Theses of the Ph.D. dissertation

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INVESTIGATING THE STATE OF THE ECOSYSTEM AND ITS SERVICES USING THE EXAMPLE OF ECOVILLAGES

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1. AIMS AND STRUCTURE OF THE THESIS

In many cases, the choice of methodology for mapping and mapping ecosystem-services in an area is challenging. The more detailed and accurate the survey, the more local knowledge is needed and the more it is necessary to develop a methodology that is adapted to the specific conditions of the area. I chose to focus my PhD thesis on the assessment of ecosystem-services in eco-villages mainly because I assumed that the local people who live and farm locally have the necessary knowledge of the area, which is essential for my research, and that my social and natural science studies can provide a realistic picture of the service delivery capacity of these villages. I also chose ecovillages because I considered it likely that in these areas the sustainable and harmonious coexistence of landscape and people is a primary concern, and thus the use of ecosystem-services in such a village actually used is optimised and in harmony with the local ecosystem. The quality of the landscape is greatly influenced by the close-to-nature management and lifestyle of the inhabitants of eco-villages, and usually provides immediate feedback to the inhabitants. Ecosystem-services may be best suited to describe this organic dependence and impact on the landscape.

The main objective of our research was to develop a methodology for assessing the ecosystem condition and ecosystem-services of two ecovillages, Visnyeszéplak and Gyűrűfű, and a non eco-village, Magyarlukafa, and to apply it to the three settlements and compare the results.

The research questions (K1 - K4) are based on the following hypotheses:

K1. Which methodology can be used to assess ecosystem condition at the level of rural settlements?

K2. What methodology can be used to assess ecosystem-services at the level of rural settlements?

H1-H2. A combination of social and natural science and geospatial methods can be used to assess ecosystem condition and ecosystem-services at the level of rural settlements, but adapted to scale.

K3. What are the similarities and differences in the condition of the ecosystems in the studied eco-villages and the studied non eco-village with similar landscape characteristics?

H3. The overall ecosystem condition in the surveyed eco-villages is better than in the surveyed non eco-village with similar landscape conditions in all land use categories and for all surveyed condition attributes.

K4. What are the similarities and differences in ecosystem-services between the studied eco-villages and the studied non eco-village with similar landscape characteristics?
H4. The surveyed eco-villages provide more ecosystem-services and to a greater extent overall than the non eco-village surveyed with similar landscape characteristics.

2. MATERIALS AND METHODS

A total of three study areas were selected for our research: the eco-village of Visnyeszéplak and Gyűrűfű, and a non eco-village close to Visnyeszéplak: Magyarlukafa. For all three settlements, our land use maps were used as the basis for the study, as ecosystem-services are habitat-dependent.

The data were collected using a variety of social and natural science methods and a map database to assess ecosystem condition characteristics and ecosystem-services (Figure 1).

