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Centralparks
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D.T2.1.2
FOREST STATE EVALUATION PROTOCOL

Forest stet evaluation methodology for the effect monitoring of forest utilizations

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Let's Get Wild!

Content

1. Introduction

A huge area of Börzsöny mountain is part of the Danube-Ipoly National Park. The native vegetation is deciduous woodland. The understanding of natural processes is a must for long-term conservation. It is precisely for the reason why it had to revise. Presisely for this reason, it was necessary to revise the forest evaluation method and update the dataset that was gathered in the SH-4/13 project (). Furthermore, the evaluation method of forest management effects and the sampling method for Börzsöny mountain itself had to be worked out.
First and foremost, possible effects were the use of wood, forest management interventions, and natural disturbances (like ice breaks).
Technical developments in the monitoring system were also included.

The new methodology has to follow the structure of the systematic forest state assessment methodology, developed within the SH4/13 project (http://karpatierdeink.hu/eng/1-feladatcsomag) and was introduced in the workshop (D.T2.1.1) and toolkit (D.T2.1.1 https://www.interreg-central.eu/Content.Node/Centralparks/Centralparks-CE1359-O.T2.1-Joint-strategic-document-on-ra-5.pdf).

2. Antecedent

2.1. Background project

The SH-4/13 project was led by Danube-Ipoly National Park Directorate. The project area was Natura 2000 sites of North Hungarian Mountains including Börzsöny, Mátra, and Aggteleki-karst. Numerous conservation researches on woodland birds, bats, and xylophagous insects were carried out. In order to protect woodland communities, the first step is describing the present states of forests. That deep knowledge is essential to understand the needs of valuable and protected species. Before this project, there was a huge lack of information and monitoring systems as well. Therefore the two main goals of the project were:

1. To set up a forest evaluation methodology
2. To make a baseline survey on a large scale

The main aim was to create a new methodology with numerous perspectives and to develop a tool for evaluating woodland habitats on a fine scale. A lot of variables were determined during development. The huge number of variables guaranteed a versatile assessment possibility. The new method supports forest and conservation management during planning and controlling.

The sampling method was based on a systematic point network. The area of a sampling point is 500 m^2. The most relevant variables are the amount of live and dead wood, the layer of herbaceous plants, and the microhabitats. A subplot was described in the middle of the plot. In each subplot, all young bush and tree individuals were recorded. Between the two plots, the valuable microhabitats and fresh natural disturbances were recorded.

Fieldwork was carried out from 2014 to 2016. During the project, almost 60.000 plots were sampled. The results were published in the ROSALIA journal. In this report, only the results from the Börzsöny mountain are represented.

In Börzsöny 35048 sampling points, covering almost 29100 hectares, were recorded. The density of sampling points was different. 1, 2, or 4 sampling points per hectare was applied. More sampling points were applied on more naturally disturbed sites. The different density methods used are shown in figure 1.

2.2. Lessons learned from the preliminary study of monitoring

The goal of the 6th work package of the SH-4/13 project was to develop and test a monitoring method which is an effective tool to get acquainted with the effects of different activities and management actions, carried out in the planned forests.

The general objectives included several projection tasks. We will illustrate them with the following examples:

i. The monitoring of the process to convert envisaged forest management into continuous forest-covered management.
ii. The examination of the effects of cutting on forests, how the forest state characteristics depend on management.
iii. The examination of the effects on the framework of nature conservation purposed forest management activities and treatments and hie they affect the forest biome, as well as the monitoring of how the forest state characteristics depend on these treatments.

Within the SH-4/13 project, only the initial phase could be implemented, due to the limited time frame.

