves Navigation

3. ASSESSMENT OF TECHNOLOGY ACCORDING TO INDIVIDUAL ACTIVITIES USED IN NFI IN SLOVAKIA

3. 1) Navigation

- The technology made easier navigation from navigation point and simplified accurate finding of IP in comparison with traditional technologies (map, compass). In the navigation there were used tracks with the footstep 10-30 meters in forest and 30-60 m in free area. Maximal total length of track in field works was something more than 700 m; usually there were used lengths 200-300 m.
- Starting navigation point being searched for by means of GPS instrument proved only with sufficient signal. The accuracy of the stabilization of navigation point was 3-5 m; in case of worse signal it was 7-10 m. With insufficient signal we recommend to use orthophotograph if good and clear identification of position is possible (crossroad, crossing of brooks, forest border, distinct tree, corner of a building, construction, fencing, etc.). The position is determined by direct pointing on the display of monitor. The accuracy of position determination depends on the resolution of orthophotograph (in our case resolution 1 m, accuracy 2-5 m).
- Duration of navigation depended on the signal receiving, selection of navigation point, passable terrain and distance. Average time of navigation in NFI was 23 minutes, minimal 2 minutes and maximal 1 hour and 15 minutes.

3. 2) Locating plots and sub-plots

- Field-Map enabled easy determination of plots, mainly on the slopes with greater aspects through automated calculation of inclined and horizontal distances. Non-centre targeting has a great advantage in demarcating when the movement of measuring instrument around IP centre could damage the vegetation and other evaluated elements.
- The accuracy of targeting horizontal distances is not specified concretely by the producer, the producer of laser Forest Pro gives the accuracy 3 cm for 25 m up to 5 cm for 150 m. During NFI the deviations according to our findings represented in navigation (distance 20-60 m) up to 10 cm and in demarcating inventory plots (radius 12.62 m) max. 5 cm and only exceptionally up to 10 cm.
- Error of area determination and trees attributes on IP with the area 500 m^2 with the error of measurement 1cm represents 0.2%, error 5cm already 0.3%, but error 10cm almost 1.6% of the area. The errors are greater with smaller IP. With greater number of IP they can equal but only in case if they are alternately positive and negative, if they are still of the same sense, they are getting systematic character and are loading very unfavourably and unanimously whole result of monitoring.

3. 3) Targeting of the objects positions

- Targeting is like very easy and not difficult movement and slight stabilization of the position of the instrument. With trees we appreciate a possibility of targeting by putting reflecting object on the margin of tree from the direction of targeting, or from the side (advantage for trees growing inclined). The trees must not be marked permanently in the field, their position identification is unanimous.
- We are less satisfied with the accuracy of targeting (the same as with plots demarcating) when errors with so called border trees are especially dangerous, similarly to the trees lying on the border of IP or closely to IP. Here already a small error ± 0.1 cm can cause that the tree is improperly classified into IP or is left out of IP. Thus the error in the number of trees (N) or their volume (V) depends in general on the diameter of border tree and on the size of IP (on smaller plot it is greater). But errors do not occur very frequently. Probability of their occurrence depends on the density of the stand and the length of the circumference of used IP (it is with the size 1000 m^2 IP three times greater than with small 100 m^2 IP). In our database the relative number of border trees that are in the zone being shorter by 1, 2 and 5 cm than r = 12.62 is 0.1, 0.2 a 0.6%.
- It is important to be aware of all possible sources of errors and with the aim of their elimination it is necessary to observe very carefully the rules for the measurement of trees position, mainly if the trees are inclined, curved and border trees, and to check up from time to time the result of measurement by Field-Map technology also through its comparing with directly measured distance by traditional method (tape).

3: Risk of incorrect targeting threats especially by slanted and boundary trees

3. 4) Measuring of trees heights

- Field-Map Technology facilitates easy targeting of the heights of trees and crowns setting. Mode of measurement with the use of trees position (mode B) proved well when after measuring the position of trees the instrument stabilized in a way to be able to see as many trees as possible from one point (place) and central reflecting object whereas tree foot must not be seen.
- Though the value of the height is rounded up to two decimal places, the accuracy of determination of the height by Field-Map technology is liable to the same regularities as for other height measuring instruments based on trigonometric principle, while this technology is influenced by three factors: characteristic of the measured object (uncertainty in the determination of intentional point top of crown), own instrument and subject (worker who is measuring), therefore individually measured value always differs to some extent from the actual height. Based on recent knowledge that were published by ČERNÝ et al. (2006) practically reachable accuracy of the measurement of heights with Field-Map is ± 0.5 up to 1.0 m (2.5 up to 3.5 % with 68 % reliability), what corresponds also to our experimental measurements and it is in accordance with the framework of accuracy that is reached for altimeters Wertex, Blume-Leiss and mirror relascope (ŠMELKO 2000). But it provides greater measurement comfort and already mentioned variants of measurement.