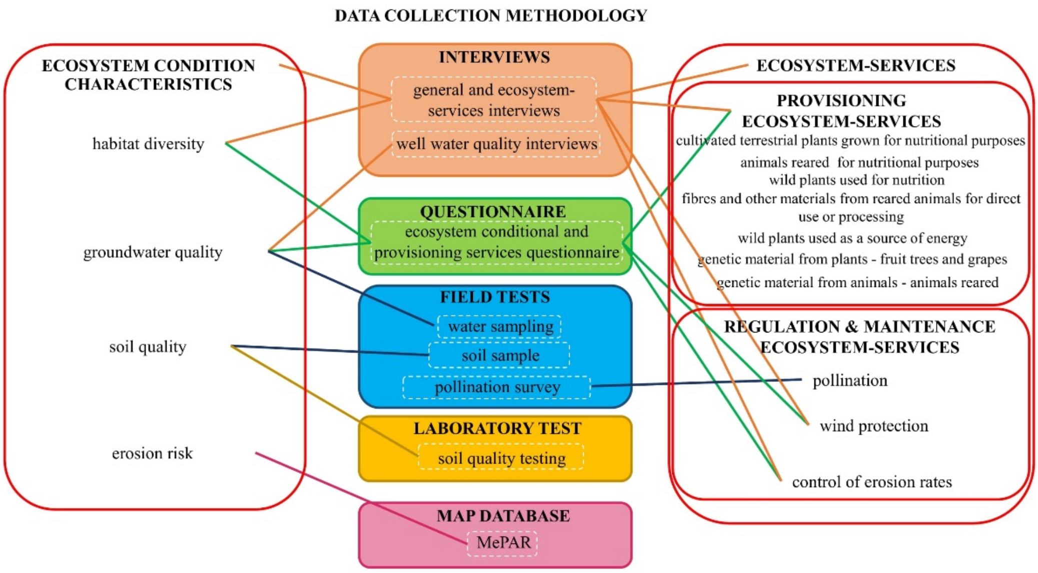

Figure 1. Flow diagram of the data collection methodology

For both ecosystem condition and ecosystem-services, the indicator values were normalised to a scale of 0−5, aggregated by village and compared between villages (Figure 2).

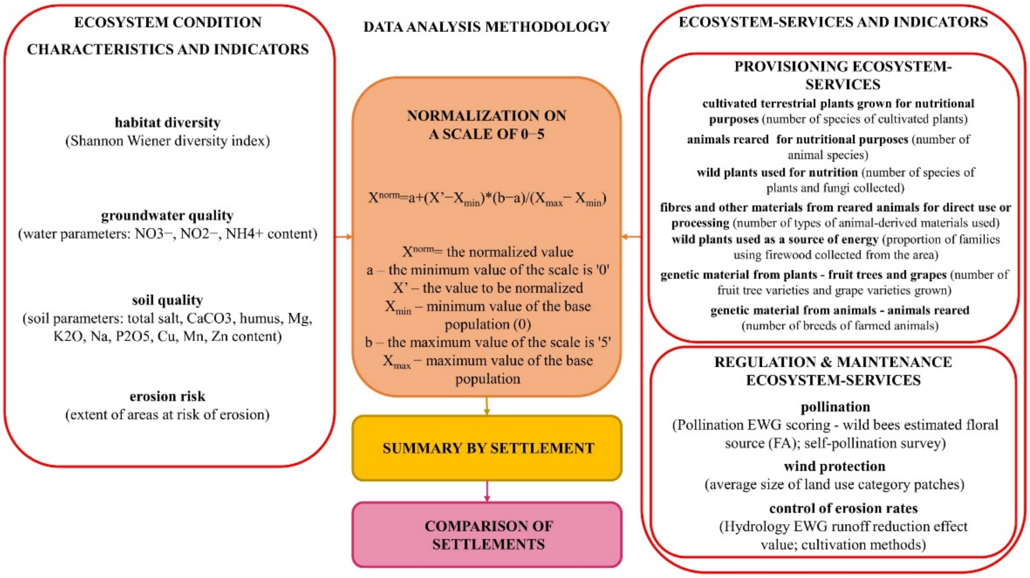

Figure 2. Flowchart of the data analysis methodology with indicators of health characteristics and services and normalisation formula

In our research, we selected the condition charasteristics and ecosystem-services to be investigated primarily on the basis of interviews. An important criterion for the selection was the ability to clearly group the characteristics and services under study, their measurability, their linkage to land use categories or at least to villages, and their realistic field duration.

The following status characteristics were selected: habitat diversity, soil quality, groundwater quality and erosion risk.

A total of 10 ecosystem-services were selected, of which 7 were provisioning (cultivated terrestrial plants grown for nutritional purposes, animals reared for nutritional purposes, wild plants used for nutrition, fibres and other materials from reared animals for direct use or processing, wild plants used as a source of energy, genetic material from plants - fruit trees and grapes, genetic material from animals - animals reared) and three were (pollination, wind protection, control of erosion rates).