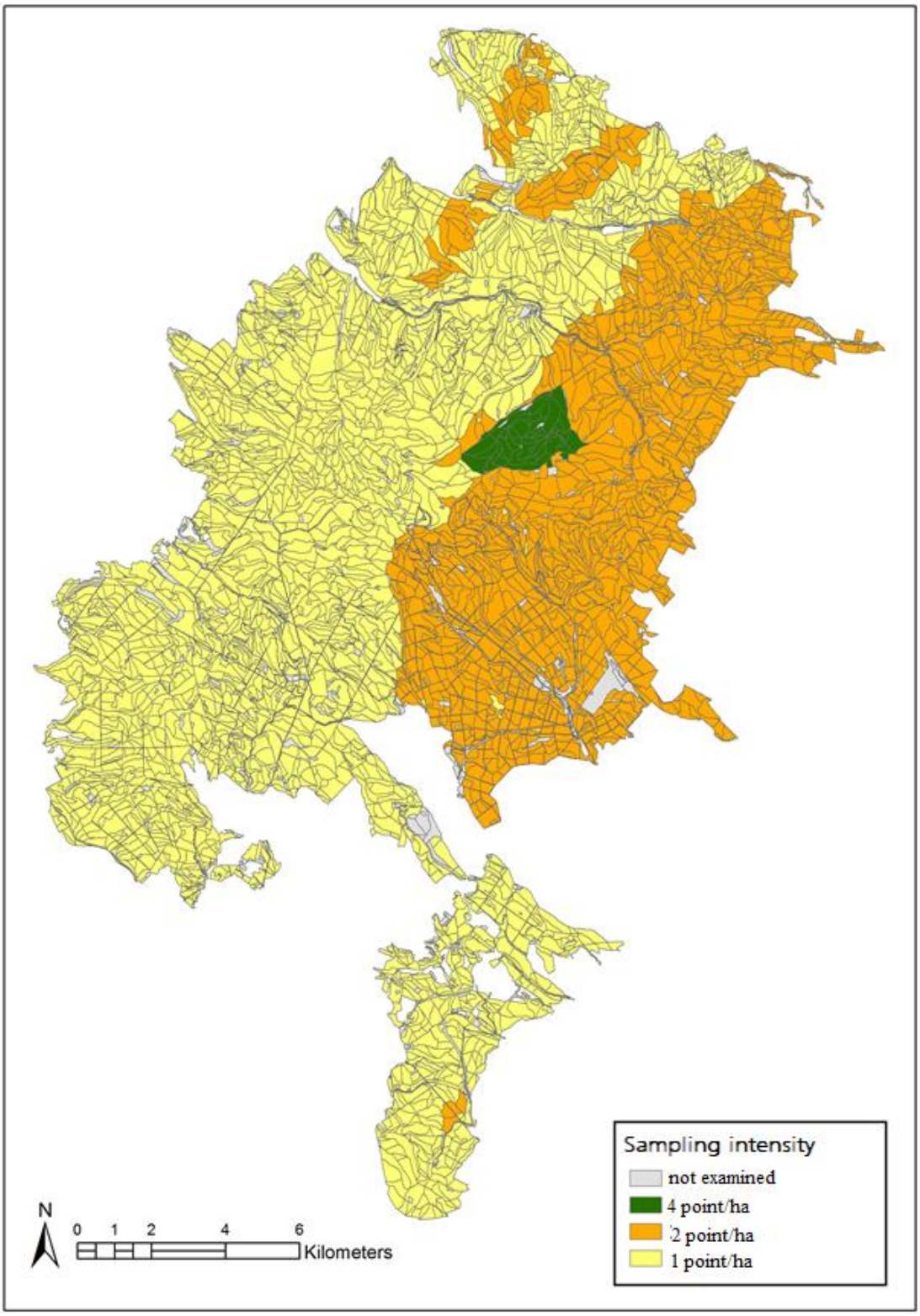


Figure 1: The arrangement of the forested areas in the Börzsöny mountains with sampling point density (Standovár et al. 2017)

The development of an impact monitoring system aimed to be the simplified version of the forest state evaluation protocol, based on previous experiences. We developed the methodology because we shared the belief that:

- the forest state evaluation methodology covers the variables needed to answer the goals of the methodology;
- The more than 10 thousand point sampling during the implementation of the forest state evaluation served as a good base to formulate a valid opinion on the accuracy, the amount of time demanded, and the reproducibility of the examination of different variables.

The diversity of possible goals requires a flexible method regarding the user's requirements. The technical implementation demanded further development of the android application (ForestDataCollect).

To test the idea, we looked for a forestry unit, managed by the Ipolyerdő LTD Nagymaros and Királyrét Foresters, which met with the following criteria:

- its area is more than 8 ha
- the last tree utilization happened after the survey in 2015.

Then, 4 examined plots were selected following the criteria, where different kinds of utilization took place (TKGY- selection thinning, NFGY – increment thinning, SZV-selection cutting).

In the selected forest plots, on every previous point, the forest state evaluation was carried out according to the protocol, except the line sampling. Furthermore, a short characterization description was added to justify the general tree utilization.

During the impact monitoring (positive and negative effects) changes were well demonstrable in the different types of tree utilization:

The proven positive effects	**The proven negative effects**
preservation of mixture tree species	control of mixture tree species
preservation of the diameter distribution	degradation of diameter distribution (e.g.: lower-level thinning/cutting)
tolerance of standing dead trees	limiting standing dead trees
expansion of lying dead tree quantity	intensive soil disturbance
gentle approach	accumulation of disturbance indicator plants
expansion of microhabitats	liquidation of microhabitats

The most important lessons learned during the previous experiences – for developing the monitoring methodology - were the following:

1. The forest state evaluation protocol developed within the project SH-4/13, in the case of many variables uses a rough prediction scale and it will not be perpetuated.
2. All of its attributes make the methodology able to describe the character of a bigger area (approximately 10 ha) with the usage of many sampling points (1-2-(4) point/ha).
3. The joint use of the summarized coordinates and documented photos allowed the retrieval of the exact points with high accuracy (in such a short-term).
4. During the point-based comparison, the differences within the predicted values could occur from prediction failure (from the first or second survey) as well as it could indicate actual changes.
5. In parallel to the repetition of the survey, the describing field notes could have high importance during the evaluation phase, e.g.: specific questions related to usage (e.g.: is there any sign of eliminating coarse-limped trees after the completion of care and clearing?).
6. The different part of the original protocol was relevant in the case of a different tree utilization. In the case of treatments, protocol development, and supporting application, flexible usage of relevant variables is suggested.

3. The aspects of the monitoring system creation

3.1. Realistic goals, thematic coverage

This chapter will review the effect of monitoring's feasible goals and the effective/restrictive factors provided.

Before planning the exact proceedings and sampling, the first task was the valuation of feasible goals. Concerning the special case (specialization on only a few countries), that is a protected forest of a national park, nature conservation, forestry, and other management goals (e.g.: tourism, hunting) shall be implemented in parallel. Clarification of what effects will and could be monitored is crucial. The main focus was originally on two groups of effects:

1) **Tree utilization:** determination includes all of the intervention/logging types carried out within the forestry activities and affected most of the forest in the Börzsöny mountains. Including the types of the cutting method, revealing: previous and end-users, the non-cutting methods, and other intervention types. The available data distinguish the following types of interventions:

- tisztítás – clearing (TI)
- törzskivágó gyérítés
- növedékfokozó gyérítés
- felújítóvágás bontóvágása
- felújítóvágás végvágása
- tarvágás – clearcutting
- szálaló vágás - selective cutting
- készletgondozó használalt (szálalás) – assortment care usage (selective cutting)
- haszonvételi gyérítés - Thinning for production
- egészségügyi fakitermelés – health care logging
- other production

Given that there are many types of interventions (11 altogether), the representation's extend of the different types has to be decided.