3. 5) Recording of data and preliminary check-up

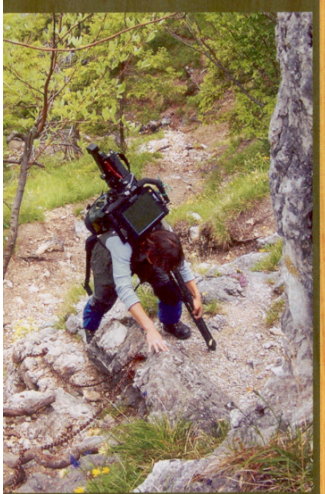
- Automated input of data into computer directly in the field saved the time for further editing. Check-up of data is done in certain cases already during inputting (restriction by maximal and minimal required values), but software enables the check-up of complete database what brings about an advantage especially in larger projects. We recorded insufficient consistence of checking on all hierarchical levels of the project structure.
- Acquirement of primary results directly in the field enabled making other evaluated data more accurate (e.g. composition of tree species in ecological assessments, selection of candidates for the measurement of heights), also immediate computation of areas proved well (percentage) of individual subplots in whole area as well as direct visualisation of elements on the monitor immediately after targeting. We consider for further processing a great advantage the automated assigning of individual point objects to the subplots according to their actual position.

Foto 2: Advantage of automatic cont of slope and horizontal distance is most demonstrated in steep terrains

Foto 2: Using of the tripod instead of monopod proved to u reliable by works in exposed localities

4. ASSESSMENT OF TECHNICAL PARAMETERS (RESISTANCE, ERGONOMICS,

- After permanent use of the FM in difficult field conditions we assess its usability as suitable. Despite that we want to show at some shortcomings on the basis of our experience. Proclaimed water resistance of instruments recommended to use them in humid weather or in slight raining. Water resistance of field computer showed as good but despite that the whole technology can be used in unfavourable weather only to such extent that is suitable for the least resistant part. In one case we had to change moist telescope, in another one laser. We recorded also problems with contacts on cables connecting the computer, laser and compass. Some failure of software occurred as well, e.g. loss of license but it was eliminated operatively.
- During longer work in one place we did not use monopod in contrast with basic technology but tripod that enabled permanent stabilization of the position though it caused small physical exertion of the worker who executed measuring as well as some small inaccuracy of measurements. But we do not recommend using tripod in using the Field-Map for mapping with frequent movement of the instrument.
- Field-Map consists of several components what reflected also in transportation in the field. In addition to instruments and batteries the workers must transport also the frame and tripod, set of marking poles and other material necessary for the work. There are needed for the transportation minimally two, but better if they are three workers in good physical condition.
- Some disadvantage of the FM is the need of electric current. The most difficult field computer requires permanent recharging of batteries by means of lead accumulators, during the day they were changed 3-4 times. With short distance of IP from the road we used also recharging of Field-Map with help of voltage changer from car battery. Other instruments (laser, compass) being driven by batteries AA had to be recharged as well (every 2-7 days). The disadvantage of lead accumulators was mainly their weight as the whole necessary equipment had higher weight too.



5: Transport of all components of Field-Mapu is often difficult in the field

Foto 6: Total water resistance limited by minimum resista individual components (laser, telescope)

5. CONCLUSIONS AND RECOMMENDATIONS

- Based on practical experience and control measurements with Field-Map during two years in Slovakia we can state that this technology proved very well and it meets required parameters.
- In considerations which technology of data collection in the field to choose for forest inventory and similar surveys in forestry and ecology we can recommend Field-Map if it is more complex monitoring of a large number of attributes and parameters and their mapping, when the possibilities of this technology can be fully utilized.
- For detection of smaller information spectrum and for the cases when detailed mapping of the objects is not necessary then various combinations of more simple measuring instruments and field portable computer (recorder) can be used.
- Economic criteria (the price of technology and the extent of its utilization) must be always taken into consideration.
- It is necessary for any technology to train working groups and to observe strictly generally known or some specially determined rules for gathering field data.