Each of the ecosystem condition charasteristics and ecosystem-services was scored per municipality or, where possible, per land use category, mostly based on normalisation of the given indicator values to a scale of 0−5. The value of the habitat diversity indicator was calculated using the Shannon Wiener diversity index formula, here one value per municipality was obtained. For groundwater, point values were calculated from field and laboratory data based on threshold values set by legislation and for soil quality based on literature and expert recommendations. For groundwater quality, we were able to calculate point values by municipality and for soil quality by land use category. For the status characteristic erosion risk, a score was given per land use category and in this case the percentage of the municipalities' areas at risk of erosion was taken. The more at risk of erosion an area was, the lower the score. For each of the ecosystem-services we were able to score by land use category. For the provisioning services, we generally worked from data extracted from the questionnaire. The indicator value for the cultivated terrestrial plants grown for nutritional purposes service for normalisation was the number of species of crops (fruit, vines, vegetables, medicinal plants) grown in the surveyed settlements, and for the genetic material from plants - fruit trees and grapes service the number of varieties of crops (fruit, grapes). For the animals reared for nutritional purposes service, this value is given by the number of species of animals farmed in the surveyed municipalities, and for the genetic material from animals - animals reared service, by the number of breeds of farmed animals. For the wild plants used for nutrition service, the number of species of wild herbs, fruits and mushrooms collected was used as the indicator value for the calculation. For the service fibres and other materials from reared animals for direct use or processing, the number of types of material used from farmed animals was used. For the wild plants used as a source of energy service, we took the percentage of families who filled in the questionnaire that collect firewood in the given land use category. For the regulation & maintenance services, we used NÖSZTÉP data for the pollination and control of erosion rates services, refined using our own field measurements for pollination and questionnaire data for control of erosion rates. The field measurements for the pollination service were based on the number of wild bees surveyed in the grassland and the grasslands under the orchard categories of the surveyed municipalities. For the control of erosion rates service, we examined the proportion of questionnaire respondents who managed their orchards and gardens without rotation or mulching. For the wind protection service, the indicator value was the average patch size for each land use category.

The results were also tabulated for ecosystem condition and ecosystem-services, and the services were plotted on a map for all three municipalities. For ecosystem-services, we also calculated a weighted ecosystem service score per 1 ha per settlement.

3. RESULTS AND DISCUSSION

The normalised scores for ecosystem condition are shown in Table 1. Soil quality characteristics and erosion risk were assessed by land use category, habitat diversity and groundwater were assessed by settlement, and the sum of these was taken as the villages' ecosystem condition score.

Table 1. Ecosystem condition scores for Visnyeszéplak, Gyűrűfű and Magyarlukafa

	study areas	Visnyeszéplak				Gyürüfü				Magyarlukafa			
	land use categories	forest	grassland	orchard	garden	forest	grassland	orchard	garden	forest	grassland	orchard	garden
ecosystem condition characteristics	indicators												
habitat diversity	Shannon Wiener diversity index	5				4				5			
erosion risk	extent of areas at risk of erosion	1	2	1	2	1	1	2	1	2	1	1	1
soil quality	soil parameters: total salt, CaCO3, humus, Mg, K2O, Na, P2O5, Cu, Mn, Zn content	3	3	4	3	4	3	4	2	3	4	3	2
groundwater quality	water parameters: NO3−, NO2−, NH4+ content	3				3				2			
TOTAL POINTS per study area		27				25				24			

The maximum total number of points per municipality for ecosystem condition was 50, of which Visnyeszéplak received 27 points, Gyűrűfű 25 points and Magyarlukafa 24 points. The scores indicate that although a ranking can be made between the settlements (1. Visnyeszéplak, 2. Gyűrűfű, 3. Magyarlukafa), the ecosystem condition of all three settlements is basically close to similar. Overall, the ecosystem condition of all three settlements is medium compared to the maximum score.

Ecosystem-services were scored in a normalized matrix model defined on a scale of 0−5 (Table 2), which was also plotted on maps (Figure 3−5).

Table 2. Assessment of ecosystem-services provided by Visnyeszéplak, Gyűrűfű and Magyarlukafa using indicators, on a scale of 0–5

