

Interactive comment on “Guidelines for depth data collection in rivers when applying interpolation techniques (kriging) for river restoration” by M. Rivas-Casado et al.

M. Rivas-Casado et al.

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1-Referee 1: there is hardly any literature cited and considered for a critical discussion of this research subject. The number of references is totally inadequate. Several recent publications are not considered and thus not discussed

1-Authors: the introduction, discussion and conclusion section will be updated and amended according to the comments from both referees. The author would like to submit a revised manuscript with these modifications. A list of references that will be included in the new version of this paper has been included at the end of the document containing the answers for the comments from the second referee (see the other

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uploaded file).

2-Referee1: The introduction does not give enough of an overview about e.g. the need of river restoration, difficulties, why is implementation needed etc.; Outline that monitoring is always constraint by technical and financial limitations. Where is the research gap? What are the advantages-disadvantages of particular approaches? What is actually new in this paper?

2-Authors: the introduction will be modified and will address the following points: a-Description of post-project appraisal (PPAs) for river restoration b-Relevance of PPAs for river restoration c-Importance of monitoring programmes for successful PPAs implementation d-Benefits of implementing monitoring programmes for PPAs e-Reasons behind the lack of implementation of monitoring programmes in river restoration projects. f-Examples of implemented monitoring programs for PPAs. g-Identification of the research gap: g.1-Need to implement monitoring programmes that capture the spatial and temporal variability of the system. g.2-Need to standardise monitoring programmes to obtain comparable results between and within PPAs. g.3-Need to adequately define the length (scale) of the reach to be sampled. g.4-Need to know the quality of the data gathered. h-How can geostatistical theory fulfil the needs identified? i-Objectives of the study.

Regarding the question 'What is new in this paper?', the authors want to emphasise the following points:

Much work has been done to define which variables need to be sampled for river restoration assessment. The monitoring protocols proposed for the sampling of these variables are usually based on a systematic approach (i.e. measurement of the variable at cross-sections) or a stratified approach (e.g measurement of the variables at specific mesohabitats). The authors consider that in both cases the data gathered may not represent the variability of the system and that misleading conclusion may be reached from its analysis.

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Intensive monitoring programmes are a way of capturing the variability of the system in time and space. However, monitoring is time and cost consuming, this being one of the main reasons not to implement it. There is a need to develop monitoring programs that are designed to capture the maximum spatio-temporal variability of the system within the time and cost constraints presented.

There is also a need to quantify the error/uncertainty associated to the implementation of limited monitoring programmes. How much error is associated to the conclusions reached from data gathered through limited monitoring programmes? There is no tool available that quantifies this uncertainty.

The paper shows an attempt to develop a methodology for design of monitoring programmes in rivers that maximises the spatio-temporal variability captured from the system. Similar work has been successfully applied to other subjects (e.g soil monitoring).

The work here presented opens a new research line for development of monitoring programmes in rivers. The conclusions reached are not expected to be applicable at all restoration projects nor river sites but just guidelines to consider when developing monitoring programmes. This is only a SMALL step forward.

This paper also presents the first attempt to quantify the uncertainty associated to limited monitoring programmes (e.g. comparison of different sampling densities/strategies when identifying depth patterns).

3-Referee 1: p.1070 L 19: there are other studies published on this subject in addition to Rivas 2006, which is grey literature.

3-Authors: these studies will be included in the amended introduction. A list of references is included in the file with the answers for Referee 2's comments.

4-Referee 1: p. 1070 L 19. Don't cite workshops as nobody else than the participants know what was actually discussed at this workshop)is there any workshop outcome?)

4-Authors: The workshop was held in December 2006 and no documents had been published on the outputs of the workshop at the time of the submission of this paper. The aim of the workshop was to bring together key people from a range of natural sciences to agree a practical monitoring protocol for river restoration projects. The document available is entitled: The River Restoration Centre (2006) Outputs from a monitoring seminar: The need for river restoration monitoring to establish the true potential (and constraints) to delivering good ecological status. 12th-13th December. http://www.therrc.co.uk/themed_workshops.htm

5-Referee 1: p.1070, L26. Little work has been carried out to address; I don't agree with this statement. There are several studies which address the issue of transferable monitoring approaches and problem regarding the implementation of restoration guidelines, considering difficulties in different countries;

5-Authors: these references have been included in the reference list presented in the document containing the answers for second Referee's comments.

6- Referee 1: p 1071 L1: this paper is part of a series; so, what are the other papers? Why several papers on the same subject?

