SYNTHESIS PROCEDURE OF ASSESSING THE HYDROMORPHO-LOGICAL STATUS OF RIVER CORRIDORS THE DRAGONJA RIVER CASE STUDY

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ABSTRACT
The paper describes the development and validation of a new synthesis method of assessing the hydromorphological status of river corridors, performed on the Dragonja River, Slovenia. Its development started by defining a list of relevant hydromorphological variables, used in the established methods. This relatively large list with more than 100 variables was then limited to only discrete ones and further on reduced by statistical and machine learning tools. A further improvement over the existing assessment methods is in the fact that the synthesis method uses a new, less time-demanding field data gathering approach. It requires the collection of data in shorter river corridor transects instead of in longer river reaches. The hydromorphological assessment scores of two different field data gathering approaches (river reaches vs river corridor transects) and of two different methods (German "Gewässerstrukturgiitebewertung" vs proposed synthesis method) are also presented in the paper with the assessment of the factor of subjectiveness on the synthesis method.

1 INTRODUCTION
In the past years, many river corridors have been degraded due to anthropocentric river management schemes. Thus, for purposes of monitoring the ecological status of rivers as well as for achieving good ecological potential on heavily modified rivers (both required in the EU WFD), the hydromorphological assessment methods are needed. The assessment of the hydromorphological status of river corridors originates from an idea of nature conservation and possibilities for their remediation and rehabilitation. This is an analytical procedure prescribing notes to hydromorphological units or categories of a river corridor. Through cognition it has become evident that the protection and improvement of water quality are not the only goal and way of river protection and conservation of the river environment. The main aim of assessing the hydromorphological status of river corridors is the categorization of their change as a consequence of anthropogenic measures in the past. The other way of its usage is an assessment of their remoteness from a potential natural form.

2 MATERIALS AND METHODS
The research deals with the development of a new synthesis method of assessing the hydromorphological status of river corridors, based on state analysis of the Dragonja River.

The basis of the new method was the time effectiveness of data gathering and accuracy of the method. Prior to the practical research implementation, a concept of a rapid transect data gathering was designed. The field data gathering was performed in cross-sectional transects instead of in river reaches along the whole river stretch under investigation (Figure 1). The transects were selected 100 m apart from the river mouth to its headwaters (origin). They were as wide as two active riverbed widths in their axes, and go for 50 m into the river corridor on both riverbanks.

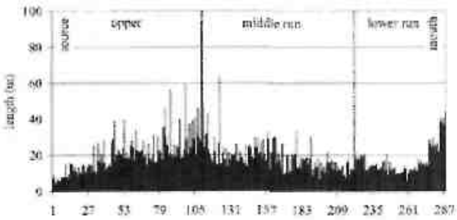

Figure 1. Length of transects (in metres) investigated along the Dragonja River (I_{min} = 4.80 m; I_{max} = 94.00 m; I_{ave} =19.71 m; I_{tot} ="5,677 m = 19..71 % of the total river length).

Additionally, an extensive hydromorphological record sheet was elaborated, including a combined list of hydromorphological variables of other frequently used methods: the Swedish Riparian, Channel and Environmental Inventory (Petersen, 1992), the American Stream Visual Assessment Protocol (Newton et al., 1998), the British River Habitat Survey (Raven et al., 1998) and the German Gewasserstrukturgiitebew ertung (Zumbroich et al., 1999).

On the basis of the hydromorphological record sheet, field data gathering was carried out in 288 transects that were a priori cartographically determined along the Dragonja watercourse at an axis distance of 100 m. In each transect, an extensive data base of 148 hydromorphological variables was designed.

In order to work out the synthesis method, a database of 99 discrete hydromorphological variables was prepared. By way of a systematic reduction, a list of 52 most significant hydromorphological variables, according to the results of statistical (Principal Component Analysis, MANOVA, Correlation Analysis) (Townend, 2002) and machine learning tools (Decision Trees) (Witten & Frank, 2000) was made (Figure 2). Based on the final list of 35 selected hydromorphological variables, the synthesis method of assessing the hydromorphological status of river corridors was devised.