		study areas	Visnyeszéplak				Gyűrűfű				Magyarlukafa			
		land use categories	forest	grassland	orchard	garden	forest	grassland	orchard	garden	forest	grassland	orchard	garden
ecosystem-services		indicators												
provisioning	cultivated terrestrial plants grown for nutritional purposes	number of species of cultivated plants	0	0	5	5	0	0	4	2	0	0	3	3
	animals reared for nutritional purposes	number of animal species	0	4	4	3	0	1	2	1	0	1	3	1
	wild plants used for nutrition	number of species of plants and fungi collected	5	5	5	0	2	2	1	0	2	2	1	0
	fibres and other materials from reared animals for direct use or processing	number of types of animal-derived materials used	0	4	3	2	0	0	0	0	0	0	1	1
	wild plants used as a source of energy	proportion of families using firewood collected from the area	4	0	3	0	4	0	2	0	2	0	2	0
	genetic material from plants - fruit trees and grapes	number of fruit tree varieties and grape varieties grown	0	0	5	0	0	0	1	0	0	0	0	0
	genetic material from animals - animals reared	number of breeds of farmed animals	0	3	3	2	0	1	1	1	0	0	1	0
regulation & maintenance	pollination	Pollination EWG scoring - wild bees estimated floral source (FA); self-pollination survey	2	4	3	2	2	4	3	2	2	3	2	2
	wind protection	average size of land use category patches	1	0	1	0	5	0	4	0	0	0	0	0
	control of erosion rates	Hydrology EWG runoff reduction effect value; cultivation methods	5	4	5	4	5	4	5	4	5	4	4	3
		TOTAL POINTS per land use category	17	24	37	18	18	12	23	10	11	10	17	10
TOTAL POINTS per study area			96				63				48			

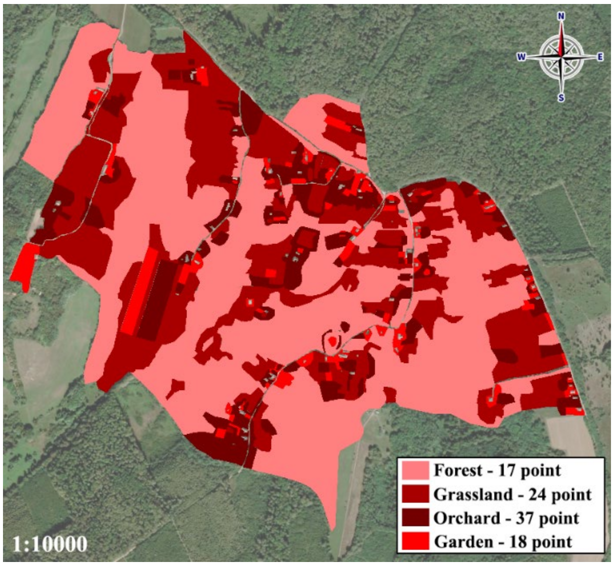

Figure 3. Visnyeszéplak ecosystem-service map (darker colour always indicates higher score)

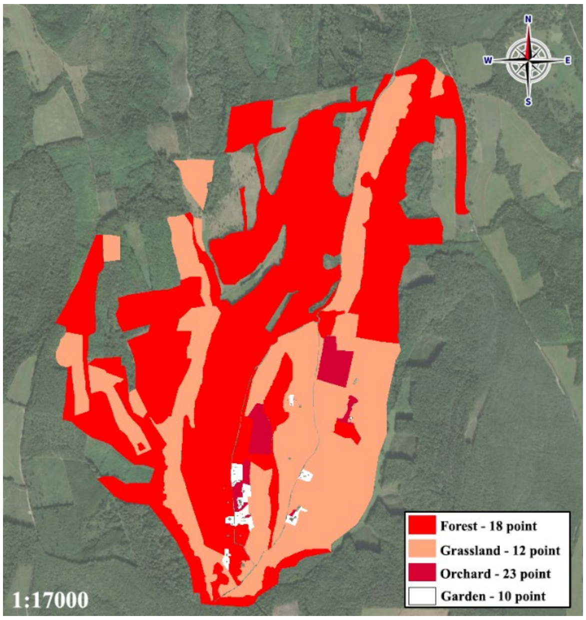

Figure 4. Gyűrűfű ecosystem-service map (darker colour always indicates higher score)