2) **Natural disturbances:** focusing the abiotic effects of the Börzsöny mountain from the last 2-3 years (wind, ice, and snow damage) and the biotic effects of the individual species [e.g.: Picea – European spruce bark beetle (*Ips typographus*); ash (*Fraxinus excelsior*) – Chalara fracinea fungi species].

The main focus does not include the following possible (and needed) intervention types, but the monitoring of its effects is also important and worthy:

3) **Arboriculture interventions:** the interventions happening before the renewal (shrub removal, soil preparation), tree replacements, and care activities.

4) Nature conservation management: ideally any intervention focusing especially on a nature conservation purpose. For the monitoring, we also should focus on these types, even though there are currently not many concrete examples for it in the Börzsöny mountains.

5) Control: there is an absolute need to monitor a forestry unit, where are no interventions according to our best knowledge (or the nature conservation management means no intervention at all), to have any information on the changes caused by spontaneous forest development, to be able to evaluate the effects of the different intervention types.

3.2. .Supporting data for planning

One of the bases for the monitoring planning was the 36.000 point database surveyed from 2014 to 2016 during the SH-4/13 project. The time of the survey was crucial information in the elaboration of the previous state, next to the objective description of the state, and the 216.000 documentation photos to reconstruct and find the previously surveyed points (2nd figure).

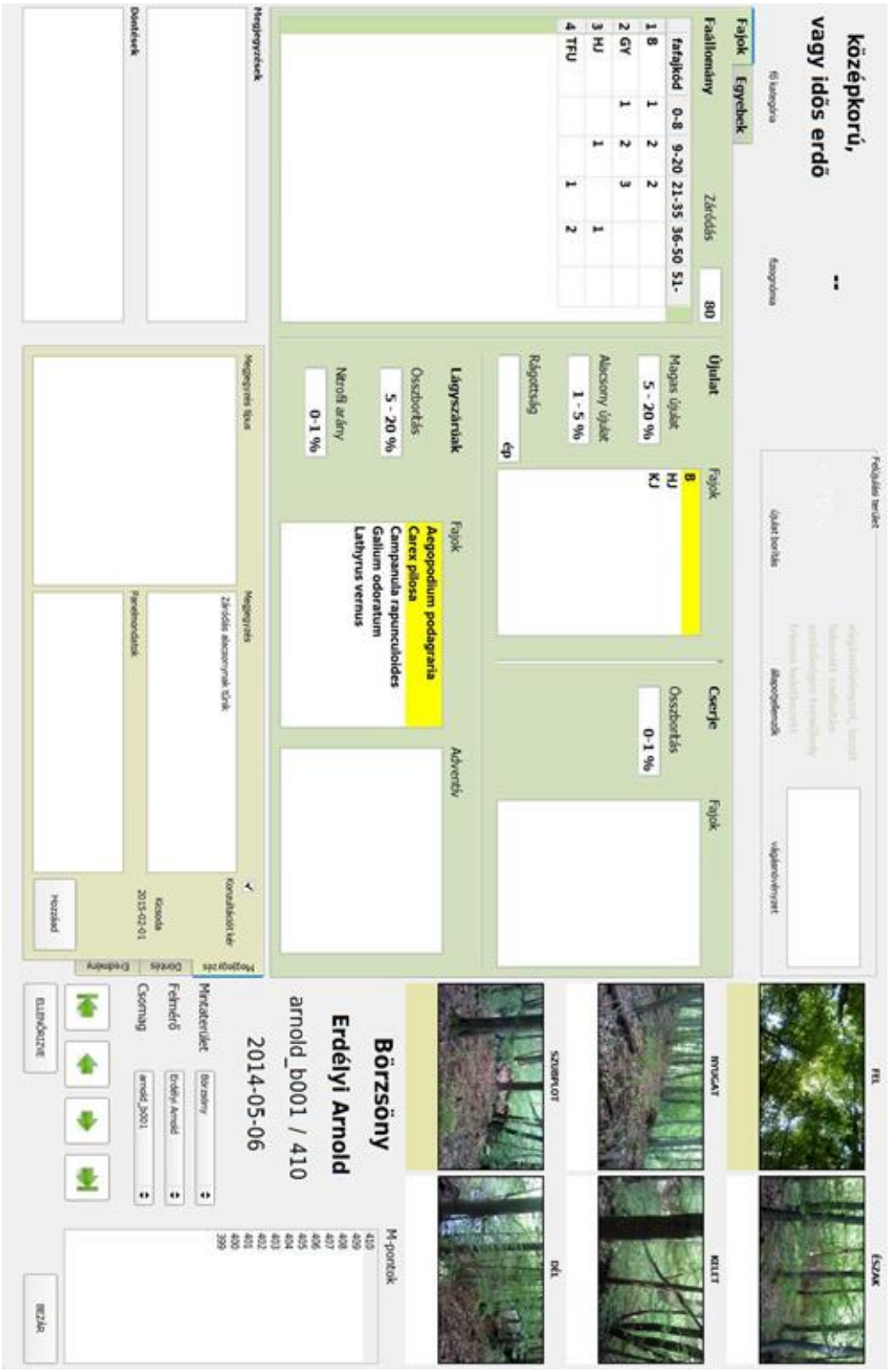


Figure 2: The surface supporting data-control with documentation photos.