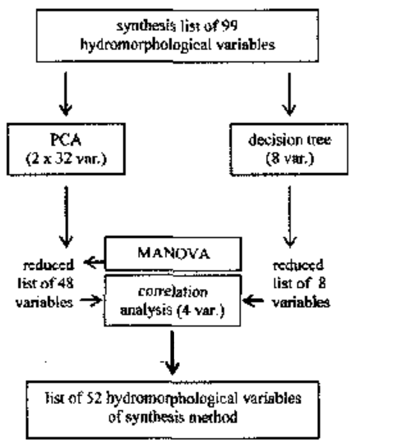

Figure 2. Analysis concept and creation of a list of hydromorphological variables of the synthesis method.

The structure and the assessment system of the method were adapted to the transect data gathering.

Hydromorphological score	Hydromorphological quality class
1.0 – 1.7	1 / natural stream
1.8 – 2.6	2 / semi-natural stream
2.7 – 3.5	3 / moderately modified stream
3.6 – 4.4	4 / modified stream
4.5 – 5.3	5 / substantially modified stream
5.4 – 6.2	6 / heavily modified stream
6.3 – 7.0	7 / extremely modified stream

Table 1. Intervals of hydromorphological scores and the corresponding hydromorphological quality classes of the synthesis method.

The method uses partial hydromorpho-ogical assessment scores for the stream pattern longitudinal profile, cross section, stream bottom, riparian areas, and adjacent riverine areas in order to get an overall hydromorphological assessment score (HAS) in an interval from 1.0 to 7.0 thus defining the hydro-morphological quality class of the transect (Table **1).**

3 RESULTS AND DISCUSSION

On the basis of the results of applying the mentioned methods in five test reaches of the Dragonja River and five test reaches of the Reka River the German Gewässerstr ukturgiitebewertung (GSGB) (Zumborich et al., 1999) was chosen as the comparison method of the research.

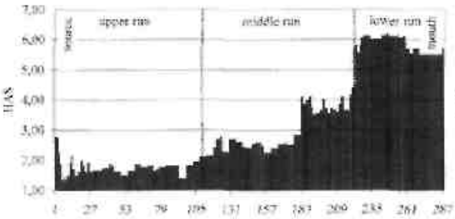

Figure 3. Hydromorphological assessment score (HAS) in 111 river reaches of the Dragonja River, the GSGB method.

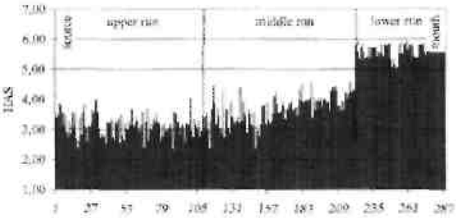

Figure 4. Hydromorphological assessment score (HAS) in 288 transects of the Dragonja River, the GSGB method.

For the hydromorphological assessment, this method requires 32 hydromor-phological variables. The method was applied along the Dragonja River in two ways, by way of its original concept of data gathering in 111 reaches (Figure 3), and by way of the adapted data gathering in 288 transects (Figure 4). Then, the synthesis method was applied in the 288 transects along the Dragonja River (Figure 5).

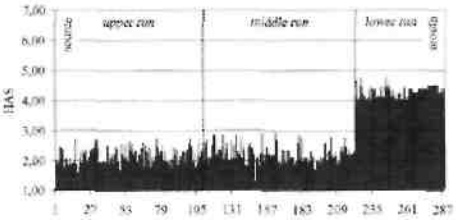

Figure 5. Hydromorphological assessment score (HAS) in 288 transects of the Dragonja River, the synthesis method.

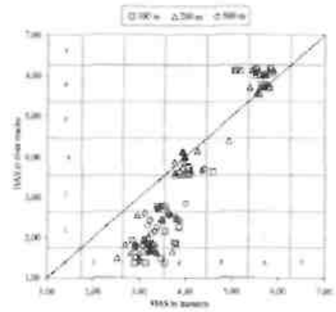

Figure 6. The GSGB method: comparison of the hydromorphological assessment score (HAS) in transects versus HAS in 100, 200 and 500 m river reaches.

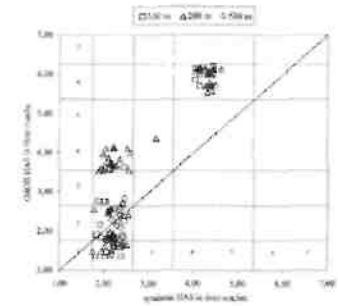

Figure 7. Comparison of the hydromorphological assessment score (HAS) in 100, 200 and 500 m river reaches: the synthesis method versus the GSGB method.