6-Authors: the other papers; will be published in the future. The idea being to publish a paper for each of the issues presented in this paper and developed the work with further data collection. Some relevant publications already available are listed below. They all correspond to proceedings presentations

Rivas Casado, M, White, S., Bellamy, P., Dunbar, M., Booker, M., & Maddock, I. (2006) Analysing the sensitivity of two variogram models for the characterisation of the spatial pattern of depth in rivers. In: Caetano, M. & Painho, M., 7th International Symposium on spatial accuracy assessment in natural resources and environmental sciences, Lisbon, Portugal. Instituto Geografico Portugues.

Rivas Casado, M., Bellamy, P., & White, S. (2006) Characterisation of the spatial vari-

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ability of rivers for the definition of effective and efficient sampling strategies of hydromorphological parameters. In: Spatial data methods for environmental and ecological processes, Baia delle Zagare, Puglia, Italy.

Rivas Casado, M., Bellamy, P., White, S., Dunbar, M. & Booker, D. (2004) Defining hydromorphological sampling strategies for ecological assessment. In: Diego Garcia de Jalon and Pilar Vizcaino Martinez, Fifth International Symposium on Ecohydraulics: aquatic habitat analysis and restoration, Madrid, Spain, IAHR., 407-414, Vol. I.

Rivas Casado, M. (2005) A geostatistical approach to define sampling strategies for rivers: the spatial, the temporal and the scaling problems. In Arustiene, J., Vaitiekis, J. and Jørgensen, L. Harmonised modelling tools for integrated river basins management. Workshop report. Joint use of modelling and monitoring for implementing the water framework directive.

Rivas Casado, M., Bellamy, P., White, S., Maddock, I., Dunbar, M., & Booker, D. (2005) Defining spatial hydromorphological sampling strategies for the Leigh Brook river site. In: Harby, A., Baptist, M., Duel, H. et al., Proceedings from the final meeting in Silkeborg, Denmark., 293-298, Silkeborg, Denmark: National Environmental Research Institute.

Borsanyi, P., Dunbar, M., Booker, D., Rivas Casado, M., & Alfredsen, K. (2005) The hydromorphological picture of meso-scale units of rivers. In: Harby, A., Baptist, M., Duel, H. et al., Proceedings from the final meeting in Silkeborg, Denmark., Silkeborg, Denmark, National Environmental Research Institute, 23-31.

7-Referee 1: p 1071 L 27-30: copy into method section

7-Authors: this will be addressed in the new version of the paper.

8-Referee 1: p 1071 L 23: formulate objectives of THIS study clearer.

8-Authors: the author has addressed this in the revised introduction (see comments to Referee 2)

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9-Referee 1: The results are not sufficient to support the interpretations and conclusions.

9-Authors: this paper presents the methodology or analytical methods used to investigate the spatial, temporal and scale variability in the selected rivers. It does not pretend to describe in detail the results obtained as this will be part of further publications. The few results included in this paper are presented to give an example of the type of outcomes that can be obtained from the data analyses. The limitations of these data analyses, the description of the data gathered and the difficulties encountered when implementing the analysis will be described in further papers.

10-Referee 1: The authors do not give proper credit to related work and clearly indicate their own new/original contribution.

10-Authors: this has already been answered in previous comments.

11-Referee 1: The title does not clearly reflect the contents of the paper. I think the study is not transferable as the original title suggests, hence please change to: **An example guideline for depth data collection in rivers applying interpolation techniques (kriging) for river restoration.**

11-Author: We suggest the following title.

A proposed methodology to define guidelines for depth data collection in rivers when applying geostatistical interpolation techniques (kriging).

12-Referee 1: The abstract does not provide a concise and complete summary. Please, add results.

12-Author: The abstract will be amended to include results.

13-Referee 1: The presentation is not well structured and clear.

13-Author: this will be addressed in the re-submission.

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14-Referee 1: The mathematical formulae, symbols, abbreviations and units are not correctly defined and used.

14- Author: the equations will be reviewed for the re-submission. The author cannot find any formula that is not properly written. It would help if the referee could give us an indication of those formulas that are not properly formulated. If the problem is the lack of text explaining the equation, this can be addressed in the re-submitted version of the paper.

15-Referee 1: p 1072 L22: where are these physical characteristics described and discussed? What is the rationale behind choosing a particular site?

15-Authors: these physical characteristics are described in Rivas Casado, M.: The use of geostatistics for hydromorphological assessment in rivers. Thesis (Ph.D thesis) Cranfield University at Silsoe. This reference is available online through the library catalogue.

Rationale behind choosing a particular site: the river should present lowland characteristics.

16-Referee 1: p1073 L2 “a wide range” ranging from?