The actual forestry maps were available during the process, which makes the tree utilization of the forest plots traceable. The relevant data from the maps were the following:

- identifier of the forestry plans
- area
- forest manager
- management mode
- tree population type
- age
- primary and other function
- naturalness
- the criteria for natural state
- year of the last usage (the freshest data was 2019)
- the type of the last usage

The joint use of these two databases allowed to detect of each point from the SHG-4/13 project, whether it was involved in any kind of tree utilization or not, the data from the database could have been validated (not counting the spontaneous changes, figure 3.).

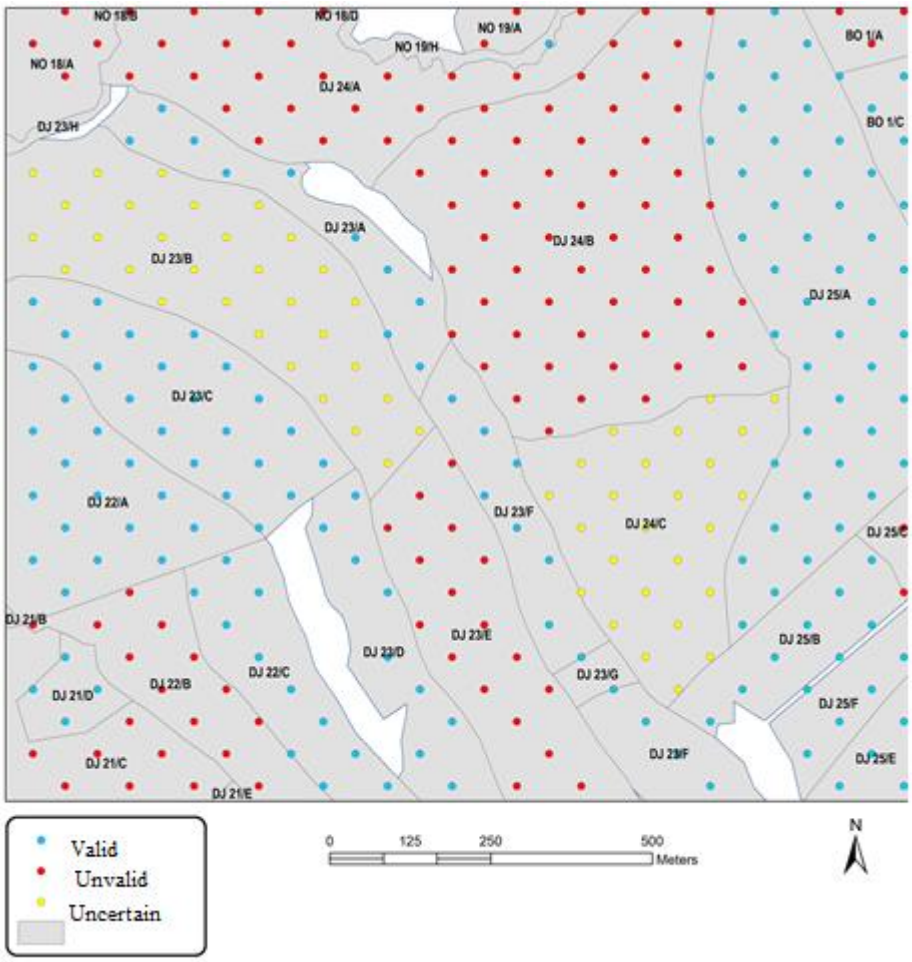


Figure 3: the validity of the SH project points (valid, if UHA year <year of the survey; obsolete, if UHA year > year of the survey; uncertain, if UHA year = year of the survey.

Consequently, this picture shall not be considered complete or precise, since there is no information on the territorial distribution and the intensity of certain interventions (whole or part of the forestry unit). The analysis (figure 3) shows a much bigger quantity of the point as obsolete than it was justified by the actual situation.

At the same time, there are no available data from interventions carried out during the 2019/2020 winter-spring and current interventions, which could also increase the number of invalid points. The data for the classification of cutting in forestry management plans were available, but there were no available data on the performed usage.

There is an ongoing negotiation with Ipolyerdő Ltd. (forestry managers) to have more precise data on the carried tree utilization and forestry activities from the forestry register.

most of the available data come from the natural disturbances in the area of the Börzsöny mountains, the ice-damage from 2014. There are no systematic data on any further natural disturbance.

4. The creation of the suggested effect-monitoring system

4.1. .The data-collecting protocol

The main product of the previous project was the development of a forest state mapping methodology and the survey carried for approximately 50.000 ha of forest. The effect monitoring system is developed to evaluate the forest states according to the experiences gained and in a simplified version.

The reason behind:

- the forest state evaluation method covers the variables to answer all of the aims;
- The more than 10.000 points surveyed from the forest state evaluation protocol give a proper base to have an experienced opinion on the certain variables' accuracy, the amount of time spent, and the reproducibility of the prediction.

The diversity of possible goals requires a flexible method regarding the user's requirements. The technical implementation demanded further development of the android application (ForestDataCollect).

The new protocol has to meet several, contradictory criteria, while compromise according to the following:

- The survey has to be fast, which means the unnecessary variable has to be missed from the protocol, to lower the time spent with it;
- The data obtained has to give a full picture of the effects of interventions/disturbances, in short, the most probably non-changing variables (e.g.: rocks, regional microhabitats) have to be eliminated from the protocol;
- The protocol has to be complex, to adapt the detection of changes caused by certain intervention types;
- The protocol should include less bifurcation, to make the construction blank easy to handle.
- Implementing the aforementioned semantic definition, the next 3 charts demonstrate the protocol.