The comparison analysis of assessing the data gathering in reaches according to the German method and the transect data gathering according to the German and the synthesis method has shown that in the case of the Dragonja River, the faster transect data gathering can be used instead of the more time consuming data gathering in the river reaches, despite the fact that the sum of the transect lengths amounts to only 20 % of the total length of the reaches (Figures 6, 7 and 8).

Additionally, it was established that it is possible to successfully apply the assessment system of the transect synthesis method even to reaches of the Dragonja river.

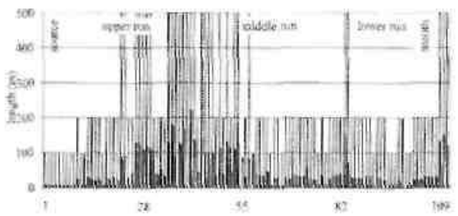

Figure 8. Comparison of the length of river reaches length (the GSGB method) and the sum of the length of transects (the synthesis method) on the Dragonja River (both in metres).

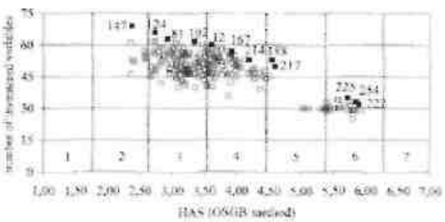

Figure 9. Selection of 12 test transects.

The analysis of the factor of subjectiveness, conducted on the basis of 144 field measurements of 12 pre-trained students in 12 test transects (Figure 9) has shown that according to the calculated values of the t-statistics in the majority of the test transects the results of student measurements differ from those of expert measurements in both methods.

The calculated confidence intervals for student measurements regarding both methods shows that the students had used the synthesis method with less variance and that they determined the hydromorphological quality classes of the transects with a higher degree of accuracy. A comparison analysis of the results of the student measurements by calculating the H-statistics of the non-parametric Kruskal-Wallis test (Townend, 2002) has shown that the students determined the hydromorphological values as well as the hydromorphological quality classes with a high level of similarity in both methods (Figures 10 and 11).

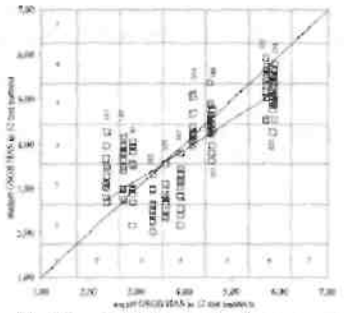

Figure 10. The GSGB method: comparison of expert and student hydromorphological assessment score (HAS) in 12 test transects.

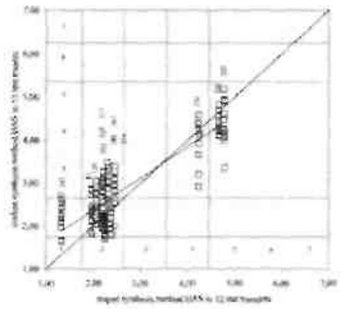

Figure 11. The synthesis method: comparison of expert and student hydromorphological assessment score (HAS) in 12 test transects.

4 CONCLUSIONS

The synthesis method for assessing the hydromorphological status of river corridors is based on elimination of a large list of variables via statistical tools and tools of artificial intelligence. It promotes some advantages in comparison with the established methods. Firstly, it uses only the most important statistically approved and case-oriented variables. Secondly, data gathering is limited to river corridor transects only instead of river reaches, which promotes the reduction of the time needed to register the assessed part of the river.

However, the analysis of the factor of subjectiveness, especially the review of deviations of measurements made by the students in comparison to the expert measurements has indicated that the assessors of hydromorphological qualities should receive a more in-depth introduction into the respective work in river corridors.

In further development of the research, the newly developed synthesis method should be applied on a river similar to the Dragonja River (e.g. a river in the same hydro-ecoregion) as well as on a randomly selected river. The analysis of the factor of subjectiveness should be further tested with a group of experts in the field of river management rather than with a group of students.

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