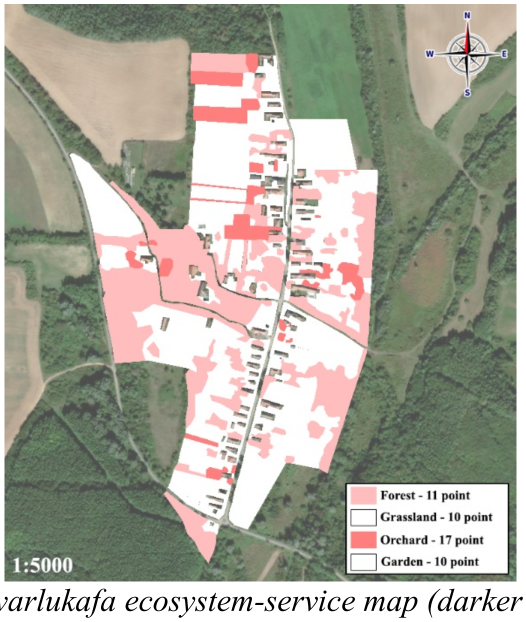

Figure 5. Magyarlukafa ecosystem-service map (darker colour always indicates higher score)

Looking at the scores in Table 2, it is clear that eco-villages provide more of the ecosystem-services defined in our study than non eco-village and within the land use categories, orchards rank first in all villages.

Among the ecovillages, Visnyeszéplak stands out. Gyűrűfű is ranked second in terms of ecosystem-service potential. This is probably due to the fact that there are basically fewer families in Gyűrűfű than in Visnyeszéplak, which has a pronounced impact on the results, especially for the provisioning ecosystem-services. In terms of overall scores, Magyarlukafa has exactly half as many ecosystem service scores as Visnyeszéplak, which may be mainly due to the fact that most families in Magyarlukafa do not emphasise farming and make less use of nature's opportunities.
The result of the weighted ecosystem-service score per hectare is as follows:
Visnyeszéplak: 22 points
Gyűrűfű: 16 points
Magyarlukafa: 11 points.
These scores confirm the results above, where Visnyeszéplak is ranked first overall, Gyűrűfű second and Magyarlukafa third in the ranking for ecosystem-services.

4. CONCLUSION AND RECOMMENDATION

CONCLUSION

My primary objective was to develop a methodology to assess the ecosystem condition and ecosystem-services of the sample areas (C1), and to answer the scientific question of what methodology can be used to assess ecosystem condition (K1) and ecosystem-services (K2) at the level of a rural settlement.
And for the research questions (K1-K2), I summarized the hypotheses, which were:

(H1-H2) A combination of social and natural science and geospatial methods can be used to assess ecosystem condition and ecosystem-services at the level of rural settlements, but adapted to scale.

In order to prove my hypotheses (H1 - H2), my research has shown that a combination of social and natural science field methods and geospatial information methods is needed to get a closer picture of the ecosystem condition and the ecosystem-service capacity of an area.

The hypothesis is confirmed.

My next objective was to compare the study areas on the basis of ecosystem condition and ecosystem-services (C2), which involved asking the scientific question of the similarities and differences between the ecosystem condition (K3) and ecosystem-services (K4) of the study eco-villages and the study non eco-village with similar landscape conditions.

I assigned hypotheses to the research questions (K3 - K4) separately, which were:

H3. The overall ecosystem condition in the surveyed eco-villages is better than in the surveyed non eco-village with similar landscape conditions in all land use categories and for all surveyed condition attributes.

In my research, I proved this hypothesis (H3), because the ecosystem condition of the eco-villages was better than that of the non eco-villages, taking into account the status characteristics (habitat diversity, erosion risk, soil quality, groundwater quality). However, for each of the condition attributes, the results were mixed, as only for soil quality and groundwater quality, when examined separately, can we clearly state that both eco-villages performed better than the non eco-village. For the erosion risk status characteristic, Visnyeszéplak was the best of the eco-villages and Gyűrűfű scored the same as the non eco-village Magyarlukafa, while these two municipalities scored worse than Visnyeszéplak. Overall, however, in terms of ecosystem condition, the eco-villages scored better.

The hypothesis is confirmed.

H4. The surveyed eco-villages provide more ecosystem-services and to a greater extent overall than the non eco-village surveyed with similar landscape characteristics.

In my research, I proved this hypothesis (H4), because ecovillages overall provided more ecosystem-services and to a greater extent than non eco-villages. In terms of land use categories, in the categories of forest, grassland and orchard, it can be said that organic villages scored higher than non-organic villages and only in the category of garden did Gyűrűfű score the same as Magyarlukafa, but in this case, Visnyeszéplak also scored higher. Looking at the provisioning and regulatory-maintenance services separately, the overall scores for these service groups were better than for the ecovillages. The aggregate scores also showed that ecovillages were better than non eco-villages in terms of the number of ecosystem-services and the aggregate extent to which they provided them.