The first step of the survey, the first response, is the intervention-type. A conclusion that, while answering the usage of the forestry unit parts, we have to decide, whether the intervention was carried out or not. If the intervention happened: how intensive was the intervention. In the same plot, several main categories could appear (e.g.: FVV- the years in the period from the first intervention: renewal area). If the intervention was not varied out, the middle-aged or old forest category should be added. The next 3 charts include the main variables mentioned or missed during the survey according to the main categories. The chart may include many 'green cells', but

that only occurs because there are many uncertain possibilities while examining a forest plot, which cannot occur or cause an error within the process. For example, in the case of clear cuttings, the program will ask what to record in a young forest, but it could be only answered in an occurred error. At the same time, while surveying younglings, the protocol may appear less detailed, but in the case of the major intervention type, it is impossible to add this category to the field.

In the case of the control forest spot, we suggest using the original protocol.

The arboriculture interventions evaluation takes part when there is a piece of information in the forest-block exceeding.

Chart 1: The variables which the surveyor should adopt (green) and should not adopt (red) in the case of middle-aged or old forests plot, following the tree utilization.

Chart 2: The variables which the surveyor should adopt (green) and should not adopt (red) in the

Middleaged - old forests											
		Type of intervention									
Sampling unit – Variable group	Variable group	TI - purification	TKGY - selection thinning	NFGY - Increment thinning	FVB - regeneration cuttting preparatory cut	FW - regeneration vutting's final cutting	TR - clear cut	SZV - selection cutting	KGH - sotck-care utilization	EÜ - sanitary thinning	ET - other production
Section:	Presence of the regional microhabitats										
	Fresh presence of tree disturbance										
	Presence of extreme sized trees										
	Presence of then aggressively distributed alien species (invasive alien species)										
	Traces of life and presence of determination species										
	Natura 2000 species										
Plot	Main category										
	Presence of a tree stand										
	Physiognomy										
	Closure of the trees										
	Diversity of the trees										
	Debarking damage										
	Anthropogenic tribe damage										
	Is there standing deadwood of tree stub?										
	Lying or other dead there										
	Full coverage of herbaceous plants										
	Dominant herbaceous plants species										
	Habitat determination herbaceous plants										
	Presence of adventive herbaceous plant species										
	Native nitrophilous and damage-indicator species ratio										
	Microhabitats related to tree stand										
	The extent of soil damage										
	Type of soil damage										
	The extent of rocky areas										
	The scale of rock sizes										
	Alien shrub species and renewal in 500 m2										
Subplot	Shrub coverage										
	Dominant shrub										
	Habitat determination shrub										
	Renewal coverage										
	High renewal coverage										
	Low renewal coverage										
	Dominant species of the renewal										
	Other species in the renewal										
	The chewing damage of the renewal										
	Does the rate of stub-offsets higher than 20%?										
Notes											
Documentation											

case of the young forests plot, following the tree utilization.

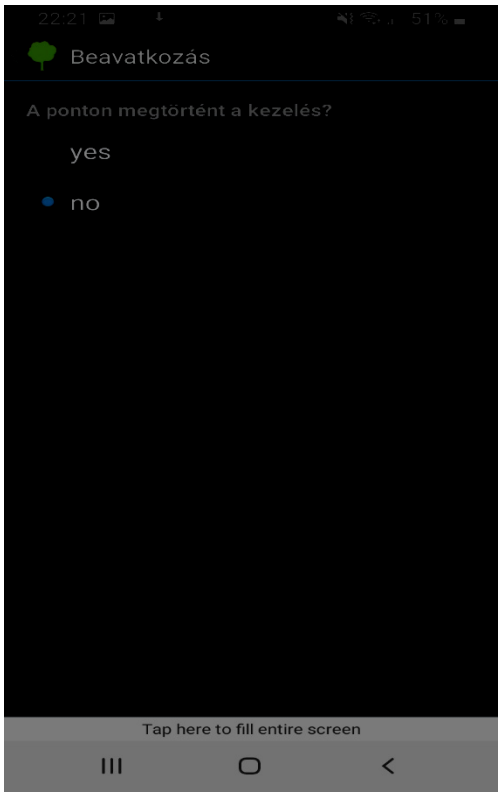
Young forests											
		Type of intervention									
Sampling unit – Variable group	Variable group	TI - purification	TKGY - selection thinning	NFGY - Increment thinning	FVB - regeneration cuttting preparatory cut	FW - regeneration vutting's final cutting	TR - clear cut	SZV - selection cutting	KGH - sotck-care utilization	EÜ - sanitary thinning	ET - other production
Section:	Presence of the regional microhabitats										
	Fresh presence of tree disturbance										
	Presence of extreme sized trees										
	Presence of then aggressively distributed alien species (invasive alien species)										
	Traces of life and presence of determination species										
	Natura 2000 species										
Plot	Main category										
	Presence of a tree stand										
	Closure of the trees										
	Diversity of the trees										
	Debarking damage										
	Anthropogenic tribe damage										
	Is there standing deadwood of tree stub?										
	Lying or other dead there										
	Full coverage of herbaceous plants										
	Dominant herbaceous plants species										
	Habitat determination herbaceous plants										
	Presence of adventive herbaceous plant species										
	Native nitrophilous and damage-indicator species ratio										
	Microhabitats related to tree stand										
	The extent of soil damage										
	Type of soil damage										
	The extent of rocky areas										
	The scale of rock sizes										
	Alien shrub species and renewal in 500 m2										
Subplot	Shrub coverage										
	Dominant shrub										
	Habitat determination shrub										
	Renewal coverage										
	High renewal coverage										
	Low renewal coverage										
	Dominant species of the renewal										
	Other species in the renewal										
	The chewing damage of the renewal										
	Does the rate of stub-offsets higher than 20%?										
Notes											
Documentation											