16-Authors: this can be found in Rivas Casado, M.: The use of geostatistics for hydromorphological assessment in rivers. Thesis (Ph.D thesis) Cranfield University at Silsoe. There are more than 10 indicators and it is not possible to define all of them plus their ranges in this paper. We would like to focus on the methodology used and explain these details in further publications.

17-Referee 1: p 1073 L 27: rationale for choosing these discharges? They are not standardised hence not really comparable for different catchments.

17-Authors: the discharges were not selected: the objective was to compare the changes in depth due to small changes in discharge. Therefore, two random days during low flows were selected for data collection. This made sure that the two dis-

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charges were not the same.

18-Referee 1: explain clearly reasons behind choosing particular methodologies. What are disadvantages/advantages of particular methods?

18-Authors: as mention in p 1071 L8 to 12 “There are several other methods for interpolating variables, which include techniques such as inverse distance weighting and splines. Geostatistical analysis has the advantage of considering the variability under study whilst providing an estimation of the error associated with the predictions obtained. “

This explanation can be moved to the methodology section and expanded if required. More detail can be given and examples can be provided. For example Kratzer et al (2006) compared 7 methodologies for interpolation of river depth, velocity and velocity. Results showed that LOESS interpolation was the best methodology. Kriging (geostatistics) also provided accurate results on the interpolation.

Kratzer, J.F., Hayes, D.B., Thompson, B.E. (2006) Methods for interpolating stream width, depth, and current velocity. Ecological modelling 196: 256-264

19-Referee 1: a lot of the results are general statements without any specific meaning or conclusion. Try to be more specific about the results in this study. Also results shown in figures and tables are not really explained in a clear way.

19-Authors: the result section is not the main focus of the paper. The methodology or analysis used is more relevant as the objective here was to describe the methods/analysis used to characterise the spatial and temporal variability of the rivers analysed. The results section will be improved in the re-submission of the paper.

20-Referee 1: I find the section titles very misleading in the result section, or rather, the sections don't really contain the relevant results (particularly in the subsection “temporal pattern analysis”).

20-Authors: the author will review the titles of each section for the re-submission of the

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paper.

21-Referee 1: p. 1078 L 35- p 1079, L6: probably better in methodology section.

21-Authors: this paragraph directly refers to a Table and a Figure presented in the results section. The author thinks that it should be included in the Results section unless it is possible to refer to the Figure and the Table in the methodology section. It would be difficult to avoid repetition of the explanation if the paragraph is moved to the methodology section.

22-Referee 1: p. 1079 L 23-24 “Thus, it could be observed that different sampling densities should be applied for different sampling objectives (indicators)”. Yes, of course! This really is nothing new! But give clear examples what is meant with “different sampling densities” or “different sampling objectives”.

22-Authors: we all know that different objectives require different sampling densities. Generally these objectives are qualitative (e.g. improve the habitat from low quality to medium quality by improving the sequence of mesohabitat units). In this paper, sampling objectives are quantitative and defined through indicators (e.g. frequency distribution of depths or error on the prediction of depth). The author thinks that each qualitative objective will have a quantitative objective that better represents its achievement. For example, a way of determining if the diversity of habitat has improved could be to compare the frequency distribution of depth before and after the restoration. Here, the quantitative objective is the frequency distribution. To make sure that we can trust the results of this comparison it is necessary to know the uncertainty associated to the results obtained from the monitoring programme applied. A set of tables is available for this purpose. Thus. it is possible to know how uncertain we are in determining the frequency distribution of our site: we can see if the differences in the frequency distribution of depth before and after the restoration project are due to an improvement in the habitat or to the lack of representation of the system due to gathering of limited

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data. Further work/papers will focus in determining which quantitative objective better represents each qualitative objective.

23-Referee 1: p. 1080 L 1-5: should be in method section.

23-Author: I agree.

24-Referee 1: Discussion is totally missing. Put the result of this study into context of similar research and other findings.

24- Authors: a new discussion section will be presented in the re-submitted paper. The author will develop the discussion according to the comments submitted by the referees.

25-Referee 1: Lowflows 2000? Unit? Standardise discharge.

25-Authors: The comment will be addressed in the re-submission of the paper. The author includes some information regarding the description of lowflows 2000 (<http://www.ceh.ac.uk/products/software/CEHSoftware-LOWFLOWS2000.htm>) below. Low Flows 2000 is a decision support tool designed to estimate river flows at ungauged sites and to aid the development of catchment and regional water resources. It is the standard software system used by the Environment Agency and the Scottish Environment Protection Agency for providing estimates of river flows, as represented by annual and monthly flow duration statistics, for any river reach in the UK. The software and underpinning science have been widely published in the scientific literature;

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 1069, 2007.

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