The hypothesis is confirmed.

RECOMMENDATION

In my experience, it makes sense to study the complex relationship and interactions between landscape and people in eco-village areas through research

on ecosystem conditions and ecosystem-services, if the methodology is multidisciplinary, broad-based and draws heavily on the knowledge and experience of local people.
My general suggestions are:

- **A broader assessment of ecosystem condition (in terms of area):** to interpret the relationship between ecosystem-services and ecosystem condition, it is worth looking not only at the status of the sample plots, but also at the surrounding areas, at least within a certain radius.
- **Broader examination of ecosystem condition (in terms of indicators):** to understand the relationship between ecosystem-services and ecosystem condition, it is also worthwhile to examine indicators more broadly.
- **Optimisation of the analysis methodology for sample size:** in most cases, we have assigned a value of 0 to the Xmin value for the data calculation during normalisation, which we believe gives better and more refined results for low sample sizes than was the case in the current study. However, for a higher sample element number, it may be useful to calculate the minimum value of Xmin for the data associated with a given condition characteristic or service.

I believe that the methods I have used are suitable for studying the ecosystem condition characteristics and ecosystem-services of eco-villages and villages that are similar or partially similar to them, and for which I have the following specific proposals for further development:

- When preparing **a land use map,** it is worthwhile to try to achieve as accurate a spatial representation of land use as possible, using aerial laser scanning, drone surveys or other methods that produce a more detailed map.
- When assessing **groundwater quality** (ecosystem condition) (if sampling from dug wells), it is also worth collecting meteorological data on precipitation for at least one week prior to sampling (up to and including the day of sampling).
- In the case of **cultivated terrestrial plants grown for nutritional purposes** (provisioning ecosystem-service), it may be appropriate to examine the nutritional value of the vegetables, herbs, field crops and fruits produced (e.g. total sugars, vitamins, dry matter content etc.), with particular attention to the quality value of the food produced.
- In the case of **genetic material from plants - fruit trees and grapes** provisioning service, it is worthwhile to complement the analysis for the

identification of varieties with genetic testing in the laboratory following field sampling.

- In the case of **pollination** as a regulating and maintaining ecosystem-service, it is recommended to sample in spring, summer and autumn, even seasonally, several times per year, in selected areas and their habitats and land use categories, if possible.

5. NEW SCIENTIFIC RESULTS

I summarise the new and novel scientific findings of my doctoral research in the following theses.

Thesis 1: In the ecosystem assessment at the level of rural settlements, I have used natural science and geospatial methods, but I have also used social science methods in combination. The combination of the three methodologies led to more accurate and realistic results than if I had used only one of the three methods. The three methodologies were coordinated and adapted to the spatial scale of the study.

During the research, field measurements were carried out at the settlement level in Visnyeszéplak, Gyűrűfű and Magyarlukafa to collect data on condition characteristics (water analysis from dug wells, soil sampling in the four land use categories under study (forest, grassland, orchard, garden)), and geospatial processing methods were applied to investigate erosion risk and habitat diversity characteristics. Among the social science methods, I used interviewing and questionnaires, which were instrumental in preparing the ground for the ecosystem condition assessment and in exploring causal relationships.

Thesis 2: I have successfully used a combination of social and natural science and geospatial methodology in order to achieve more accurate and realistic results in the ecosystem-service assessment at the level of rural settlements. I have found that the use of social science methodologies is more appropriate for provisioning services, while the use of natural science methodologies is more appropriate for regulation and maintenance services. The three types of methodologies were harmonised and adapted to the territorial scale of the study.

During the research, I also conducted interviews and a questionnaire survey in Visnyeszéplak, Gyűrűfű and Magyarlukafa, which was related to the 7 provisioning services under study (cultivated terrestrial plants grown for nutritional purposes, animals reared for nutritional purposes, wild plants used for nutrition, fibres and other materials from reared animals for direct use or processing, wild plants used as a source of energy, genetic material from plants - fruit trees and grapes, genetic material from animals - animals reared) and partially for one regulation and maintenance service (control of erosion rates). A field study method was used to assess the pollination regulation and maintenance service based on the recording of observed wild bees on the grassland of the settlements and on the grasslands under the orchard. For the windbreak regulation and maintenance service, I used the average patch size of the forest and orchard land use categories, which was derived from geospatial data. Using geospatial methods, I was able to represent the services spatially at the scale of a rural settlement.