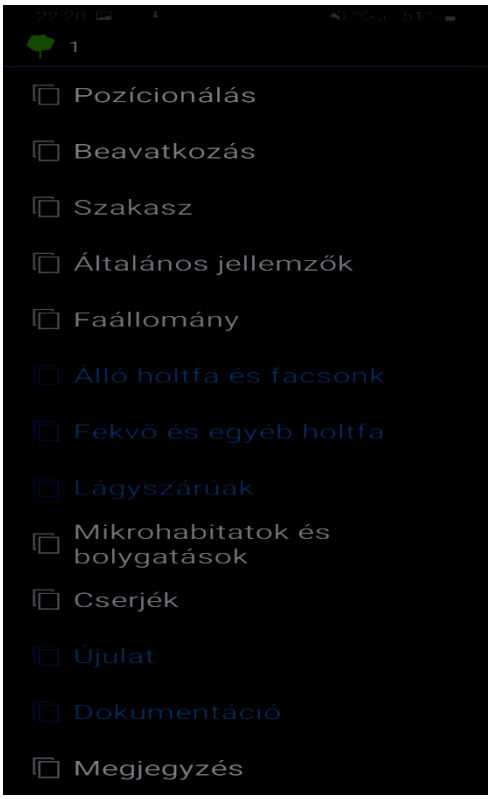
Chart 3: Section: The variables which the surveyor should adopt (green) and should not adopt (red) in the case of renewal plot, under the tree utilization

Area of renewal											
		Type of intervention									
Sampling unit – Variable group	Variable group	TI - purification	TKGY - selection thinning	NFGY - Increment thinning	FVB - regeneration cuttting preparatory cut	FW - regeneration vutting's final cutting	TR - clear cut	SZV - selection cutting	KGH - sotck-care utilization	EÜ - sanitary thinning	ET - other production
Section:	Presence of the regional microhabitats										
	Fresh presence of tree disturbance										
	Presence of extreme sized trees										
	Presence of then aggressively distributed alien species (invasive alien species)										
	Traces of life and presence of determination species										
	Natura 2000 species										
Plot	Main category										
	Closure of the renewal >70%										
	If < 70% what is the reason										
	Presence of trees										
	Closure of trees										
	Debarking damage										
	Anthropogenic tribe damage										
	Is there standing deadwood of tree stub?										
	Lying or other dead there										
	Habitat determination herbaceous plants										
	Presence of adventive herbaceous plant species										
	Microhabitats related to tree stand										
	The extent of soil damage										
	Type of soil damage										
	The extent of rocky areas										
	The scale of rock sizes										
	Alien shrub species and renewal in 500 m2										
Subplot	Shrub coverage										
	Dominant shrub										
	Habitat determination shrub										
	Renewal coverage										
	High renewal coverage										
	Low renewal coverage										
	Dominant species of the renewal										
	Other species in the renewal										
	The chewing damage of the renewal										
	Does the rate of stub-offsets higher than 20%?										
Notes											
Documentation											

The developed blank offers the different groups of variables flexibly, according to the type of intervention and main category, as appointed in the charts, as well as at the start of the survey the finished tree utilization is recorded. Furthermore, the screenshots will show that the type of intervention shall not be reordered, it is automatically read from the package. On the second screenshot, we can see the simple answer possibilities for the happened intervention. In the last picture, the different variables in a branch are visible (the light blue variables were not added).

A sample of the blank can be found within the digital annexes:





4.2. Support of the relocation

For the new best implementation of the new methodology, it is crucial to relocate the original survey points. The documentation photos are essential to relocate the original points. For this reason, it was necessary to develop a toll that could discriminate the photos for the relevant point (with this support the relevant pictures can be called down from then 216.00 photos on the field). Moreover, it was necessary to visualize the application in the field environment. The chosen application was SMASH, which is the new application of the company that also develops Geopaparazzi. The app can retrieve the documentation photos according to the location, based on the averaged coordinates, next to the background map (figure 4.). The individual pictures will be presented as “notes”, and the image notes related to one package could be uploaded in gpap extension on android mobile phones. One example of the gpap database is included in the digital annexes.

The steps of the database’s establishment:

1. The data of the selected package's (forest block) plot from the previous project database are retrieved: identification and nomination of the pictures, averaged positioning of the plot, the start of the plot recording, altitude of the plot.

2. To every picture taken to the plot (except the upward-facing picture 5-5 picture/plot) separate records are generated and are optimized to the recognition in the SMASH application. The picture is moved towards the compass direction, for example, the pictures taken from North are moved in a northern direction (Figure 5).

3. The preparation of the pictures and stamp-pictures is controlled, the pictures are individually identified to assure there is no duplication of the information.

4. An empty Geopaparazzi/SMASH project database got its field package name with the use of the recorded information mentioned above, the pictures, stamp-pictures, image notes, and the recognition information (position, altitude, date and time, name of the plot, direction of the picture taken) get uploaded to the database.

5. The generation of project databases is happening through python scripts and SQL retrievals and commands.

6. The so prepared project database could be used after copying and associating it to the smartphones (SMASH/project folder). The copying is manual so far, but the Geopaparazzi Server could allow the import of the project within the application.

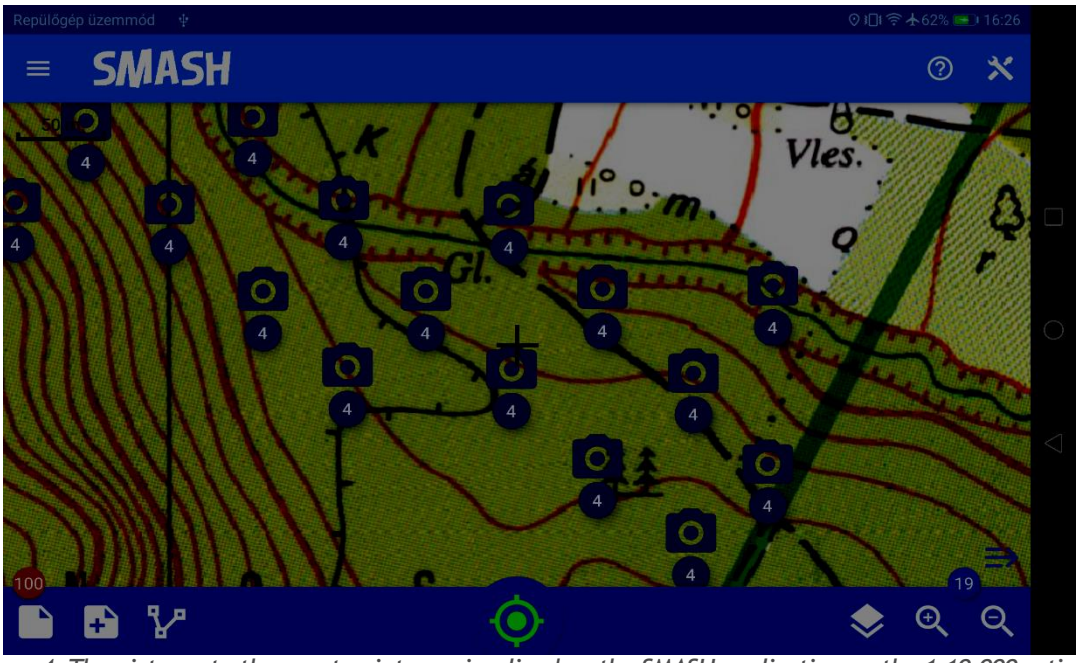


Figure 4: The pictures to the exact point are visualized on the SMASH application on the 1:10.000 ratio topography map as background. The numbers in the small circles show the number of pictures after zooming in.

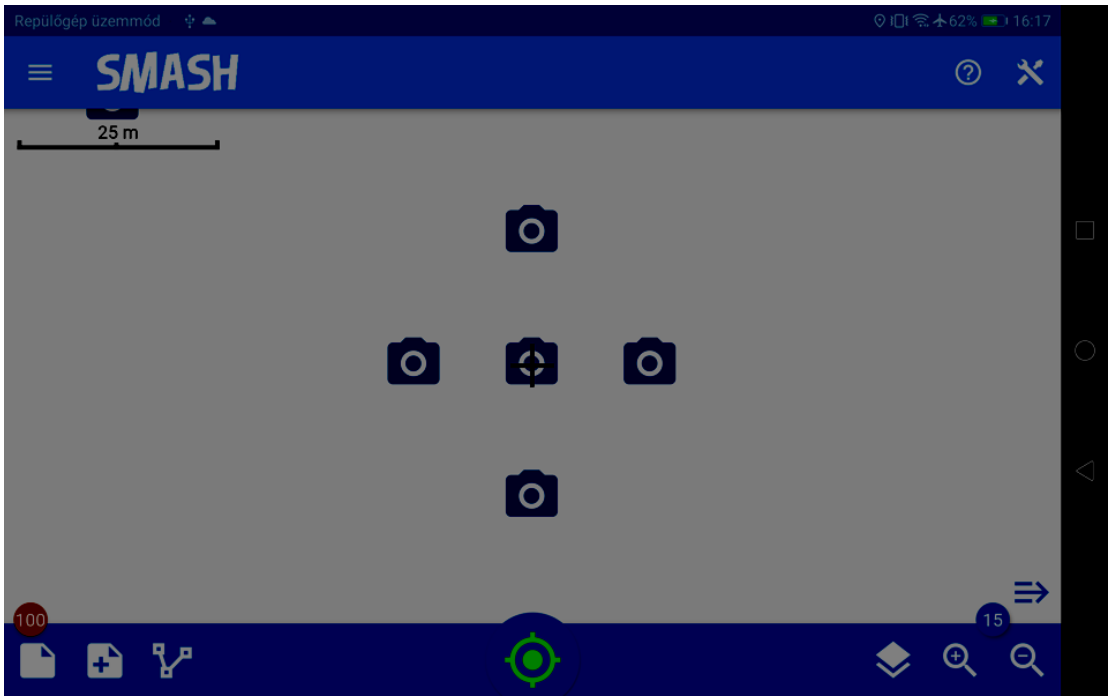


Figure 5: The 5 image notes from zooming in within the SMASH application. The exact pictures could be opened while clicking on the wanted icon (middle, N, E, S, W).