Thesis 3: For the three settlements under study (Visnyeszéplak, Gyűrűfű, Magyarlukafa), I have prepared a database based on field sampling and social science survey, with special emphasis on the status characteristics of soil quality and groundwater quality, as well as on the ecosystem-services of cultivated terrestrial plants grown for nutritional purposes, wild plants used for nutrition, genetic material from plants - fruit trees and grapes, genetic material from animals - animals reared.

For the **soil quality** ecosystem condition, a total of **600 measurements** are available for 60 sampling points (5–5 samples per land use category per settlement) for the 10 parameters assessed and used for scoring.
For **groundwater quality** ecosystem condition, the 37 sampling points for the three parameters assessed and used for scoring, corresponding to 7 sampling occasions (excluding failed measurements: 33 measurements, corresponding to 99 measurements), include a total of **678 measurements.**
In the case of the **cultivated terrestrial plants grown for nutritional purposes** service, I recorded a total of **117 crop species** (fruit species and grapes, vegetables and herbs, and arable crops) **grown in** the three municipalities surveyed, with the help of the questionnaire fillers.
For the **wild plants used for nutrition** ecosystem service, a total of **104 species** (54 medicinal plants, 14 wild fruits, 36 mushrooms) were collected by the questionnaire respondents from the village areas at the time of the survey, in the total of medicinal plants, fruits and mushrooms.
For the **genetic material from plants - fruit trees and grapes** ecosystem-service, the questionnaire respondents were growing a total of **226 plant species in the** three municipalities at the time of the survey.
In the case of **genetic material from animals - animals reared,** the questionnaire respondents had a total of **29 breeds of farmed animals** at the time of the survey for the three municipalities.

For the ecosystem service of **pollination**, a total of **3,764 wild honeybees** were counted in two habitats (grassland and the grasslands under the orchard) in three settlements, sampled at three sampling dates, covering 18 sampling occasions.

Thesis 4: I have developed a new methodology for assessing ecosystem condition at the rural municipality level. On the basis of field studies carried out in three villages, I developed a detailed scoring-based assessment system for soil quality and groundwater quality status attributes that allows the different parameters to be integrated into one assessment system, making them comparable with each other. The scoring was based on literature and expert recommendations for soil quality and on threshold values set by legislation for water quality.

During the development of the soil quality scoring, the lowest possible score for 8 parameters (total salt, CaCO3, humus, Mg, Na, Cu, Mn, Zn) was 0 points in all cases, and for two parameters (K2O, P2O5) -2 points, and the maximum possible score ranged between 1−4, depending on the limit values of the parameters. On this basis, the maximum total score available for the parameters was 23 points.

In developing the groundwater quality scoring, I also relied on the limit values for the three parameters (nitrite, nitrate, ammonium), but the scores for these were set on a scale of 0−5 and applied to the measured data individually. Thus the summed average of these gave the ecosystem condition score.

These two scoring systems based on points are ideal because they allow for objective scoring due to the given thresholds. I was able to evaluate these points in one system by normalizing to a scale of 0−5.

Thesis 5: I have developed a new valuation methodology to assess the ecosystem-services of rural settlements. For two regulation and maintenance ecosystem-services (pollination, control of erosion rates), I integrated my own measurement data (field survey for pollination service, questionnaire data for control of erosion rates service) with the results of a project (NÖSZTÉP) working with national scale data. The measured or collected data used as a basis for scoring the services were brought to a common denominator by normalizing on a scale of 0−5 and using a matrix model, these scores were assigned to the land use categories under study (forest, grassland, orchard, garden). This also allowed an aggregated assessment of services and their representation on a map (mapping).