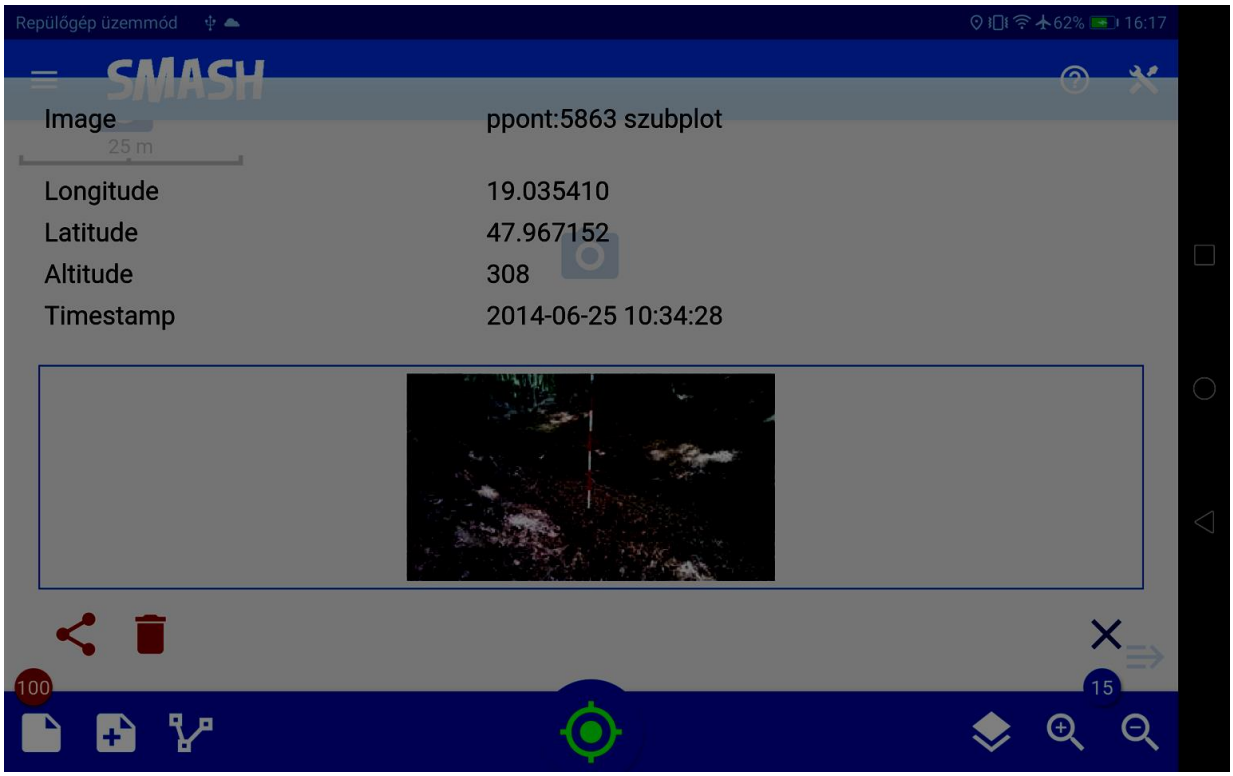


Figure 6: The content of the uploaded image notes from the SMASH application. The original high-resolution pictures could be opened by clicking on the stamp-pictures.

4. 3. The data-collecting protocol

In chapter 3.2 we also had a look at the databases the planning could be built on. We highlighted that the original data are explicit in space, and in addition to the traceability, the localization of the forestry interventions and the natural disturbance affected areas.

For these reasons, the monitoring methodology has the following essential features:

- It is not based on the time series of the exact points
- the base unit of the changes in the forest unit
- the point-based evaluation clarifies and supplements the forest unit scaled comparisons in the case of precise localization.

The selection of concrete sampling areas happens following the criteria:

- tree utilization types (TI- purification, TKGY – selection thinning, NFGY – increment thinning, FVB – regeneration cutting's preparatory cut, FVV regeneration cutting's final cut- the years in the period from the first intervention, TRV, - clear-cutting SZV -selection cutting, KGH – stock-care

utilization, HGY-production thinning, EÜ – sanctuary cutting, ET – other production)
- natural disturbance interventions (abiotic, biotic)
- forestry interventions (shrub elimination, soil preparation, tree replacement, and care)
- nature conservation treatment
- in case of a renewal, the presence or absence of game control fences (no/evidence)
- effect of forestry manager (KRT, NM, DJ, KE, private)
- the years in the period from the first intervention
- control
- tree stand type (B- beech, GYT-hornbeam-oak forest, CS -Turkey oak)
- age (young, middle-aged, old)
- size of the forestry unit

The number of variables mentioned above in square brackets leads to the conclusion that the examination of all of the realistic combinations of the variables could have required a large number of sampling areas within the forest unit.

The exact number of sampling plots also depends on the planned frequency of samplings within the forest unit. The SH-4/13 project's protocol allows with 1, 2, or 4 points in one ha. The planned 3.000 points redesign will take part between 3.000 and 750 ha.

Suggestions to the selection of sampling forestry units (or well-defined unit parts):

1. The sampling should focus on the prior tree utilization (TI - purification, KGY – selection thinning, NFGY – increment thinning, KGH- stock-care utilization) and selection cutting. The classic cutting utilization of the final harvest should be underrepresented.
2. The sampling should take the forestry manager's layer.
3. The sampling should include not-treated control areas, including ice breaking and not ice-breaking parts, with the main age groups.
4. The sampling should be limited to the main 3 tree stand types (B- beech, GYT-hornbeam-oak forest, CS -Turkey oak).
5. The sampling should not focus generally on forestry interventions. If there is information on the intervention, then a 1-1 targeted examination should plan later.
6. The sampling shall not focus on the presence/absence of the fences.
7. The number of years in the period from the first intervention shall not be taken into account from 2021, shall focus on the intervention implemented in 2019. That is how we can limit the chance of the review of a forestry plan.

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