In the case of the 7 care services and partly one regulation and maintenance service (control of erosion rates) that I examined, I worked mainly with the quantified data extracted from the questionnaires. For five of the provisioning services (cultivated terrestrial plants grown for nutritional purposes, animals reared for nutritional purposes, wild plants used for nutrition, genetic material from plants - fruit trees and grapes, genetic material from animals - animals reared), the indicators selected differ from the indicators commonly used, as I have based them on species and species number instead of quantity (e.g. kg (apples, meat)). This approach (quantitative analysis with qualitative indicators) can provide information for a number of research areas (e.g. conservation, genetic conservation) in addition to the valuation of ecosystem-services. I was able to refine the scoring system used by the NÖSZTÉP by using field measurements for the pollination service for orchard and grassland land use categories, and by using data extracted from the questionnaire for the control of erosion rates service for orchard and garden categories.

Thesis 6: I found that in the three settlements studied (eco-villages: Visnyeszéplak, Gyűrűfű, non eco-village: Magyarlukafa), eco-villages show better results compared to non eco-village in terms of the four status characteristics (habitat diversity, erosion risk, soil quality, groundwater quality).

I assessed a total of four condition attributes, two of which (habitat diversity and groundwater quality) were assessed at village level and two (soil quality and erosion risk) were assessed by land use category. In the results for habitat diversity, where I was able to give an ecosystem condition score at village level, all three settlements scored highly and had similar diversity compared to each other (Gyűrűfű: 4 points, Visnyeszéplak and Magyarlukafa: 5−5 points). For erosion risk, I was able to calculate scores by land use category. In this case, the land use categories of the municipalities scored more points if they were less vulnerable to erosion. The results show that all three municipalities are highly vulnerable to erosion, as indicated by the scores obtained for this status characteristic. The normalised total score was a maximum of 20 points (5− 5 points per land use category), of which Visnyeszéplak scored 6 points and Gyűrűfű and Magyarlukafa scored 5−5 points. Overall, Visnyeszéplak can be considered better than Gyűrűfű and Magyarlukafa in terms of erosion risk. For the soil quality status indicator, the municipalities also scored points per land use category. The normalised total scores for Visnyeszéplak and Gyűrűfű (which in this case could also be up to 20 points) were 13−13 points, while the normalised total score for the non eco-village was 12 points. In terms of soil quality, therefore, eco-villages can be considered better than non eco-village. For the groundwater quality ecosystem condition attribute, we were able to score on a settlement by

settlement basis and the scores of the eco-villages (Visnyeszéplak and Gyűrűfű: 3−3 points) were also higher than the ecosystem condition score of Magyarlukafa (2 points).
The overall ecosystem condition scores allow ranking the municipalities, with Visnyeszéplak in first place, Gyűrűfű in second and Magyarlukafa in third (Visnyeszéplak: 27 points, Gyűrűfű: 25 points, Magyarlukafa: 24 points). However, the similar overall scores mean that there is not much difference and, compared to the maximum total of 50 points, all three municipalities have a medium ecosystem condition.

Thesis 7: I have found that of three settlements studied (eco-villages: Visnyeszéplak, Gyűrűfű, non eco-village: Magyarlukafa), eco-villages provide more ecosystem-services and to a greater extent than non eco-villages of the 10 ecosystem-services studied.

In total, 10 ecosystem-services (cultivated terrestrial plants grown for nutritional purposes, animals reared for nutritional purposes, wild plants used for nutrition, fibres and other materials from reared animals for direct use or processing, wild plants used as a source of energy, genetic material from plants - fruit trees and grapes, genetic material from animals - animals reared, pollination, wind protection, control of erosion rates) were assessed and mapped in the three municipalities, of which 7 were provisioning services and 3 were regulation and maintenance services.

I have identified 10 ecosystem-services in the case of Visnyeszéplak, 9 in the case of Gyűrűfű and 8 in the case of Magyarlukafa, showing that eco-villages provide more ecosystem-services than non eco-village, but not a large difference.
Overall, based on the total ecosystem service scores per village (Visnyeszéplak: 96 points, Gyűrűfű: 63 points, Magyarlukafa: 48 points) and the weighted ecosystem-service score per 1 ha (Visnyeszéplak: 22 points, Gyűrűfű: 16 points, Magyarlukafa: 11 points), I have shown that eco-villages provide ecosystem-services to a greater extent than non eco-village and that Visnyeszéplak stands out highly among eco-villages in this respect.

6. PUBLICATIONS

Journal articles connected to the research topics:

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